# Written Public Comments Submitted to Ohio Environmental Protection Agency (OEPA) Regarding the Proposed PTI/PTO Air Permit for SOBE Thermal Energy Systems, LLC

The following written public comments are submitted to Ohio Environmental Protection Agency (OEPA) as part of the public participation process for the proposed PTI/PTO air quality permit for SOBE Thermal Energy Systems, LLC.

Facility ID: 0250110024
Permit Number: P0132799
Public Comment Deadline: 5:00 pm Sunday September 10, 2023

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**Recommendation:** The permit application must be rejected and OEPA should require the applicant to include ALL facility wide emissions showing uncontrolled and controlled potential to emit emissions so that the appropriate permit (natural minor, synthetic minor, or Title V) and permit conditions can be applied to the proposed facility.

The following public comments contain numerous questions that are highlighted in **bold text** for your convenience.

# Potential to Emit Highly Inadequate

Proposed facility will operate 351 days per year using 88 tons shredded tires per day or **30,888 tons shredded tires per year** to produce 506 million cubic feet of syngas that will be burned in a single 100-ton Thermolyzer™ system and/or disposed of by flare.

**From page 3 of 5 of the PTIO Cover Letter:**

**Total Potential Emissions**

Thermolyzer™ Run Hours
1) The Thermolyzer™ system will operate for a total of 8,424 hours per year
2) 24 of these hours will be associated with start-up where the system will utilize natural gas. Each start-up takes 8 hours
3) Total annual system run time on synthetic gas is 8400 hours

Boiler Run Hours (per boiler)
1) Each boiler will operate for 8,592 hours
2) 24 of these hours are on natural gas
3) Total annual system run time on synthetic gas is 8,568

Thermolyzer™ Flare Operation
1) In normal annual operation the flare gas system will operate for a total of 48 hours
2) For initial system commissioning the flare system will be required to operate for approximately 160 hours

Figure – Snapshot of the expected operating hours for the air pollutant sources

**Note**: The potential to emit calculations did not include:

a. Shredded Tire storage and conveyance system
b. Carbon Black storage and conveyance system
c. Gas Cleaning system
d. Gas Conditioning system
e. Wastewater Treatment system
f. Main Stack
g. Fugitive Emissions from piping and valves

**Question:** How can OEPA determine whether uncontrolled and controlled potential to emit emissions trigger various Clean Air Act permit requirements without a complete understanding of the facility-wide potential to emit?

**Recommendation:** The permit application must be rejected and OEPA should require the applicant to include ALL facility wide emissions showing uncontrolled and controlled potential to emit emissions so that the appropriate permit (natural minor, synthetic minor, or Title V) and permit conditions can be applied to the proposed facility.

# SOBE Thermal Energy Systems, LLC  Air PTIO Notice

The public comment period will run until **09/10/2023 at 05:00 PM**.
**Link:** https://ebiz.epa.ohio.gov/Notices/jsp/view_notice.jsp?noticeID=186942

OEPA Air permit document search:
Link: https://edocpub.epa.ohio.gov/publicportal/edochome.aspx

| | |
|---|---|
| Facility ID: 0250110024 | Permit Number: P0132799 |
| Permit Type: Initial Installation | County: Mahoning |

**Proposed PTI/PTO summary from Permit Write-Up in public notice document**:
**Filename:** 2023 07-06 SOBE proposed PTI-PTO steam plant 41 pgs

> "Source Description:
> SOBE Thermal Energy Systems, LLC proposes to install a 13.72 MMBtu/hr Thermolyzer® (a type of pyrolysis unit (P001) that will extract syngas from tire derived chips (TDC) to power existing natural gas boilers (B006 and B007). The boilers provide steam for various buildings in downtown Youngstown, and will burn the syngas along with natural gas. The pyrolysis unit is equipped with two gas cleaning units (GCU) and a 1.09 MMBtu/hr flare. Carbon black and carbon steel are byproducts of the process, and enclosed conveyors will be used for all material handling.

**Question:** Why does source description say 'existing natural gas boilers (B006 and B007) if the facility has been completely dismantled? Are these the two boilers that were installed and operated under the Permit-by-Rule option? When will the rented boiler be removed from the site?

> Facility Emissions and Attainment Status:
> The facility is the site of the former Youngstown Thermal Plant. There are no longer coal-fired boilers at the facility. The facility is considered a true minor source of air emissions, and includes two 55 MMBtu/hr natural gas-fired boilers (B006 and B007) equipped with low NOx burners and flue gas recirculation, a 31.8 MMBtu/hr natural-gas fired boiler (B005) (that will not be used to burn the syngas) equipped with a low NOx burner and flue gas recirculation, a fuel storage tank (T001), and roadways (F001). T001 and F001 are *de minimis* and do not require an air permit. Mahoning County is in attainment for all criteria pollutants.

**Note:** Ratings for boilers – 31.8 MMBtu/hr natural gas fired (B005)
55 MMBtu/hr natural gas-fired boilers (B006 and B007)

**Question:** Why are they called natural gas-fired when the application states the primary fuel will be tire-derived synthetic gas (backup fuel is natural gas)?

Source Emissions:

The potential to emit (PTE) Particulate Matter, $SO_2$, and VOC for P001, B006 and B007 combined is less than 10 tons per year. Therefore Best Available Technology (BAT) does not apply to these pollutants. The source PTE of Hazardous Air Pollutants (HAPs) is less than one ton per year; therefore air toxics modeling was not necessary for this project. The PTE $NO_x$ is 43.79 tons per year, and the PTE CO is 19.79 tons per year, therefore BAT applies to these pollutants. The NESHAP for Industrial, Commercial, and Institutional Boilers Area Sources (40 CFR Part 63, Subpart JJJJJJ) is an applicable requirement. Ohio EPA is not accepting delegation authority to implement and enforce 40 CFR Part 63, Subpart JJJJJJ, therefore U.S. EPA is retaining the authority to implement and enforce 40 CFR Part 63, Subpart JJJJJJ.

Potential to emit less than 10 tons per year: PM, $SO_2$, and VOCs
Potential to emit for $NO_x$ = 43.79 tons per year
Potential to emit CO = 19.79 tons per year

**Question:** How can OEPA confirm that particulate potential to emit is less than 10 tons per year without a full explanation of where the tire shreds will be stored and engineering drawings that show the conveyance of tire shreds to the pyrolysis unit(s) will be dust-free? What types of covering will be used for conveyor belts? Will there be baghouses or uncontrolled?

**Question:** What type of particulates will be generated when transporting carbon black from the pyrolysis unit(s) to storage and/or disposal sites? What is the potential to emit for the carbon black conveyance and storage system?

**Question:** If the Phase II additional Thermolyzers were included in this permit, would the PTE for particulates, $SO_2$ and VOCs be greater than 10 tons per year and thus trigger Best Available Technology? Would the PTE for $NO_x$ be greater than 100 tons per year and thus trigger Title V permitting requirements?

**Question:** How will OEPA and USEPA enforce 40 CFR Part 63 Subpart JJJJJ in this permit?

# Surrounding Community

**Physical address of proposed facility:** 205 North Avenue, Youngstown, OH


Figure – Google Earth image of 204 North Avenue, Youngstown, Ohio showing the Mahoning County Sheriff's Office and County Jail to the east and TerraSafe Recycling directly south.

**Note:** Neighbor is Terra Safe Recycling
**Link:** https://terrasaferecycling.com/

> "TerraSafe Recycling provides electronic waste recycling services to small and large sized companies. Our services include electronic recycling, data destruction, deinstallation, asset disposition and asset management to improve efficiency and reduce waste reaching landfills."

**Question:** Would SOBE Thermal Energy Systems, LLC be allowed to take electronic waste from their neighbor as feedstock for the Thermolyzer under the PTI/PTO or would they have to have a modified permit before changing their feedstock? Would OEPA consider that to be a public noticed modification?


Figure – Google Earth image closeup of Youngstown Thermal before demolition.


Figure - Google Earth image of surrounding community and proximity to highways.

# Ohio Air Program Regulations

**Ohio Administrative Code rule 3745-31-33**
**Link:** https://codes.ohio.gov/ohio-administrative-code/rule-3745-31-33
**Filename:** OAC 3745-31-33_const activities allowed before PTI-PTO issuance 5 pgs

> "[Comment: Some activities described in this rule may not begin until any applicable national pollutant discharge elimination system (NPDES) permit, isolated wetland permit or 401 water quality certification is obtained."
>
> "The construction of warehouses, store rooms, office buildings, or other buildings or structures that are not planned to contain any air contaminant source as part of an air contaminant source project may be constructed prior to obtaining a final permit-to-install or PTIO if the buildings or structures would be built (for business financial reasons) even though no final permit-to-install or PTIO could be obtained."

**Ohio EPA Air permitting**
https://epa.ohio.gov/divisions-and-offices/air-pollution-control/permitting/applying-for-an-air-pollution-control-permit

**General permits for boilers** (compare language to proposed PTI/PTO)
Link: https://epa.ohio.gov/divisions-and-offices/air-pollution-control/permitting/boilers-general-permit-options

**Note:** Ohio is in USEPA Region V out of Chicago Illinois
Link: https://www.epa.gov/aboutepa/epa-region-5

**USEPA Region V Air Program - Ohio**

EPA Approved Regulations in the Ohio SIP
Link: https://www.epa.gov/air-quality-implementation-plans/epa-approved-regulations-ohio-sip

EPA Approved Ohio Source-Specific Requirements
Link: https://www.epa.gov/air-quality-implementation-plans/epa-approved-ohio-source-specific-requirements

**Note:** most of the dozen or so permits listed were done in the 1995-2000 time frame with one permit issued in 2019.

EPA Approved Nonregulatory Provisions and Quasi-Regulatory Measures in Ohio SIP
Link: https://www.epa.gov/air-quality-implementation-plans/epa-approved-nonregulatory-provisions-and-quasi-regulatory-8

# Federal Regulations Applicable to Facility

**Filename:** PTIPTIO SOBE app sec1 Facility Info 5 pgs

**From page 3 of 5:**

3. **Federal Rules Applicability** - Please check all of the appropriate boxes below.

**New Source Performance Standards (NSPS)**
*New Source Performance Standards are listed under 40 CFR 60 - Standards of Performance for New Stationary Sources.*
https://www.epa.gov/stationary-sources-air-pollution/new-source-performance-standards

☐ not affected ☒ subject to Subpart: Dc
☐ unknown ☐ exempt - explain below

**National Emission Standards for Hazardous Air Pollutant (NESHAP)**
*National Emissions Standards for Hazardous Air Pollutants are listed under 40 CFR 61. (These include asbestos, benzene, beryllium, mercury, and vinyl chloride).*
https://www.epa.gov/compliance/national-emission-standards-hazardous-air-pollutants-compliance-monitoring

☒ not affected ☐ subject to Subpart:
☐ unknown ☐ subject, but exempt -explain below

**Maximum Achievable Control Technology (MACT)**
*The Maximum Achievable Control Technology standards are listed under 40 CFR 63 and OAC rule 3745-31-28.*
https://www.epa.gov/stationary-sources-air-pollution/national-emission-standards-hazardous-air-pollutants-neshap-9

☒ not affected ☐ subject to Subpart:
☐ unknown ☐ subject, but exempt – explain below

Figure – Snapshot of responses to section 3 – Federal Rules Applicability.

**Industrial-Commercial-Institutional Steam Generating Units: New Source Standards of Performance (NSPS)**
Link: https://www.epa.gov/stationary-sources-air-pollution/industrial-commercial-institutional-steam-generating-units-new

**NSPS Subpart Dc**
**Link:** https://www.govinfo.gov/content/pkg/CFR-2015-title40-vol7/pdf/CFR-2015-title40-vol7-part60-subpartDc.pdf
**Filename:** 40 CFR-2015-title40-vol7-part60-subpartDc 19 pgs

> [NSPS Subpart Dc] § 60.40c Applicability and delegation of authority.
> (a) Except as provided in paragraphs (d), (e), (f), and (g) of this section, the affected facility to which this subpart applies is each steam generating unit for which construction, modification, or reconstruction is commenced after June 9, 1989 and that has a maximum design heat input capacity of 29 megawatts (MW) (100 million British thermal units per hour (MMBtu/h)) or less, but greater than or equal to 2.9 MW (10 MMBtu/h)."

**Some Definitions from Subpart Dc:**

> *Annual capacity factor* means the ratio between the actual heat input to a steam generating unit from an individual fuel or combination of fuels during a period of 12 consecutive calendar months and the potential heat input to the steam

generating unit from all fuels had the steam generating unit been operated for 8,760 hours during that 12-month period at the maximum design heat input capacity. In the case of steam generating units that are rented or leased, the actual heat input shall be determined based on the combined heat input from all operations of the affected facility during a period of 12 consecutive calendar months."

*Maximum design heat input capacity* means the ability of a steam generating unit to combust a stated maximum amount of fuel (or combination of fuels) on a steady state basis as determined by the physical design and characteristics of the steam generating unit.

*Natural gas* means:
(1) A naturally occurring mixture of hydrocarbon and nonhydrocarbon gases found in geologic formations beneath the earth's surface, of which the principal constituent is methane; or
(2) Liquefied petroleum (LP) gas, as defined by the American Society for Testing and Materials in ASTM D1835 (incorporated by reference, see § 60.17); or
(3) A mixture of hydrocarbons that maintains a gaseous state at ISO conditions. Additionally, natural gas must either be composed of at least 70 percent methane by volume or have a gross calorific value between 34 and 43 megajoules (MJ) per dry standard cubic meter (910 and 1,150 Btu per dry standard cubic foot).

*Steam generating unit* means a device that combusts any fuel and produces steam or heats water or heats any heat transfer medium. This term includes any duct burner that combusts fuel and is part of a combined cycle system. This term does not include process heaters as defined in this subpart."

§ 60.42c Standard for sulfur dioxide ($SO_2$) – coal-fired steam-generating units only.

§ 60.43c Standard for particulate matter (PM) – focuses on coal, wood, and oil fuels.

§ 60.44c Compliance and performance test methods and procedures for sulfur dioxide.

**National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources**
Link: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-63/subpart-JJJJJJ

# OEPA emails regarding SOBE air permit

June 2022

**From:** Jennifer.Kurko@epa.ohio.gov <Jennifer.Kurko@epa.ohio.gov>

**Sent:** Tuesday, June 28, 2022 3:56 PM

**To:** Mike Conway <mike@opticsems.com>; dave@sobethermalenergy.com

**Cc:** erik.bewley@epa.ohio.gov; Misty.Whitmyer@epa.ohio.gov; Jerry.Parker@epa.ohio.gov; Patrick.Slattery@epa.ohio.gov; Zorica.Dejanovic@epa.ohio.gov; Daniel.Bogoevski@epa.ohio.gov; Jarnal.Singh@epa.ohio.gov; corey.kurjian@epa.ohio.gov

**Subject:** Ohio EPA follow-up for SOBE Thermal Energy

> "Youngstown site
> From what we understand, SOBE plans to undertake the following activities at the former Youngstown Thermal site:
>
> 1) Replacement of the existing natural gas/wood oil/coal-fired boilers with new dual-fuel natural gas/synthetic gas boilers;
>
> 2) Installation of up to 12 waste-to-energy gasification units. These units convert various forms of solid waste to synthetic gas with no liquid/oil or other hazardous waste by product production. SOBE plans to start with scrap tire shreds, and eventually broaden operations to include plastics and e-waste; and
>
> 3) Installation of up to 20, 1.8 MW gas turbines driving electrical generators. These will be packaged with heat recovery steam generators and steam turbine drive electrical generators.
>
> The system, in total, will generate approximately 49 MWs of electrical power.
>
> **Division of Air Pollution Control (DAPC)** – As the boilers are SOBE's first priority, DAPC recommends submitting a permit-to-install (PTI) application for those first. DAPC anticipates that this particular application should be straightforward. Barring any unforeseen complications, a final air permit could be issued within 2 months from receipt of a complete application. If we receive significant public interest, however, Ohio EPA may first issue a draft permit to provide a 30-day public comment period. A public meeting may be held as part of this process. The public comment process, if needed, would extend the amount of time to obtain a final permit by approximately 2 months.

DAPC anticipates that the permit required to install phases 2 and 3 of the project will be more complex and could take up to 6 months for review prior to issuance.

The company will also need to obtain an updated Title V permit to reflect the changes in operation, within 1 year of beginning those operations. DAPC's contact for air permitting is Erik Bewley, who can be reached at (330) 963-1252 and Erik.Bewley@epa.ohio.gov.

**Question:** Does OEPA believe that the facility when fully constructed (Phases 1, 2, and 3) would qualify as a Title V source? How many pyrolysis units? Flares? Boilers? Gas Conditioners? Gas Cleaners? Tar/Oil Crackers? Baghouses? Does Phase 2 or 3 include a tire-shredding operation onsite?

**Requirements and Information § 63.11237**
Link: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-63/subpart-JJJJJJ/subject-group-ECFRe177339bea70935/section-63.11237

*Electric utility steam generating unit (EGU)* means a fossil fuel-fired combustion unit of more than 25 megawatts that serves a generator that produces electricity for sale. A fossil fuel-fired unit that cogenerates steam and electricity and supplies more than one-third of its potential electric output capacity and more than 25 megawatts electrical output to any utility power distribution system for sale is considered an electric utility steam generating unit. To be "capable of combusting" fossil fuels, an EGU would need to have these fuels allowed in their operating permits and have the appropriate fuel handling facilities on-site or otherwise available (*e.g.,* coal handling equipment, including coal storage area, belts and conveyers, pulverizers, etc.; oil storage facilities). In addition, fossil fuel-fired EGU means any EGU that fired fossil fuel for more than 10.0 percent of the average annual heat input in any 3 consecutive calendar years or for more than 15.0 percent of the annual heat input during any one calendar year after April 16, 2015.

**Question:** What federal protections under the Clean Air Act Title V permit program are not included in the proposed PTI/PTO air permit that would have been included if the entire project was permitted together rather than piecemeal?

**Division of Materials and Waste Management (DMWM)** – The program is determining whether the proposed gasification of scrap tires, plastics and e-waste would make the facility a solid waste energy recovery facility. If so, the facility would require a solid waste PTI per Ohio Administrative Code (OAC) Rule 3745-27-50. This particular type of permit requires certain public involvement activities, including issuance of a draft permit for public comment. A disclosure statement for key employees must also be submitted to the Ohio Attorney

General's Office for a background check. DMWM recommends submittal of a complete application and disclosure statement at least 6 months prior to when SOBE wishes to begin construction of the gasification operation. An annual Ohio EPA operating license is also required prior to operation.

Additional requirements may apply related to the storage of scrap tire shreds. DMWM recommends a follow up meeting within the next couple weeks to further discuss the company's plans and determine which specific solid waste requirements will apply. DMWM's contact is Jerry Parker, who can be reached at (330) 963-1186 and Jerry.Parker@epa.ohio.gov.

**Question:** Does SOBE Thermal Energy Systems, LLC need to apply for a solid waste PTI/PTO? If yes, when will they submit a permit application to DMWM?

**Division of Surface Water (DSW)** – You indicated that the facility will not be discharging wastewater directly to waters of the state, but to the local publicly-owned treatment works. DSW's pre-treatment contact for Mahoning County is Patrick Slattery, who can be reached at (330) 963-1131 and Patrick.Slattery@epa.ohio.gov. Certain industrial activities may also require a storm water permit. To determine if SOBE's activities are regulated under the storm water program, please contact Zorica Dejanovic, who can be reached at (330) 963-1222 and Zorica.Dejanovic@epa.ohio.gov."

**Question:** How much wastewater will be generated by the proposed facility (volume per day)? What are the contaminants of concern (e.g., heavy metals, hydrocarbons, total solids)? Will SOBE Thermal Energy Systems, LLC discharge the pyrolysis wastewater to the sanitary sewer or just the domestic wastewater from employees?

"From: Mike Conway <mike@opticsems.com>
Sent: Friday, June 10, 2022 3:31 PM
To: Bewley, Erik <erik.bewley@epa.ohio.gov>
Cc: David Ferro <dave@sobethermalenergy.com>
Subject: SPOBE Thermal Permitting Process
Erik,
I am following up on our last email thread regarding modernization plans at SOBE Thermal. SOBE is prepared to move forward with the permitting process for the plant modernization which includes three major components consisting of:

1) Replacement of the existing natural gas/wood oil/coal fired boilers with new dual-fuel natural gas/synthetic gas boilers
2) Installation of up to 12 waste-to-energy gasification units. These units convert various forms of solid waste to synthetic gas with no liquid/oil or other hazardous waste by product production.

> 3) Installation of up to twenty 1.8 MW Oprah gas turbines driving electrical generators. These will be packaged with heat recovery steam generators and steam turbine drive electrical generators.
> The system, in total, will generate approximately 49 MWs of electrical power."

**Question:** Is this email the basis for OEPA terminology of Phase 1, 2, and 3? Who would be using the 49 MW of electrical power?

Link: http://www.caiso.com/about/Pages/OurBusiness/Understanding-electricity.aspx

> "Megawatt - One megawatt equals one million watts or 1,000 kilowatts, roughly enough electricity for the instantaneous demand of 750 homes at once. That number fluctuates because electrical demand changes based on the season, the time of day and other factors."

> **49 MW x 750 homes/MW = 36,750 homes**

Youngstown OH = 2020 census population of 60,068.
**Link:** https://www.census.gov/quickfacts/fact/table/youngstowncityohio/INC110221

# PTI/PTO Permit Application Documents

The following documents were reviewed and are understood to be the complete PTI/PTO permit application for SOBE Thermal Energy Systems, LLC.

Filename: 3100_Process_Emission Activity Category SOBE Thermolyzer 3 pgs

Filename: 3101_Fuel_Burning_Emission Activity Category_SOBE Boiler 6 3 pgs

Filename: 3101_Fuel_Burning_Emission Activity Category_SOBE Boiler 7 3 pgs

Filename: Boiler Process Flow Diagram

Filename: PTIPTIO application sec1 Facility Info SOBE 091222 5 pgs

Filename: PTIPTIO SOBE app sec2 Boiler 6 Specific Source Info 13 pgs

Filename: PTIPTIO SOBE app sec2  Boiler 7 Specific Source info 13 pgs

Filename: PTIPTIO SOBE app sec2 Thermolyzer 1 Specific Source Info 13 pgs

Filename: SOBE Potential Emissions Calcs 092922
(several sheets to this excel spreadsheet)

Filename: 2022 09-12 SOBE PTIO Application Cover Letter 5 pgs

Filename: SOBE Thermal Thermolyzer Emissions Estimates 10_30_20 8 9 ofa

Filename: Thermolyzer Process Flow Diagram

# PTI/PTO Summary in SOBE Cover Letter

**Filename:** 2022 09-12 SOBE PTIO Application Cover Letter 5 pgs

> "Attached to this cover letter you will find the air permit application package for the first phase of SOBE's modernization plan. This phase includes the installation of one 100-ton Thermolyzer™ system that will convert used tires to a clean synthetic gas. The application also seeks approval to use this gas in the two new boilers previously approved for installation via the departments permit by rule process. In the sections below, we have provided a re-cap of the overall plan for the facility as well as provided a summary of the technical detail that supports this permit application."

**Question:** What is the regulatory authority OEPA relies upon to allow a facility with a Title V air permit (for the coal-fired boilers) receive approval for 2 natural-gas fired boilers without modifying the existing Title V permit – but only 'permit by rule'?

1. Is the purpose of this application to transition from OAC Chapter 3745-77 (Title V) to OAC Chapter 3745-31 (PTIO)?

☐ yes ☒ no

Figure – Snapshot of page 3 of 5 PTI/PTO Application Form indicating "no" to the question: Is the purpose of this application to transition from Title V to PTIO.

**Question:** When did OEPA decide that this Facility ID *did not need to transition* from a Title V air permit (due to coal-fired steam) to a PTIO even though using the same ID?

**OEPA Permit-by-Rule**
Link; https://epa.ohio.gov/divisions-and-offices/air-pollution-control/permitting/permit-by-rule-pbr
Factsheet: https://epa.ohio.gov/static/Portals/41/sb/PBRfactsheet.pdf

**From OEPA Permit-by-Rule Fact Sheet:**

> "*How does a PBR differ from an ordinary permit*?
> [Answer] Many air pollution sources must obtain PTIOs from Ohio EPA. A PTIO is required before installing and operating the air pollution source, and the PTIO is renewable on a 5- or 10-year cycle. A PBR exempts the air pollution source from the PTIO process, functions as both the installation and operating permit for the source, and does not expire. However, the air pollution source must continually meet all the PBR criteria to remain eligible."

"*What types of air pollution sources have PBR provisions*?
[Answer] OAC 3745-31-03(A)(4) contains provisions for:
• emergency electrical generators, pumps and compressors;
• resin injection/compression molding equipment;
• small crushing and screening plants;
• remediation projects for soil-vapor extraction:
• remediation projects for soil-liquid extraction;
• auto body refinishing shops;
• gas stations with Stage I vapor controls;
• gas stations with Stage I and II vapor controls;
• natural gas fired boilers and heaters;
• small printing facilities; and
• mid-size printing facilities.
• Unpaved roadways and parking areas where facility wide total unpaved roadways and parking areas are greater than 12,000 square feet but less than 30,000 square feet in size.
• Paved roadways and parking areas where facility wide total paved roadways and parking areas are greater than 45,000 square feet but less than 90,000 square feet in size.

OAC 3745-31-03(A)(4) is **not the correct citation**, what that section of the code says:

"OAC 3745-31-03
(A) (4) Compliance with any applicable national emissions standard for hazardous air pollutant (NESHAP) standard as contained in 40 CFR part 61."

The correct citation is: OAC 3745-**31-30(C)(2)**
**Link:** https://codes.ohio.gov/ohio-administrative-code/rule-3745-31-30
Filename: 3745-31-30_(2023) Permit by Rule 52 pgs

"(C) Permit-by-rule.
The following air contaminant sources may elect to be permitted under this paragraph in lieu of the requirement to obtain a permit-to-install or PTIO under rule 3745-31-02 of the Administrative Code. These permits-by-rule are valid only as long as the owner or operator complies with all of the permit-by-rule general provisions, meets the qualifying criteria defined in the applicable permit-by-rule and complies with all of the requirements under the applicable permit-by-rule specific provisions. Upon request by the director, the owner or operator of a facility that has exceeded the permit-by-rule thresholds or that the director finds is causing or may cause a public nuisance in violation of rule 3745-15-07 of the Administrative Code shall submit an application for a permit-to-install or PTIO.

These permits-by-rule do not, however, exempt any air contaminant source from requirements of the Clean Air Act, including being considered for purposes of determining whether a facility constitutes a major source or is otherwise regulated under Chapter 3745-77 of the Administrative Code or any requirement to list significant or insignificant activities and emission levels in a Title V permit application. In addition, this rule does not relieve the owner or operator from the requirement of including the emissions associated with these sources into any major NSR permitting action.
(2) Source specific provisions."

**OAC 3745-31-30(C)(2)(i)** refers to Permit-by-Rule for boilers and heaters as follows:

**From page 23 of 52:**

**"(i) Boiler and heater permit-by-rule.**

**(i) Qualifications**. Boilers, preheaters, air heaters, water heaters, or heaters used for other heat exchange media that meet all of the following qualifications are eligible to use this permit-by-rule:

[Comment: Air contaminant sources which meet the definition of process heater as specified in 40 CFR part 60, subpart Dc are not eligible to use this permit-by-rule.]

(a) The maximum rated heat input capacity of the air contaminant source is greater than or equal to ten million British thermal units per hour and less than or equal to one hundred million British thermal units per hour.

(b) The air contaminant source is capable of burning only natural gas.

(c) The emissions from the air contaminant source consist entirely of the products of fuel combustion.

(d) Air contaminant sources with a maximum rated heat input capacity of greater than fifty million British thermal units per hour shall be equipped with low-NOx burners or other combustion control techniques designed to meet an emission limitation of not greater than 0.050 pound of nitrogen oxides per million British thermal units of heat input.

**Note:** Permit-by-rule restrictions - heat input capacity 10 MMBtu/hr to 100 MMBtu/hr
Burns only natural gas
If heat input capacity > 50 MMBtu/hr then low-NOx burners or other controls

**(ii) Applicable emission limitations and control requirements**.

(a) The applicable rules, emission limitations, and control requirements that apply to each air contaminant source subject to this permit-by-rule are defined in the following table:

| Applicable rule | Applicable Emission Limitations/Control Requirements |
|---|---|
| Paragraph (A) of rule 3745-17-07 of the Administrative Code | The visible particulate matter emission limitations specified by this rule are less stringent than the visible particulate matter emission limitation established pursuant to paragraph (A)(3) of rule 3745-31-05 of the Administrative Code. |
| Paragraph (B) of rule 3745-17-10 of the Administrative Code | Particulate matter emissions shall not exceed 0.020 pound per million British thermal units of actual heat input. |
| Paragraph (B) of rule 3745-23-06 of the Administrative Code | Units meeting the permit-by-rule qualification criteria satisfy the latest available control techniques and operating practices pursuant to the rule. |
| Paragraph (A) of rule 3745-18-06 of the Administrative Code | Air contaminant sources are exempt from this rule when natural gas is the only fuel burned. |
| Paragraph (A)(3) of rule 3745-31-05 of the Administrative Code | Best Available Technology (BAT) includes: 8.76 tons particulate matter per year, 5.0 pounds of nitrogen oxides (NOx) per hour, 21.90 tons of NOx per year, 8.24 pounds of carbon monoxide (CO) per hour, 36.07 tons CO per year, 1.08 pounds organic compounds (OC) per hour, 4.72 tons OC per year, 0.06 pounds of sulfur dioxide (SO2) per hour, 0.26 tons SO2 per year, five percent opacity, as a six-minute average of visible particulate matter, compliance with rule 3745-18-06, compliance with rule 3745-23-06, and compliance with paragraph (B) of rule 3745-17-10 of the Administrative Code. |
| 40 CFR part 60, subpart Dc | This regulation does not specify emission limitations for air contaminant sources that only fire natural gas. |

Figure – Snapshot of Permit-by-Rule emissions limitations and applicable rules.

**Question:** Did SOBE adhere to the BAT restrictions when operating the two boilers under the Permit-by-Rule option? Did OEPA evaluate and determine the compliance status of the facility prior to issuance of the PTI/PTO that allows burning of syn gas?

**Question:** *If SOBE had not chosen to burn syn gas*, would OEPA have allowed the steam plant to operate more than 2 boilers under Permit-by-Rule?

**Question:** *If SOBE had not chosen to burn syn gas*, would OEPA have continued to allow the facility, whose sole purpose is to create steam from boilers, be permitted under Permit-by-Rule basically “forever” without a traditional PTI/PTO public participation process and thus eliminate the opportunity for communities to express their concerns about health and the environment in the permitting process?

**Note:** There are 309 boilers authorized under the Permit-by-Rule option located at refineries, food manufacturers, airports, and other potentially Title V air permit locations.

**From page 2 of 5 of the SOBE PTI/PTO Cover Letter:**

**Gas Composition**

The composition of the gas produced from the Thermolyzer™ system is:

| Chemical Symbol | Gas Constituent | % By Volume |
|---|---|---|
| $CH_4$ | Methane | 47.25 |
| $H_2$ | Hydrogen | 30.8 |
| $C_2H_4$ | Ethylene | 8.5 |
| $CO_2$ | Carbon Dioxide | 5.0 |
| CO | Carbon Monoxide | 3.1 |
| $C_2H_6$ | Ethane | 3.0 |
| $C_3H_6$ | Propene | 1.6 |
| $C_3H_8$ | Propane | 0.12 |
| C8H18 | Octane | 0.63 |
| Total | | 100 |

Like natural gas, this syn-gas is hydrocarbon based. The major difference being that this gas contains up to 32 percent hydrogen by volume.

Figure – Snapshot of the 'gas produced from the Thermolyzer" **30.8% hydrogen**.

Compare Thermolyzer unrefined syn gas to unrefined fossil-fuel natural gas:
Link: http://naturalgas.org/overview/background/

**Typical Composition of Natural Gas**

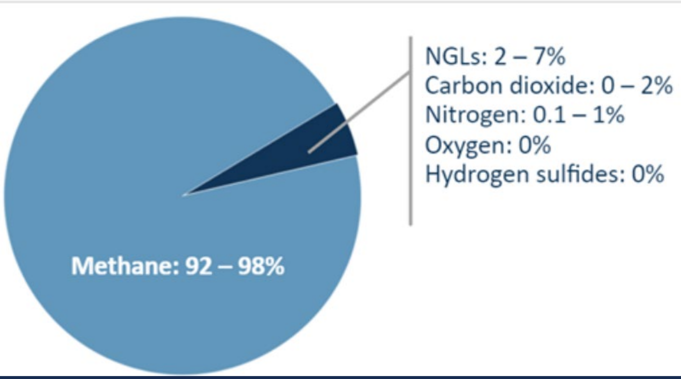
| | | |
|---|---|---|
| Methane | $CH_4$ | 70-90% |
| Ethane | $C_2H_6$ | 0-20% |
| Propane | $C_3H_8$ | |
| Butane | $C_4H_{10}$ | |
| Carbon Dioxide | $CO_2$ | 0-8% |
| Oxygen | $O_2$ | 0-0.2% |
| Nitrogen | $N_2$ | 0-5% |
| Hydrogen sulphide | $H_2S$ | 0-5% |
| Rare gases | A, He, Ne, Xe | trace |

Unrefined:
Syn Gas 47.25% methane
Nat Gas 70-90% methane

Refined:
Natural Gas 92-98% methane

Figure – Snapshot of composition of *unrefined* natural gas.

**Note:** Traditional composition of natural gas supplied in a pipeline is mostly methane.
Link: https://energyknowledgebase.com/topics/pipeline-quality-gas.asp




**Question:** Did OEPA consider the waste-tire derived syngas hydrogen (H2) concentration of 30% when allowing emission factors equivalent to natural gas?

**From page 2 of 5 of the Cover Letter (refers to 2020 TRC report):**

> "Thermolyzer™ - Previously, SOBE Thermal hired TRC Environmental Corporation to review the gas composition and develop emissions factors associated with using this gas. Their report is included as Attachment One. In summary, TRC advises that there are no published AP42 emissions factors for tire derived synthetic gas. Their review shows that the tire derived gas is close in make-up to what the EPA defines as process gas. TRC also reviewed several EPA reports and references to help characterize emissions from this gas. Again, these are noted in the attached report. OPTICs utilized the emissions factors for process gas, as analyzed in the attached report, to calculate total potential emissions from the Thermolyzer™ system. "

**From page 3 of 5 of the Cover Letter:**

> "We note that, based on the composition of the synthetic gas, there is no production of any hazardous air pollutants or air toxics."

**From page 5 of 9 Attachment One (TRC Report):**

**Table 1: CHZ Technologies Thermolyzer Test Summary, May 2017**

| Constituent | Sample 1 | Sample 2 | Sample 3 | Sample 4 | Sample 5 | Sample 6 | Average Samples 1 - 3 |
|---|---|---|---|---|---|---|---|
| $H_2$ | 24.9 | 27.8 | 32.1 | 23.7 | 25.4 | 29.6 | 28.3 |
| $O_2$ | 0.3 | 1.8 | 0.48 | 0.5 | 0.42 | 0.06 | 0.9 |
| $N_2$ | 1.4 | 7.7 | 2.7 | 1.6 | 2 | 0.52 | 3.9 |
| $CH_4$ | 49.6 | 41.1 | 40.7 | 37.5 | 35.3 | 37.1 | 43.8 |
| $CO_2$ | 3.5 | 4.3 | 5.7 | 2.3 | 2.9 | 4.1 | 4.5 |
| CO | 2.3 | 2.4 | 3.6 | 2.1 | 2.6 | 3.1 | 2.8 |
| $C_2H_6$ | 3.6 | 2.8 | 2.1 | 4.7 | 4.6 | 3.6 | 2.8 |
| $C_2H_4$ | 9.2 | 6.8 | 6.7 | 7.1 | 7.2 | 6.9 | 7.6 |
| $C_3H_8$ | 0.07 | 0.19 | 0.03 | 1.2 | 1.3 | 0.76 | 0.1 |
| $C_3H_6$ | 1.3 | 1.8 | 1.1 | 3 | 1.8 | 5 | 1.4 |
| i-$C_4H_{10}$ | <0.01 | <0.01 | <0.01 | 0.15 | 0.21 | 0.09 | |
| n-$C_4H_{10}$ | 0.03 | 0.05 | 0.01 | 0.45 | 0.47 | 0.22 | 0.0 |
| $H_2O$ | 3.00 | 3.00 | 3.00 | Insufficient Data | | | 3.0 |
| Benzene, Aromatics, Olefin | 0.8 | 0.3 | 1.8 | | | | 1.0 |
| Total | 100 | 100 | 100 | 84.3 | 84.2 | 91.1 | 100.0 |

Figure – Snapshot of the pilot test results for Thermolyzer 'syn gas' unrefined.

**Question:** Did OEPA assume that the 3 widely varied data points (0.3 to 1.8%) for the category of "Benzene, Aromatics, Olefin" was sufficient information to determine that "no hazardous air pollutants or air toxics" produced from the Thermolyzer?

**Question:** What are the safety concerns with large percentage of hydrogen gas in the waste-tire derived syngas? Will the H2 gas adversely affect the efficiency of flares?

**From page 2 of 5 of the Cover Letter:**

Boilers

SOBE Thermal provided the above noted gas composition to Victory Energy. Victory is the original equipment manufacturer of the boilers that SOBE intends on installing later this year. Victory's combustion group analyzed the synthetic gas, and they provided the following emissions estimates for the boilers when burning synthetic gas:

| Chemical Symbol | lb./MMBTU |
|---|---|
| PM10 | 0.0099 |
| PM2.5 | 0.006 |
| CO | 0.037 |
| VOC | 0 |
| $SO_2$ | 0 |
| NOx | 0.07 |

Victory's projected emissions firing natural gas are shown below:

| Chemical Symbol | lb./MMBTU |
|---|---|
| PM10 | 0.005 |
| PM2.5 | 0.005 |
| CO | 0.037 |
| VOC | 0 |
| $SO_2$ | 0 |
| NOx | 0.036 |

Figure – Snapshot of Victory Energy (boiler supplier) estimates of emissions.
**Note:** The emissions are estimated mathematically and not from actually burning the syn gas in the boiler and measuring emissions.

**Question:** Did SOBE *only provide* the short carbon chain version of syn gas (refined) composition to Victory Energy for their analysis, or did they *also provide* the pilot test results of unrefined syn gas that included aromatics (benzene)?

**Question:** Is SOBE assuming 100% removal of aromatics and corrosives from the raw syngas in the gas cleaning and gas conditioning processes? If so – how are the aromatics removed from the syngas; are they directed to the flare; and what percentage of aromatics and corrosives are destroyed by the flare?

**Question:** Did Victory Energy have opinions regarding the burning of waste tire-derived syn gas in their boilers with respect to maintenance requirements and effect on boiler steam production efficiency?

**Question:** How do the 'gas cleaning' and 'gas conditioning' processes remove the large amount of hydrogen gas from the unrefined syngas?

**Ohio Air Toxics Program**
**Link:** https://epa.ohio.gov/divisions-and-offices/air-pollution-control/reports-and-data/air-toxics

> "On Aug. 3, 2006, an amendment of Ohio Revised Code (ORC) 3704.03(F) became effective as a result of Senate Bill 265 of the 126th General Assembly. The newly amended statute identifies the requirements for reviewing new and modified air contaminant sources with air toxic emissions. Prior to this, Ohio EPA had an "Air Toxics Policy" often referred to as "Option A." The newly amended statute incorporated the use of Option A into law and it also required that Ohio EPA promulgate a list of toxic air contaminants that would fall under this review requirement. On Dec. 1, 2006, Ohio EPA's list of toxic air contaminants became effective in Ohio Administrative Code (OAC) 3745-114-01. Ohio EPA toxicologists recommended 303 compounds for the toxic air contaminant list based on a review of scientific evidence available."

**(OAC) 3745-114-01 List of Air Toxics**
**Link:** https://codes.ohio.gov/ohio-administrative-code/rule-3745-114-01

| | |
|---|---|
| benzene | 00071-43-2 |

**Question:** How does OEPA protect communities from air toxics, such as benzene, and other aromatics in the proposed PTI/PTO *if the permit application does not acknowledge their presence*?

# Flow Diagrams

**Filename:** Boiler Process Flow Diagram

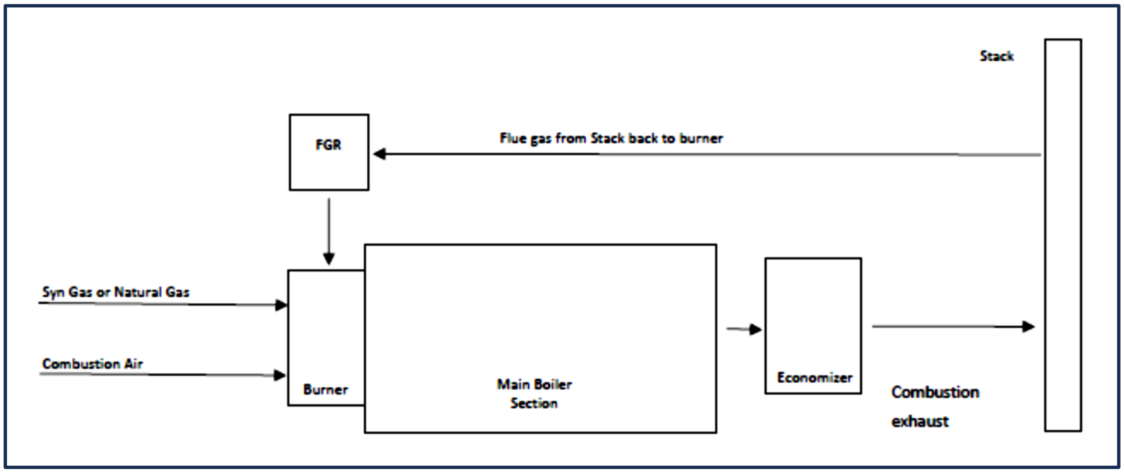



Figure – Snapshot of Boiler Flow Diagram showing flue gas recirculation.
**Note:** Syn Gas or Natural Gas input

**Filename:** Thermolyzer Process Flow Diagram

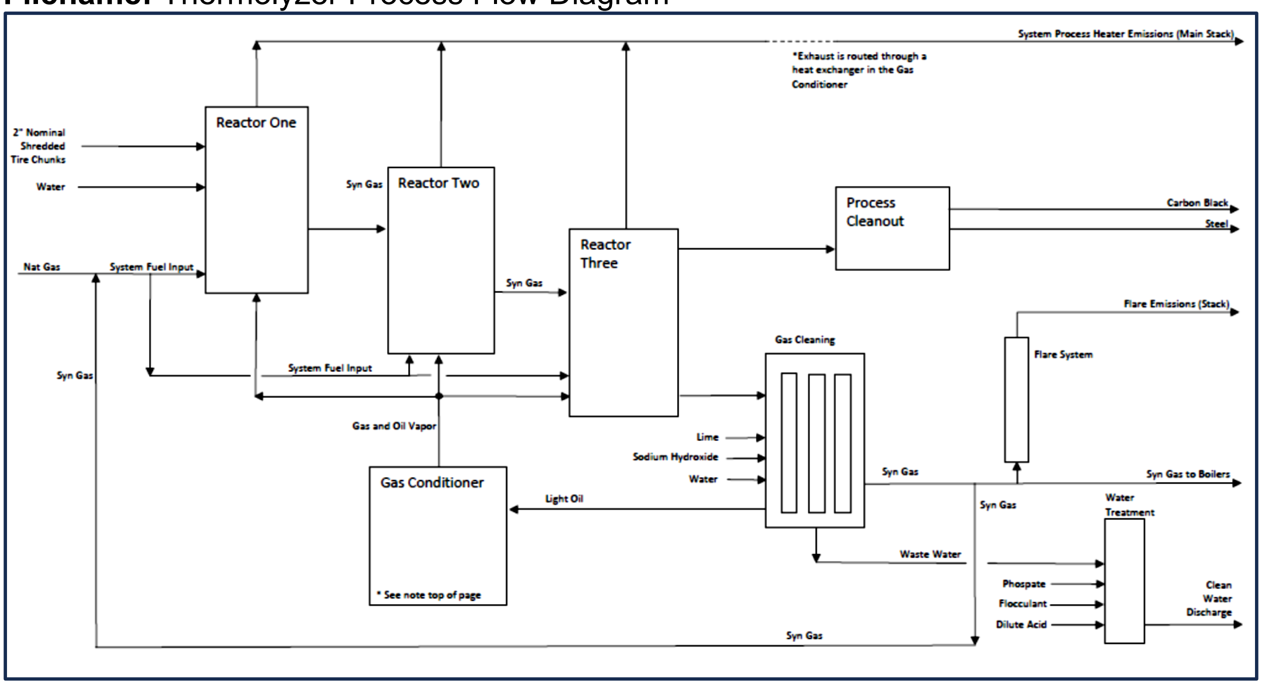



Figure – Snapshot of Thermolyzer Flow Diagram

**Note:** Natural Gas line has entrance for Syn Gas at beginning of flow diagram then all other inputs are Syn Gas from Reactor to Reactor.

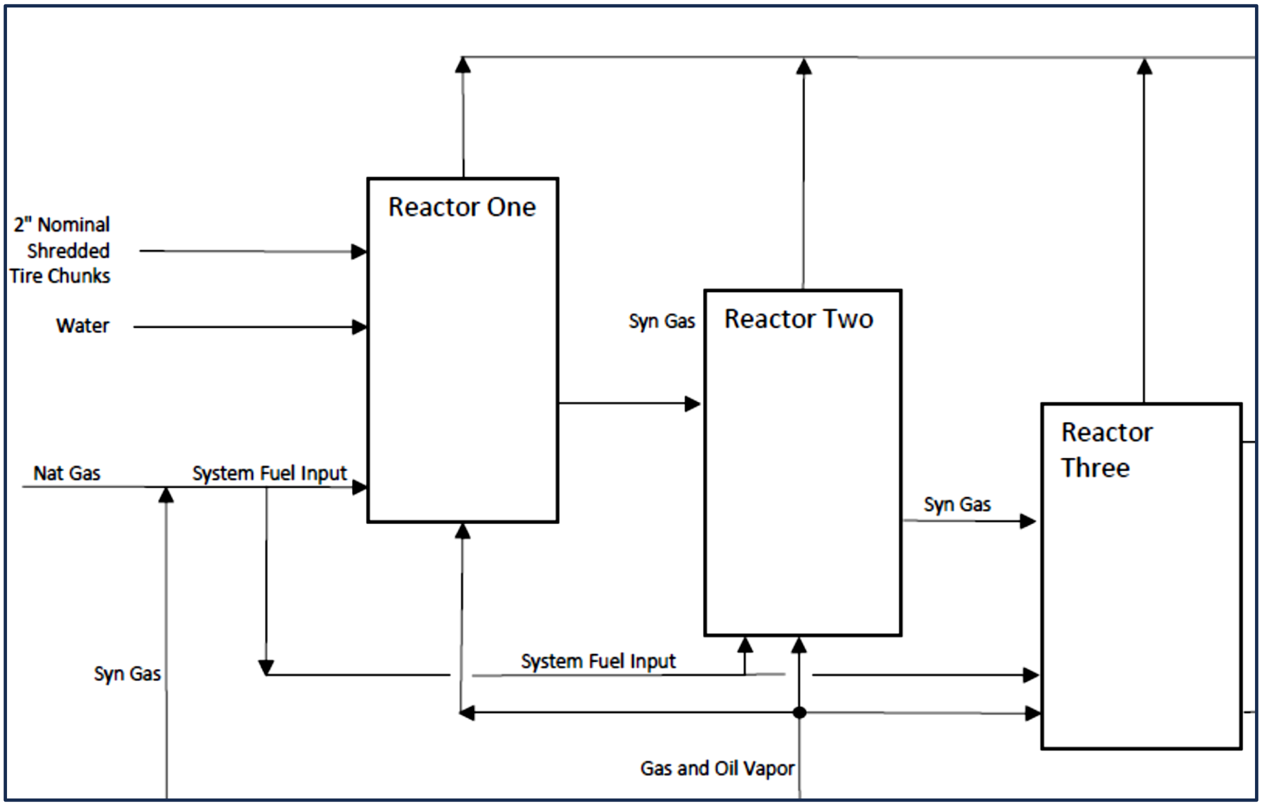



Figure – Closeup of the Thermolyzer Flow Diagram showing natural gas and syn gas inputs between reactors.

**Note:** 2 inch nominal shredded tire chunks and water go into Reactor One.

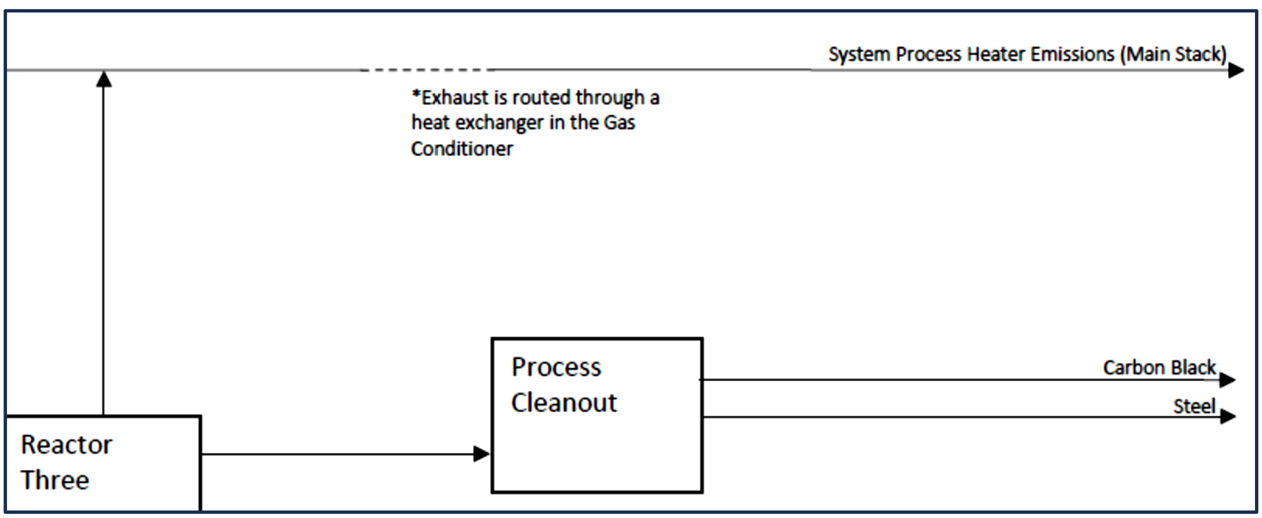



Figure – Closeup of Thermolyzer Flow Diagram showing outputs of Process Cleanout

**Question:** Carbon Black and Steel would be generated – where is the control equipment for dust? How will the two by-products be conveyed and stored prior to removal? Will SOBE purchase tire chunks that have steel removed or not?

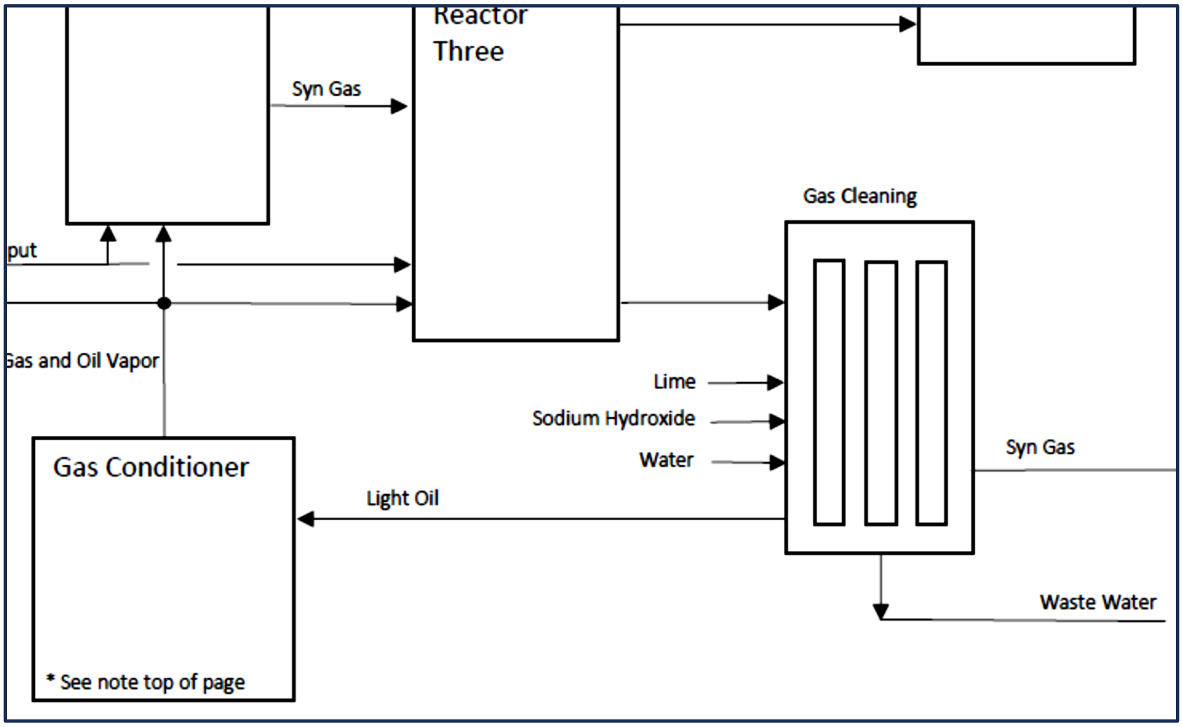



Figure – Snapshot of the Thermolyzer Flow Diagram showing pathway of gas cleaning to produce 'syn gas', 'light oil', and wastewater.

**Note:** Syn gas from 'gas cleaning' goes to boilers (shown on full diagram) – no pathway for excess or below-grade syn gas directed to flare for disposal in this diagram.

**Question:** Why is 'light oil' only directed to 'gas conditioner' and not the 'syn gas' prior to use in the boiler?

**Question:** What is the quantity and composition of "syn gas and oil vapor" from the 'gas conditioner' directed to Reactor 2?

**Question:** Where are the emissions calculations for (a) Gas Cleaning system, (b) Gas Conditioning system, (c) the conveyance of syngas (pipes and fittings), and (d) Wastewater Treatment system?

**Question:** How much water is required for Reactor 1? Will they use water from the wastewater treatment system or fresh water?

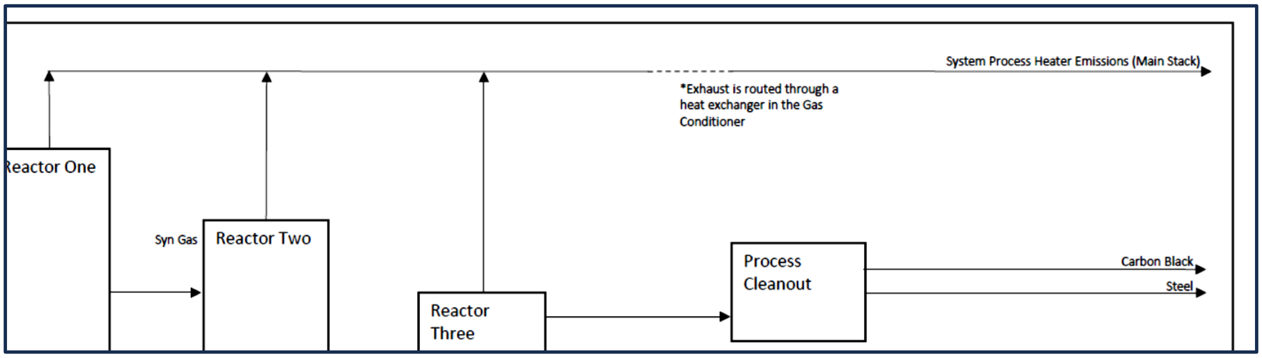



Figure – Snapshot of Thermolyzer Flow Diagram showing inputs to “main stack”

**Note:** From the Flow Diagram it appears the “Main Stack” received syngas from all three Reactors and thus could be receiving various versions of unrefined syngas.

**Question:** Why didn’t OEPA require more detailed information for the “Main Stack”? What is its purpose? What is the destruction efficiency for all applicable air pollutants of the Main Stack?

**Question:** Did OEPA draft the PTI/PTO assuming the gaseous emissions from Reactor One would be different than from Reactor Two and Three or that it would resemble the final unrefined syngas prior to cleaning and conditioning?

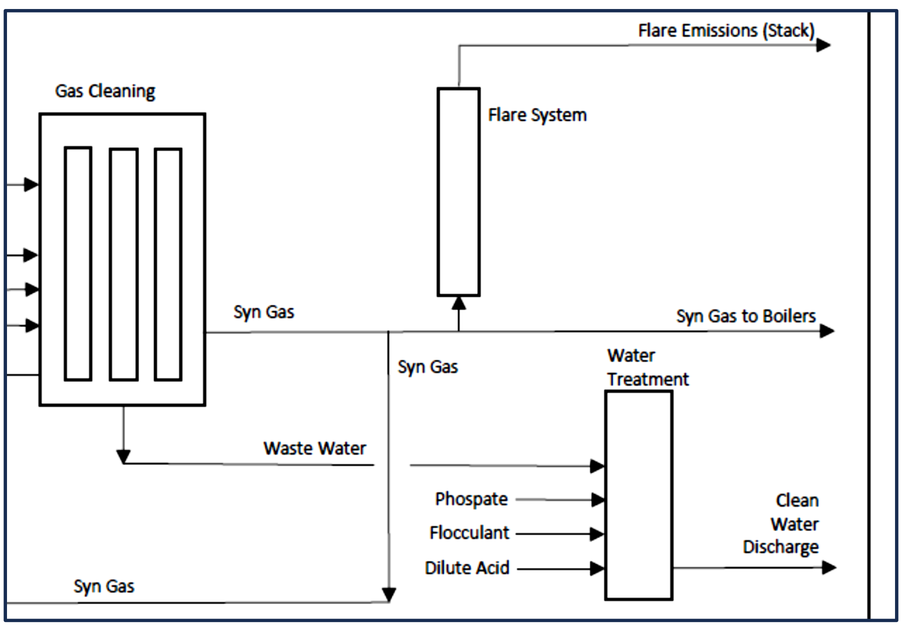



Figure – Snapshot of Thermolyzer Flow Diagram showing Flare and Wastewater treatment systems.

**Question:** Why didn’t the OEPA require a more detailed narrative that describes how the various components will be relied upon to remove pollutants prior to exhaust from the Main Stack and Flare?

# Youngstown Thermal Emissions Report (2020)

**Filename:** SOBE Thermal Thermolyzer Emissions Estimates 10_30_20 8 9 ofa

**From page 3 of 9:**

> "Youngstown Thermal, LLC (Youngstown Thermal) operates four steam boilers at its steam plant:
> - B001 - 113 million British thermal units per hour (MMBtu/hr) dual-fueled (natural gas or oil) Vogt steam boiler
> - B002 and B003 - two 113 MMBtu/hr dual-fueled (natural gas or coal) Vogt steam boilers
> - B004 - one natural gas-fired package boiler
>
> Youngstown Thermal is proposing a two-phase modernization program to recover energy from waste tires in an environmentally responsible manner. In Phase 1, one CHZ Technologies "Thermolyzer" will be installed. The Thermolyzer is designed to produce synthetic gas (syngas) from the pyrolysis of shredded waste tire feedstock (as well as alternative waste feedstocks in the future). Also in Phase 1, boilers B001, B002, and B003 will be replaced by three 40.46 MMBtu/hr dual-fueled (natural gas or syngas) Victory steam boilers. In
>
> Phase 2, two additional Thermolyzers will be installed. The purpose of this report is to provide air emissions estimates for the Thermolyzers.
>
> Each Thermolyzer's rated heat input will be 62.2 MMBtu/hr. A Thermolyzer will fire natural gas during startup, and syngas when it reaches full operating conditions."

**Note:** This report was written before the demolition of the Youngstown Thermal steam plant and the removal of existing boilers. It does not mention Boiler #5 which was in operation in 2021. It does not seem to include the 2 boilers permitted by rule.

**Question:** Would the emissions from the 2 additional Thermolyzers (Phase 2) change whether this facility would be a natural minor or synthetic minor air permit?

> "Syngas Composition –
> Table 1 presents the composition of six syngas samples collected from a CHZ Technologies Thermolyzer test facility in May 2017, which is described in Reference 1. The feedstock during the test was tires shredded to a size of one inch or smaller.
> Table 2 presents the concentrations of impurities measured in a syngas sample collected during the May 2017 testing.
> Table 3 presents the projected syngas composition when the Thermolyzer uses shredded tires as feedstock.

These data were obtained from Reference 2, which also provides emission estimates for the Victory boilers when firing natural gas and syngas.
Table 4 presents calculations of the higher heating value (HHV) of the projected syngas along with the carbon dioxide (CO2) emission factor."

**Note:** Table 1 is provided in the earlier section of these comments.

**From page 6 of 9:** (Note the table number is incorrect – should be Table 2 not 3)

**Table 3: CHZ Technologies May 2017 Thermolyzer Test Syngas Impurities**

| Constituent | Concentration | Units |
|---|---|---|
| Total Sulfur | 30.1 | $mg/m^3$ |
| $H_2S$ | <.05 | Volume % |
| Chloride | 30.9 | $mg/m^3$ |
| Fluoride | ND | $mg/m^3$ |
| Ammonia | ND | $mg/m^3$ |
| Chromium | 0.09 | $mg/m^3$ |
| Copper | 0.1 | $mg/m^3$ |
| Nickel | 0.05 | $mg/m^3$ |
| Zinc | 81.1 | $mg/m^3$ |
| Vanadium | ND | $mg/m^3$ |
| Lead | 0.45 | $mg/m^3$ |
| Cadmium | 0.06 | $mg/m^3$ |
| Bismuth | 13.1 | $mg/m^3$ |
| Arsenic | ND | $mg/m^3$ |
| Antimony | ND | $mg/m^3$ |
| Boron | 0.09 | $mg/m^3$ |
| Aluminum | 1.64 | $mg/m^3$ |
| Calcium | 234.4 | $mg/m^3$ |
| Magnesium | 15.9 | $mg/m^3$ |
| Potassium | 12.9 | $mg/m^3$ |
| Sodium | 23.2 | $mg/m^3$ |
| Mercury | ND | $mg/m^3$ |

Figure – Snapshot of impurities in May 2017 Thermolyzer test syn gas.

**Note:** Highest concentrations of impurities include Total Sulfur, Chloride, Zinc, Bismuth, Calcium, Magnesium, Potassium, and Sodium.
Lesser concentrations of heavy metals include Chromium, Copper, Nickel, Lead, Cadmium, and Boron.

**Question:** Are these heavy metal impurities removed by the Gas Cleaning process and then end up in the wastewater? How is the wastewater regulated by OEPA?

**From page 7 of 9 (the true Table 3):**

**Table 3: Projected Thermolyzer Syngas Composition with Shredded Tire Feedstock**

| Constituent | Volume (%) |
|---|---|
| $H_2$ | 30.80 |
| $O_2$ | - |
| $N_2$ | - |
| $CH_4$ | 47.25 |
| $CO_2$ | 5.00 |
| CO | 3.10 |
| $C_2H_6$ | 3.00 |
| $C_2H_4$ | 8.50 |
| $C_3H_8$ | 0.12 |
| $C_3H_6$ | 1.60 |
| $C_8H_{18}$ | 0.63 |
| Total | 100.00 |
| Source: Reference 2 | |

Thermolyzer Syngas

| | |
|---|---|
| Methane | 47.25% |
| Hydrogen | 30.80% |
| Ethene | 8.50% |
| Carbon Dioxide | 5.0% |
| Carbon Monoxide | 3.10% |
| Ethane | 3.0% |
| Propene | 1.60% |
| Octane | 0.63% |

Assumes removal of impurities including water, hydrogen gas and aromatics.

Figure – Snapshot of Table 3 showing 30% hydrogen and 47.25% methane

**Note:** Does not include aromatics so assumed to be 'cleaned and conditioned' syn gas.

**Question:** Report refers to Reference 1 for data in Table 1 and Reference 2 for data in Table 3 (highlighted below) both of which appear to be memos authored by Ferro and Conway. Did OEPA review copies of the memos and why are they not included in the PTI/PTO application materials?

**References on page 4 of 9:**

1. Test Results from CHZ Technologies Thermolyzer System, Letter from D. Ferro and M. Conway to J. Houle, August 15, 2017

2. Youngstown Thermal Summary of Existing Potential to Emit and Potential to Emit with New Boilers and Thermolyzer, Memo by D. Ferro and M. Conway, September 21, 2020

3. AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, January 1995 https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-fifth-edition-volume-ichapter-1-external-0

4. Alternative Control Techniques Document - NOx Emissions from Process Heaters, EPA-453/R-93-034, U.S. Environmental Protection Agency, September 1993 https://www3.epa.gov/ttncatc1/dir1/procheat.pdf

5. Uncontrolled Emission Factor Listing for Criteria Air Pollutants, Eastern Research Group, Inc., July 2001 https://www.epa.gov/sites/production/files/2015-08/documents/ii14_july2001.pdf

**From page 7 of 9:**

**Table 4: Syngas Heating Value and $CO_2$ Emissions**

| Syngas Constituent | Volume (%) | Constituent HHV (Btu/ft$^3$) | Btu/ft$^3$ Syngas | ft$^3$ $CO_2$/ ft$^3$ Constituent Combusted | ft$^3$ $CO_2$/ ft$^3$ Syngas Combusted | $CO_2$ (lb/mmcf Syngas Combusted) |
|---|---|---|---|---|---|---|
| $H_2$ | 30.80 | 274.6[1] | 84.6 | - | - | - |
| $CH_4$ | 47.25 | 912.0[1] | 430.9 | 1.0 | 0.473 | 54,824 |
| $CO_2$ | 5.00 | - | - | 1.0 | 0.050 | 5,801 |
| CO | 3.10 | 321.9[1] | 10.0 | 1.0 | 0.031 | 3,597 |
| $C_2H_6$ | 3.00 | 1,639.0[1] | 49.2 | 2.0 | 0.060 | 6,962 |
| $C_2H_4$ | 8.50 | 1,512.0[1] | 128.5 | 2.0 | 0.170 | 19,725 |
| $C_3H_8$ | 0.12 | 2,385.0[1] | 2.9 | 3.0 | 0.004 | 418 |
| $C_3H_6$ | 1.60 | 2,185.0[1] | 35.0 | 3.0 | 0.048 | 5,569 |
| $C_8H_{18}$ | 0.63 | 6,247.3[2] | 39.4 | 8.0 | 0.050 | 5,848 |
| Total | 100.00 | | 780.3 | | 0.886 | 102,744 |

1. *Steam: Its Generation and Use*, 40th Edition, Babcock and Wilcox, Page 9-2
2. *Fundamentals of Combustion Processes*, S. McAllister et al., Springer Science + Business Media, LLC, 2011 https://link.springer.com/content/pdf/bbm%3A978-1-4419-7943-8%2F1.pdf, page 244

Figure – Snapshot of Table 4 from the Youngstown Thermal report (green arrow points to syngas constituent values purportedly derived from Reference 2).

**From page 244 Fundamentals of Combustion Processes:**

244

| Formula | Fuel | M (kg/kmol) | $T_b$ (°C) | $c_{pg}$[a] (kJ/kg-K) | $T_{ig}$ (°C) | HHV (MJ/kg) | LHV (MJ/kg) | $h_{fg}$[b] (kJ/kg) | AFRs | $T_f$ (K)[c] | $\Delta\hat{h}^0$ (kJ/mol) | RON[d] | MON[e] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $CH_4$ | Methane | 16.04 | −161 | 2.21 | 537 | 55.536 | 50.048 | 510 | 17.2 | 2,226 | −74.4 | 120 | 120 |
| $C_2H_2$ | Acetylene | 26.04 | −84 | 1.60 | 305 | 49.923 | 48.225 | – | 13.2 | 2,540 | 8.7 | 50 | 50 |
| $C_2H_4$ | Ethylene | 28.05 | −104 | 1.54 | 490 | 50.312 | 47.132 | – | 14.7 | 2,380 | 52.4 | – | – |
| $C_2H_6$ | Ethane | 30.07 | −89 | 1.75 | 472 | 51.902 | 47.611 | 489 | 16.1 | 2,370 | −83.8 | 115 | 99 |
| $C_3H_8$ | Propane | 44.10 | −42 | 1.62 | 470 | 50.322 | 46.330 | 432 | 15.7 | 2,334 | −104.7 | 112 | 97 |
| $C_4H_{10}$ | n-Butane | 58.12 | −0.5 | 1.64 | 365 | 49.511 | 45.725 | 386 | 15.5 | 2,270 | −146.6 | 94 | 90 |
| $C_4H_{10}$ | iso-Butane | 58.12 | −12 | 1.62 | 460 | 49.363 | 45.577 | 366 | 15.5 | 2,310 | −153.5 | 102 | 98 |
| $C_5H_{12}$ | n-Pentane | 72.15 | 36 | 1.62 | 284 | 49.003 | 45.343 | 357 | 15.3 | 2,270 | −173.5 | 62 | 63 |
| $C_5H_{12}$ | iso-Pentane | 72.15 | 28 | 1.60 | 420 | 48.909 | 45.249 | 342 | 15.3 | 2,310 | −178.5 | 93 | 90 |
| $C_6H_{14}$ | n-Hexane | 86.18 | 69 | 1.62 | 233 | 48.674 | 45.099 | 335 | 15.2 | 2,271 | −198.7 | 25 | 26 |
| $C_6H_{14}$ | iso-Hexane | 86.18 | 50 | 1.58 | 421 | 48.454 | 44.879 | 305 | 15.2 | 2,300 | −207.4 | 104 | 94 |
| $C_7H_{16}$ | n-Heptane | 100.20 | 99 | 1.61 | 215 | 48.438 | 44.925 | 317 | 15.2 | 2,273 | −224.2 | 0 | 0 |
| $C_8H_{18}$ | n-Octane | 114.23 | 126 | 1.61 | 206 | 48.254 | 44.786 | 301 | 15.1 | 2,275 | −250.1 | 20 | 17 |
| $C_8H_{18}$ | iso-Octane | 114.23 | 114 | 1.59 | 418 | 48.119 | 44.651 | 283 | 15.1 | 2,300 | −259.2 | 100 | 100 |
| $C_9H_{20}$ | n-Nonane | 128.6 | 151 | 1.61 | – | 48.119 | 44.688 | 295 | 15.1 | 2,274 | −274.7 | – | – |
| $C_{10}H_{22}$ | n-Decane | 142.28 | 174 | 1.61 | 210 | 48.002 | 44.599 | 277 | 15.1 | 2,278 | −300.9 | −41 | −38 |
| $C_{10}H_{22}$ | iso-Decane | 142.28 | 171 | 1.61 | – | 48.565 | 44.413 | – | 15.1 | 2,340 | – | 113 | 92 |
| $C_{12}H_{26}$ | n-Dodecane | 170.33 | 216 | 1.61 | 204 | 47.838 | 44.574 | 256 | 15.0 | 2,276 | −350.9 | −88 | −90 |
| $CH_4O$ | Methanol | 32.04 | 65 | 1.37 | 385 | 22.663 | 19.915 | 1,099 | 6.5 | 2,183 | −201.5 | 106 | 92 |
| $C_2H_6O$ | Ethanol | 46.07 | 78 | 1.42 | 365 | 29.668 | 26.803 | 836 | 9.0 | 2,144 | −235.1 | 107 | 89 |
| $H_2$ | Hydrogen | 2.02 | −253 | 14.47 | 400 | 141.72 | 119.96 | 451 | 34.3 | 2,345 | 0 | – | – |

[a] Gas phase specific heat evaluated at 25°C
[b] Heat of vaporization at 1 atm
[c] Estimated equilibrium flame temperature
[d] Research octane number
[e] Motoring octane number

Appendix 1

Figure – Snapshot of page 244 – which is also the first table in Appendix 1. Yellow arrow points to data for C8H18 n-octane and iso-octane.

**Table 4 Reference 2** (not to be confused with Report Reference 2):
Link: https://link.springer.com/content/pdf/bbm:978-1-4419-7943-8/1.pdf
**Filename:** Reference 2  Table 4 Properties of Fuels 56 pgs

**Fundamentals of Combustion Processes** (book includes Appendix 1)
**Link:** https://experimentsitestoil.weebly.com/uploads/1/0/1/9/10190142/2-sara_mcallister_jyh-yuan_chen_a._carlos_fernandez-pello_fundamentals_of_combustion_processes.pdf
**Filename:** Reference 2 Fundamentals of Combustion Processes 315 pgs

**Note:** a search for “tire” in Appendix 1 – Properties of Fuels produced zero search results.

**Question:** What data was obtained from “Table 4 Reference 2” to determine the Btu/ft3 value for octane in Report Table 4?

**From page 9 of 9:**

**Table 6: Estimated Thermolyzer Emissions**

| Operating Schedule (hr/yr) | | Heat Input | 62.2 mmBtu/hr |
|---|---|---|---|
| Natural Gas | 760 | | |
| Syngas Gas | 8,000 | | |

| Pollutant | Natural Gas | | | Syngas | | | Annual Emissions (tpy) |
|---|---|---|---|---|---|---|---|
| | Emission Factor (lb/mmBtu) | Ref. | Emissions (lb/hr) | Emission Factor (lb/mmBtu) | Ref. | Emissions (lb/hr) | |
| $NO_x$ | 0.0980 | 1 | 6.10 | 0.2100 | 6 | 8.50 | 54.57 |
| $PM_{10}$ | 0.0075 | 2 | 0.46 | 0.0154 | 7 | 0.62 | 4.00 |
| $PM_{2.5}$ | 0.0075 | 2 | 0.46 | 0.0154 | 7 | 0.62 | 4.00 |
| CO | 0.0824 | 1 | 5.12 | 0.0449 | 7 | 1.81 | 13.11 |
| VOC | 0.0029 | 2 | 0.18 | 0.0036 | 7 | 0.15 | 0.96 |
| $SO_2$ | 0.0014 | 3,4 | 0.09 | 0.0048 | 7 | 0.19 | 1.23 |
| $CO_2$ | 117.0 | 5 | 7,276 | 131.7 | 7 | 5,327 | 35,523 |

1. AP-42 Table 1.4-1
2. AP-42 Table 1.4-2
3. Fuel sulfur content = 0.50 grains/100 scf
4. 40 CFR §72.2
5. 40 CFR 98 Subpart C, Table C-1
6. EPA-453/R-93-034, September 1993 https://www3.epa.gov/ttncatc1/dir1/procheat.pdf
7. Table 5

Figure – Snapshot of estimated emissions of natural gas and syngas.

**The following are URL links for the references in Table 4**

**AP-42 Table 1.4-1 and 1.4-2**
Link: https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf

**40 CFR 72.2**
Link: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-72/subpart-A/section-72.2

**Search for definitions that refer to SO2 or sulfur dioxide:**

> *Flue gas desulfurization system* means a type of add-on emission control used to remove sulfur dioxide from flue gas, commonly referred to as a "scrubber."
>
> *Most stringent federally enforceable emissions limitation* means the most stringent emissions limitation for a given pollutant applicable to the unit, which has been approved by the Administrator under the Act, whether in a State

implementation plan approved pursuant to title I of the Act, a new source performance standard, or otherwise. To determine the most stringent emissions limitation for sulfur dioxide, each limitation shall be converted to lbs/MMBtu, using the appropriate conversion factors in appendix B of this part; *provided* that for determining the most stringent emissions limitation for sulfur dioxide for 1985, each limitation shall also be annualized, using the appropriate annualization factors in appendix A of this part.

*Offset plan* means a plan pursuant to part 77 of this chapter for offsetting excess emissions of sulfur dioxide that have occurred at an affected source in any calendar year.

*Qualifying Phase I technology* means a technological system of continuous emission reduction that is demonstrated to achieve a ninety (90) percent (or greater) reduction in emissions of sulfur dioxide from the emissions that would have resulted from the use of fossil fuels that were not subject to treatment prior to combustion, as provided in § 72.42.

*Spot allowance* means an allowance that may be used for purposes of compliance with a source's Acid Rain sulfur dioxide emissions limitation requirements beginning in the year in which the allowance is offered for sale.

*Sulfur-free generation* means the generation of electricity by a process that does not have any emissions of sulfur dioxide, including hydroelectric, nuclear, solar, or wind generation. A "sulfur-free generator" is a generator that is located in one of the 48 contiguous States or the District of Columbia and produces "sulfur-free generation."

**Question:** Which definition In 40 CFR 72.2 was relied upon?

**EPA-453/R-93-034,** Alternative Control Techniques Document—NO Emissions from Process Heaters (Revised) **September 1993**
**Link:** https://www3.epa.gov/ttncatc1/dir1/procheat.pdf
**Filename:** 1993 EPA Alternative Control NOx Process Heaters 316 pgs

**Note:** The author of the report did not provide a page number or other indicator of where they found the Emission Factor for syngas to be 0.2100 lbs NOx/MMBtu. Considering the document was published in 1993, chances are there isn't any waste-tire derived syngas data or emission factors. It is not helpful that the author did not provide a page number when the document has over 300 pages.

**QuestIon:** Did OEPA investigate the reference provided for the emission factor of **0.2100 lbs NOx per million Btu** for waste-tire derived syn gas?

**On pages 106 to 108 of 316:**

"4.3.1 Uncontrolled NO Emissions
AP-42 provides uncontrolled emission factors for process heaters and boilers classified by the heat input rate, using the higher heating value for the type of fuel burned. These 23 emission factors, shown in Table 4-1, are based on test data for boilers. Three ranges of heat rates were defined for gas-fired units, two ranges of heat rates were defined for distillate oil-fired units, and three ranges of heat rates were defined for residual oil-fired units. Uncontrolled NO emission factors were reported for each of the ranges of heat rates for each fuel."

**TABLE 4-1. AP-42 ESTIMATES FOR UNCONTROLLED $NO_x$ EMISSIONS FROM BOILERS AND PROCESS HEATERS[23]**

| Heat rate, MMBtu/hr | Fuel | $NO_x$ emission factor | |
|---|---|---|---|
| | | ng/J[a] | lb/MMBtu |
| <10 | Natural gas | 41 | 0.10 |
| 10-100 | Natural gas | 58 | 0.14 |
| >100 | Natural gas | 228 | 0.53 |
| <10 | Distillate oil[b] | 63 | 0.15 |
| | Residual oil[c] | 162 | 0.38 |
| 10-100 | Distillate oil[b] | 63 | 0.15 |
| | Residual oil[c] | 162 | 0.38 |
| >100 | Residual oil[c] | 197 | 0.46 |

[a]ng/J = nanogram per Joule
[b]Distillate oils include Nos. 1 and 2 fuel oils.
[c]Residual oils include Nos. 4, 5, and 6 fuel oils.

Figure – Snapshot of NOx emission factors in 1993 document refers to AP-42

**Note:** none of the emission factors in 1993 document equal 0.2100 lbs NOx/MMBtu
**Note:** The AP-42 values that existed in 1993 were published before the 1998 background document was published, thus those values would be outdated.

**Emission Factor Documentation for AP-42 Section 1-4 Natural Gas Combustion**
Link: https://www.epa.gov/sites/default/files/2020-09/documents/background_document_ap-42_section_1.4_natural_gas_combustion.pdf
Published March 1998 (48 pages).

**Question:** Why would the Youngstown Thermal emissions report rely upon 30 year old EPA publications that pre-date current AP-42 emission factors for natural gas combustion?

**40 CFR 98 Subpart C, Table C-1**
**Link:** https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-98/subpart-C
**Filename:** 40 CFR Part 98 Subpart C mandatory GHG reporting 48 pgs

117 lbs CO2/MMBtu for natural gas (where 1lb CO2 = 0.4536 kg CO2)
53.06 kg CO2/MMBtu x 1 lb CO2/0.4536 kg CO2 = 116.9 lbs CO2/MMBtu

**Table C–1 to Subpart C of Part 98—Default $CO_2$ Emission Factors and High Heat Values for Various Types of Fuel**

Default $CO_2$ Emission Factors and High Heat Values for Various Types of Fuel

| Fuel type | Default high heat value | Default $CO_2$ emission factor |
| --- | --- | --- |
| Natural gas | mmBtu/scf | kg $CO_2$/mmBtu |
| (Weighted U.S. Average) | $1.026 \times 10^{-3}$ | 53.06 |

Figure – Snapshot of Table C-1 showing CO2 emission factor for natural gas.

**From page 3 of 9** (Youngstown Thermal Emissions Report):

> "Unlike natural gas-fired boilers and heaters, there are no standard AP-42 (Reference 3) emission factors for the combustion of tire-derived syngas. Petroleum refinery process gas[1] resembles syngas in that both are mixtures of mostly hydrocarbons (primarily methane), hydrogen (H2), carbon monoxide (CO), and CO2. Refinery process gas typically "burns hotter" than natural gas in similar applications. Reference 4 is a U.S. Environmental Protection Agency (EPA) report concerning nitrogen oxides (NOx) control technologies for process heaters. On page 2-2 Reference 4 states, "Refinery fuel gas firing generally yields higher thermal NOx formation than natural gas firing due to the higher flame temperatures caused by the higher hydrogen content of the refinery fuel gas." It is reasonable to assumed that Thermolyzer-produced syngas combustion will resemble refinery process gas combustion and result in similar emissions. Therefore, this report will use criteria pollutant emissions factors for refinery fuel gas combustion to estimate criteria pollutant emissions for syngas combustion."

**Definition provided in report:**

> "40 CFR 60 101(c) defines process gas means as "any gas generated by a petroleum refinery process unit, except fuel gas and process upset gas as defined in this section."

**Question:** Why would the author assume that the syngas would not be cleaned to resemble natural gas more closely (e.g., remove hydrogen prior to use in the boilers)?

**From page 3 of 9 Youngstown Thermal Report:**

Based this EPA report, $NO_x$ emission with syngas firing will be estimated using an emission factor of 0.210 pounds per million British thermal units per hour (lb/mmBtu/hr).

Reference 5 on page 14.A-6 lists the following emission factors for the external combustion of refinery process gas in an industrial boiler (EPA Source Category Code 1-02-007-01):

- PM no larger than 2.5 microns ($PM_{2.5}$) — 3.0 pounds per million cubic feet (lb/mmcf)
- PM no larger than 10 microns ($PM_{10}$) — 3.0 lb/mmcf
- CO — 35 lb/mmcf
- VOC — 2.8 lb/mmcf

PM consists of condensable and filterable fractions. The PM emission factors listed above include only the filterable fraction. AP-42 Table 1.4.2 provides emission factors for natural gas combustion in boilers. It lists emission factors for condensable and filterable PM of 5.7 and 1.9 lb/mmcf, respectively. Therefore, a 3 to 1 ratio of condensable to filterable PM is assumed for syngas combustion.

Figure – Snapshot of the report where it discusses Reference 5

**Report Reference 5:**

5. Uncontrolled Emission Factor Listing for Criteria Air Pollutants, Eastern Research Group, Inc., July 2001 https://www.epa.gov/sites/production/files/2015-08/documents/ii14_july2001.pdf

**Filename:** 2001 Uncontrolled Emission Factor Listing for Criteria Air Pollutants 397 pgs

**From page 3 of 397:**

"DISCLAIMER
Note: The emission factors presented in this document were taken from the Factor Information Retrieval (FIRE) database management system, version 6.23. The information in this document is not intended to serve as new guidance or policy and does not take the place of Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, Fifth Edition, AP-42."

# Boiler Specifications and Emissions

**Filename:** 3101_Fuel_Burning_Emission Activity Category_SOBE Boiler 6 3 pgs

1. Type of fuel burning equipment:

   a. ☒ Boiler ☐ Process Heater ☐ Furnace ☐ Other (specify):

   b. Primary purpose to produce: ☐ Power ☒ Heat

   c. Heat Transfer: ☐ Direct (products of combustion come into contact with process materials, e.g., rotary drying kiln); or

   ☒ Indirect (a barrier prevents products of combustion from coming into contact with process materials, e.g., boiler or furnace)

2. Maximum Operating Schedule: 24 hours per day 358 days per year

If the schedule is less than 24 hours/day or 365 days/year, what limits the schedule to less than maximum? (*See instructions for examples):* Maintenance activity

Figure – Snapshot of Form 3101 Emission Activity Category – Boiler

Equipment Manufacturer: Victory Energy
Model No: VS-4-51 Model Year: 2015 Serial Number: 12665-1

4. Heat Input Capacity – Higher Heating Value – HHV (million Btu/hr):

| **Rated** *(Indicate units if other than mmBtu/hr)* | **Maximum** *(Indicate units if other than mmBtu/hr)* | **Normal** *(Indicate units if other than mmBtu/hr)* |
|---|---|---|
| 55 | 55 | 44 |

Figure – Snapshot of Form 3101 showing Heat Input Capacity

5. Boilers: Steam Output Capacity:

| **Rated** *(lb steam/hr)* | **Maximum** *(lb steam/hr)* | **Normal** *(lb steam/hr)* |
|---|---|---|
| **46030** | **46030** | **36824** |
| **Steam Pressure** *(PSI)* | **Steam Temperature** *(Fahrenheit)* | **Feedwater Temperature** *(Fahrenheit)* |
| **145** | **369** | **294** |

Is the boiler equipped with an economizer? ☒ Yes ☐ No

Figure – Snapshot of Form 3101 showing Steam Output Capacity.

**Summary from Form 3101**
Boiler Rated Higher Heating Value (HHV) 55 MMBtu/hr (max 55; normal 44 MMBtu/hr)
Boiler Steam Rated 46,030 lbs steam/hr (mac 46,030; normal 36,824 lbs steam/hr)
Boiler pressure 145 psi Steam Temp 369 F Feedwater Temp 294 F

From page 2 of 3 of Form 3100:

10. Type of Fuel Fired (Complete all that apply):

| Fuel* | Fired as... | Min. Heat Content (Btu/unit) | Max. % Ash | Max. % Sulfur | Max. Annual Fuel Use | Average Hourly Fuel Use | Maximum Hourly Fuel Use |
|---|---|---|---|---|---|---|---|
| Coal | ☐ Primary<br>☐ Backup | | % | % | tons | lbs | lbs |
| No. 2 Fuel Oil | ☐ Primary<br>☐ Backup | | % | % | gal | gal | gal |
| Ultra low sulfur diesel fuel | ☐ Primary<br>☐ Backup | | % | 15 ppm# (0.0015) | gal | gal | gal |
| Other liquid fuel | ☐ Primary<br>☐ Backup | | % | % | gal | gal | gal |
| Natural Gas | ☐ Primary<br>☒ Backup | 1027 | | <5*% | 66,835,443 $ft^3$ | 42,843 $ft^3$ | 53554 $ft^3$ |
| Wood | ☐ Primary<br>☐ Backup | | % | % | tons | lbs | lbs |
| LPG | ☐ Primary<br>☐ Backup | | | % | gal | gal | gal |
| Other** | ☒ Primary<br>☐ Backup | 780 | 0% | 0% | 506,000,000 | 56,410 | 70,512 |

Figure – Snapshot of characteristics of Fuel Fired from Form 3100.

**From page 3 of 3 in reference to the Other** entry:**

** Identify other fuel(s):
Tire derived synthetic gas, measurements above are noted per cubic foot of fuel"

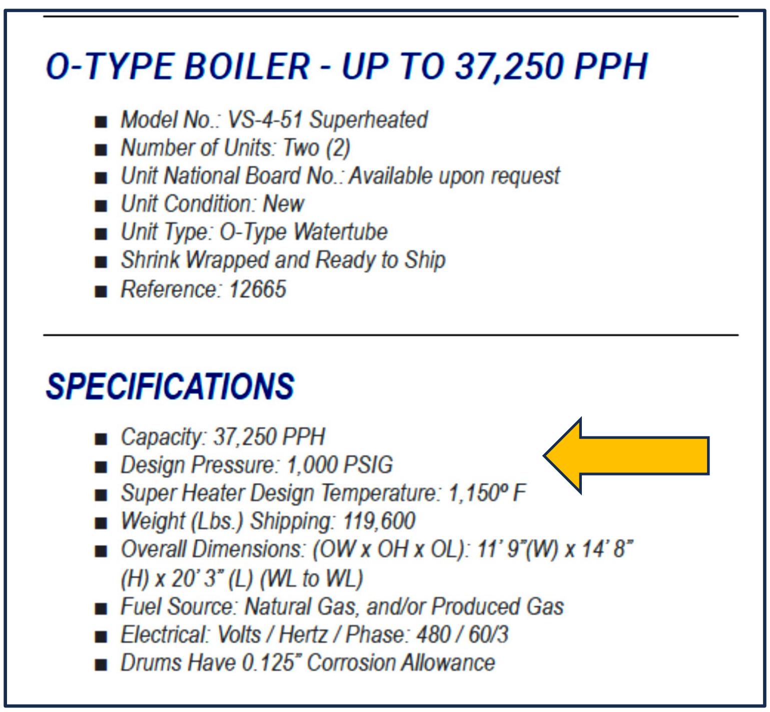
**Note:** Primary Fuel = Tire-derived Synthetic Gas 506 million cu ft per year
Backup Fuel = natural gas 66.8 million cu ft per year

**Question:** How much waste-tire feedstock is needed to generate 506 million cu ft per year "tire-derived synthetic gas" that is of sufficient quality to operate the boilers?

**A search on the Victory Energy website for Model No. VS-4-52:**
Link: [https://victoryenergy.com/fa-content/uploads/2020/03/VEO-IN-STOCK-INVENTORY_03-31-2020.pdf](https://victoryenergy.com/fa-content/uploads/2020/03/VEO-IN-STOCK-INVENTORY_03-31-2020.pdf)
Filename: Victory Energy Boiler IN-STOCK-INVENTORY_03-31-2020 9 pgs

From the brochure Model No. VS-4-51:

Figure – Snapshot of VS-4-51 boiler manufactured by Victory Energy



## O-TYPE BOILER - UP TO 37,250 PPH

- *Model No.: VS-4-51 Superheated*
- *Number of Units: Two (2)*
- *Unit National Board No.: Available upon request*
- *Unit Condition: New*
- *Unit Type: O-Type Watertube*
- *Shrink Wrapped and Ready to Ship*
- *Reference: 12665*

## SPECIFICATIONS

- *Capacity: 37,250 PPH*
- *Design Pressure: 1,000 PSIG*
- *Super Heater Design Temperature: 1,150º F*
- *Weight (Lbs.) Shipping: 119,600*
- *Overall Dimensions: (OW x OH x OL): 11' 9"(W) x 14' 8" (H) x 20' 3" (L) (WL to WL)*
- *Fuel Source: Natural Gas, and/or Produced Gas*
- *Electrical: Volts / Hertz / Phase: 480 / 60/3*
- *Drums Have 0.125" Corrosion Allowance*

**Summary from Form 3101**
Boiler Rated Higher Heating Value (HHV)
55 MMBtu/hr
(max 55; normal 44 MMBtu/hr)

Boiler Steam Rated
46,030 lbs steam/hr
(max 46,030; normal 36,824 lbs steam/hr)

Boiler pressure 145 psi
Steam Temp 369 F
Feedwater Temp 294 F

Note the differences

Figure – Snapshot of Specifications of Model No. VS-4-51 from brochure:

# Thermolyzer and Flare Specifications

**Filename:** PTIPTIO SOBE app sec2 Thermolyzer 1 Specific Source Info 13 pgs

> "Section II - Specific Air Contaminant Source Information
> One copy of this section should be filled out for each air contaminant source (emissions unit) covered by this PTI/PTIO application identified in Section I, Question 5. See the application instructions for additional information."

**From page 1 of 13:**

1. **Air Contaminant Source Installation or Modification Schedule** – Check all that apply (must be completed regardless of date of installation or modification):

   ☒ New installation (for which construction has not yet begun, in accordance with OAC rule 3745-31-33).
   When will you begin to install the air contaminant source?
   (month/year) _____ **OR** ☒ after installation permit has been issued

Figure -Snapshot of Thermolyzer 1 – new installation (box checked).

**From page 2 of 13:**

2. **SCC Codes** - List all Source Classification Code(s) (SCC) that describe the process(es) performed by this air contaminant source (e.g., 1-02-002-04). https://ofmpub.epa.gov/sccsearch/

   39900701 _____ _____ _____ _____

Figure – Snapshot of SCC Code entry for Thermolyzer.

> SCC 39900701 = Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, **Process Gas**

**Online list of SCC Codes:**
https://business.deq.louisiana.gov/Eric/EricCommon/SCCReference

| | |
|---|---|
| 39900501 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Distillate Oil |
| 39900601 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Natural Gas |
| 39900701 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Process Gas |
| 39900711 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Refinery Gas |
| 39900721 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Digester Gas |
| 39900801 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Landfill Gas |
| 39901001 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, LPG |
| 39901601 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Methanol |
| 39901701 | Industrial Processes, Miscellaneous Manufacturing Industries, Process Heater/Furnace, Gasoline |

Figure – Snapshot of available SCC codes for Process Heater/Furnace using various fuels (distillate oil, natural gas, process gas, refinery gas, digester gas, landfill gas, LPG, methanol, and gasoline).

**From page 2 of 13:** (Instructions on form)

> "Emissions Information - The following table requests information needed to determine the applicable requirements and the compliance status of this air contaminant source with those requirements. Suggestions for how to estimate emissions may be found in the instructions to the Emissions Activity Category (EAC) forms required with this application. If you need further assistance, contact your District Office/Local Air Agency representative.
>
> > • If total potential emissions of any Toxic Air Contaminant (as identified in OAC rule 3745-114-01) are greater than 1 ton/yr, fill in the table for that (those) pollutant(s). For all other pollutants, including all Hazardous Air Pollutants, include all of the emissions data regardless of potential emissions levels."

| Pollutant | Emissions before controls (max)* (lb/hr) | Actual emissions* (lb/hr) | Actual emissions* (ton/year) | Requested Allowable* (lb/hr) | Requested Allowable* (ton/year) |
|---|---|---|---|---|---|
| **Particulate emissions (PE/PM) (formerly particulate matter, PM)** | | | | | |
| **PM # 10 microns in diameter (PE/$PM_{10}$)** | 0.1876 | | | .1876 | .79 |
| **PM # 2.5 microns in diameter (PE/$PM_{2.5}$)** | 0.01463 | | | .01463 | 0.75 |
| **Sulfur dioxide ($SO_2$)** | .0585 | | | .0585 | .25 |
| **Nitrogen oxides ($NO_x$)** | 2.55 | | | 2.55 | 10.76 |
| **Carbon monoxide (CO)** | .5469 | | | .5469 | 2.31 |
| **Organic compounds (OC)** | 0 | | | | 0 |
| **Volatile organic compounds (VOC)** | .0439 | | | .0439 | .18 |
| **Lead (Pb)** | 0 | | | | 0 |
| **Total Hazardous Air Pollutants (HAPs)** | 0 | | | | 0 |
| **Highest single HAP:** | 0 | | | | 0 |
| **Toxic Air Contaminants (see instructions):** | 0 | | | | 0 |

Figure – Snapshot of emissions listed on form for Thermolyzer

**Note:** Total Hazardous Air Pollutants (HAPs) emissions before controls is listed as zero but the Thermolyzer test data indicated production of benzene and aromatics which are hazardous air pollutants and air toxics.

**USEPA list of Hazardous Air Pollutants (HAPs) under the Clean Air Act**
**Link:** https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications

| | |
|---|---|
| 71432 | Benzene (including benzene from gasoline) |

Figure – Snapshot of HAPs table showing CAS number and chemical name Benzene

**From Youngstown Thermal report on Thermolyzer Table 1:**

| | | | | | |
|---|---|---|---|---|---|
| $H_2O$ | 3.00 | 3.00 | 3.00 | Insufficient Data | 3.0 |
| Benzene, Aromatics, Olefin | 0.8 | 0.3 | 1.8 | | 1.0 |

Figure – Snapshot of benzene/aromatic concentration in syngas from Thermolyzer ranges from 0.3 to 1.8 percent of total syngas produced.

**Question:** Did the OEPA ask the applicant to further explain which aromatics would be produced during pyrolysis of waste tire shreds to make sure all the HAPs are properly identified and emission quantified?

**Note:** According to pubiished research, H2S is expected as follows:

> **2. Syngas Quality as a Key Factor in the Design of an Energy-Efficient Pyrolysis Plant for Scrap Tyres**
> **Link:** https://www.mdpi.com/2504-3900/2/23/1455
>
> "The evolved gaseous mixture obtained from the pyrolysis of waste tyres was examined several times and then carefully reviewed by Williams [12]. It is possible to assume, that the mixture consists of methane and other hydrocarbons (mainly paraffins and olefins), carbon oxides, hydrogen and small amounts of impurities. Approximately 20 vol.% of the gas is methane [12]. Additionally, pyrolytic gas contains noticeable amount of hydrogen sulfide (H2S) which is highly corrosive."

**Note:** see section on Journal Articles for more information from this article.

**Question:** Does OEPA ask why the Youngstown Thermal report does not include information about production of hydrogen sulfide (H2S) gas as an expected part of the pyrolysis process?

**Question:** Would H2S gas be directed to the "Main Stack" from the various reactors (according to the Thermolyzer Flow Diagram)?

**Question:** Does OEPA consider hydrogen sulfide (H2S) gas to be an Air Toxic?

**From page 7 of 13:**

☒ Flare
Manufacturer: KUG | Year installed: ____

**Your ID for control equipment:** Flare 1

Describe this control equipment: enclosed burner in flare stack

**Pollutant(s) controlled:** ☐ PE/PM ☐ PE/$PM_{10}$ ☐ PE/$PM_{2.5}$ ☐ OC ☐ VOC ☐ $SO_2$ ☐ $NO_x$ ☐ CO ☐ Pb ☒ Other pressure

**Estimated capture efficiency (%):** _____ Basis for efficiency: _____
**Design control efficiency (%):** _____ Basis for efficiency: _____
**Operating control efficiency (%):** _____ Basis for efficiency: _____

**Type:** ☒ **Enclosed** ☐ **Elevated (open)**
**If Elevated (open):** ☐ **Air-assisted** ☐ **Steam-assisted** ☐ **Non-assisted** ☐ **Ignition device:** ☐ **Electric arc** ☐ **Pilot flame**
**Flame presence sensor:** ☒ **Yes** ☐ **No**
Inlet gas flow rate (acfm): 705 Outlet gas flow rate (acfm): 705
Inlet gas temperature (°F): 77 Outlet gas temperature (°F): 481
☒ **This is the only control equipment on this air contaminant source**
**If not, this control equipment is:** ☐ Primary ☐ Secondary ☐ Parallel
List all other air contaminant sources that are also vented to this control equipment: _____
**List all egress point IDs (from Table 7-A) associated with this control equipment:** _____

Figure – Snapshot of Form listing control technology for the Thermolyzer (flare)

Inlet gas flow rate (acfm): 705 Outlet gas flow rate (acfm): 705
Inlet gas temperature (°F): 77 Outlet gas temperature (°F): 481

Type of Flare – enclosed
No egress point IDs provided (from Table 7-A)

**Note:** Manufacturer listed as "KUG" which can't be found easily using Google. The "pollutant' controlled by Flare 1 is listed as "other" and described as "pressure".

**From CHZ Technologies website:**

> "Chief Engineer - Ullrich H. Engel
> Subject matter expert in the field of gasification for more than 25 years, focusing on thermolytic gasification as an efficient way to convert biomass and hydrocarbon waste streams into a substitute gas for Natural Gas, clean power and/or liquid transportation fuels. Ullrich developed his own pilot plant for tire gasification in 1998. He was introduced to the new, evolutionary concept in pyrolytic gasification from KUG GMBH and joined CHZ Technologies, LLC to license and build the Thermolyzer™ technology for North America and elsewhere."

**Googling** KUG GMBH – no obvious results

GmbH is an abbreviation of the German phrase "Gesellschaft mit beschränkter Haftung," which means "company with limited liability."
https://www.investopedia.com/terms/g/gmbh.asp

**Question:** Why would OEPA permit a flare manufactured by a company with no internet presence, no letters of guarantee for flare destruction performance, and no proof of ability to manufacture a flare(s) suitable for the proposed facility?

**Question:** When they indicate "pressure" are they saying this flare only serves the purpose of a pressure relief valve for the entire Thermolyzer including all three Reactors? Why are no pollutant boxes checked? Will the flare emit untreated syngas without thermal destruction?

**Question:** Why isn't the gas cleaning process and the gas conditioning process listed?

**Question:** The flare is identified as 'the only control equipment for this air contaminant source (e.g., Thermolyzer 1). Why did they not identify the pollutants that would be controlled by "Flare 1"?

**Question:** Why didn't they list the egress point IDs from Table 7-A?

**From pages 10 and 11 of 13:** (Table 7-A)

> "Complete Table 7-A below for each stack emissions egress point. An egress point is a point at which emissions from an air contaminant source are released into the ambient (outside) air. List each individual egress point on a separate pair of lines. In each case, use the dimensions of the tallest nearby (or attached) building, building segment or structure. "
>
> "Type codes for stack egress points:
> A. vertical stack (unobstructed): There are no obstructions to upward flow in or on the stack such as a rain cap.
> B. vertical stack (obstructed): There are obstructions to the upward flow, such as a rain cap, which prevents or inhibits the air flow in a vertical direction.
> C. non-vertical stack: The stack directs the air flow in a direction which is not directly upward."

| Table 7-A, Stack Egress Point Information | | | | | | |
|---|---|---|---|---|---|---|
| **❶ Company ID for the Egress Point** | Type Code* | Dimensions or Diameter | Height from the Ground (ft) | Temp. at Max. Operation (F) | Flow Rate at Max. Operation (ACFM) | Minimum Distance to Fence Line (ft) |
| **Thermolyzer 1 Main Stack** | A | 24 | 100 | 482 | 12111 | 85 |
| **Company Description for the Egress Point** | Shape: round, square, rectangular | Cross Sectional Area | Base Elevation (ft) | Building Height (ft) | Building Width (ft) | Building Length (ft) |
| Thermolyzer 1 Main Stack | Round | 452.16 | 866 | 30 | 60 | 80 |

| Facility ID:______ | Emissions Unit ID:______ | Company Equipment ID: ______ | | | | |
|---|---|---|---|---|---|---|
| **Table 7-A, Stack Egress Point Information (continued)** | | | | | | |
| **❶ Company ID for the Egress Point** | Type Code* | Dimensions or Diameter | Height from the Ground (ft) | Temp. at Max. Operation (F) | Flow Rate at Max. Operation (ACFM) | Minimum Distance to Fence Line (ft) |
| Thermolyzer 1 Flare Stack | B | 10 | 50 | **482** | 712 | 75 |
| **Company Description for the Egress Point** | Shape: round, square, rectangular | Cross Sectional Area | Base Elevation (ft) | Building Height (ft) | Building Width (ft) | Building Length (ft) |
| Thermolyzer 1 Flare Stack | **Round** | **314** | **866** | 30 | 70 | 145 |

Figure – Snapshot of Table 7-A egress points for Thermolyzer 1 Main Stack and Flare.

> Thermolyzer 1 Main Stack = 24 inch diameter 100 feet tall
> Flow Rate = 12,111 acfm Temp = 482 °F
>
> Thermolyzer 1 Flare Stack = 10 inch diameter 50 feet tall
> Flow Rate = 712 acfm Temp = 482 °F

**Question:** Will they be shipping the Main Stack and Flare Stack from KUG in Germany? Who will assemble it in Youngstown OH? Who will guarantee the destruction efficiency of the flare? For which regulated air pollutants?

**Question:** Does the OEPA agree/claim that a flare temperature of 482 °F is sufficient to completely destroy hydrogen sulfide gas, aromatics, including benzene, and other hydrocarbons in the wasted syngas?

**From page 13 of 13:**

> "10. EAC Forms - The appropriate Emissions Activity Category (EAC) form(s) must be completed and attached for each air contaminant source unless a general permit is being requested. At least one complete EAC form must be submitted for each air contaminant source for the application to be considered complete. Refer to the list attached to the application instructions. Please indicate which EAC form corresponds to this air contaminant source.
>
> [Applicant] Please see attached EPA Form 3100 for the Thermolyzer, file name 311_Process_eac_SOBE Thermolyzer 1 091222

**Note:** EAC = emission activity category

**Filename:** 3100_Process_Emission Activity Category SOBE Thermolyzer 3 pgs

**From page 1 of 3:**

> "*Maximum Operating Schedule*: 24 hours per day ;351 days per year
> *If the schedule is less than 24 hours/day or 365 days/year, what limits the schedule to less than maximum?* See instructions for examples.
> [answer] The unit needs to be shut down for maintenance."

**From page 2 of 3:**

Materials used in process at maximum hourly production rate (add rows/pages as needed):

| Material | Physical State at Standard Conditions | Principle Use | Amount** |
|---|---|---|---|
| Tires | Two Inch Chunks | Feedstock | 88 tons per day |
| Water | Liquid | To support syngas scrubbing | 9,514 gallons per day |
| Calcium Hydroxide | Powder | To support syngas scrubbing | 821 pounds per day |
| Sodium Hydroxide | Powder | Waste Water Treatment | 14 pounds per day |
| | | | |

** Please indicate the amount **and** rate (e.g., lbs/hr, gallons/hr, lbs/cycle, etc.).

Figure – Snapshot of materials used in the Thermolyzer (EAC) EPA Form 3100.

| | | |
|---|---|---|
| **Feedstock** | Tires 2 inch chunks | **88 tons per day** |
| **Syn gas scrubbing** | Water = 5,514 gal/day | (scrubber) |
| | CaOH powder = 821 lbs/day | (lime) |
| | NaOH powder = 14 lbs/day | (neutralizer) |

**Note:** facility operates 351 days per year x 88 tons tires per day = **30,888 tons tires per year** to produce 506 MM cubic feet of syngas in a one 100-ton Thermolyzer™ system.

**From page 2 of 3:**

> "*Please provide a narrative description of the process below (e.g., coating of metal parts using high VOC content coatings for the manufacture of widgets; emissions controlled by thermal oxidizer...):*
>
> [Answer] The Thermolyzer process is a modified pyrolysis process. The process utilizes shredded tires as a feedstock. The tires are fed via a screw auger into a multi-stage process where the tires are externally heated to cause thermal decomposition which breaks the tires into their raw components. The process completely gasifies the components in the tire. The resulting gas is scrubbed

utilizing calcium hydroxide (lime) before it is ready to burn in the sites boiler. Water from the gas scrubbing operation is neutralized of any acids via an effluent scrubber that utilizes sodium hydroxide as an active agent. In addition to producing a synthetic gas that is comparable to natural gas, the system also recovers the steel in the tires and carbon black from the rubber. Both of these products will be put back into the commodities markets displacing virgin production of these products."

**Question:** How will they store and convey powdered lime during operation? Will there be baghouses associated with the conveyance and if so, where is the information? How much lime will be kept on-site?

**From the Thermolyzer Flow Diagram:**

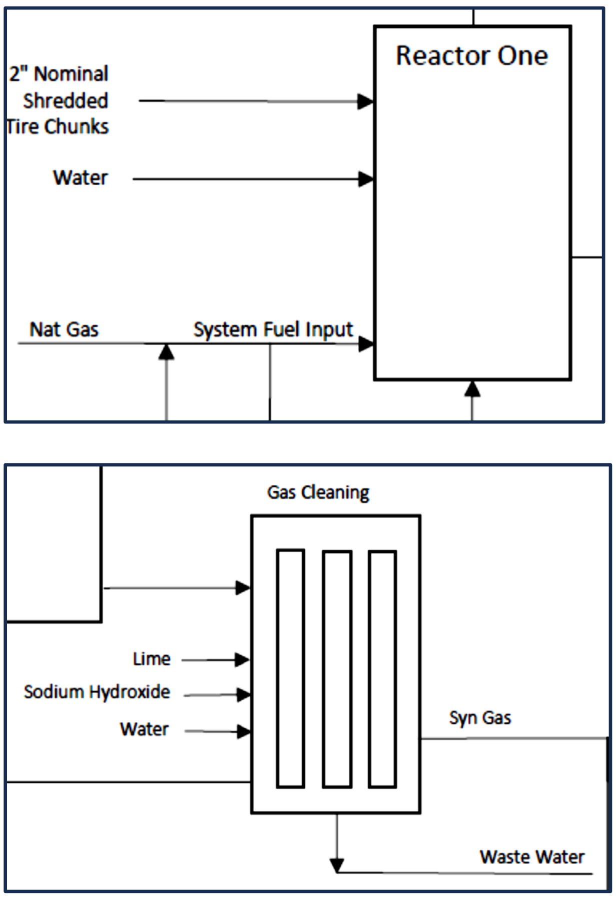



Figure – Snapshot from the Thermolyzer Flow Diagram

The flow diagram shows water introduced into Reactor One.

**Question:** How much water is needed for Reactor One and what is the purpose?

The flow diagram shows water introduced into Gas Cleaning.

EPA Form 3100 indicates the facility will use 5,514 gallons per day.

**Question:** How was this volume calculated to be so precise?

**From page 2 of 3:**

Hourly production rates (indicate appropriate units). Please see the instructions for clarification of "Maximum" and "Average" for new versus existing operations:

| Hourly | Rate | Units (e.g., widgets) |
|---|---|---|
| Average production | 90 | DecaTherms per Hour |
| Maximum production | 90 | DecaTherms per Hour |

Annual production rates (indicate appropriate units) Please see the instructions for clarification of "Maximum" and "Actual" for new versus existing operations:

| Annual | Rate | Units (e.g., widgets) |
|---|---|---|
| Actual production | 720,000 | DecaTherms |
| Maximum production | 720,000 | DecaTherms |

Figure – Snapshot of Thermolyzer hourly and annual production rate.

**Note:** Decatherm = million Btu

**Question:** Why is the average and maximum production rate the same?

Thermolyzer™ Flare Operation

1) In normal annual operation the flare gas system will operate for a total of 48 hours
2) For initial system commissioning the flare system will be required to operate for approximately 160 hours

Figure – Snapshot of flare operating hours from the PTIO cover letter page 3 of 5

**OEPA Document regarding Flares**
Link: https://epa.ohio.gov/static/Portals/27/engineer/eguides/flares.pdf

> "Enclosed Ground Flares--Ground level flares locate the flare tip and combustion zone at ground level. This type still requires an elevated stack for release of effluent gases. In enclosed ground flare systems the burner heads are enclosed within a refractory shell that is internally insulated. Figure 8-1 illustrates a typical enclosed ground flare. The shell reduces noise, luminosity and heat radiation, and it provides protection from wind. Enclosed flares generally have less capacity than open flares and are normally used for low volume, constant flow vent streams. Reliable and efficient operations can be obtained over a wide range of inlet conditions. More stable combustion can be achieved with lower Btu content gases with enclosed flares than with open flare designs. Enclosed flares are typically found at landfills, and in industrial settings that are densely populated."

**Question:** How did OEPA determine that the main stack and flares will not be a nuisance to the surrounding community (urban/densely populated)?

# SOBE Air Permit History

**OEPA air permit search   use Facility ID: 0250110024**
Link: https://edocpub.epa.ohio.gov/publicportal/edochome.aspx

Search returned 79 matching documents.

| | Select All On Page | Entity Name - Doc Type - Doc Date - Program - County - Secondary ID | Related Documents | Keywords |
|---|---|---|---|---|
| 1 | ☐ | SOBE THERMAL ENERGY SYSTEMS LLC - Permit - Long Term - 7/6/2023 - AIR PERMIT - MAHONING - 0250110024 - P0132799 - 2436406 https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2436406 | | |
| 2 | ☐ | SOBE THERMAL ENERGY SYSTEMS LLC - Permit - Long Term - 4/5/2023 - AIR PERMIT - MAHONING - 0250110024 - 2271481 https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2271481 | | |
| 3 | ☐ | SOBE THERMAL ENERGY SYSTEMS, LLC - Compliance Notification - 3/10/2023 - AIR PERMIT - MAHONING - 0250110024 - - 2237533 https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2237533 | | |

Figure – Snapshot of search results with 3 of 79 documents related to SOBE permit.

The most recent entries for Youngstown Thermal Energy Corp include the following:

Link: https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2039831
**Filename:** 2022 09-13 OEPA rec'd PTI-PTO admin complete 1 pg

YOUNGSTOWN THERMAL ENERGY CORP - Permit - Long Term - 9/13/2022 - AIR PERMIT - MAHONING - 0250110024 - 2039831
https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=2039831

September 13, 2022

**TRANSMITTED ELECTRONICALLY**

Mr. David Ferro
Youngstown Thermal
205 North Avenue
Youngstown, OH 44502

Re: Mahoning County
SOBE Thermal Energy Systems
DAPC Facility ID # 0250110024
A0072686 received on 09/12/2022

Dear Mr. David Ferro:

This letter is to inform you that the District Office/Local Air Agency (DO/LAA) received your application for a Permit-to-Install or Permit-to-Install and Operate (PTI/PTIO) for an air pollution source(s), and has determined that the application is preliminarily and administratively complete. This determination does not imply that the application is approvable, only that all of the necessary material has been submitted in order to continue the review. This letter informs you of the

Figure – Snapshot of the last search result labeled Youngstown Thermal.

**Note:** Mr. Ferro/SOBE was operating the facility (when it was in receivership) prior to purchase by SOBE. See additional quotes from the news article at end of this review: https://businessjournaldaily.com/sobe-energy-steams-ahead-embraces-new-era/

> "It's going to be very modern. It's going to be a complete automation system," David Ferro, CEO of SOBE Thermal Energy Systems, says of his plans to revitalize the plant. SOBE, based in Dublin, Ohio, purchased Youngstown Thermal out of receivership in December 2021 after more than two years of managing its operations, Ferro said. The company provides district heating and cooling services to 35 customers in or near downtown."

**OEPA to Youngstown Thermal requesting submittal of Title V renewal application**.
Link: https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=1830711
Filename: 2022 06-03 OEPA to Youngstown Thermal Title V permit renewal req'd 1 pg

6/3/2022

Mr. David Ferro
Youngstown Thermal
205 North Avenue
Youngstown, OH 44502

Re: **RENEWAL TITLE V APPLICATION DUE 06/01/2023 !**
Facility: 0250110024
Youngstown Thermal
205 North Ave
Youngstown, OH 44502-1172
Permit Number: P0124527
Expiration Date: 11/28/2023

Dear Mr. David Ferro:

If a timely Title V renewal application has already been submitted for this facility, please disregard this notice. This document serves as notification that the Title V permit to control air pollution issued to the facility identified above expires on 11/28/2023. This permit and the authorization to operate the air contaminant sources (emissions units) at this facility shall expire at midnight on the expiration date. If a renewal permit is not issued prior to the expiration date, the permittee may continue to operate pursuant to OAC rule 3745-77-06(A) and in accordance with the terms of this permit beyond the expiration date, provided that a complete renewal application is submitted no earlier than eighteen (18) months and no later than one-hundred eighty (180) days prior to the expiration date.

Figure – Snapshot of OEPA letter to Mr. Ferro/Youngstown Thermal Title V permit.

**Question:** If SOBE purchased the facility in December 2021, why is OEPA still sending letters to "Youngstown Thermal" instead of SOBE Energy? Shouldn't there have been a Title V permit transfer from Youngstown Thermal to SOBE Energy in early 2022?

**TV Annual Compliance Certification 245701 - Youngstown Thermal –**
Submitted May 18, 2022 for Reporting Period: 2021 **Note:** TV = Title V
Link: [https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=1817564](https://edocpub.epa.ohio.gov/publicportal/ViewDocument.aspx?docid=1817564)
**Filename:** 2022 05-18 Title V Emission Report for 2021 17 pgs

**From pages 4 and 8 of 17:**

| Equipment | JAN | FEB |
|---|---|---|
| Boiler 1 (Natural Gas) | 0 | 0 |
| Boiler 1 (Wood Oil) | 0 | 0 |
| Boiler 2 | 0 | 0 |
| Boiler 3 | 0 | 0 |
| Boiler 5 | 744 | 696 |

| Equipment | JAN | FEB |
|---|---|---|
| Boiler 1 (Natural Gas-DT) | 0 | 0 |
| Boiler 1 (Wood Oil-Gal) | 0 | 0 |
| Boiler 2 (Tons) | 0 | 0 |
| Boiler 3 (Tons) | 0 | 0 |
| Boiler 5 (DT) | 23,337 | 21,742 |

Notes:
The only boiler that operated during 2021 was boiler 5

Figure – Snapshot of Youngstown Thermal (Only Boiler 5 operating in 2021)
Note: (yellow arrow) Only Boiler #5 was operational during 2021.

**2021 Boiler Run Hours**

| MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 744 | 720 | 744 | 720 | 744 | 744 | 720 | 744 | 720 |

**2021 Boiler Fuel Consumption**

| MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18,332 | 12,589 | 8,668 | 6,229 | 6,099 | 6,249 | 6,303 | 8,643 | 18,153 |

Figure – Snapshot of the rest of the 2021 Boiler #5 run hours and fuel consumption.
**Not shown:** December boiler run hours = 744 and fuel consumption = 22,102

| |
|---|
| DEC |
| 0 |
| 0 |
| 0 |
| 0 |
| 744 |

| |
|---|
| DEC |
| 0 |
| 0 |
| 0 |
| 0 |
| 22,102 |

744 hours = 31 days/mo x 24 hours/day
720 hours = 30 days/mo x 24 hours/day
696 hours = 29 days/mo x 24 hours/day

Fuel Consumption

| | | | |
|---|---|---|---|
| Jan | 23,337 | July | 6,099 |
| Feb | 21,742 | Aug | 6,249 |
| Mar | 18,332 | Sept | 6,301 |
| April | 12,589 | Oct | 8,643 |
| May | 8,668 | Nov | 18,153 |
| June | 6,229 | Dec | 22,102 |

From page 8 of 17:

| Pollutant | Boiler 5 Emission Factor (lb/10^6 scf) | Emission Factor (lb/MMBTU) |
|---|---|---|
| NOx | 32 | 0.031373 |
| CO | 84 | 0.082353 |
| $CO_2$ | 120000 | 117.6471 |
| Lead | 0.0005 | 4.9E-07 |
| $N_2O$ | 2.2 | 0.002157 |
| PM (Total) | 0.64 | 0.000627 |
| PM (Conde | 7.6 | 0.007451 |
| PM (Filtera | 5.7 | 0.005588 |
| $SO_2$ | 1.9 | 0.001863 |
| TOC | 0.6 | 0.000588 |
| Methane | 11 | 0.010784 |
| VOC | 2.3 | 0.002255 |

Figure – Snapshot of criteria air pollutant emission factors used to calculate emissions.

**Question:** Where are the references for each emission factor so that the public can ascertain applicability and check calculations (note at bottom of Table * = AP-42)?

**AP 42, Fifth Edition, Volume I Chapter 1: External Combustion Sources**
https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-fifth-edition-volume-i-chapter-1-external-0

Chapter 1.4 - Natural Gas: https://www.epa.gov/sites/production/files/2020-09/documents/1.4_natural_gas_combustion.pdf

> "For the purposes of developing emission factors, natural gas combustors have been organized into three general categories: large wall-fired boilers with greater than 100 MMBtu/hr of heat input, boilers and residential furnaces with less than 100 MMBtu/hr of heat input, and tangential-fired boilers."

In the Annual Report NOx emission factor = 32 lbs/$10^6$ cubic feet
see AP-42 Ch 1.4 Natural Gas Combustion
Small Boilers (<100 MMBtu/hr) – yellow arrow in Table
low NOx burner/flue gas recirculation = 32 lbs/$10^6$ cubic feet

Table 1.4-1. EMISSION FACTORS FOR NITROGEN OXIDES ($NO_x$) AND CARBON MONOXIDE (CO) FROM NATURAL GAS COMBUSTION[a]

| Combustor Type (MMBtu/hr Heat Input) [SCC] | $NO_x$[b] | | CO | |
|---|---|---|---|---|
| | Emission Factor (lb/$10^6$ scf) | Emission Factor Rating | Emission Factor (lb/$10^6$ scf) | Emission Factor Rating |
| Large Wall-Fired Boilers (>100) [1-01-006-01, 1-02-006-01, 1-03-006-01] | | | | |
| Uncontrolled (Pre-NSPS)[c] | 280 | A | 84 | B |
| Uncontrolled (Post-NSPS)[c] | 190 | A | 84 | B |
| Controlled - Low $NO_x$ burners | 140 | A | 84 | B |
| Controlled - Flue gas recirculation | 100 | D | 84 | B |
| Small Boilers (<100) [1-01-006-02, 1-02-006-02, 1-03-006-02, 1-03-006-03] | | | | |
| Uncontrolled | 100 | B | 84 | B |
| Controlled - Low $NO_x$ burners | 50 | D | 84 | B |
| Controlled - Low $NO_x$ burners/Flue gas recirculation | 32 | C | 84 | B |
| Tangential-Fired Boilers (All Sizes) [1-01-006-04] | | | | |
| Uncontrolled | 170 | A | 24 | C |
| Controlled - Flue gas recirculation | 76 | D | 98 | D |

Figure – Snapshot of emission factors for natural gas combustion (AP-42 Chapter 1.4)

**From pages 5 and 10 of 17:**

| Criteria Emissions (Tons) | | 2021 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV |
| Boiler 5 | NOx | 0.36606745 | 0.34105255 | 0.28756078 | 0.197481 | 0.135964 | 0.097707 | 0.095667 | 0.09802 | 0.098875 | 0.135583 | 0.284759 |
| | CO | 0.96092706 | 0.89526294 | 0.75484706 | 0.518387 | 0.356905 | 0.25648 | 0.251127 | 0.257304 | 0.259548 | 0.355905 | 0.747493 |
| | CO2 | 1372.75294 | 1278.94706 | 1078.35294 | 740.5529 | 509.8647 | 366.4 | 358.7529 | 367.5765 | 370.7824 | 508.4353 | 1067.847 |
| | Lead | 5.7198E-06 | 5.3289E-06 | 4.4931E-06 | 3.09E-06 | 2.12E-06 | 1.53E-06 | 1.49E-06 | 1.53E-06 | 1.54E-06 | 2.12E-06 | 4.45E-06 |
| | N2O (Is this controlled?) | 0.02516714 | 0.02344736 | 0.0197698 | 0.013577 | 0.009348 | 0.006717 | 0.006577 | 0.006739 | 0.006798 | 0.009321 | 0.019577 |
| | PM (Total) | 0.00732135 | 0.00682105 | 0.00575122 | 0.00395 | 0.002719 | 0.001954 | 0.001913 | 0.00196 | 0.001978 | 0.002712 | 0.005695 |
| | PM (Condensable) | 0.08694102 | 0.08099998 | 0.06829569 | 0.046902 | 0.032291 | 0.023205 | 0.022721 | 0.02328 | 0.023483 | 0.032201 | 0.06763 |
| | PM (Filterable) | 0.06520576 | 0.06074999 | 0.05122176 | 0.035176 | 0.024219 | 0.017404 | 0.017041 | 0.01746 | 0.017612 | 0.024151 | 0.050723 |
| | SO2 | 0.02173525 | 0.02025 | 0.01707392 | 0.011725 | 0.008073 | 0.005801 | 0.00568 | 0.00582 | 0.005871 | 0.00805 | 0.016908 |
| | TOC | 0.00686376 | 0.00639474 | 0.00539176 | 0.003703 | 0.002549 | 0.001832 | 0.001794 | 0.001838 | 0.001854 | 0.002542 | 0.005339 |
| | Methane | 0.12583569 | 0.11723681 | 0.09884902 | 0.067884 | 0.046738 | 0.033587 | 0.032886 | 0.033695 | 0.033988 | 0.046607 | 0.097886 |
| | VOC | 0.0263111 | 0.02451315 | 0.02066843 | 0.014194 | 0.009772 | 0.007023 | 0.006876 | 0.007045 | 0.007107 | 0.009745 | 0.020467 |

Figure – Snapshot of Boiler 5 criteria air pollutant emissions in 2021.

From page

| HAP Pollutant Factors* | | | |
|---|---|---|---|
| CAS No. | Pollutant | Factor (lb/10^6 scf) | Factor (lb/MMBTU) |
| 91-57-6 | 2-Methylnaphthalene | 2.40E-05 | 2.35E-08 |
| 56-49-5 | 3-Methylnaphthalene* | 1.80E-06 | 1.76E-09 |
| | 7,12 - Dimethylbenz(a)anthracene* | 1.60E-05 | 1.57E-08 |

**From page 7 of 17:**

| HAP Emissions (Tons) | | JAN | FEB |
|---|---|---|---|
| Boiler 5 | 2-Methylnaphthalene | #REF! | #REF! |
| | 3-Methylnaphthalene | #REF! | #REF! |
| | 7,12 - Dimethylbenz(a)anthracene | #REF! | #REF! |
| | Acenaphthene | #REF! | #REF! |
| | Acenaphthylene | #REF! | #REF! |
| | Anthracene | #REF! | #REF! |
| | Benz(a)anthracene | #REF! | #REF! |
| | Benzene | #REF! | #REF! |
| | Benzo(a)pyrene | #REF! | #REF! |
| | Benzo(b)fluoranthene | #REF! | #REF! |
| | Benzo(g,h,i)perylene | #REF! | #REF! |
| | Benzo(k)fluoranthene | #REF! | #REF! |
| | Chrysene | #REF! | #REF! |
| | Dibenzo(a,h)anthracene | #REF! | #REF! |
| | Dichlorobenzene | #REF! | #REF! |
| | Fluoranthene | #REF! | #REF! |
| | Fluorene | #REF! | #REF! |
| | Formaldehyde | #REF! | #REF! |
| | Hexane | #REF! | #REF! |
| | Indeno(1,2,3-cd)pyrene | #REF! | #REF! |
| | Naphthalene | #REF! | #REF! |
| | Phenanathrene | #REF! | #REF! |
| | Pyrene | #REF! | #REF! |
| | Toluene | #REF! | #REF! |

Figure – Snapshot of HAP emissions for Boiler #5 – something wrong with data.

**April 5, 2023 - Air PTI/PTO determined administratively complete**
**Filename:** 2023 04-05 air PTI-PTO administratively complete letter 2 pgs

Mahoning County - SOBE Thermal Energy Systems, LLC
DAPC Facility ID # 0250110024 A0074198 received on 03/31/2023

"This letter is to inform you that the District Office/Local Air Agency (DO/LAA) received your application for a Permit-to-Install or Permit-to-Install and Operate (PTI/PTIO) for an air pollution source(s), and has determined that the application is preliminarily and administratively complete. This determination does not imply that the application is approvable, only that all of the necessary material has been submitted in order to continue the review. This letter informs you of the following:

• The next steps in the process.
• The estimated time for processing the permit application.
• The site preparation activities allowed before permit issuance.
• The contact for questions about your permit application.

The next steps in the process.

The technical review is the next step in processing the application in order to reach a final permit approval or denial. During this review, you may be contacted for additional information or clarification. Following the technical review, the permit terms and conditions or application denial will be prepared. If the review indicates a denial, you will be contacted to discuss options. Once prepared, the terms and conditions will be forwarded to the Central Office Ohio EPA, Division of Air Pollution Control (DAPC) for their review and issuance. It is possible they may ask for clarifying information as well before proceeding to issue a draft or final permit, or a denial of the application.

Some site preparation activities can be undertaken prior to obtaining a final PTI or PTIO. The specific types of activities and criteria are listed in Ohio Administrative Code rule 3745-31-33, "Site preparation activities prior to obtaining a final permit-to-install or PTIO." Please note there are risks that the owner/operator of this facility should be aware of prior to proceeding, including additional costs associated with design changes that may become necessary in order to comply with a final issued permit."

**Question:** Did OEPA perform a site inspection during the demolition of the coal-fired steam plant?

# Ohio Air Quality Attainment status

**Table 1. NAAQS**

| | | | Level | |
|---|---|---|---|---|
| **Pollutant** | **Averaging Time** | **Form** | **Primary*** | **Secondary*** |
| $PM_{10}$ | 24-hour | Not to be exceeded more than once per year on average over 3 years | 150 µg/m³ | 150 µg/m³ |
| $PM_{2.5}$ | 1-year | Annual mean, averaged over 3 years | 12.0 µg/m³ | 15.0 µg/m³ |
| | 24-hour | 98th percentile, averaged over 3 years | 35 µg/m³ | 35 µg/m³ |
| Ozone | 8-hour | Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years | 0.070 ppm | 0.070 ppm |
| $NO_2$ | 1-hour | 98th percentile of 1-hour daily maximum concentrations, average over 3 years | 100 ppb | none |
| | 1-year | Annual mean | 53 ppb | 53 ppb |
| $SO_2$ | 1-hour | 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years | 75 ppb | none |
| | 3-hour | Not to be exceeded more than once per year | none | 0.5 ppm |
| CO | 8-hour | Not to be exceeded more than once per year | 9 ppm | none |
| | 1-hour | Not to be exceeded more than once per year | 35 ppm | none |
| Lead | Rolling 3-month average | Not to be exceeded | 0.15 µg/m³ | 0.15 µg/m³ |

*Primary NAAQS are established for protection of public health; secondary NAAQS are established for protection of public welfare.

Figure – Snapshot of NAAQS from

**Ohio 2022-2023 Air Monitoring Network Plan**

**Link:** https://epa.ohio.gov/static/Portals/27/ams/sites/2022-2023-AMNPMainReport_Final.pdf
**Filename:** 2022-2023-Ohio AMNP MainReport_54 pgs

> "The Ohio EPA, DAPC, is responsible for regulating air quality to protect public health and the environment in the State of Ohio. As part of achieving these goals, Ohio EPA DAPC, with four DOs and eight LAAs, operates and maintains an extensive network of monitoring sites that collect air quality data in each of the numerous metropolitan areas and in many rural areas. Much of the monitoring sites are in urban areas where the majority of the population resides. There are over 110 monitoring sites operating in Ohio with over 250 air monitors sampling on an hourly or intermittent 24-hour basis.
>
> The Ohio EPA monitors six criteria pollutants: ozone, PM2.5, PM10, SO2, NO2 CO and lead. Other pollutants that are monitored by Ohio EPA which are not associated with NAAQS include metals, PM10-2.5, toxics, VOC, carbonyls,

PM2.5 speciated compounds, and ozone precursors. In addition, meteorological data are collected at some sites to support the monitoring and aid in air quality modeling analyses.

The minimum number of monitoring sites required for each of the U.S. EPA criteria pollutants is established in the federal regulations in 40 CFR Part 58, Appendix D. The minimum number of required sites is often dependent on the population count within large and small statistical areas. These areas are referred to as MSA, micropolitan-statistical areas, CBSA, and CSA. A CBSA associated with at least one urbanized area of 50,000 population or greater is termed an MSA. A CBSA associated with at least one urbanized cluster of at least 10,000 population but less than 50,000 is termed a micropolitan statistical area."

**Ohio 2023-2024 Air Monitoring Network Plan**
Link: https://epa.ohio.gov/divisions-and-offices/air-pollution-control/reports-and-data/amnp-2023-2024

**AMNP Appendix C – Monitoring Site Descriptions**
Link: https://epa.ohio.gov/static/Portals/27/ams/sites/C1-2023AMNP-MonSiteDesc.pdf
Filename: 2023 OH Air Monitoring Network Plan App C1-MonSiteDesc 122 pgs

There is only one monitoring station in Mahoning County Ohio.

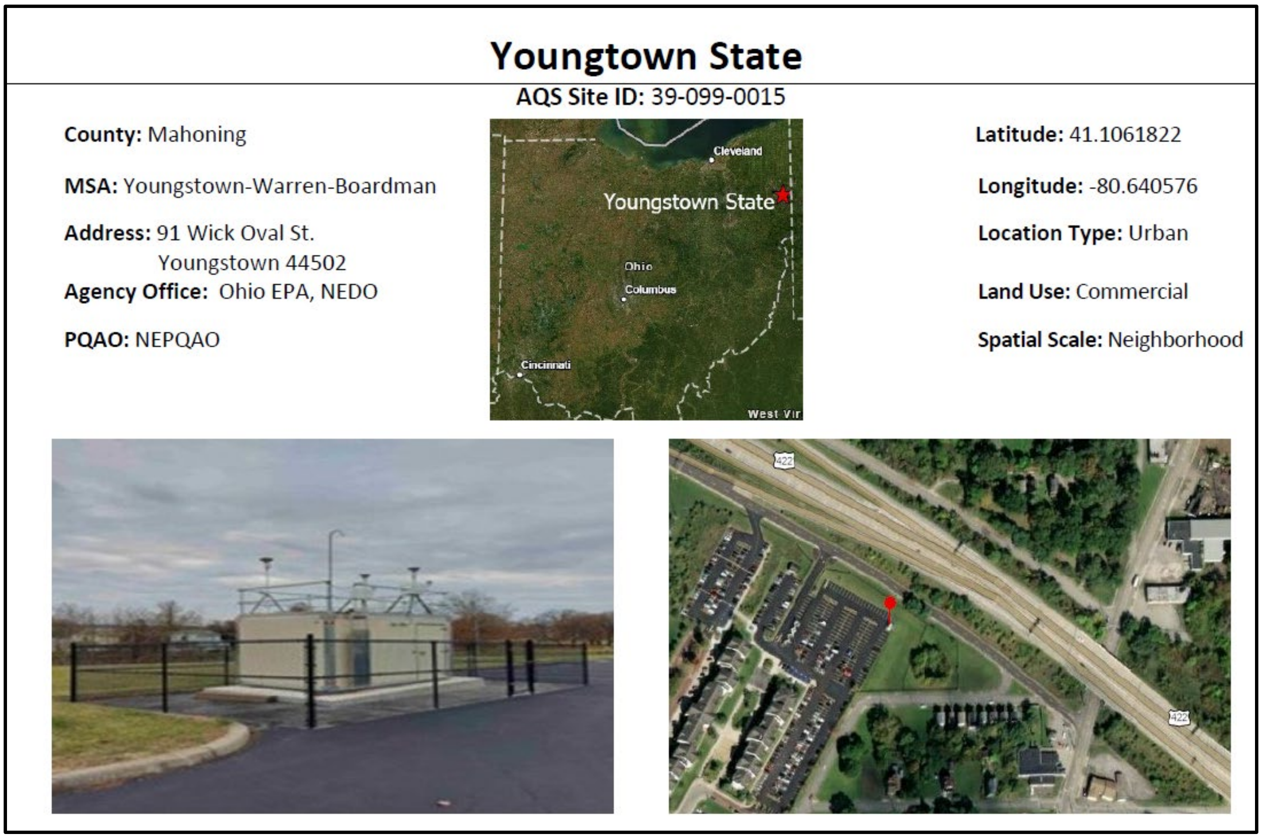


Figure – Snapshot of NAAQS monitoring station at Youngstown State University

> "Site Description: This is a PM10 continuous, PM2.5 (FRM and continuous), SO2 and ozone site. It is located northeast of the Youngstown State University campus in a parking lot.
>
> Monitoring Objective: Population exposure and to determine compliance with and/or progress made toward meeting ambient PM10, PM2.5, SO2 and ozone.
>
> Proposed Changes: O3 instrument changed from (047) Thermo 49i to (047) Thermo 49iQ on 3/1/23."

**Ohio 2015 Eight-Hour Ozone (0.070 ppm) Nonattainment Areas**
Original Designations of Marginal Effective 08/03/2018
Reclassified Designation of Moderate Effective 11/07/2022

Link: https://epa.ohio.gov/static/Portals/27/sip/Nonattain/2015_Ozone_final_062322.pdf
**Filename:** 2022 06-23 Ohio Attainment Status 2015_Ozone 1 pg

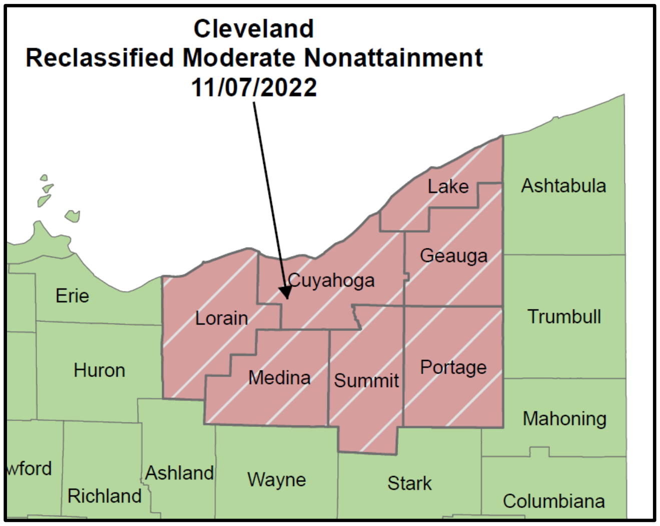



Figure – Snapshot of Ohio NAAQS 2015 ozone attainment status map (2022)
Pink areas are "non-attainment" for ozone 8 hr.

**Ohio 2006 24-Hour PM2.5 (35 ug/m3) – last updated 2013**
Nonattainment Areas Effective 12/14/2009
https://epa.ohio.gov/static/Portals/27/sip/Nonattain/PM25_24hr_12_9_2013_update_web.pdf
**Filename:** 2013 Ohio PM25_24 hr_attainment map 1 pg

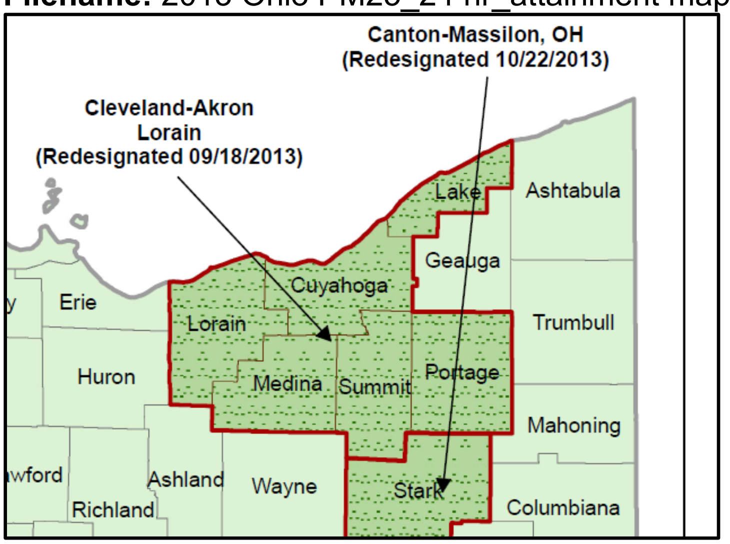



Figure – Snapshot of Ohio NAAQS 2006 PM2.5 24 hr attainment map (2013)
Darker green areas are "maintenance"

# Tire Shredding

**1. Ohio EPA fact sheet on scrap tires**
**Link:** https://epa.ohio.gov/static/Portals/34/document/guidance/gd_642.pdf
**Filename:** OEPA Guidance Doc 642 What is a Scrap Tire 2 pgs

> "Are tire shreds considered scrap tires?
> Tire derived fuel (TDF) and tire derived chips (TDC), less than four inches in all dimensions, are considered scrap tires while they are stored at a scrap tire recovery facility. If the TDF or TDC is transported from the scrap tire recovery facility for use as a fuel or for a beneficial use preauthorized by rule or authorized by the Director of Ohio EPA, then it does not have to be transported by a registered transporter to the end user. During transport and at the end user, TDF and TDC are not regulated as scrap tires. Tire shreds larger than four inches in any dimension do not meet the definition of TDF or TDC and are always defined as scrap tires."
>
> "Scrap tires processed into TDC and TDF are no longer regulated as scrap tires when the TDF or TDC is transported from the scrap tire recovery facility for use as a fuel or for a beneficial use preauthorized by rule or authorized by the Director of Ohio EPA. Once TDC and other scrap tire shreds have been beneficially used in a project, it is no longer regulated as a scrap tire. When the beneficial use project is abandoned, removed, or demolished, materials may be reused, recycled or disposed, in accordance with the appropriate regulations, as a solid waste.
> References • Ohio Revised Code 3734
> • Ohio Administrative Code 3745-580-02
> • Ohio Administrative Code Chapter 3745-580"

**2. YouTube videos of tire shredding process:**
https://www.youtube.com/watch?v=gDRAosmLlUA

**3. CM Dual Speed Chipping Shredder** - Whole Tires to 1" Chips for Fuel In one Step
https://www.youtube.com/watch?v=Bfcv_bR-20Y

**4. USEPA webpage on Tire-Derived Fuel**
https://archive.epa.gov/epawaste/conserve/materials/tires/web/html/tdf.html

> "Scrap tires are used as fuel because of their high heating value. Using scrap tires is not recycling, but is considered a beneficial use — it is better to recover the energy from a tire rather than landfill it. In 2003, 130 million scrap tires were used as fuel (about 45% of all generated) — up from 25.9 million (10.7% of all generated) in 1991.

Tires can be used as fuel either in shredded form - known as tire-derived fuel (TDF) — or whole, depending on the type of combustion device. Scrap tires are typically used as a supplement to traditional fuels such as coal or wood. Generally, tires need to be reduced in size to fit in most combustion units. Besides size reduction, use of TDF may require additional physical processing, such as de-wiring.

There are several advantages to using tires as fuel:

Tires produce the same amount of energy as oil and 25% more energy than coal;
The ash residues from TDF may contain a lower heavy metals content than some coals;
Results in lower NOx emissions when compared to many US coals, particularly the high-sulfur coals."

"Dedicated Tire-To-Energy Facilities [publication date is 2004 or 2005]'

Approximately 10 million tires per year are consumed as fuel at dedicated tire-to-energy facilities. A dedicated tire-to-energy facility is specifically designed to burn TDF as its only fuel to create energy.

According to a Rubber Manufacturers Association survey at the end of 2003, there was only one dedicated tire-to-energy facility operating in the US. The dedicated tire-to-energy facility, Exeter Energy Limited in Sterling, Connecticut burns mainly whole tires and consumes 10 million tires per year. This facility serves as a major scrap tire market for scrap tires in New York and northern New Jersey. The second dedicated tire-to-energy facility in the US is located in Ford Heights, Illinois and was not in operation at the end of 2003."

**5. What is Tire Shredding** – industry e-magazine
https://contec.tech/what-is-tire-shredding/

"Due to the composition of tires, the ELTs from various vehicles like cars, trucks, and earthmovers (EM) will yield varying proportions of recovered rubber, steel, and fabrics; see **Table 1**."

| Product Yield from: | Truck Tires | EM Tires | Car Tires |
|---|---|---|---|
| Crumb Rubber | 70% | 78% | 70% |
| Steel | 27% | 15% | 15% |
| Fiber and Scrap | 3% | 7% | 15% |

Table 1. : "Typical product yield from scrap tires," Reschner, K, 2016. **Scrap Tire Recycling**.

“Tire shredding has two objectives: (a) Separating steel and fabrics from the rubber and (b) Reducing the size of the rubber into a fixed particle size. These objectives are met by the following tire shredding process.

“**Debeading**: This preprocessing stage removes the steel bead from truck tires and significantly reduces wear and tear on the shredder and subsequent machines. The steel bead is only 10-15 per cent of the weight of a truck tire but causes 70 per cent of the wear and tear on the machines.

**Primary shredding**: Here, the rubber is cut into large bits, but in the absence of debeading, this stage has also to cut the steel ring and wires. The machines commonly used for primary shredding are rotary shears with one or two counter-rotating shafts. Shreds from single shafts are uniform in size, while those from double shafts are irregular. These machines can work at low and high speeds of 20 to 40 RPM to handle light and heavy-duty tires.

**Secondary shredding**: These machines are also called graters and reduce the size of the shreds into chips. Standard equipment includes bobcats and front-end loaders. The engines run on electricity, and most tire shredders and grinding machines process 2 -6 tons of tires per hour. Screening controls chip size and separates steel wires.”

“Rubber chips and granulates are used as feedstock for pyrolysis, a thermo-chemical recycling technique that recovers Carbon Black, steel, oil, and gas.”

# Journal Articles

**1. Emission factors of industrial boilers burning biomass-derived fuels**
**Filename:** 2022 Emission factor industrial boilers biomass derived fuel 18 pgs
**Link:** https://pubmed.ncbi.nlm.nih.gov/36637238/

> "ABSTRACT - Boilers are combustion devices that provide process heat and are integral to many industrial facilities. Historically, outside of the pulp and paper industry, most boilers burned fossil fuels, although interest in decarbonization has been leading to an increased use of renewable fuels in boilers. These boilers, including those in the biorefineries, are often large sources of air pollutant emissions, and the characterization of these emissions is critical to obtaining air permits and ensuring protection of the surrounding air quality. Several industrial boilers and new biorefineries allow utilization of biomass-derived fuels (e.g. wastewater sludge, lignin, etc.) produced during their operation as a fuel for the boiler to meet process energy needs.
>
> However, there is limited empirical data on emission factors for the burning of unconventional fuels, such as solid-gas mixtures containing biomass residues. To fill this gap, we carry out a comprehensive data survey, collecting information on emission factors for boilers burning either a single or a mixture of solid and gaseous biomass-derived fuels. We review multiple hard-to-obtain and unconventional data sources, such as air permit applications, stack test data, and industry-sponsored data collection efforts, to compile emission factors for biomass-derived fuels. We then compare this data with wood residue emission factors from the U.S. Environmental Protection Agency's AP-42 emission factor database. Our results indicate that the emission factors for boilers burning unconventional fuels vary widely depending on the fuel composition, boiler type, and fuel characteristics. Overall, we find that median emission factors of selected biomass-derived fuels are typically lower than those of wood residue boilers in AP-42. The information collected herein could be useful to permitting agencies and industries utilizing boilers who may want to reduce the carbon impact of their facilities by combusting biomass-derived wastes for process energy needs, for more accurate emission estimation for permitting.
>
> Implications: Emission factors are often used for air permitting, specifically for emission estimation purposes. This study carries out a comprehensive data survey of emission factors burning unconventional biomass-derived fuels from underutilized sources such as air permits, stack test data, and industry-led efforts, and compare the results to EPA's wood residue emission factor database. The results from this study can be used can be used by multiple stakeholders such as air permitting agencies, industries burning biomass-derived fuels, and biorefineries, that utilize more advanced boiler technologies."

**2. Syngas Quality as a Key Factor in the Design of an Energy-Efficient Pyrolysis Plant for Scrap Tyres**
**Link:** https://www.mdpi.com/2504-3900/2/23/1455
**Filename:** 2018 Syngas Quality Key Factor Energy Efficient Pyrolysis Plant Scrap Tires. 4 pgs

> "Abstract: In 2016 4.94 million tonnes of tyres were produced. Each tyre eventually become waste and pyrolysis has been considered an effective way of utilizing scrap tyres for several decades. However, pyrolysis has failed many times because the process has a great energy demand and the quality of products is unstable or insufficient for commercial use. Usually plants are focused on the production of pyrolytic oil or char and the gaseous phase is only a by-product. In this paper the importance of composition and quality of pyrolytic gas is emphasized. The main chemical properties make this gas a valuable biofuel that may satisfy energy requirements of the whole process (except for the start-up phase). Available data from literature concerning composition and other features of the pyrolytic gas from scrap tyres obtained at temperatures up to 1000 °C are compared with experimental results. The quality of evolved gases is discussed in the context of the Industrial Emissions Directive (IED), too. Finally, an analysis of the mass balances obtained allows a decision about the business profile and profitability."

> "On the other hand, it must be mentioned that pyrolysis is a process featuring a high energy consumption. As a result, waste tyre pyrolysis plants should be designed in a way that allows the use of the energy from the released syngas. In the first stage of the process, a reactor can be heated by combusted natural gas and then it may be fueled by the gases evolving. As reported by Aylón et al. [10] the amount of energy obtained through the combustion of the pyrolytic gas can cover all heating demands of the process, as well as to compensate for some heat losses. However, the quality of exhaust gases from scrap tyre pyrolysis should meet the EU requirements listed in the IED [11]. In this work the quality of pyrolytic gas will be examined in this wider context."

> "Gases evolving during the pyrolysis were investigated in a gas chromatograph (GS) equipped with Thermal Conductivity Detector (TCD) and Flame Ionization Detector (FID). Additionally, in order to prepare mass balances solid residues and oils collected from the process were weighed. The amount of evolved gases was calculated from the difference in mass between the original samples and that of solid and liquid residues.

> The evolved gaseous mixture obtained from the pyrolysis of waste tyres was examined several times and then carefully reviewed by Williams [12]. It is possible to assume, that the mixture consists of methane and other hydrocarbons (mainly paraffins and olefins), carbon oxides, hydrogen and

small amounts of impurities. Approximately 20 vol.% of the gas is methane [12]. Additionally, pyrolytic gas contains noticeable amount of hydrogen sulfide (H2S) which is highly corrosive."

"In this work gas chromatography analysis showed the presence of compounds such as methane, ethylene, ethane, hydrogen or carbon monoxide. The GC/FID analysis results are shown in Appendix A. However, further analysis should be made since the concentration of particular components was influenced by the high concentration of nitrogen, for which a constant flow was maintained."

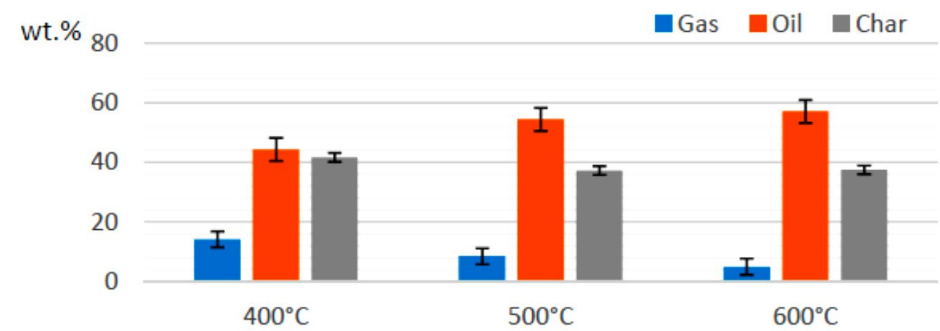



**Figure 2.** Gas, oil and char yields obtained at different temperatures of pyrolysis.

Figure – Snapshot of gas/oil/char depending on pyrolysis temperature.

"Previous research and this work show that pyrolysis gas from scrap tyres consists of flammable gases with a relatively high heating value. This was reported to be as high as 81.6 MJ/m3 [13], although usually it varies between 30 and 40 MJ/m3. On-site utilization of pyrolytic gas in the waste tyre pyrolysis plant may significantly enhance the profitability of the business.

However, the environmental issues must be considered too. According to the IED [11], pyrolysis of scrap tyres is considered as combustion of waste, thus it is obliged to keep a very high quality of exhaust gases. Concentrations of SO2, NOX, HCl, HF, heavy metals, dioxins and other substances must be controlled. According to Aylón et al. [10] some of those will exceed limits (especially for SO2 emissions), when pyrolytic gas is being combusted. Thus, proper flue gas cleaning methods should be implemented.

Moreover, the appearance of H2S in the raw gas obligate the designer to use very durable and expensive devices to prevent corrosion"

**3. Emissions from the combustion of gas-phase products at tyre pyrolysis**
Link: https://www.sciencedirect.com/science/article/abs/pii/S0165237006001380
Filename: (behind paywall)

> "Abstract - This is the first time that the thermochemical recycling of rubber from old tyres by pyrolysis and the emissions from combustion of the gas obtained in the pyrolytic process have been studied. In tyre pyrolysis, compounds in three phases are obtained: solid, liquid and gas. The solid compounds, approximately 40% weight of the initial rubber, are mostly constituted of carbon black but also contains the mineral matter initially present in the used tyre. The liquid phase is a complex hydrocarbon mixture that could be used directly as fuel or added to refinery feed stocks. The gas phase, here studied, composed by the non-condensable gases, contains a mixture of light hydrocarbons, carbon dioxide, carbon monoxide and hydrogen, showing a high calorific value. This gas could be used to supply energy to the tyre endothermic pyrolytic process. In this paper, the assessment of the emissions produced in the combustion of these gases in order to meet with the strict Spanish and European Legislation which consider this type of process as a residues incineration is analysed. The experiments were performed in a pilot plant provided with two fixed bed reactors. In the first one the pyrolysis of rubber tyre was carried out at 600 °C and atmospheric pressure using nitrogen as carrier gas. The gas obtained in this step was passed through the second reactor where combustion took place at 850 °C. The corresponding emissions were analysed: CO2, CO, SO2, NO2, particulate matter (PM), total organic carbon (TOC), metals (As, Sb, Hg, Pb, Sn, Cd, Ni, Cr, Co, V, Tl, Cu, Mn), HF, HCl, dioxins and furans emissions. Results are reported and commented."

**Note:** carbon black = 40% by weight of 'initial rubber'. So what will SOBE do with all that carbon black?

> "The raw material used for the pyrolysis experiments was a homogeneous sample of shredded tyre rubber supplied by a waste tyre recycling company. The average particle size was 2 mm approximately and had the following ultimate and proximate analyses: C (ar) 85.58%; H (ar) 7.63%; S (ar) 1.61%, moisture (ar) 0.64%, ash content 4.88%, volatile matter (ar) 64.46% and fixed carbon (ar) 30.02%. Where ar means as received.
>
> The experiments were carried out in a system consisting of two fixed bed reactors Gas produced in tyre pyrolysis…
>
> In pyrolysis three fractions are obtained: liquid, solid and gas. In all the runs performed, similar values for all the yields were observed. The difference between the different values was always under the experimental error. The solid residue yielded 37.9%, the liquid yielded 54.6% and finally the gas yielded 7.5%. These results are similar to those reported by other authors working in similar experimental devices and conditions [4], [5], [6]."

**4. Pyro-gas analysis of fixed bed reactor end of life tyres (ELTs) pyrolysis: A comparative study**
Link: https://www.sciencedirect.com/science/article/abs/pii/S0301479722014256
Filename: (behind paywall)

> "Abstract - Pyrolysis of end of life tyres (ELTs) present a promising alternative to their incineration or classical product recovery using mechanical means. It can produce light hydrocarbons (HCs) and other valuable chemicals as part of the pyro-gas stream it generates. In this work, two grades of tyres namely a fresh (virgin) one and a waste disposed ELTs, were used as a feedstock to analyse their pyro-gas constituents. There wasn't much difference in the maximum conversion rate between both tyre grades where the fresh tyres had an estimated 15.17% conversion and the ELTs was 13.45% conversion (both at 800 °C). The difference herein was attributed to release of free radicals prior to subjecting the samples to pyrolysis due to their history. The analysis of the pyro-gas samples showed a large make of light hydrocarbon (HC) products, namely methane ($CH_4$/C1), ethane ($C_2H_6$/C2), ethylene ($C_2H_4$), propane ($C_3H_8$/C3), propylene ($C_3H_6$), n-butane ($C_4H_{10}$), butadiene compounds, carbon mono and dioxide (CO,$CO_2$). Light HCs mimicking natural gas were more abundant in the case of ELTs were C1 was estimated as 14.53% at 500 °C and 16.73% at 800 °C. C2 was also estimated higher than the fresh tyres where a 11.78% at 500 °C was noted and 7.67% at 800 °C. It can be recommended that future integration plans in oil and gas ventures, namely refinery and petrochemical complexes, are to start taking responsible measures towards the environment by substituting part of their operations with sustainable feedstock such as ELTs."

**5. 2011 - Improving Light Olefins and Light Oil Production Using Ru/MCM-48 in Catalytic Pyrolysis of Waste Tire**
https://www.researchgate.net/publication/251712591_Improving_Light_Olefins_and_Light_Oil_Production_Using_RuMCM-48_in_Catalytic_Pyrolysis_of_Waste_Tire
**Filename:** 2011 improving light olefins catylitic pyrolysis waste tires 7 pgs

**Note:** This was a bench-scale research project.

> "Abstract - Mobil Composition of Matter (MCM) is the name given for a series of mesoporous materials. The MCM-48 is one of three phases of the mesoporous materials, which is cubic crystalline structure. The MCM-48 in this work was synthesized from silatrane route, and Ru metal was loaded by incipient wetness impregnation. This work investigated the activity and selectivity of MCM-48 and Ru/MCM-48 used as the catalysts for waste tire pyrolysis. The results showed that Ru/MCM-48 improved the gas yield. In addition, the use of Ru/MCM-48 catalyst produced light olefins twice as much as the non-catalytic pyrolysis. On the other hand, the catalyst helped to improve the oil quality by increasing light oil portion. Furthermore, it also reduced poly- and polar-aromatic compounds and sulfur content in the derived oil. Surface area analysis, XRD, and CHNS analysis were performed to explain the experimental results."

"2.3. Pyrolysis of Waste Tire - 10 gram of waste tire sample was loaded, and was pyrolyzed at 500ºC in the lower zone of the pyrolysis reactor as in [6]. 2.5 gram of catalyst was packed and heated at 350 °C in the upper zone. The pyrolysis product was carried by a nitrogen flow, and was swept to the condensers. The non-condensable product was passed through the condensers and collected in the gas sampling bag. The solid and liquid products were weighed to determine the gas quantity by mass balance. The gas product was analyzed by a Gas Chromatography; Agilent Technologies 6890 Network GC system. The oil product was separated into maltene and asphaltene by adding n-pentane into the pyrolytic oil at the ratio of 40:1. Then, the maltenes were fractionated into saturated hydrocarbons, mono-, di-, poly-, and polar-aromatics by liquid adsorption chromatography [4]."

**6. 2019 - A comparative analysis of pyrolysis and gasification of tyre waste by thermal plasma technology for environmentally sound waste disposal**
http://uest.ntua.gr/heraklion2019/proceedings/pdf/HERAKLION2019_James_etal.pdf
Filename: 2019 compare pyrolysis gasification tyre waste India 8 pgs

"Abstract - Plasma based pyrolysis and gasification technique can dispose tyre waste and generate combustible gases which can be used as a fuel and avoid the formation of higher molecular aromatic compounds. In this work plasma gasification and plasma pyrolysis of waste tyres have been conducted in a batch reactor having graphite electrodes and direct current (DC) arc plasma system. The process temperature was maintained at 700°C- 800°C and the material was fed at a constant rate of 1 kg/6 min. The two processes are compared based on the gas composition, syngas yield, char yield and efficiency of the process. Results indicate 4% increase in syngas yield in plasma gasification than in plasma pyrolysis. The syngas analysis shows that higher amount of CO and H2 are obtained and 8.18% rise in cold gas efficiency (CGE) in plasma gasification compared to plasma pyrolysis. The results suggest plasma gasification as a better alternative than plasma pyrolysis."

Table 1
Proximate and ultimate analysis of tyre waste

| Proximate analysis (wt %) | | Ultimate analysis (wt %) | |
|---|---|---|---|
| Fixed carbon[a] | 21.33 | Carbon | 81.93 |
| Volatile matter | 65.19 | Hydrogen | 6.27 |
| Ash | 12.57 | Nitrogen | - |
| Moisture | 0.91 | Sulphur | 3.21 |
| HHV | 33.4MJ/Kg | Oxygen[a] | 8.59 |

[a] (by difference)

Figure – Snapshot of Table 1 from the research paper.

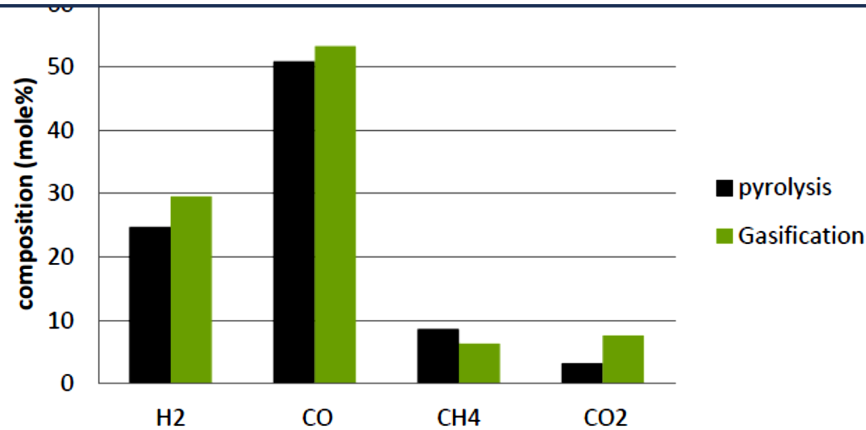



Fig.2. Gas composition of plasma pyrolysis and plasma gasification

Snapshot of Figure 2 from the research paper showing gas composition.

> "The principal gas components analyzed are CO, CO2, H2 and CH4. This is depicted in the graph shown in Fig. 2. As depicted in the graph, the gaseous components has higher amount of H2 and CO in plasma gasification than plasma pyrolysis process. H2 and CO increased from 24.7 and 50.9 to 29.6 and 53.3 respectively. CO2 content also increased by 4.4% in plasma gasification. This is due to the fact that as the oxygen content increases, it oxidizes the substance into CO, CO2 and H2 and hence enhances the formation of syngas. The CH4 content decreased to 6.3% from 8.6%. This shows that fewer amounts of hydrocarbons were produced because of oxidation. Similar results have been shown in other published papers [18]."

Table 4
Elemental composition of char

| **Element** | Pyrolysis (wt %) | Gasification (wt %) |
|---|---|---|
| **C** | 64.51 | 54.28 |
| **O** | 7.12 | 27.51 |
| **Na** | 2.29 | 0.83 |
| **Mg** | 0.65 | 0.16 |
| **Al** | 0.15 | 2.41 |
| **Si** | 0.81 | 2.17 |
| **S** | 3.10 | 2.9 |
| **K** | 0.02 | 0.05 |
| **Ca** | 0.06 | 5.63 |
| **Fe** | 0.91 | 0.80 |
| **Zn** | 20.38 | 2.31 |
| **Zr** | - | 0.97 |

Figure – Snapshot of Table 4 waste-tire pyrolysis and gasification char.

**7. Rubber Manufacturers Association – Scrap Tire Management Council**
**Scrap Tire Characteristics**
Link: http://www.energyjustice.net/files/tires/files/scrapchn.html

"84% OF A TIRE'S WEIGHT IS FROM RUBBER COMPOUNDS. REMAINDER IS BEAD AND BELT WIRE PLUS CARCASS AND CHAFER FABRIC"

| This table lists the typical types of materials used to manufacture tires. |
|---|
| Typical Composition of a Tire |
| Synthetic Rubber |
| Natural Rubber |
| Sulfur and sulfur compounds |
| Silica |
| Phenolic resin |
| Oil: aromatic, naphthenic, paraffinic |
| Fabric: Polyester, Nylon, Etc. |
| Petroleum waxes |
| Pigments: zinc oxide, titanium dioxide, etc. |
| Carbon black |
| Fatty acids |
| Inert materials |
| Steel Wire |

Figure – Snapshot of typical materials in tires from website.

A tire is manufactured from several separate components, such as tread, innerliner, beads, belts, etc. This table shows which components account for the rubber used to make the tire.

**RUBBER PERCENT BY WEIGHT IN A NEW RADIAL PASSENGER TIRE**

| | |
|---|---|
| TREAD | 32.6% |
| **BASE** | 1.7% |
| SIDEWALL | 21.9% |
| BEAD APEX | 5.0% |
| BEAD INSULATION | 1.2% |
| FABRIC INSULATION | 11.8% |
| INSULATION OF STEEL CORD | 9.5% |
| INNERLINER | 12.4% |
| UNDERCUSHION | 3.9% |
| | 100.0% |

Figure – Snapshot of information about how much of each material is in a typical tire,

**3. Typical Composition by Weight**

This lists the major classes of materials used to manufacture tires by the percentage of the total weight of the finished tire that each material class represents.

**Passenger Tire**

| | |
|---|---|
| Natural rubber | 14 % |
| Synthetic rubber | 27% |
| Carbon black | 28% |
| Steel | 14 - 15% |
| Fabric, fillers, accelerators, antiozonants, etc. | 16 - 17% |
| Average weight: | New 25 lbs, Scrap 20 lbs. |

**Truck Tire**

| | |
|---|---|
| Natural rubber | 27 % |
| Synthetic rubber | 14% |
| Carbon black | 28% |
| Steel | 14 - 15% |
| Fabric, fillers, accelerators, antiozonants, etc. | 16 - 17% |
| Average weight: | New 120 lbs., Scrap 100 lbs. |

Figure – Snapshot of information for composition of passenger and truck tires.

"**ASTM 1070 Steel Tire Wire -** There are approximately 2.5 pounds of steel belts and bead wire in a passenger car tire. This material is made from high carbon steel with a nominal tensile strength of 2,750 MN/m2 and the following typical composition:

| | STEEL BELTS | BEAD WIRE |
|---|---|---|
| Carbon | 0.67 - 0.73% | 0.60% min. |
| Maganese | 0.40 - 0.70% | 0.40 - 0.70% |
| Silicon | 0.15 - 0.03% | 0.15 - 0.30% |
| Phosphorus | 0.03% max. | 0.04% max. |
| Sulfur | 0.03% max. | 0.04% max. |
| Copper | Trace | Trace |
| Chromium | Trace | Trace |
| Nickel | Trace | Trace |
| COATING | 66% Copper<br>34% Zinc | 98% Brass<br>2% Tin |

Figure – Snapshot of steel composition for passenger tire.

# News Articles

**1. August 2023** (this year) story about the zoning issue because of the Thermolyzer
https://www.wkbn.com/news/local-news/youngstown-news/rally-outside-county-courthouse-protesting-energy-plant-unit/

> "Before the Youngstown City Council meeting on Wednesday, about a dozen people protested outside the Mahoning County Courthouse, urging council members to stop the proposed SOBE Energy Solutions plant near downtown from using a thermolyzer unit.
>
> SOBE wants final EPA approval to incinerate tire chips to produce synthetic gas to sell and some to augment the burning of natural gas to fire the boilers for steam heating and cooling. At a meeting two weeks ago, Mayor Jamael "Tito" Brown said he opposed the use of the thermolyzer unit.
>
> "They're going to have to have the zoning changed, so we're saying zoning department and elected officials don't allow them to do that because there's commercial, there's restaurants, there's the dorms. It's a populated area," said Susie Beiersdorfer, rally organizer. Beiersdorfer said the EPA has given no indication of when it will make a final ruling."

**2. May 2023 story** -Group opposed to proposed SOBE tire and plastic waste gasification plant gives petition to Youngstown Mayor Tito Brown
https://www.mahoningmatters.com/news/local/article275280116.html

> "The Love Your Neighbor Block Watch and SOBE Concerned Citizens presented a petition with 550 Youngstown residents, neighborhood leaders and organizations, to Youngstown Mayor Tito Brown asking for City Council members, the Planning Commission and him to stop SOBE Thermal Energy Solutions from opening a tire and plastic waste gasification plant at 205 North Avenue downtown.

**Note:** Copy of Petition language provided at end of this report.

**3. July 2022 (last summer)** - story with image of old defunct plant and news about $500 million investment by SOBE
https://businessjournaldaily.com/sobe-thermal-energy-systems-to-invest-500m-in-mahoning-valley/

> "David Ferro, CEO of SOBE Thermal Energy Systems shares his plans to supply steam used to heat buildings in downtown Youngstown. "Over the last two and a half to three years, we've been fixing the distribution network," Ferro says. "There were probably twenty leaks in the system in total and every single one of them has been repaired or replaced."

> Ferro says the next step is to replace the old coal boilers with dual purpose boilers that can run on two different forms of energy; natural gas and a synthetic gas which will be produced on site. Overall, the company plans to invest $500 million between its Lowellville and Youngstown operations.

**Note:** most folks thought it would be natural gas-fired steam and were just recently aware of the waste-tire to energy 'synthetic gas' option. *Not clear if everyone in the community knows that the primary fuel would be tire-derived synthetic gas*.

**4. July 2022 (last summer)** story how SOBE acquired the defunct steam plant
https://businessjournaldaily.com/sobe-energy-steams-ahead-embraces-new-era/

> "Within the next two weeks, passersby along the far west end of downtown should notice a dramatic change to the skyline. Four large, steel steam stacks that tower above the former Youngstown Thermal plant on North Avenue are coming down, signifying a new era in how energy, heat and cooling services are delivered to downtown customers, its new owner said Wednesday.
>
> "It's going to be very modern. It's going to be a complete automation system," David Ferro, CEO of SOBE Thermal Energy Systems, says of his plans to revitalize the plant. SOBE, based in Dublin, Ohio, purchased Youngstown Thermal out of receivership in December 2021 after more than two years of managing its operations, Ferro said. The company provides district heating and cooling services to 35 customers in or near downtown.
>
> While under SOBE management, the company repaired or replaced significant portions of the old steam pipes in order to stabilize its delivery network. Once the official sale was finalized, Ferro said SOBE could now turn its attention to redeveloping the entire operation.
>
> Ferro said his company plans to ultimately invest $500 million "minimum" into its operations in the Mahoning Valley. This includes $200 million in upgrading the Youngstown plant and another $300 million in Youngstown and Lowellville, where the company plans to build a gasification plant that would be used to produce feedstock for the North Avenue site from recycled waste such as tires.
>
> Today, a single boiler that operates outside the building provides enough steam to supply its downtown customers, Ferro said. "We're at 75% efficiency now versus 30% when we took it over." Using the external boiler also enabled the company to begin demolition without disrupting service to its customers, he said.
>
> As more customers join the system, it will require additional capacity. Ferro said the plan is to install three new boilers in a brick building that was built during the first decade of the 20th century. Youngstown State University, for example, has

agreed to join the SOBE system, Ferro noted. This alone would require the addition of another boiler, he said.

**Note:** In July 2022 SOBE knew they would need a third boiler to service the University.

Ferro explained that the company has plans to build a tire and plastics recycling facility in Lowellville that is able to convert this waste into reusable gas. That gas would be trucked to Youngstown to serve its boiler system.

Ferro said he has plans to replicate this system across the country and has identified approximately 25 sites in the U.S. and its territories. "Our goal is to be the lowest cost-system in the world," Ferro said. "We can accomplish that with the technology that we have."

**Note:** In July 2022, the waste tire syngas operation was going to be in Lowellville but now will be in Youngstown. Otherwise, they would be trucking syngas.

**5. July 2022 (last summer)** - Columbus energy company plans waste-to-energy plant to former Youngstown Thermal site
Link: https://www.wfmj.com/story/46913288/columbus-energy-company-plans-wastetoenergy-plant-to-former-youngstown-thermal-site

""All this will be completely renovated," he said. Ferro's vision - to turn what used to be Youngstown Thermal into a waste-to-energy facility. "We are bringing innovation," he said. "We've got a lot of support."

The facility would not burn, but indirectly heat things like tires, railroad ties and plastics. That creates a synthetic gas to use in process heating, gas turbines or reciprocating engines to make electricity. We pressed him to assure people that the process is safe and that the energy produced will be truly clean.

Ferro has already applied for air permits.

**Note:** Actually the air PTI/PTO is dated March 2023 – not summer of 2022.
Is there another permit application that is not uploaded to the OEPA cloud?

Thursday, he'll meet with Youngstown city council's public utilities committee to go over the project. He knows people will have questions but is confident in the answers they'll get.

"Years of trial and error with a pilot facility in Germany...we hired independent engineering companies to validate the gas composition and the emissions associated with burning that gas."

Ferro also says there's no hazardous waste removal, no importing energy to run the facility, and that emissions are clean controllable to less than EPA requirements.

The facility would operate continuously and wouldn't rely on government subsidies.

**Note:** They actually applied for a low interest loan in 2019

Link: https://development.ohio.gov/static/community/redevelopment/Energy-Loan-Fund-PreApplications-Submitted092019.pdf
Filename: 2019 OH Energy-Loan-Fund-PreApplications-Submitted 9 pgs

**Ohio Development Services Agency**
**Energy Loan Fund Pre-Application**

Customer Name: SOBE Thermal Energy Systems, LLC

Parent Company: SOBE Energy Solutions

Company Ownership: Private

| Applicant Address | | | Project Address | | |
|---|---|---|---|---|---|
| 545 Metro Place South | | | 545 Metro Place South | | |
| Suite 100 | | | Suite 100 | | |
| Dublin | OH | 43017 | Dublin | OH | 43017 |

Figure – Snapshot of pre-application for SOBE Thermal on page 4 of 9

> "Youngstown Thermal, a Public Utility Company located in Youngstown, Ohio, currently operating as a steam and chilled-water district energy system. Over the years, the district system has lost much of the historical load. This was primarily due to mismanagement and the impact Marcellus shale has on the cost of natural gas in the region, making it possible for some end-users to consider the installation of boilers. Youngstown is considered an Opportunity Zone by the Federal and State government, making available additional funding sources and significant advantages for investors in the project.
> Historically speaking, District energy facilities are successful because of the load they serve. As load leaves the system, the success of the district system is in jeopardy. Our project changes the relationship with end-user load and removes this dependency. However, our process will make it challenging for nearby facilities to justify independent boiler plants and will more than likely force them to join the district system. There are end-users in close proximity that would add significant load to the district system and revenues which has minimal cost to provide.
>
> Youngstown Thermal facility utilized coal as its primary fuel source, however, recent upgrades enable the system to use natural gas and a biofuel oil (wood oil). The wood oil is the primary fuel source as the price is deeply discounted to the current natural gas market. The oil is produced in Canada and railed to Youngstown area. If we acquire the facility, our first order of business is to

ensure maximum use of the wood oil for the period needed to design and build our power generation facility.

Additionally, SOBE has a long-term development plan based on Thermolyzer technology for low cost energy. The plan has two phases. In phase 1, SOBE will install a single 88-ton Thermolyzer unit which will replace the natural gas requirements and costs. New revenues streams are realized as noted in the tables below. Phase 2 will introduce additional Thermolyzer units and power generation.

Phase 1 will include a new boiler and a single 88-ton gasification system which will change how steam and chilled water are produced at the district system. Additional ancillary equipment and retro-commissioning of existing facilities are included in the project. Our technology is continuous renewable energy generation.

| | | | |
|---|---|---|---|
| Project Total Cost ($): | $15,000,000 | Projected Loan Request ($): | $3,000,000.00 |
| Projected Energy Savings (%): | 80 | Project Energy Cost Savings ($): | $1400000.00 |
| Simple Payback (Years): | 4 | Term For Repayment (Years): | 10 |
| Expected Project Start Date: | 7/1/2019 | Expected Project End Date: | 6/30/2020 |

Figure – Snapshot of loan amount for Youngstown Thermal/SOBE

**6. July 2019** - SOBE Energy Solutions Announces Alliance to Foster Investment in Sustainable Energy Plants
Link: https://www.prnewswire.com/news-releases/sobe-energy-solutions-announces-alliance-to-foster-investment-in-sustainable-energy-plants-300885287.html
Filename: 2019 07-16 SOBE and Hong Kong investment plastic electronic waste

"SOBE Energy Solutions LLC, an owner and operator of innovative sustainable power generation technology, has engaged Earl H. Roberts Ltd. of Hong Kong to act on its behalf in securing investment funding for its portfolio of energy projects in the U.S. The portfolio will encompass raising initial financing of $990 million (U.S.) (Nine hundred and ninety million United States Dollars). The funding will be used for the construction and implementation of several state-of-the-art waste-to-energy (WTE) technology plants.

The plants will process hydrocarbon-based waste such as used tires, as well as all seven grades of plastic **and electronic waste**. These prolific waste streams are converted into a clean synthetic gas that can be used in burners to produce steam or chilled water, or in reciprocating engines or gas turbines to produce electricity."

**Note:** there is a big difference between gasifying waste tires and 'all seven grades of plastic' and 'electronic waste'.

**7. August 2023** – In Youngstown, a Downtown Tire Pyrolysis Plant Is Called a 'Recipe for Disaster'
Link: https://insideclimatenews.org/news/07082023/youngstown-tire-pyrolysis-plant-called-recipe-for-disaster/

> "new owner, a businessman named David Ferro from the Columbus suburbs, and his company, SOBE Energy Solutions, have visions of restoring that service and doing a whole lot more—but this time, using as much as 88 tons of old tires a day as fuel.
>
> His plan would deploy another old but reimagined technology—pyrolysis, a centuries-old process for decomposing materials at high temperatures in an oxygen-free environment that's been used for making tar from timber for wooden ships and coke from coal for steelmaking during the last century.
>
> The SOBE proposal for loading shredded tires, which can contain as much as 24 percent synthetic polymers, a type of plastic, into a sealed chamber at high temperatures is based on a proprietary version of pyrolysis developed by another Ohio-based company, CHZ Technologies.
>
> While promising to limit its Youngstown plant to using only shredded tires as a feedstock, Ferro describes a broader business plan that would add plastic and electronic waste to tires at as many as 30 other "waste-to-energy" plants in the United States and overseas, including one in Lowellville, Ohio, eight miles southeast of Youngstown.
>
> "Our strategy was, let's get rid of the coal," Ferro said, describing what he called a $55 million project. "Let's clean this disastrous area up. And let's bring in a new technology that can enable us to clean our environment while producing clean burning energy at the same time, enabling us to provide lower cost energy to our community."

**Link:** https://chztechnologies.com/
5547 Mahoning Ave Mahoning Ave Ste 340, Austintown, Ohio, 44515

**8. 2021 news article** – CHZ Technologies to Model Thermolyzer Waste-to-Energy Technology Through Agreement With NREL
Link: https://www.prnewswire.com/news-releases/chz-technologies-to-model-thermolyzer-waste-to-energy-technology-through-agreement-with-nrel-301255116.html

> CHZ Technologies, LLC has entered into a Cooperative Research and Development Agreement (CRADA) entitled "Simulation of Complex Reacting Media in Multidimensional Reaction Chamber" with the U.S. Department of

Energy's National Renewable Energy Laboratory (NREL). The objective of the agreement is to use NREL's high-performance computing capabilities plus data from CHZ Technology's ThermolyzerTM technology to maximize the efficiency and achieve larger scale Thermolyzer systems. Such improvements will enable Thermolyzer systems to convert more plastic waste into energy economically.

"We are grateful for this opportunity to illustrate how improvements in design of the Thermolyzer technology will lead to a global solution to waste plastics," said Ernest Zavoral, CEO of CHZ Technologies, LLC. "The technology currently recycles plastics and tires into beneficial recycled saleable products such as renewable syngas, and a biochar can be sold for a profit. The technology has the potential to be a waste industry disruptor," he explained.

NREL's Computational Science Center will perform computational modeling of the reactor using high performance computing, which is essential to understand the physico-chemical interactions and to derive the best operating conditions for maximum efficiency. These results will be coupled to experimental data to validate the plastic pyrolysis mechanism and models. Then the models will be used to finalize geometry and settings for a larger-scale reactor."

**Note:** Need to FOIA the CRADA agreement and any reports that were written on the results of the computer modeling.

**Googling:** Simulation of Complex Reacting Media in Multidimensional Reaction Chamber

SIMULATION OF COMPLEX REACTING MEDIA IN MULTIDIMENSIONAL REACTION CHAMBER - Winter 2020
Link: https://hpc4energyinnovation.llnl.gov/projects

"CHZ Technologies, LLC | National Renewable Energy Laboratory
Principal Investigator: Dr. Henry W. Brandhorst, Jr. | CHZ Technologies, LLC
National Lab Partner: Dr. Hariswaran Sitaraman, Dr. Shashank Yellapantula, Dr. Vivek Bharadwaj, Dr. Marc Henry de Frahan | National Renewable Energy Laboratory

Summary: Thermolyzer™ is the only technology that can convert all waste hydrocarbon materials cleanly and safely into a fuel gas and salable byproducts. This means that tons of plastics now in storehouses can be converted into energy, thereby conserving non-renewable fossil fuels. The impact on the U.S. economy can be huge. However, pyrolysis of plastics is a complex process. The feedstock material that is of high variability is continuously gasified creating multiple species as it gets converted to a complex synthesis gas and carbon. The geometry and temperature gradients within the reactor are also complex. Thus, computational modeling of the reactor using high performance computing is essential in order to understand the physico-chemical interactions and to derive the best operating conditions for maximum efficiency. This project will provide the capability to achieve efficient larger-scale Thermolyzer systems (~200 ton/day capacity) that can significantly reduce the backlog of scrap plastics in the US."

**9. November 2018 – Thermolyzer & Crossties: A Convenient Opportunity**
https://www.rta.org/assets/docs/2018Crossties/NovDec/Tie%20Recovery%20Research.pdf

"During that summer timeframe, CHZ Technologies explored a solution that may safely dispose of used crossties and deliver a salable byproduct as well as energy. This technology is called Thermolyzer. Our 7 ton/day pilot plant in Forst (Lausitz), Germany, is shown above. It is a third-generation gasification technology that is unique among all other gasification technologies. It can accept all types of feedstocks such as wood, tires, plastics, polymers, auto shredder residue, composites and electronic wastes."

"The energy content of the syngas from each feedstock is different, and the salability of the char is also different. For example, with tires as a feedstock, the syngas has an energy content very close to that of natural gas, and the char consists mainly of carbon black and steel."

"Based on this analysis, CHZ Technologies processed about one ton of scrap crossties and utility poles in our pilot plant in Forst. The primary purpose of the test was to show that a clean biochar could be produced from crossties (containing no dangerous polyaromatic hydrocarbons (PAHs) or PCBs, polychlorinated biphenyls) and to evaluate some physical properties of the biochar."

**Author:** Henry W. Brandhorst Jr
**Patents:** https://patents.justia.com/inventor/henry-w-brandhorst-jr

# CHZ Technologies Videos and Reports

**Video:** https://reimaginingenergy.afwerx.com/exhibitor/chz-technologies-llc-10806/

> "Thermolyzer™ is a circular economy technology solution to the waste plastic and climate change crisis. It is a non-incineration technology that converts hydrocarbon wastes into a clean renewable fuel gas, delivers salable recycled byproducts, and reduces CO2 emissions and energy costs. The fuel gas can be used to produce heat, steam, or electricity. Once started, the oxygen-free system uses its own fuel gas for reliable 24/7 operation. The system has multiple reactors and gas scrubbers to ensure that all output byproducts are free of contamination. Any toxic compounds in the wastes are destroyed and safely removed while meeting the toughest of air quality demands. Typical feedstock materials include all grades of plastics, and tires. The technology is fully sustainable, using daily wastes produced by a base, providing a reliable source of energy, resiliency, GHG avoidance and reduces expensive and landfill costs. With an expected mixed waste stream (plastic, tires, wood, paper, clothing…) the Thermolyzer system would produce 2 MWe or 20 dekatherms of thermal energy. With plastics, the system would produce 4 MWe or 35 dekatherms of thermal energy at competitive costs. It is true recycling, capitalizing on the recoverable embodied energy in all hydrocarbon materials."

(at the link above option to download report)

**Thermolyzer - The Future of De-carbonization in Waste-to-Energy Technology**
https://cdn.sanity.io/files/93t5on0n/production/694110881c1ec9ae35fcc2f3959f38684d8e5a36.pdf

**From page 4 of 12:**

> "The company has manufactured three generations of 4 tons/day (TPD) pilot plants and one 44 TPD commercial demonstration plant to prove technology scale-up in Germany. All future systems will be built in the USA.
>
> The patented thermolysis gasifier includes three cascading internal reactors, scrubbers, and a tar/oil cracker. Feedstock is indirectly heated in an Oxygen-Free environment using the system's own synthesis gas called "Thermolgas™ to maintain reactor temperature. The system uses only 18-30% of the Thermolgas to maintain the thermolysis reaction. The cracked tar and oils are recirculated to make more Thermol gas and increase efficiency, reduce maintenance and increase economic returns."

**Note:** Uses 18-30% 'thermolgas" to the reactor (remainder would be natural gas?)

**Question:** Does the SOBE Thermolyzer also include a tar/oil cracker?

"INDEPENDENT REVIEW
The Thermolyzer system has been reviewed and vetted by R.W. Beck, HDI Gerling and Munich RE Insurance. Additionally, Siemens AG and Caterpillar Division MWM, have approved the direct injection of Thermolgas™ into its turbines and gas engines with full warranty. This direct use of Thermolgas allows users to install gas turbines that make the system significantly more efficient than heating a boiler to make steam to operate a steam turbine."

**From page 8 of 12:**

"The complete system includes a sorting area, shredder, patented gasifier, gas scrubbers, char processor, gas engine or gas turbine, electric generator, waste heat boiler, steam turbine for combined cycle operation and a grid substation. Liquid transportation fuels will require the addition of a gas-to-liquid reactor and storage component and are under development."

**From page 9 of 12:**

*A view of a section of a 44 TPD Plant*

Figure – Snapshot from the Thermolyzer brochure showing a 44 ton per day operation.

**Question:** Did SOBE share this brochure and photo with OEPA so they could visualize what the proposed facility might look like and ask about all the components that look like flares? What is the expected footprint for the proposed steam plant?

**From page 8 of 12:**

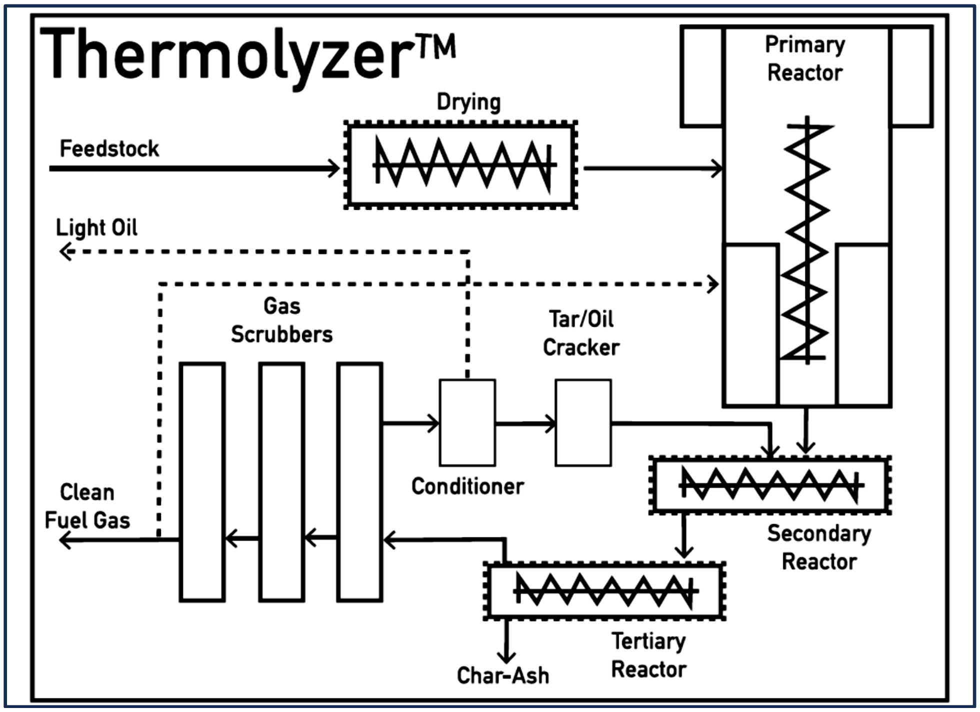



Figure – Snapshot of flow diagram in Thermolyzer report page 8 of 12.

**Note:** This illustration is slightly different than what was provided to OEPA in the Thermolyzer Flow Diagram with respect to Tar/Oil Cracker downgradient from the Gas Scrubbers and Conditioner. Also shows recycling of Cracker output into Reactor Two.

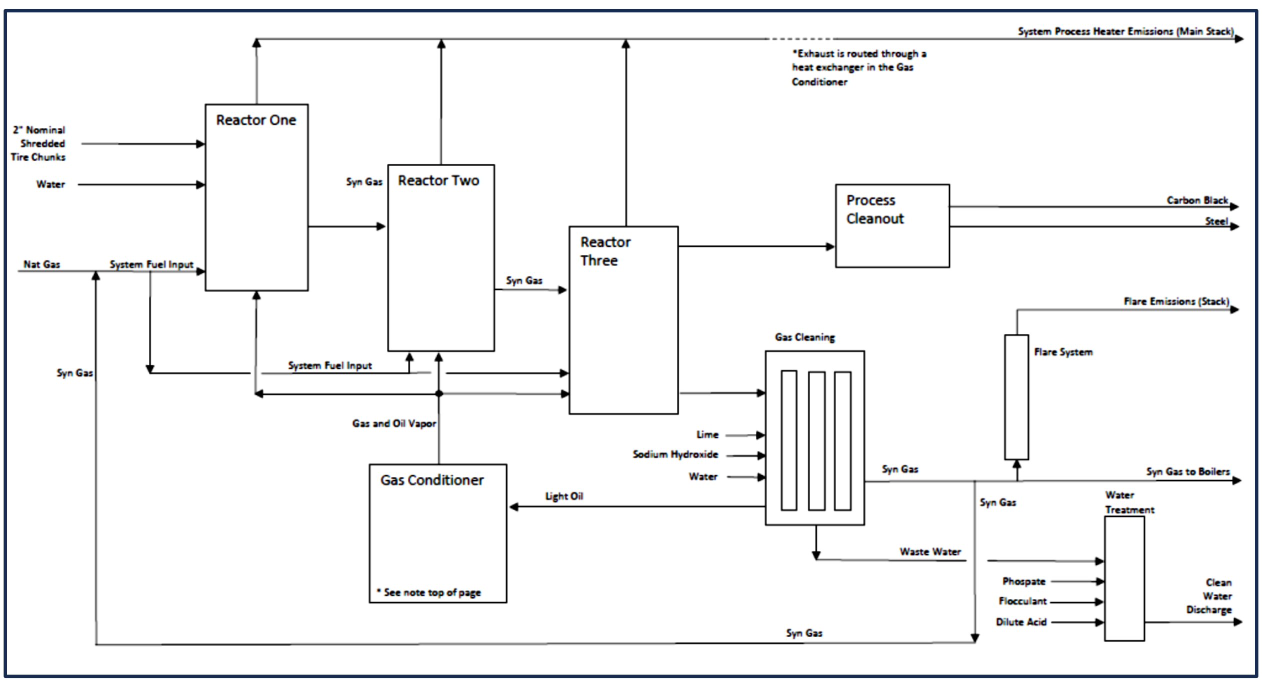



Figure – Snapshot of Thermolyzer Flow Diagram

**CHZ Technologies executive officers**
President and CEO - Ernest J. Zavoral, Sr
Co-Managing Director - Chuck T. Ludwig
Co-Managing Director - Henry W. Brandhorst, Jr.

Chief Engineer - Ullrich H. Engel

> "Subject matter expert in the field of gasification for more than 25 years, focusing on thermolytic gasification as an efficient way to convert biomass and hydrocarbon waste streams into a substitute gas for Natural Gas, clean power and/or liquid transportation fuels. Ullrich developed his own pilot plant for tire gasification in 1998. He was introduced to the new, evolutionary concept in pyrolytic gasification from KUG GMBH and joined CHZ Technologies, LLC to license and build the Thermolyzer™ technology for North America and elsewhere."

**Googling** KUG GMBH – no obvious results

GmbH is an abbreviation of the German phrase "Gesellschaft mit beschränkter Haftung," which means "company with limited liability.
https://www.investopedia.com/terms/g/gmbh.asp

**Googling** KUG GMBH Thermolyzer

**2022 Process and Applications Development for Recycled Mixed-Stream Composites**
Link: https://iacmi.org/wp-content/uploads/2022/03/IACMI-6.29-Final-Project-Report-2021-draft-3.21.22-Approved.pdf
Filename: 2022 recycled mixed stream composites 53 pgs

> Principal Investigator: Daniel Coughlin
> Organization: American Composites Manufacturers Association
> Address: 2000 N. 15th Street, Ste. 250. Arlington, VA 22201
> Co-authors: Ryan Ginder, University of Tennessee
> Michael Gruskiewicz, LyondellBassell
> David Hartman, Owens Corning
> Charles Ludwig, CHZ Technologies
> Soydan Ozcan, Oak Ridge National Laboratory
> David R. Salem, South Dakota School of Mines and Technology
> Paula Stevenson, UVG Group
> Halil Tekinalp, Oak Ridge National Laboratory
> Uday Vaidya, University of Tennessee
> N. Krishnan P. Veluswamy, South Dakota School of Mines and Technology
> Sanjita Wasti, Oak Ridge National Laboratory
> Xianhui Zhao, Oak Ridge National Laboratory

"The goal of this IACMI Phase II Technical Collaboration Project was to establish the viability of producing affordable, recycled composite parts, which were produced from fibers with the properties in the range of those reclaimed through the controlled pyrolysis technology demonstrated in Phase I [1]. For the purpose of this report, we use the terms "recovered carbon fiber" (rCF) and "recovered glass fiber" (rGF) as the material reclaimed from controlled pyrolysis. This fiber recycling technology utilizes the inherent energy in composites for fuel and preserves the structural value of glass fiber (GF) and carbon fiber (CF) for reuse. It can also be used for recycling other waste streams at the same facility, thus spreading capital risk and recovery across multiple industries and achieving economy of scale. A second goal to be addressed was the viability of using recycled fibers as reinforcing materials in additive manufacturing applications.

The project scope was to evaluate and validate demonstration of recycled composite parts and preforms that show the potential for successful business cases built around recycled composite products. The ultimate vision of the Phase II project is to enable widespread adoption of recycled materials throughout the U.S. and contribute significantly to the Institute's technical goal of 80% composite recycling in five years."

**From page 12 of 53:**

"A commercial pyrolysis unit has been permitted and site prep started in Youngstown, OH by CHZ Technologies, Inc to process tires which is anticipated to be in operation by early 2023. Testing is in process for electronic scrap, treated railroad ties/utility poles, and other materials. Funding for a further demonstration system dedicated to composites is being pursued with a combination of public and private support."

**Question:** Why would a federally funded report contain the inaccurate status of the permit for Youngstown, OH pyrolysis unit and why is CHZ Technologies listed instead of SOBE Thermal Energy Systems, LLC?

**From page 15 of 53:**

"Final Milestone 6.29.1 - A source of pyrolyzed fiber feedstock without metallic (or other showstopper) contamination and sufficiently intact mechanical properties was made available to the rest of the project development team. CHZ"

"Milestone 6.29.2.1 - The results of pyrolyzed fiber characterization before and after potential char removal were reported to the project team and DOE for review. UT"

**From page 16 of 53:**

> "Approximately 1000 lbs. of end-of-life wind blade fiberglass composite material was supplied by GE Renewable Energy for project research. CHZ Technologies, working with a commercial shredding subcontractor, put the incoming blade pieces through a two-pass shredding process (Figure 1) to get the materials broken down into nominally 2" inch chip sizes with a final yield of ~700 lbs. The shredded material was then shipped to CHZ Technologies' partner KUG's pilot pyrolysis reactor facility in Germany. The incoming material was processed in 2 rounds: a temperature range finding sweep followed by processing at observed ideal conditions. Prior to processing, the pyrolysis reactor was thoroughly cleaned out to avoid cross contamination of recycled fiber with metals, etc. from previous research projects performed at the site. This cleaning step was especially important as metal contamination had been a limiting factor in materials research during Phase I of the project. After processing, ~100 lbs. of pyrolysis recovered fiber/char mixture was shipped back the US for further study."

Note: The report says KUG is CHZ Technologies' partner in Germany

> "Visual inspection of the pyrolyzed fiber provided by CHZ Technologies in Figure 2 indicated the presence of intact, recovered glass fiber coated and mixed with loose carbon char alongside wood chips used to plasticize / force the original input composite shreds to flow through CHZ Technologies' continuous pyrolysis reactor design. One metal object was detected in the visually inspected specimen; however, metal/other contamination was well below specimens received during the project's earlier phase and appeared to be at an acceptable level for lab scale composite development. Direct measurements on the charred fiber bundles indicated an average recovered fiber length of approximately 1.8" although lengths varied from 1.4"- 2.8"."

**Note:** rest of the report focuses on the fiber research

**Note:** 'wood chips used to plasticize/force the original input composite shreds to flow through the CHZ Technologies' continuous pyrolysis reactor design."

**Question:** Would the waste-tire pyrolysis also need some additive to 'force flow" through the reactor? If so, what material would be used and are there air pollutant concerns associated with the additive? Perhaps the wood chips weighed down the glass fibers on the conveyor belt?

**2021 - Controlled Pyrolysis: A Robust Scalable Composite Recycling Technology**
**Link:** https://www.osti.gov/servlets/purl/1762486
**Filename:** 2021 controlled pyrolysis robust scalable recycling tech 69 pgs

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>
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**From page 12 of 69:**

> "The Thermolyzer™ technology is a highly-modified pyrolysis system, Figure 1, that converts all types of hydrocarbon-containing wastes into a fuel gas suitable for co-generation or synfuels, and "char". This novel technology overcomes the limitations of previous pyrolysis process. First, it is a continuous, oxygen- free

process meaning it operates 24/7.[1] Secondly, all hazardous oils and tars are turned into fuel gas. In this manner toxins are removed, and the process is more efficient. The process is halogen-tolerant. Halogens present in the recycled materials are converted to salts that can safely be removed in the waste water. Additionally, no measurable toxic dioxins or furans are created in comparison to other pyrolysis or incineration processes with halogens present. The clean fuel gas that is created is so clean that it can be used directly in gas turbines to generate electricity."

**Figure 1.** Photo of the pilot Thermolyzer™ line located in Forst, Germany

Figure – Snapshot of image in government funded Controlled Pyrolysis report.

"One reason this process was selected for trial it the flexibility it has to process a variety of End-of-Life (EOL) materials. Hydrocarbon-containing materials which can be used as feedstocks include tires, all seven grades of plastics, carpet, wood, electronics waste, automobile shredder residue, and Fiber Reinforced Polymer (FRP) composites. The energy content of the produced gas will depend upon the available energy in any of the feedstocks. The char that is produced also depends upon the feedstock selected."

**Reference in Report:** [1]Brandhorst, Henry W., Jr., "Thermolyzer Technology – a Revolutionary Change in WTE Processing," AIAA Propulsion and Energy Forum, 19-22 August 2019, Indianapolis IN, http://arc.aiaa.org, DOI: 10.2514/6.2019-4159.
**Link:** https://arc.aiaa.org/doi/10.2514/6.2019-4159
**Filename:** (behind paywall)

# Petition submitted to Youngstown Mayor

**Link to Petition:**
https://drive.google.com/file/d/1rINo5RZ7zu5Fe_0FdbZEoeysQ2olIdeG/view
**Filename:** Community Petition with sigs protesting SOBE facility 40 pgs

> "After reviewing the information as presented by the property owner in this article, the zoning code, and other relevant public records, we believe that the proposed use as a solid waste gasification plant is not only a violation of existing zoning, but that granting a zone change to allow solid waste gasification at this location would constitute an illegal use of spot zoning."
>
> "We believe that the current use of the property, which operates as a heating and cooling plant for existing customers (see PUCO Ruling 21-28-HC-ATC), complies with current zoning regulations as a "historic nonconforming use". In other words, even though heating and cooling plants are no longer allowed in this district as of the 2013 zoning code update, because the property has been historically used for this purpose continuously since the late 19th Century, it is allowed to continue to be used for this purpose as-is at its current level of intensity."
>
> "On the other hand, the property owner does not have a right to intensify this nonconforming use, or to add any additional nonconforming uses, including solid waste gasification, as these would violate the existing zoning district in which the property is located. While the property owner can keep operating the heating and cooling plant at current levels, they cannot expand the plant beyond its existing footprint and cannot add other industrial uses to the property that do not comply with existing zoning requirements for the district."
>
> "The property is located in an MU-C ("Mixed Use - Community") zoning district and surrounded on all sides by properties in this district. The Youngstown Redevelopment Code ("Zoning Code" or "Code"), defines the purpose of MU-C as "providing areas for a variety of retail and services uses serving secondary market areas in the city, as well as wholesaling, servicing, distributing, storing, processing, and medium-density residential uses." This district is intended for medium-density commercial and residential uses outside of the central business district, and not for industrial uses, as evidenced by the fact that no industrial-type uses of any kind are permitted in the MU-C zoning district, including "Electric power or heat generation."
>
> "Solid waste gasification, a novel industrial process not explicitly defined under the Code, falls under the use definition of "Manufacturing, Hazardous or Special," because the process produces syngas, which is a mixture of carbon monoxide and hydrogen, both of which are considered hazardous materials according to the OSHA Hazard Communication Standard (29 CFR 1910.1200)."

"Furthermore, the definition of the "Manufacturing, General," a slightly less intense industrial use, explicitly states that only "non-hazardous gas production" falls into this category, which clarifies that a) gas production is considered a "Manufacturing" use per the Code, rather than other possible uses such as "Recycling Services," and b) production of hazardous gasses is considered a more intensive industrial use than "Manufacturing, General." "Manufacturing, Hazardous and Special" is the only manufacturing use that is more intense than "Manufacturing, General," meaning that solid waste gasification and syngas production must fall into this category."

"Even if the property owner were to argue that the solid waste gasification falls under another related industrial category such as "Recycling Services" or "Electric power or heat generation plant," these uses are also prohibited in MU-C zones, meaning that there is little room for debate that gasification of solid waste and syngas production at 205 North Avenue would be a violation of the zoning code."