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October 1, 2025

Edward S. Andrews
West Virginia Department of Environmental
Protection
Division of Air Quality
601 57th Street, SE
Charleston, West Virginia 25304
edward.s.andrews@wv.gov

HAND DELIVERY

Re: Clean Seas West Virginia Inc.
Application for NSR Permit And
Title V Permit Revision

Dear Mr. Andrews:

Per your email on September 19, 2025, please find enclosed the requested information and items which you deemed to need updating or correction for Clean-Seas West Virginia, Inc.'s application for a construction permit for a plastic pyrolysis plant to be deemed complete (Permit Application No. R13-3728, Plant ID No. 039-00760). Included herein are the following documents:

1. Application with updated UTM coordinates;
2. An updated Attachment D with a waste/non-waste determination of the proposed feedstock;
3. A detailed process description for the TRE Unit;
4. An updated Attachment F with General Process Flow Diagram Sheet 2 of 2;
5. The adjusted calculations utilized for the Maximum True Vapor Pressure of the stored pyrolysis oil (Volatile Organic Liquid - VOL); and
6. A new process description of the plant with discussion of the proposed flare; and
7. An updated and legible version of the drawing titled "25 TONS/DAY PLASTIC"

If you have any questions regarding this filing, please contact me.

Very truly yours,

A handwritten signature in dark ink, appearing to read 'Marc Mignault', with a long, sweeping horizontal stroke extending to the right.

Marc Mignault

MM:tlp

Attachments

cc: Samantha N. Blair (via e-mail)

DOCUMENT 1



WEST VIRGINIA DEPARTMENT OF
ENVIRONMENTAL PROTECTION
DIVISION OF AIR QUALITY

601 57th Street, SE
Charleston, WV 25304
(304) 926-0475
www.dep.wv.gov/daq

**APPLICATION FOR NSR PERMIT
AND
TITLE V PERMIT REVISION
(OPTIONAL)**

PLEASE CHECK ALL THAT APPLY TO **NSR (45CSR13)** (IF KNOWN):

- ☒ **CONSTRUCTION** ☐ **MODIFICATION** ☐ **RELOCATION**
☐ **CLASS I ADMINISTRATIVE UPDATE** ☐ **TEMPORARY**
☐ **CLASS II ADMINISTRATIVE UPDATE** ☐ **AFTER-THE-FACT**

PLEASE CHECK TYPE OF **45CSR30 (TITLE V)** REVISION (IF ANY):

- ☐ **ADMINISTRATIVE AMENDMENT** ☐ **MINOR MODIFICATION**
☐ **SIGNIFICANT MODIFICATION**

IF ANY BOX ABOVE IS CHECKED, INCLUDE TITLE V REVISION
INFORMATION AS **ATTACHMENT S** TO THIS APPLICATION

FOR TITLE V FACILITIES ONLY: Please refer to "Title V Revision Guidance" in order to determine your Title V Revision options
(Appendix A, "Title V Permit Revision Flowchart") and ability to operate with the changes requested in this Permit Application.

Section I. General

1. Name of applicant (as registered with the WV Secretary of State's Office): Clean-Seas West Virginia Inc.		2. Federal Employer ID No. (FEIN): 92-3247592	
3. Name of facility (if different from above):		4. The applicant is the: <input type="checkbox"/> OWNER <input type="checkbox"/> OPERATOR <input checked="" type="checkbox"/> BOTH	
5A. Applicant's mailing address: 2700 E Dupont Ave, Ste 3B Belle WV 25015		5B. Facility's present physical address: 2700 E Dupont Ave Ste 3B Belle WV 25015	
6. West Virginia Business Registration. Is the applicant a resident of the State of West Virginia? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO – If YES , provide a copy of the Certificate of Incorporation/Organization/Limited Partnership (one page) including any name change amendments or other Business Registration Certificate as Attachment A . – If NO , provide a copy of the Certificate of Authority/Authority of L.L.C./Registration (one page) including any name change amendments or other Business Certificate as Attachment A .			
7. If applicant is a subsidiary corporation, please provide the name of parent corporation: Clean-Seas Inc.			
8. Does the applicant own, lease, have an option to buy or otherwise have control of the <i>proposed site</i> ? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO – If YES , please explain: 20 year lease, commencing March 1 2025 – If NO , you are not eligible for a permit for this source.			
9. Type of plant or facility (stationary source) to be constructed, modified, relocated, administratively updated or temporarily permitted (e.g., coal preparation plant, primary crusher, etc.): Plastics Pyrolysis Plant		10. North American Industry Classification System (NAICS) code for the facility: 325199	
11A. DAQ Plant ID No. (for existing facilities only): –		11B. List all current 45CSR13 and 45CSR30 (Title V) permit numbers associated with this process (for existing facilities only):	

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

12A. – For Modifications, Administrative Updates or Temporary permits at an existing facility, please provide directions to the <i>present location</i> of the facility from the nearest state road; – For Construction or Relocation permits , please provide directions to the <i>proposed new site location</i> from the nearest state road. Include a MAP as Attachment B . From US Rte 60, turn SOUTH onto Warrior Way. Turn EAST on E Dupont Ave. In approx.. 400 feet, turn NORTH into existing parking lot at 2700 E Dupont Ave		
12.B. New site address (if applicable): 2700 E Dupont Ave	12C. Nearest city or town: Belle	12D. County: Kanawha
12.E. UTM Northing (KM): 440427.769	12F. UTM Easting (KM): 1822380.411	12G. UTM Zone: 17n
13. Briefly describe the proposed change(s) at the facility: A plastics conversion plant will be constructed at the site of a lumber sales building. This work includes a delivery dock, preprocessing, pyrolysis of plastic, pyrolysis oil loading into trucks, oil storage in frac tanks, a flare, backup generator, offices, a baghouse for recovery of airborne plastic and parking.		
14A. Provide the date of anticipated installation or change: Oct 1 2025 – If this is an After-The-Fact permit application, provide the date upon which the proposed change did happen: / /		14B. Date of anticipated Start-Up if a permit is granted: Nov 1 2025
14C. Provide a Schedule of the planned Installation of/ Change to and Start-Up of each of the units proposed in this permit application as Attachment C (if more than one unit is involved).		
15. Provide maximum projected Operating Schedule of activity/activities outlined in this application: Hours Per Day 24 Days Per Week 7 Weeks Per Year 52		
16. Is demolition or physical renovation at an existing facility involved? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
17. Risk Management Plans. If this facility is subject to 112(r) of the 1990 CAAA, or will become subject due to proposed changes (for applicability help see www.epa.gov/ceppo), submit your Risk Management Plan (RMP) to U. S. EPA Region III.		
18. Regulatory Discussion. List all Federal and State air pollution control regulations that you believe are applicable to the proposed process (<i>if known</i>). A list of possible applicable requirements is also included in Attachment S of this application (Title V Permit Revision Information). Discuss applicability and proposed demonstration(s) of compliance (<i>if known</i>). Provide this information as Attachment D .		
Section II. Additional attachments and supporting documents.		
19. Include a check payable to WVDEP – Division of Air Quality with the appropriate application fee (per 45CSR22 and 45CSR13).		
20. Include a Table of Contents as the first page of your application package.		
21. Provide a Plot Plan , e.g. scaled map(s) and/or sketch(es) showing the location of the property on which the stationary source(s) is or is to be located as Attachment E (Refer to Plot Plan Guidance) . – Indicate the location of the nearest occupied structure (e.g. church, school, business, residence).		
22. Provide a Detailed Process Flow Diagram(s) showing each proposed or modified emissions unit, emission point and control device as Attachment F .		
23. Provide a Process Description as Attachment G . – Also describe and quantify to the extent possible all changes made to the facility since the last permit review (<i>if applicable</i>).		
<i>All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.</i>		

24. Provide **Material Safety Data Sheets (MSDS)** for all materials processed, used or produced as **Attachment H**.
 – For chemical processes, provide a MSDS for each compound emitted to the air.

25. Fill out the **Emission Units Table** and provide it as **Attachment I**.

26. Fill out the **Emission Points Data Summary Sheet (Table 1 and Table 2)** and provide it as **Attachment J**.

27. Fill out the **Fugitive Emissions Data Summary Sheet** and provide it as **Attachment K**.

28. Check all applicable **Emissions Unit Data Sheets** listed below:

<input checked="" type="checkbox"/> Bulk Liquid Transfer Operations	<input type="checkbox"/> Haul Road Emissions	<input type="checkbox"/> Quarry
<input checked="" type="checkbox"/> Chemical Processes	<input type="checkbox"/> Hot Mix Asphalt Plant	<input type="checkbox"/> Solid Materials Sizing, Handling and Storage Facilities
<input type="checkbox"/> Concrete Batch Plant	<input type="checkbox"/> Incinerator	<input type="checkbox"/> Storage Tanks
<input type="checkbox"/> Grey Iron and Steel Foundry	<input checked="" type="checkbox"/> Indirect Heat Exchanger	
<input checked="" type="checkbox"/> General Emission Unit, specify: Plastics Pyrolysis units (2) and a Flare		

Fill out and provide the **Emissions Unit Data Sheet(s)** as **Attachment L**.

29. Check all applicable **Air Pollution Control Device Sheets** listed below:

<input type="checkbox"/> Absorption Systems	<input type="checkbox"/> Baghouse	<input checked="" type="checkbox"/> Flare
<input type="checkbox"/> Adsorption Systems	<input checked="" type="checkbox"/> Condenser	<input type="checkbox"/> Mechanical Collector
<input type="checkbox"/> Afterburner	<input type="checkbox"/> Electrostatic Precipitator	<input type="checkbox"/> Wet Collecting System
<input type="checkbox"/> Other Collectors, specify:		

Fill out and provide the **Air Pollution Control Device Sheet(s)** as **Attachment M**.

30. Provide all **Supporting Emissions Calculations** as **Attachment N**, or attach the calculations directly to the forms listed in Items 28 through 31.

31. **Monitoring, Recordkeeping, Reporting and Testing Plans.** Attach proposed monitoring, recordkeeping, reporting and testing plans in order to demonstrate compliance with the proposed emissions limits and operating parameters in this permit application. Provide this information as **Attachment O**.
 ➤ Please be aware that all permits must be practically enforceable whether or not the applicant chooses to propose such measures. Additionally, the DAQ may not be able to accept all measures proposed by the applicant. If none of these plans are proposed by the applicant, DAQ will develop such plans and include them in the permit.

32. **Public Notice.** At the time that the application is submitted, place a **Class I Legal Advertisement** in a newspaper of general circulation in the area where the source is or will be located (See 45CSR§13-8.3 through 45CSR§13-8.5 and **Example Legal Advertisement** for details). Please submit the **Affidavit of Publication** as **Attachment P** immediately upon receipt.

33. **Business Confidentiality Claims.** Does this application include confidential information (per 45CSR31)?
☐ YES ☒ NO
 ➤ If **YES**, identify each segment of information on each page that is submitted as confidential and provide justification for each segment claimed confidential, including the criteria under 45CSR§31-4.1, and in accordance with the DAQ's **"Precautionary Notice – Claims of Confidentiality"** guidance found in the **General Instructions** as **Attachment Q**.

Section III. Certification of Information

34. **Authority/Delegation of Authority.** Only required when someone other than the responsible official signs the application. Check applicable **Authority Form** below:

<input type="checkbox"/> Authority of Corporation or Other Business Entity	<input type="checkbox"/> Authority of Partnership
<input type="checkbox"/> Authority of Governmental Agency	<input type="checkbox"/> Authority of Limited Partnership

Submit completed and signed **Authority Form** as **Attachment R**.

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

35A. **Certification of Information.** To certify this permit application, a Responsible Official (per 45CSR§13-2.22 and 45CSR§30-2.28) or Authorized Representative shall check the appropriate box and sign below.

Certification of Truth, Accuracy, and Completeness

I, the undersigned ☒ **Responsible Official** / ☐ **Authorized Representative**, hereby certify that all information contained in this application and any supporting documents appended hereto, is true, accurate, and complete based on information and belief after reasonable inquiry I further agree to assume responsibility for the construction, modification and/or relocation and operation of the stationary source described herein in accordance with this application and any amendments thereto, as well as the Department of Environmental Protection, Division of Air Quality permit issued in accordance with this application, along with all applicable rules and regulations of the West Virginia Division of Air Quality and W.Va. Code § 22-5-1 et seq. (State Air Pollution Control Act). If the business or agency changes its Responsible Official or Authorized Representative, the Director of the Division of Air Quality will be notified in writing within 30 days of the official change.

Compliance Certification

Except for requirements identified in the Title V Application for which compliance is not achieved, I, the undersigned hereby certify that, based on information and belief formed after reasonable inquiry, all air contaminant sources identified in this application are in compliance with all applicable requirements.

SIGNATURE _____



(Please use blue ink)

DATE: _____

08/08/25

(Please use blue ink)

35B. Printed name of signee: Daniel Bates

35C. Title: CEO

35D. E-mail: Dan@clean-seas.com

36E. Phone: 310-387-7636

36F. FAX:

36A. Printed name of contact person (if different from above): Roger Hanshaw

36B. Title: Attorney

36C. E-mail: rhanshaw@bowlesrice.com

36D. Phone: 304-347-1100

36E. FAX: 304-343-2867

PLEASE CHECK ALL APPLICABLE ATTACHMENTS INCLUDED WITH THIS PERMIT APPLICATION:

- | | |
|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> Attachment A: Business Certificate | <input checked="" type="checkbox"/> Attachment K: Fugitive Emissions Data Summary Sheet |
| <input checked="" type="checkbox"/> Attachment B: Map(s) | <input checked="" type="checkbox"/> Attachment L: Emissions Unit Data Sheet(s) |
| <input checked="" type="checkbox"/> Attachment C: Installation and Start Up Schedule | <input checked="" type="checkbox"/> Attachment M: Air Pollution Control Device Sheet(s) |
| <input checked="" type="checkbox"/> Attachment D: Regulatory Discussion | <input type="checkbox"/> Attachment N: Supporting Emissions Calculations |
| <input checked="" type="checkbox"/> Attachment E: Plot Plan | <input checked="" type="checkbox"/> Attachment O: Monitoring/Recordkeeping/Reporting/Testing Plans |
| <input checked="" type="checkbox"/> Attachment F: Detailed Process Flow Diagram(s) | <input checked="" type="checkbox"/> Attachment P: Public Notice |
| <input checked="" type="checkbox"/> Attachment G: Process Description | <input type="checkbox"/> Attachment Q: Business Confidential Claims |
| <input type="checkbox"/> Attachment H: Material Safety Data Sheets (MSDS) | <input type="checkbox"/> Attachment R: Authority Forms |
| <input checked="" type="checkbox"/> Attachment I: Emission Units Table | <input type="checkbox"/> Attachment S: Title V Permit Revision Information |
| <input checked="" type="checkbox"/> Attachment J: Emission Points Data Summary Sheet | <input checked="" type="checkbox"/> Application Fee |

Please mail an original and three (3) copies of the complete permit application with the signature(s) to the DAQ, Permitting Section, at the address listed on the first page of this application. Please DO NOT fax permit applications.

FOR AGENCY USE ONLY – IF THIS IS A TITLE V SOURCE:

- ☐ Forward 1 copy of the application to the Title V Permitting Group and:
- ☐ For Title V Administrative Amendments:
- ☐ NSR permit writer should notify Title V permit writer of draft permit,
- ☐ For Title V Minor Modifications:
- ☐ Title V permit writer should send appropriate notification to EPA and affected states within 5 days of receipt,
- ☐ NSR permit writer should notify Title V permit writer of draft permit.
- ☐ For Title V Significant Modifications processed in parallel with NSR Permit revision:
- ☐ NSR permit writer should notify a Title V permit writer of draft permit,
- ☐ Public notice should reference both 45CSR13 and Title V permits,
- ☐ EPA has 45 day review period of a draft permit.

All of the required forms and additional information can be found under the Permitting Section of DAQ's website, or requested by phone.

DOCUMENT 2

**Attachment “D”
Clean Seas Facility
Regulatory Discussion**

The regulatory Discussion reviews the federal and West Virginia regulations potentially applicable to the proposed Clean Seas Facility in Kanawha County, West Virginia, owned and operated by Clean Seas West Virginia LLC.

- D.0 Federal Regulations
- D.01 Prevention of Signification
 - D.01.01 Prevention of Significant Deterioration (40 CFR Part 51)
 - D.01.02 Nonattainment New Source Review (40 CFR Part 51)
- D.02 New Source Performance Standards (40 CFR Part 60)
 - D.02.01 NSPS — 40 CFR Part 60 — Subpart CCCC and DDDD Standards of Performance and Emission Guidelines and Compliance for Commercial and Industrial Solid Waste Incineration Units
- D.03 National Emission Standards for Hazardous Air Pollutants (40 CFR 63)
- D.04 Chemical Accident Prevention (40 CFR 68)
- D.05 State Operating Permit Program (40 CFR 70)
- D.06 Mandatory Greenhouse Gas Reporting (40 CFR 98)
- D.07 Maximum Achievable Control Technology (MACT) applicability
- D.08 Risk Management Plan
- D.09 Stack height
- D.10 Plastic Pyrolysis Operations
- D1.0 West Virginia State Regulations
 - D1.01 45CSR10 — To Prevent and Control Air Pollution from Emission of Sulfur Oxides <https://dep.wv.gov>
 - D1.02 45CSR13 — Permits for Construction
- D2.0 Insignificant Activities.

D.0 Federal Regulations

The Code of Federal Regulations (CFR) are regulations adopted by the US EPA and published in the Federal Register pursuant to the authority of the grant by Congress in the Clean Air Act. The CFR addresses multiple aspects, including but not limited to, permitting requirements, performance standards, testing methods, and monitoring requirements. The (CFR's) may be viewed online.

D.01 Prevention of Significant Deterioration Determination

The Prevention of Significant Deterioration (PSD) permitting program is a Clean Air Act permitting program for new and modified major stationary sources of air pollution. Implementation of the federal PSD regulations is delegated to the state of West Virginia by U.S. EPA and these regulations are contained at 40 CFR Part 52.21. Therefore, BAPC implements the federal PSD regulations directly. These regulations specify federally required permitting procedures for each "major stationary source." The PSD regulations define a "stationary source" as "any buildings, structure, facility or installation which emits or may emit any air pollutant subject to regulation under the Act." A building structure facility or installation" is defined as "all of the pollutant-emitting activities which belong to the same industrial grouping, are located on one or more contiguous or adjacent properties, and are under the control of the same person (or persons under common control) except the activities of ant vessel. Pollutant-emitting activities shall be considered as part of the same industrial grouping if they belong to the same 'Major Group' (i.e., which have the same first two-digit code) as described in the Standard Industrial Classification Manual, 1972, as amended by the 1977 Supplement."

"Major" is defined as the potential to emit of a stationary source, which equal or exceeds a specified threshold (in tons per year) or any air pollutants regulated under the Clean Air Act (40 CFR 52.21(b)(1)). The first threshold is for a stationary source that emits or has the potential to emit 100 tons per year or more of any regulated NSR pollutants and is defined as one of 28 specific categories of sources (see 40 CFR 52.21(b)(1)(i)(a)). The other applicability threshold is for any other stationary source that emits or has the potential to emit 250 tons per year of any regulated NSR pollutant (see 40 CFR 52.21(b)(1)(i)9b)). The Clean-Seas facility is not a major source as defined by PSD.

D.01.01 Prevention of Significant Deterioration (40 CFR 51)

Prevention of Significant Deterioration (PSD) applies to all criteria pollutants in an area that has been designated as attainment, such as the city of Belle, WV. The PSD program is set forth in 40 CFR 51 and is part of the federal New Source Review (NSR) permitting program for pollutants in an attainment area. Potential emissions of each PSD pollutant are below the program threshold; therefore, federal PSD review does not apply.

D.01.02 Nonattainment New Source Review (40 CFR Part 51)

Nonattainment New Source Review (NNSR) applies to major stationary sources located in nonattainment areas. The proposed plant will be located in Kanawha County, which is currently in attainment for all pollutants. Therefore, NNSR does not apply.

D.02 New Source Performance Standards (40 CFR Part 60)

Section 111 of the Clean Air Act, Standards of performance for New Stationary Sources, (NSPS) requires US EPA to establish federal emission standards for source categories which cause or contribute significantly to air pollution. Each NSPS defines the facilities subject to these requirements and prescribes emission limits for specific pollutants, compliance requirements monitoring requirements and test methods and procedures. These standards are intended to promote use of best air pollution control technologies, taking into account the cost of such technology and any other non-air quality, health, and environmental impact and energy requirements. These standards apply to sources which have been constructed or modified since the proposal of the standard. These standards can be found in the CFR at Title 40 (Protection of Environment), Part 60 (Standards of Performance for New Stationary Sources).

Generally, state and local air pollution control agencies are responsible for implementation, compliance assistance, and enforcement of the NSPS. US EPA retains concurrent enforcement authority and is also available to provide technical assistance when a state or local agency seeks help. US EPA also retains a few of the NSPS responsibilities such as the ability to approve alternative monitoring methods to maintain a minimum level of national consistency.

There are several federal and state regulations that apply to new source constructed and operating in an attainment area such as “Other Solid Waste Incineration Units” (OSWI) or “Commercial and Industrial Solid Waste Incineration Units” (CISWI). Brief overviews of these requirements are listed in subsections that follows. The Clean Air Act of 1970 directed US EPA to establish new source performance standards for specific industrial categories. There are few NSPS applicable to this project.

D.02.01 NSPS — 40 CFR Part 60 Subparts CCCC and DDDD — Standards of Performance and Emission Guidelines and Compliance for Commercial and Industrial Solid Waste Incineration Units

Clean-Seas is subject to Subparts CCCC and DDDD as a Commercial and Industrial Solid Waste Incineration Unit.

Commercial and industrial solid waste incineration unit (CISWI) means any distinct operating unit of any commercial or industrial facility that combusts, or has combusted in the preceding 6 months, any solid waste as that term is defined in 40 CFR part 241. If the operating unit burns materials other than traditional fuels as defined in § 241.2 that have been discarded, and you do not keep and produce records as required by § 60.2740(u), the operating unit is a CISWI. While not all CISWIs will include all of the following components, a CISWI includes, but is not limited to, the solid waste feed system, grate system, flue gas system, waste heat recovery equipment, if any, and bottom ash system. The CISWI does not include air pollution control equipment or the stack. The CISWI boundary starts at the solid waste hopper (if applicable) and extends through two areas: The combustion unit flue gas system, which ends immediately after the last combustion chamber or after the waste heat recovery equipment, if any; and the combustion unit bottom ash system, which ends at the truck loading station or similar equipment that transfers the

ash to final disposal. The CISWI includes all ash handling systems connected to the bottom ash handling system.

Despite the applicability Subparts CCCC and DDDD and Clean-Seas units being determined to be CISWI units, Clean-Seas notes that the units do not utilize combustion in any way. The primary product from the facility, Plastic Pyrolysis Oil, is a marketable product. The syngas generated in the facility has sufficient BTU content to power the process, and the remaining residue is expected to have commercial applications as well, and the facility is therefore not subject to regulation as an industrial incinerator.

Clean-Seas Minor Source Construction Permit Application

Clean-Seas is proposing to construct and operate a Plastic Pyrolysis Plant. The proposed Clean-Seas facility will convert plastic to plastic pyrolysis oil (PPO) as a precursor to new plastic and ultra-low sulfur fuels, lubricants, and other products.

Plastic Feedstock Specifications

Clean-Seas only accepts feedstock that: (1) is plastic derived from industrial, commercial, agricultural, or other such activities; (2) is not mixed with solid waste or hazardous waste onsite or during processing at the facility; (3) is intended use as a feedstock for the manufacturing of plastic and chemical feedstocks, other basic hydrocarbons, raw materials, or other intermediate products or final products using advanced recycling; and (4) has been sorted from solid waste and other regulated waste but may contain residual amounts of solid waste such as organic material and incidental contaminants or impurities (e.g., paper labels and metal rings).

The feedstock is typically items made of polyethylene (LDPE, LLDPE, or HDPE) and polypropylene (PP) such as containers, trays, cups, films, and bags.

All items free of contents or free flowing liquids and rinsed.

Minimum 85% polyethylene or polypropylene

Maximum moisture content: 7%

D.03 National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 63)

The NESHAPs contained in 40 CFR 63 have been adopted by the USEPA to regulate hazardous air pollutants via industrial controls. There are no sources at the proposed facility which will be subject to these standards.

D.04 Chemical Accident Prevention (40 CFR Part 68)

The facility does not have more than a threshold quantity of the chemicals listed in this subpart;

therefore, this regulation does not apply.

D.05 State Operating Permit Programs (40 CFR 70)

West Virginia's Operating Permit Program applies to major sources of criteria pollutants or hazardous air pollutants. The proposed facility is below both of these thresholds and is not subject to this regulation.

D.06 Mandatory Greenhouse Gas Reporting (40 CFR 98)

The proposed facility is subject to greenhouse gas reporting in accordance with 40 CFR 98.2(a)(3). Specifically, all three of the conditions in this section have been met:

- The facility will meet the requirements of either 40 CFR 98.2(a)(1) or (a)(2).
- The aggregate maximum rated heat input capacity of the stationary fuel combustion units at the facility is 8 MMBTU/hr or greater.
- The facility emits 25,000 metric tons CO₂e or more per year in combined emissions from all stationary fuel combustion sources.

D.07 Maximum Achievable Control Technology Standards

Maximum Achievable Control Technology (MACT) Standards were established under Section 112 of Clean Air Act for control of hazardous air pollutants ("HAPs"). These MACT standards are specified based on the category and subcategory list applicable to the major source. A minor source of HAPs is a source with total predicted HAP emissions of 25 TPY or greater or any single HAP emissions equal to 10 TPY or greater.

MACT Applicability

Predicted HAP emissions from the Clean-Seas' Plant are less than 25 tons per year total and less than 10 tons per year of any single HAP, hence Clean-Seas is not defined as a major source of HAPs.

D.08 Risk Management Plan

40 CFR 68 requires that Risk Management Plan (RMP) be developed for any regulated substance in excess of the threshold quantity as defined in subpart F. The Clean-Seas Plant does not have any regulated substance in excess of threshold limit.

D.09 Stack Height

The stack height regulations promulgated by U.S. EPA on July 8, 1985 (50 FE27892), established a stack height limitation to assure that stack height increases, and other plume dispersion techniques would not be used in lieu of constant emission controls. These regulations apply to facilities that commenced construction after December 31, 1970, and to dispersion techniques implemented after that date. These federal requirements have been included in the

regulations for Good Engineering Practice Stack Height. The regulations specify that Good Engineering Practice (GEP) stack height is the maximum creditable stack height a source may use in establishing its applicable State Implementation Plan (SIP) emission limitation. A GEP stack height means the greater of one of the following two options:

1. 65 meters, measured from ground-level elevation at the base of the stack (de minimus stack height); or
2. For stacks uninfluenced by terrain features, the determination of GEP stack height for a source is based on the following empirical equation:

$$H_g = H + H + 1.5L_b$$

Where: H_g = GEP stack height;
 H = Height of the structure on which the source is located, or nearby structure; and
 L_b = Lesser dimension (height or width) of the structure on which the source is located, or nearby structure.

Both the height and width of the structure are determined from the frontal area of the structure projected onto a plane perpendicular to the direction of the wind. The area where a nearby structure can have significant influence on the source is limited to 5 times the lesser dimension (height or width) of that structure or within 0.5 mile (0.8 km) of the proposed stack, whichever is less. The methods for determining GEP stack height for various building configurations have been described in U.S. EPA's technical support document (U.S. EPA, 1985).

All stacks at Clean-Seas Plant are less than 65 meters in height.

D.10 Plastic Pyrolysis Operations

The process utilized by the applicant is a pyrolysis technology and does not involve combustion. Accordingly, under the analysis outlined in 40 CFR 241, neither the feedstock nor the output of the process will come within the definition of a waste or hazardous material/hazardous substance. There are specific standards and specifications for the pyrolysis oil.

Synthetic gas from the pyrolysis unit will feed into the top of the first stage venturi scrubbers. Only one scrubber shall be utilized at a time. Cooling oil will be sprayed into the scrubbers to cool the syn gas. The first stage of cooling will be only for long chain hydrocarbon to prevent waxing of the system. The cooling temperature will be maintained at 350 °F. Light gases travel to the heat exchangers provided on the tank C to further cool down to below 90 °F. At this point 99% of the oil has been removed from the gas stream. The gas traveling further to the chilled condenser and will be chilled to 50 °F. Any condensed liquid from the syn gas and particulate matter will be removed from the bottom of the scrubber. The recovered cooling oil will be pumped, cooled, and recirculated to the venturi scrubbers. Any condensed liquid will be separated from the syn gas. Cooled syn gas will flow to the fuel gas compression system to be used in the process.

The process measures to be followed and observed by the operation are summarized as follows:

Plastics Pyrolysis Gas Production during Startup and Normal Operation

The expected pyrolysis gas flow and composition during the startup of the 2200 lb./hr. plastics pyrolysis plant (two skids 4400 lb./hr. normal operation, this is for one skid startup). During the heat up from ambient to 400°F only nitrogen heating and water vapor are the contents of the small volume of gas evolved from the process equipment. In the transition from 400°F to 600°F the plastic begins vaporizing and the components of the plastic. These vaporized components are condensed in the spray cooler being absorbed into the circulating diesel oil. Any additional vapors are condensed in the water cooled and refrigerated condenser on the ARTI Skid. The pyrolysis gas from the ARTI skid during the heat up from 400°F to 600°F will be Nitrogen, small amounts of CO, CO₂, O₂ and methane. This gas flow will be very low in this heat up period.

As the temperature increases from 600°F to 1000°F over about 2-hours, the gas flow rate will not be constant but will increase as the plastic feedstock reaches its thermal decomposition temperature. The gas production will escalate as temperatures climb from the initial thermal cracking phase into the more efficient high-temperature cracking phase.

Table 1: Estimated Pyrolysis Gas Flow Rate Progression

Time (Minutes)	Temperature Range (°F)	Pyrolysis Activity	Estimated Gas Flow Rate (% of Peak Capacity)
0–60	600–800	Initial cracking and thermal decomposition. Moisture and low-molecular-weight fractions evaporate. Gas 300–400 btu/scf Approximately 30% x 350/660 x 8.8= 1.4 mm btu/hr / ARTI skid Approximately 55 m btu/hr TRE	10–50%
60–120	800–1000	More aggressive thermal cracking of polymer chains, shifting towards higher gas yield. Gas 400 - 600 btu/scf. Approximately 70% x 500/660 x 8.8= 4.7 mm btu/hr / ARTI skid Approximately 187 m btu/hr TRE	50–90%
120+	1000–1200	More aggressive thermal cracking of polymer chains, shifting towards higher gas yield. Gas 660 btu/scf. Approximately 8.8 mm btu/hr/ARTI skid Approximately 350 m btu/hr TRE	90–100%

Peak Gas Production:

At the peak temperature of 1200°F, gas production is expected to be significant. Although gas is a byproduct, at operating temperatures, the yield can reach up to 440 lb/hr of the 2200 lb/hr fed to each ARTI skid. For a 2200 lb/hr feed rate, this could translate to a peak gas production of approximately 440 lb/hr for each ARTI skid. The diesel venturi scrubber, water cooled exchangers, and the glycol refrigerated exchanger condense heavier hydrocarbons from the gas resulting in an estimated 440 lb./hr./skid, 12.4MW, 660 btu/scf and 13.4 mscfh gas. The higher heating value of this gas is estimated to be 8.8mm btu/hr./skid.

TRE Gas Production:

The TRE - Training skid is designed to process 1/25th of the feed per hour that the ARTI 25TPD skid processes. The process design is nearly the same and the gas production will be 1/25th of the full size skid. Again, at the peak temperature of 1200°F, gas production is expected to be significant. Although gas is a byproduct, at operating temperatures, the yield can reach up to 17.6 lb/hr of the 88 lb/hr fed to the TRE skid. For an 88 lb/hr feed rate, this could translate to a peak gas production of approximately 17.6 lb/hr. The diesel venturi scrubber, water cooled exchangers, and the glycol refrigerated exchanger condense heavier hydrocarbons from the gas resulting in an estimated 17.6 lb/hr, 12.4MW, 660 btu/scf and 536 scfh gas. The higher heating value of this gas is estimated to be 355,000 btu/hr. During startup of the TRE the pyrolysis gas production will be very low. As with the full-size skid it follows the same ramp up with low btu gas initially, a little higher as the heatup progresses and finally the same gas process resulting in the light pyrolysis gas.

Estimated Pyrolysis Gas Flow Rate vs. Time

Expected gas composition

The composition of the pyrolysis gas changes as the temperature increases due to the progressive thermal cracking of the plastic feedstock.

Initial Phase (600°F–800°F):

During this phase, milder cracking and the evaporation of lighter components occur. The btu value of this gas is estimated to be

- **Hydrocarbons:** C2–C4 hydrocarbons like ethane, propane, and butanes are common, resulting from the initial, less severe chain scission.
- **Water Vapor:** Moisture present in the feedstock will evaporate, contributing to the gas volume.
- **Carbon Oxides:** Low to moderate amounts of CO and CO₂ may be present.

Mid-to-Late Phase (800°F–1000°F):

As the temperature rises, the thermal cracking becomes more vigorous, leading to the formation of smaller, more stable molecules.

- **Methane (CH_4):** The yield of methane tends to increase significantly with higher temperatures, becoming one of the most important components at high temperatures.
- **Ethane (C_2H_6), Propane, Butane:** mid-range hydrocarbon yields increase with temperature.
- **Hydrogen (H_2):** The concentration of hydrogen increases as temperatures climb, and more intensive cracking and aromatization reactions occur.
- **Heavier Hydrocarbons (C_5 – C_{10}):** While some C_5+ hydrocarbons will be present, the trend at higher temperatures is to crack these down into lighter gases. These are removed in the process exchangers resulting in a light low btu gas.
- **Aromatics:** are recovered in the venturi scrubber and sold with pyrolysis oil.
- **Carbon Oxides (CO , CO_2):** Both CO and CO_2 yields increase, reflecting the more complete degradation of carbon-based material.

Estimated Pyrolysis Gas Composition Profile

Considerations for practical applications

- **Feedstock Variation:** This analysis assumes a generic plastics mix. The specific composition (e.g., presence of PVC, PET, HDPE) dramatically alters the gas products.
- **Catalysts:** Using catalysts can change the product distribution, often promoting a higher yield of specific hydrocarbons.
- **Reactor Design:** Reactor type (e.g., fixed-bed, fluidized-bed) and residence time influence the extent of secondary cracking reactions and product distribution.
- **Mass Balance:** It is important to account for all products, including liquids (oils), char, and gases, to establish a complete mass balance for the process.
- **Heat Transfer:** The rate of heat transfer to plastics influences the actual heating rate and, therefore, the product yields.

Summary and conclusion

The startup of a plastics pyrolysis plant involves a dynamic process where both the gas flow rate and composition change significantly as the temperature rises. The initial heating phase produces very little low btu gas, while the higher-temperature phase yields a larger volume of gas with more hydrocarbons, H_2 , and CO .

D1.0 State Regulations

In addition to the federal air permitting requirements, the WVDEP applicable air quality regulations are summarized in this section.

The West Virginia Air Quality Standards and Regulations (DAQ) contains all state regulations applicable to the proposed site. All new or modified emission sources that are not specifically exempt from permitting requirements must obtain a construction and operating permit from the State of West Virginia Department of Environmental Protection Division of Air Quality prior to commencing construction and/or operation. This application and attached forms fulfill the information requirements needed to obtain a construction and operating permit required by regulation. Applicable sections include:

D1.01 45CSR10: Emission of Sulfur Dioxide

Clean-Seas' Plastic Pyrolysis System will burn the synthetic gas generated by, and powering, the pyrolysis reactor. The unit will use natural gas and propane. Both of these fuels have odorant for the purpose of leak detection. The quantities of SO₂ from these sources is very low and below

reportable quantities. Plastic materials used as feedstock for the plant will be selected for low chemical content as such S emissions generating SO₂ will be minor.

D1.02 45CSR13: "Minor New Source" Permit for Construction

Review permitting is divided into three categories:

1. NSR (45CSR13) Preconstruction Permit — See Table 9.4 for pollutant

NSR (45CSR13) Preconstruction — Requirements

This is an existing infrastructure previously used for sales and storage of lumber and construction materials.

Clean-Seas' Facility will meet all requirements as per NSR (45CSR13) See WVDEP 45CSR 13 Table 13A Revised and Table 1313 as well as Table 9.4.

All potential TAP and HAP emissions as listed in table 45-13A are calculated and included with this application. See permit application and attachments as listed under NSR (CSR13)

Respective Air Pollution for HAPs and TAPs See tables 9.4.1, 9.4.1A, 9.4.2 & 9.4.2A

2. 45CSR13 — Hazardous Air Pollution (HAP)
3. 45CSR13 — Toxic Air Pollution (TAP)

West Virginia Minor Source Air Permitting Program is enacted through 45CSR13 in which air Toxins are addressed in 45CSR 13. Any source that proposes to have the potential to emit before control at or above 2 lb/hr or 5 tpy of TAPs considered on aggregated basis for new facility. Clean-Seas will meet the necessary requirements. The EPA has determined that the following units do not require stringent regulations under Part 266, Subpart H.

- 1.0 Units burning gas recovered from hazardous or solid waste.

- 2.0 Units burning hazardous waste exempt from regulation 216.6(a)(s)iii)-v and maybe from 261.5
- 3.0 Applicability and exemptions, there are two classes of units covered under the Part 266, Subpart H. Regulation — Boilers and Industrial Furnaces. EPA defines a boiler as an enclosed device that uses controlled flame combustion to recover and export energy in the form of steam. Boilers have a combustion chamber and energy recovery efficiency of 60 percent. Reference RCRA, 40 CFR Part 266H — Boilers and Industrial Furnaces.

Emissions from Clean-Seas Operation — Attachments 'N' for all tables starting with No. 9.

- a) Table 9.4 — Emission Factors/Emission Calculations Note 1 Attachment N
- b) Tables 9.4.1, 9.4.1A, 9.4.2 & 9.4.2A — Emission Summary (Section 9.0)
- c) Table 9.4.3 — Metals and Other Emission Factors/Emission (Section 9.0)
- d) TAP & HAP Emission Summary (Section 9.0)
Organic HAPs Emission Summary (Section 9.0)
- e) Table 9.4.5 - Hazardous Air Pollutants Summary (Section 9.0)
Including Metallic HAPs Summary

3.0 Emergency Generator (Section 9.0) Subsection 9.6.2
Generac 150 kw (Attachments I & J)

1.0 Basic Operations & Process Description

Pre-approved plastic feedstock will arrive on the site via semi-trailer trucks and small box trucks. The plastic will be shipped in properly secured gaylord boxes, sacks or bales. The feedstock will be directly unloaded into the facility building. Once inside, the contents are unpacked, and prepared for processing.

The feedstock is manually fed into the American Renewable Technologies Inc. (ARTI) pyrolysis system, designed to operate on a continuous basis except for controlled, planned shutdowns.

2.0 Emissions:

Emission from the following emission units

<u>Emission Unit I.D.</u>	<u>Description</u>	<u>Points</u>
1-S	Pyrolyzer Unit 1	1-E
2-S	Pyrolyzer Unit 2	2-E
3-S	Flare	3-E
4-S	Frac Tanks	4-E

5-S	Generator-backup	5-E
6-S	Truck Loading	6-E
IR	Paved Roads	IR-E

APCD

Description

1C

Pyrolysis Unit 1 Burner

2C

Pyrolysis Unit 2 Burner

3C

Flare

These air pollution components have been selected and arranged to provide targeted and redundant levels of removal for the “nine pollutants” of concern specified the Table 1B of 40 CFR part EC, for which Clean-Seas is not subject to, but are using for reference. These controls include Low NOx Burners (NOx control), and Flare to control emissions.

3. 5-EG5 — Emergency Natural Gas Generator Unit (ID 5-EG5)

Emergency generator will be a Generac 150kWh natural gas generator and provide power during emergency events. The generator will be permitted for 100 hours per year for non-emergency uses including maintenance and upkeep activities.

D2.0 Insignificant Activities Exempt from Permitting

Certain sources, operations, and activities are considered to be insignificant based on following categories.

- A. Size or emission rate
- B. Type of activity
- C. Type of pollutant

Table List of Insignificant Activities

Insignificant Activity	Insignificant Activity Subcategory Class
- Two 0.2 MMBtu/hr gas-fired HVAC furnaces - Six 0.05-MMBtu/hr space heaters	A-5

DOCUMENT 3

Attachment G - TRE Process Description

In addition to the 25 ton/day main reactors, Clean-Seas West Virginia will also deploy a 1/24th-scale Training, Research and feedstock Evaluation unit to train its workforce, research and develop best practices and Standard Operating Procedures (ISO, OSHA), and evaluate feedstock suitability.

The unit, manufactured by American Renewable Technologies Inc., is identical to one deployed in 2023 by Clean-Seas in Hyderabad India, in partnership with the Indian Institute of Chemical Technology.

Powered by low-emission natural gas burners, the Unit processes up to 120 pounds/hour of shredded plastic feedstock through an auger-fed continuous reactor, converting it via pyrolysis to: 70-80% Plastic Pyrolysis Oil, 20-25% non-condensable syngas and 0-5% solid residue; all products may be captured and analyzed in a lab.

A typical cycle will involve pre-heating the unit to approximately 700°C (1 hour), feeding plastic to generate sufficient testable quantities of products (up to 3.5 hours of residence time for the feedstock; up to 20 hours per campaign), and cooling (up to 3 hours.)

The TRE pyrolysis reactor is fed the plastic through two slide valves that are sequenced to prevent the escape of gases and air from entering the piping (retorts) in the furnace. Augers convey the plastic through the retorts, heating it to between 700F and 1200F and converting the plastic into oil, gas and residue.

The TRE retort burners are fueled by propane using low NO_x burners which reduce NO_x, CO and other emissions. The Pyrolysis equipment is combined onto a skid. The equipment will operate at a slight vacuum to prevent leakage.

Cooling, separation, centrifuge, pumping and refrigeration equipment separate the oil, gas and residue into concentrated streams that will be stored. A flare will collect PSVs, vents and sources of overpressure due to shutdowns or upsets designed to efficiently combust gases preventing raw gas emissions to the atmosphere. During TRE operation the pyrolysis gas is flared.

The pyrolysis oil (oil) will be stored in a 260 gallon liquid tote. The tote will have surrounding spill containment capable of the full tote volume to contain any drips.

Pyrolysis gasses are the non-condensable gases mainly methane, ethane, propane, butane, CO, CO₂ and H₂. This gas is safely flared through a TRE-dedicated flare. The flare has a 2" opening for gas exit with an air blower to introduce combustion air for maximum destruction removal efficiency. The flare will have a pilot lit at all times of TRE operation.

Solid residue is directed into a covered bin to contain any dust. The residue will be sold for beneficial use or disposed of in an EPA-approved landfill via a licensed waste hauler.

Clean-Seas does not expect to operate the TRE Unit more than 1 shift (8 hours)/day.

DOCUMENT 4

Attachment F

Plastics Pyrolysis Gas Production during Startup and Normal Operation

The expected pyrolysis gas flow and composition during the startup of the 2200 lb/hr plastics pyrolysis plant (two skids 4400lb/hr normal operation, this is for one skid startup). During the heat up from ambient to 400F only nitrogen heating and water vapor are the contents of the small volume of gas evolved from the process equipment. In the transition from 400F to 600F the plastic begins vaporizing and the components of the plastic. These vaporized components are condensed in the spray cooler being absorbed into the circulating diesel oil. Any additional vapors are condensed in the water cooled and refrigerated condenser on the ARTI Skid. The pyrolysis gas from the ARTI skid during the heat up from 400F to 600F will be Nitrogen, small amounts of CO, CO₂, O₂ and methane. This gas flow will be very low in this heat up period.

As the temperature increases from 600°F to 1000°F over about 2-hours, the gas flow rate will not be constant but will increase as the plastic feedstock reaches its thermal decomposition temperature. The gas production will escalate as temperatures climb from the initial thermal cracking phase into the more efficient high-temperature cracking phase.

Table 1: Estimated Pyrolysis Gas Flow Rate Progression

Time (Minutes)	Temperature Range (°F)	Pyrolysis Activity	Estimated Gas Flow Rate (% of Peak Capacity)
0–60	600–800	Initial cracking and thermal decomposition. Moisture and low-molecular-weight fractions evaporate. Gas 300-400 btu/scf Approximately 30% x 350/660 x 8.8= 1.4 mm btu/hr / ARTI skid Approximately 55 m btu/hr TRE	10–50%
60–120	800–1000	More aggressive thermal cracking of polymer chains, shifting towards higher gas yield. Gas 400 - 600 btu/scf. Approximately 70% x 500/660 x 8.8= 4.7 mm btu/hr / ARTI skid Approximately 187 m btu/hr TRE	50–90%
120+	1000–1200	More aggressive thermal cracking of polymer chains, shifting towards higher gas yield. Gas 660 btu/scf. Approximately 8.8 mm btu/hr/ARTI skid Approximately 350 m btu/hr TRE	90–100%

Peak Gas Production:

At the peak temperature of 1200°F, gas production is expected to be significant. Although gas is a byproduct, at operating temperatures, the yield can reach up to 440 lb/hr of the 2200 lb/hr fed to each ARTI skid. For a 2200 lb/hr feed rate, this could translate to a peak gas production of approximately 440 lb/hr for each ARTI skid. The diesel venturi scrubber, water cooled exchangers, and the glycol refrigerated exchanger condense heavier hydrocarbons from the gas resulting in an estimated 440 lb/hr/skid, 12.4MW, 660 btu/scf and 13.4mscfh gas. The higher heating value of this gas is estimated to be 8.8mm btu/hr/skid.

TRE Gas Production:

The TRE - Training skid is designed to process 1/25th of the feed per hour that the ARTI 25TPD skid processes. The process design is nearly the same and the gas production will be 1/25th of the full size skid. Again, at the peak temperature of 1200°F, gas production is expected to be significant. Although gas is a byproduct, at operating temperatures, the yield can reach up to 17.6 lb/hr of the 88 lb/hr fed to the TRE skid. For an 88 lb/hr feed rate, this could translate to a peak gas production of approximately 17.6 lb/hr. The diesel venturi scrubber, water cooled exchangers, and the glycol refrigerated exchanger condense heavier hydrocarbons from the gas resulting in an estimated 17.6 lb/hr, 12.4MW, 660 btu/scf and 536 scfh gas. The higher heating value of this gas is estimated to be 355,000 btu/hr. During startup of the TRE the pyrolysis gas production will be very low. As with the full-size skid it follows the same ramp up with low btu gas initially, a little higher as the heatup progresses and finally the same gas process resulting in the light pyrolysis gas.

Estimated Pyrolysis Gas Flow Rate vs. Time

Expected gas composition

The composition of the pyrolysis gas changes as the temperature increases due to the progressive thermal cracking of the plastic feedstock.

Initial Phase (600°F–800°F):

During this phase, milder cracking and the evaporation of lighter components occur. The btu value of this gas is estimated to be

- **Hydrocarbons:** C2–C4 hydrocarbons like ethane, propane, and butanes are common, resulting from the initial, less severe chain scission.
 - **Water Vapor:** Moisture present in the feedstock will evaporate, contributing to the gas volume.
 - **Carbon Oxides:** Low to moderate amounts of CO and CO₂ may be present.
-

Mid-to-Late Phase (800°F–1000°F):

As the temperature rises, the thermal cracking becomes more vigorous, leading to the formation of smaller, more stable molecules.

- **Methane (CH_4):** The yield of methane tends to increase significantly with higher temperatures, becoming one of the most important components at high temperatures.
- **Ethane (C_2H_6), Propane, Butane:** mid-range hydrocarbon yields increase with temperature.
- **Hydrogen (H_2):** The concentration of hydrogen increases as temperatures climb, and more intensive cracking and aromatization reactions occur.
- **Heavier Hydrocarbons (C_5 – C_{10}):** While some C_5+ hydrocarbons will be present, the trend at higher temperatures is to crack these down into lighter gases. These are removed in the process exchangers resulting in a light low btu gas.
- **Aromatics:** are recovered in the venturi scrubber and sold with pyrolysis oil.
- **Carbon Oxides (CO , CO_2):** Both CO and CO_2 yields increase, reflecting the more complete degradation of carbon-based material.

Estimated Pyrolysis Gas Composition Profile

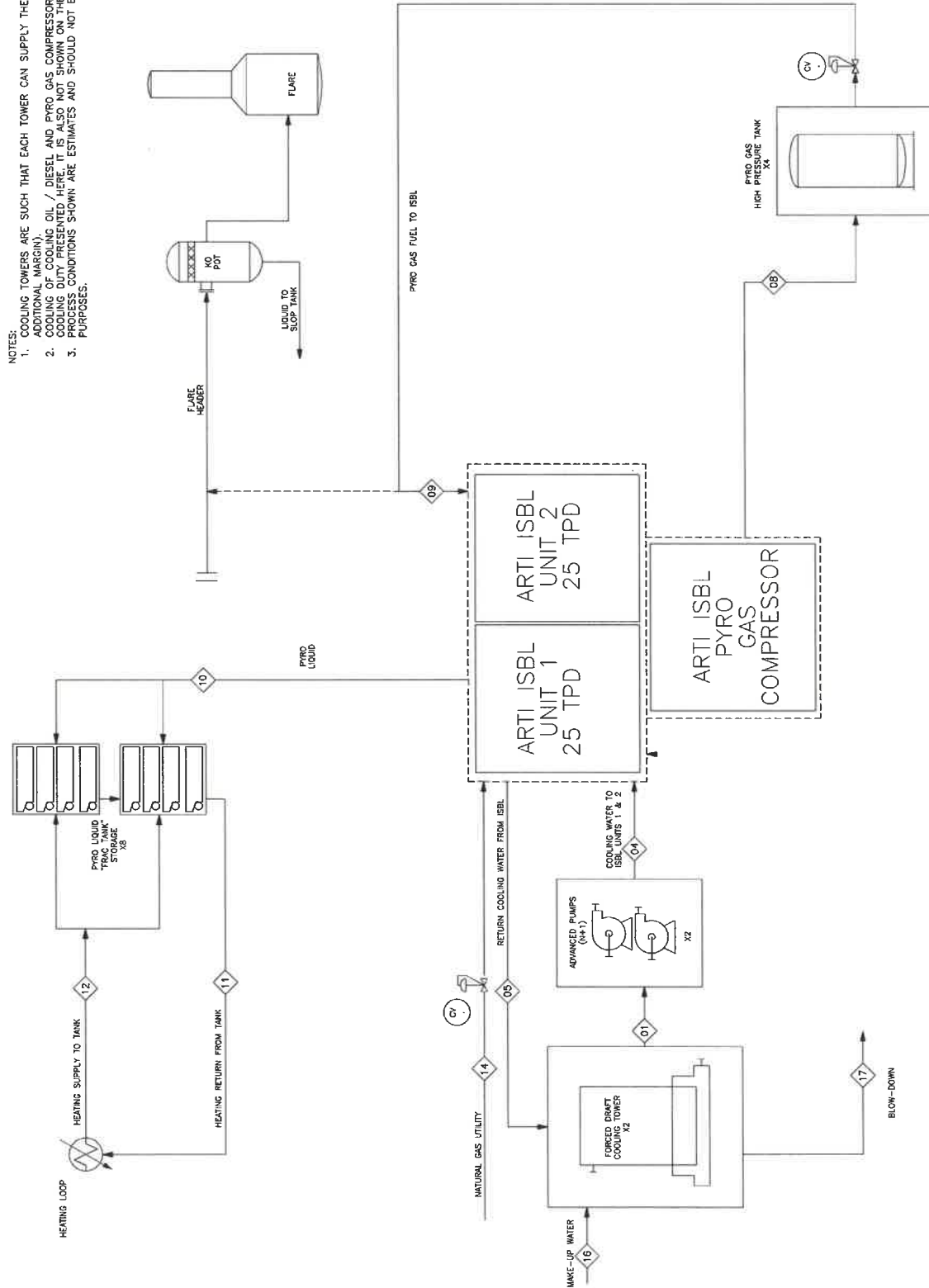
Considerations for practical applications

- **Feedstock Variation:** This analysis assumes a generic plastics mix. The specific composition (e.g., presence of PVC, PET, HDPE) dramatically alters the gas products.
- **Catalysts:** Using catalysts can change the product distribution, often promoting a higher yield of specific hydrocarbons.
- **Reactor Design:** Reactor type (e.g., fixed-bed, fluidized-bed) and residence time influence the extent of secondary cracking reactions and product distribution.
- **Mass Balance:** It is important to account for all products, including liquids (oils), char, and gases, to establish a complete mass balance for the process.
- **Heat Transfer:** The rate of heat transfer to plastics influences the actual heating rate and, therefore, the product yields.

Summary and conclusion

The startup of a plastics pyrolysis plant involves a dynamic process where both the gas flow rate and composition change significantly as the temperature rises. The initial heating phase produces very little low btu gas, while the higher-temperature phase yields a larger volume of gas with more hydrocarbons, H_2 , and CO .

- NOTES:
1. COOLING TOWERS ARE SUCH THAT EACH TOWER CAN SUPPLY THE DUTY FOR THREE ARTI 25 TPD REACTORS (33% ADDITIONAL MARGIN).
 2. COOLING TOWERS ARE SUPPLIED WITH DIESEL OIL / DIESEL AND PYRO GAS COMPRESSOR SWD. IS NOT ACCOUNTED FOR IN THE NET COOLING DUTY PRESENTED HERE. IT IS ALSO NOT SHOWN ON THE PFD.
 3. PROCESS CONDITIONS SHOWN ARE ESTIMATES AND SHOULD NOT BE CONSIDERED SUITABLE FOR CONSTRUCTION PURPOSES.



A		09/10/25	ISSUE FOR REVIEW
midbough		CLEAN SEAS	
		QUINCY, WV FACILITY	
		GENERAL	
		PROCESS FLOW DIAGRAM	
		UIS2501	
DATE	BY	CHKD	APP'D
09/10/25	UIS	UIS	UIS
SCALE: NONE		PFD-0001	
A		PROJ # UIS2501	

DOCUMENT 5

The PPO (Plastics Pyrolysis Oil) SDS was used to calculate the RVP and TVP of the PPO, with an IBP 20F, avg boiling of 423F, density of 0.7996

GPT-4o mini:

To estimate the True Vapor Pressure (TVP) in psia for plastics pyrolysis oil, we can use the Antoine equation or similar empirical correlations. However, without specific constants for the substance in question, we can provide a general approach.

Estimation of TVP

1. **Input Parameters**:

- **Initial Boiling Point (IBP)**: 20°F
- **Average Boiling Point (ABP)**: 423°F
- **Density**: 0.7996 g/cm³

2. **Conversion of Units**:

- Convert temperatures to Rankine (°R) for calculations:
 - IBP: $(20^{\circ}\text{F} + 459.67 = 479.67^{\circ}\text{R})$
 - ABP: $(423^{\circ}\text{F} + 459.67 = 882.67^{\circ}\text{R})$

3. **Using the Antoine Equation**:

The Antoine equation is generally expressed as:

$$\log_{10}(P) = A - \frac{B}{C + T}$$

where P is the vapor pressure, T is the temperature in °C, and A , B , and C are substance-specific constants.

4. **Estimation**:

Since we don't have the specific constants for plastics pyrolysis oil, we can use typical values for similar hydrocarbons. For example, if we assume:

- $A = 6.9$
- $B = 1200$
- $C = 200$

You would need to convert the average boiling point to Celsius for the calculation:

$$T(^{\circ}\text{C}) = \frac{(423 - 32) \times 5}{9} \approx 217.22^{\circ}\text{C}$$

5. **Calculate TVP**:

Plugging the values into the Antoine equation:

$$\log_{10}(P) = 6.9 - \frac{1200}{200 + 217.22}$$

Calculate $\ln(P)$ and convert it to psia (1 atm = 14.7 psia).

Conclusion

Without specific constants for the pyrolysis oil, the exact TVP cannot be calculated. However, using the above method with appropriate constants for similar materials will yield an estimated TVP in psia. If you have access to specific Antoine constants for the pyrolysis oil, you can substitute them into the equation for a more accurate result.

Calc p

GPT-4o mini:

To calculate the vapor pressure $\ln(P)$ using the Antoine equation, we will follow the steps outlined previously. Let's assume the Antoine constants for a similar hydrocarbon are:

- $A = 6.9$
- $B = 1200$
- $C = 200$

Step-by-Step Calculation

1. **Convert Average Boiling Point to Celsius**:

$$T(^{\circ}\text{C}) = \frac{(423 - 32) \times 5}{9} \approx 217.22^{\circ}\text{C}$$

2. **Plug Values into the Antoine Equation**:

$$\log_{10}(P) = A - \frac{B}{C + T}$$

Substituting the values:

$$\log_{10}(P) = 6.9 - \frac{1200}{200 + 217.22}$$

3. **Calculate the Denominator**:

$$200 + 217.22 = 417.22$$

4. **Calculate the Fraction**:

$$\frac{1200}{417.22} \approx 2.874$$

5. **Calculate $\log_{10}(P)$:**

$$\log_{10}(P) = 6.9 - 2.874 \approx 4.026$$

6. **Convert from Logarithmic to Pressure:**

$$P = 10^{4.026} \approx 106.8 \text{ atm}$$

7. **Convert to psia:**

Since $1 \text{ atm} = 14.7 \text{ psia}$:

$$P \approx 106.8 \times 14.7 \approx 1560.96 \text{ psia}$$

Conclusion

The estimated vapor pressure (P) for the plastics pyrolysis oil at an average boiling point of 423°F is approximately **1560.96 psia**.

Please note that this is a rough estimate based on assumed Antoine constants. For more accurate results, specific constants for the actual pyrolysis oil should be used.

Tvp at 100f

GPT-4o mini:

To calculate the True Vapor Pressure (TVP) at **100°F** using the Antoine equation, we will follow a similar approach as before.

Step-by-Step Calculation

1. **Convert 100°F to Celsius:**

$$T(^{\circ}\text{C}) = \frac{(100 - 32) \times 5}{9} \approx 37.78^{\circ}\text{C}$$

2. **Assumed Antoine Constants:**

We'll continue using the assumed constants for a similar hydrocarbon: - (
 $A = 6.9$)
- ($B = 1200$)
- ($C = 200$)

3. **Plug Values into the Antoine Equation:**

$$\log_{10}(P) = A - \frac{B}{C + T}$$

\]

Substituting the values:

\[

$$\log_{10}(P) = 6.9 - \frac{1200}{200 + 37.78}$$

\]

4. **Calculate the Denominator**:

\[

$$200 + 37.78 = 237.78$$

\]

5. **Calculate the Fraction**:

\[

$$\frac{1200}{237.78} \approx 5.04$$

\]

6. **Calculate $\log_{10}(P)$** :

\[

$$\log_{10}(P) = 6.9 - 5.04 \approx 1.86$$

\]

7. **Convert from Logarithmic to Pressure**:

\[

$$P = 10^{1.86} \approx 72.38 \text{ mmHg}$$

\]

8. **Convert mmHg to psia**:

Since $1 \text{ atm} = 760 \text{ mmHg}$ and $1 \text{ atm} = 14.7 \text{ psia}$:

$$P \approx \frac{72.38}{760} \times 14.7 \approx 1.43 \text{ psia}$$

\]

Conclusion

The estimated True Vapor Pressure (TVP) for the plastics pyrolysis oil at **100°F** is approximately **1.43 psia**.

Again, this is a rough estimate based on assumed Antoine constants. For more accurate results, specific constants for the actual pyrolysis oil should be used.

Tvp at 60f

GPT-4o mini:

To calculate the True Vapor Pressure (TVP) at **60°F**, we will use the same approach as before with the Antoine equation.

Step-by-Step Calculation

1. **Convert 60°F to Celsius**:

$$T(^{\circ}\text{C}) = \frac{(60 - 32) \times 5}{9} \approx 15.56^{\circ}\text{C}$$

2. **Assumed Antoine Constants**:

We'll continue using the assumed constants for a similar hydrocarbon: - \

$$A = 6.9 \text{ \}$$

$$- \text{ \} (B = 1200 \text{ \})$$

$$- \text{ \} (C = 200 \text{ \})$$

3. **Plug Values into the Antoine Equation**:

$$\log_{10}(P) = A - \frac{B}{C + T}$$

Substituting the values:

$$\log_{10}(P) = 6.9 - \frac{1200}{200 + 15.56}$$

4. **Calculate the Denominator**:

$$200 + 15.56 = 215.56$$

5. **Calculate the Fraction**:

$$\frac{1200}{215.56} \approx 5.57$$

6. **Calculate $\log_{10}(P)$** :

$$\log_{10}(P) = 6.9 - 5.57 \approx 1.33$$

7. **Convert from Logarithmic to Pressure**:

$$P = 10^{1.33} \approx 21.54 \text{ mmHg}$$

8. **Convert mmHg to psia**:

Since $1 \text{ atm} = 760 \text{ mmHg}$ and $1 \text{ atm} = 14.7 \text{ psia}$:

$$P \approx \frac{21.54}{760} \times 14.7 \approx 0.42 \text{ psia}$$

Conclusion

The estimated True Vapor Pressure (TVP) for the plastics pyrolysis oil at **60°F** is approximately **0.42 psia**.

As always, this is a rough estimate based on assumed Antoine constants. For more accurate results, specific constants for the actual pyrolysis oil should be used.

What are the estimated liquid molecular weight and vapor (@100F) molecular weight

GPT-4o mini:

To estimate the molecular weights of the liquid and vapor phases of plastics pyrolysis oil at **100°F**, we can use the following general approach:

Estimation of Molecular Weights

1. **Liquid Molecular Weight**:

The molecular weight of a liquid can often be estimated based on its density and the average composition of the components in the mixture. For plastics pyrolysis oil, which typically consists of a complex mixture of hydrocarbons, a rough estimate can be made.

- **Density of Liquid**: Given as **0.7996 g/cm³**.
- A common range for the molecular weight of hydrocarbons is between **100 g/mol** to **300 g/mol**. For pyrolysis oils, a typical average molecular weight might be around **150 g/mol** to **200 g/mol**.

2. **Vapor Molecular Weight**:

The vapor molecular weight can be estimated using the ideal gas law and the vapor pressure at the given temperature. The molecular weight of the vapor phase can be influenced by the lighter components that are more volatile.

- **Vapor Pressure at 100°F**: Previously calculated as approximately **1.43 psia**. - Using the ideal gas law, we can estimate the molecular weight of the vapor phase using the formula:

$$MW = \frac{P \cdot R \cdot T}{V}$$

where:

- P = pressure in atm (**1.43 psia** \approx **0.096 atm**)
- R = ideal gas constant (**0.0821 L·atm/(K·mol)**)
- T = temperature in Kelvin (**100°F** \approx **310.93 K**)

Calculation of Vapor Molecular Weight

1. **Convert Pressure**:

$$P \approx 1.43 \text{ psia} \approx 0.096 \text{ atm}$$

2. **Use Ideal Gas Law**:

Rearranging the ideal gas law to find molecular weight:

$$MW = \frac{P \cdot R \cdot T}{V}$$

Assuming a volume of 1 L for simplicity:

$$MW = P \cdot R \cdot T$$

$$MW = 0.096 \cdot 0.0821 \cdot 310.93$$

$$MW \approx 2.43 \text{ g/mol}$$

Conclusion

- **Estimated Liquid Molecular Weight**: Approximately **150 g/mol to 200 g/mol** (a rough estimate based on typical values for similar hydrocarbons).
- **Estimated Vapor Molecular Weight**: The calculation above seems incorrect due to the assumptions made. The vapor molecular weight for hydrocarbons is typically higher, often in the range of **50 g/mol to 100 g/mol** for lighter fractions.

For a more accurate assessment, specific compositional analysis of the pyrolysis oil would be necessary.

What is a likely cas no for the liquid

GPT-4o mini:

For plastics pyrolysis oil, which is a complex mixture of various hydrocarbons and other organic compounds, there isn't a single CAS (Chemical Abstracts Service) number that can represent the entire mixture. However, several components commonly found in pyrolysis oils have specific CAS numbers. Here are a few likely candidates:

1. **Phenol**:

- **CAS No**: **108-95-2**

- Commonly found in pyrolysis oils derived from plastics.
2. **Benzene**:
 - **CAS No**: **71-43-2**
 - A common aromatic hydrocarbon present in many pyrolysis oils.
 3. **Toluene**:
 - **CAS No**: **108-88-3**
 - Another aromatic compound that may be present.
 4. **Xylenes**:
 - **CAS No**: **1330-20-7** (for mixed isomers)
 - Often found in the distillate of pyrolysis oils.
 5. **Cyclohexane**:
 - **CAS No**: **110-82-7**
 - A saturated hydrocarbon that can be present in the mixture.
 6. **Decane**:
 - **CAS No**: **124-18-5**
 - A straight-chain alkane that may be part of the oil.

Conclusion

While there isn't a single CAS number for plastics pyrolysis oil, the above compounds are representative of the types of chemicals you might find in such a mixture. If you need a specific CAS number for regulatory or safety purposes, it would be best to analyze the specific composition of the pyrolysis oil in question.

What is the estimated Reid vapor pressure for the liquid

GPT-4o mini:

To estimate the Reid Vapor Pressure (RVP) for plastics pyrolysis oil, we can use the following approach. RVP is typically measured at 100°F (37.8°C) and is an important parameter for understanding the volatility of a liquid.

Estimation of Reid Vapor Pressure (RVP)

1. **Understanding RVP**:

RVP is defined as the vapor pressure of a liquid at a specified temperature, typically measured using a Reid apparatus. It is often expressed in psi.
2. **Using Antoine Equation**:

We can use the Antoine equation to estimate the vapor pressure at 100°F, which we previously calculated as approximately **1.43 psia**. However, RVP is typically higher than the vapor

pressure due to the presence of lighter fractions in the liquid.

3. **Adjustment for RVP:**

RVP can be estimated by considering the vapor pressure and adjusting for the presence of lighter components. A common rule of thumb is that RVP can be approximately 1.5 to 2 times the vapor pressure for complex mixtures like pyrolysis oil.

Calculation

1. **Vapor Pressure at 100°F:**

- Previously calculated as approximately **1.43 psia**.

2. **Estimate RVP:**

Using a multiplier (let's use 1.5 for a conservative estimate):

$$\begin{aligned} & \backslash[\\ & \text{RVP} \approx 1.5 \times 1.43 \approx 2.15 \text{ psia} \\ & \backslash] \end{aligned}$$

Conclusion

The estimated Reid Vapor Pressure (RVP) for plastics pyrolysis oil at **100°F** is approximately **2.15 psia**.

This is a rough estimate, and actual RVP can vary based on the specific composition of the pyrolysis oil. For precise measurements, laboratory testing would be required.

DOCUMENT 6

Clean Seas Facility

Attachment G – Process Description

Clean Seas West Virginia LLC (Clean Seas) is constructing the Clean Seas facility near Belle in Kanawha County West Virginia. The facility will process plastics into marketable products: precursors for plastics, fuel, and oil.

This thermochemical pyrolysis process converts used plastic material into oil, gas and residue by heating in the absence of oxygen. The process involves breaking down large plastic molecules into smaller hydrocarbon molecules resulting in the production of these three main outputs.

The facility will receive plastic feedstock from outside suppliers. The supplier will clean and sort to remove paper, metals and dirt, and the plastic is then shredded into smaller pieces to increase the surface area in preparation for conversion.

The pyrolysis reactors feed the plastic through two valves sequenced to prevent escape of gases and air from entering the piping in the furnace. This piping is called a retort and has several passes that have powered augers to push the plastic through heating it to between 700F and 1200F. This temperature increase converts the plastic into oil, gas and residue.

Natural gas will be used to initially fire burners converting the plastic into pyrolysis oil, pyrolysis gas and solid residue. When sufficient non-condensable synthetic gas is generated, the two Pyrolysis furnace burners will be fueled by the synthetic gas using low NOx burners. The Pyrolysis equipment is combined onto a skid. The equipment will operate at a slight vacuum to prevent leakage.

Cooling, separation, centrifuge, pumping and refrigeration equipment separate the oil, gas and residue into concentrated streams that will be stored and sold.

Synthetic gas from the pyrolysis unit will feed into the top of the first stage venturi scrubbers. Only one scrubber shall be utilized at a time. Cooling oil will be sprayed into the scrubbers to cool the syn gas. The first stage of cooling will be only for long chain hydrocarbon to prevent waxing of the system. The cooling temperature will be maintained at 350 °F. Light gases travel to the heat exchangers provided on the tank C to further cool down to below 90 °F. At this point 99% of the oil has been removed from the gas stream. The gas traveling further to the chilled condenser and will be chilled to 50 °F. Any condensed liquid from the syn gas and particulate matter will be removed from the bottom of the scrubber. The recovered cooling oil will be pumped, cooled, and recirculated to the venturi scrubbers. Any condensed liquid will be separated from the syn gas. Cooled syn gas will flow to the fuel gas compression system to be used in the process.

A flare will collect flows from pressure relief valves, vents and sources of overpressure due to shutdowns or upsets designed to efficiently combust gases preventing raw gas emissions to the atmosphere.

The flare is a ground based enclosed combustion chamber that will combust vent gases for maximum destruction removal efficiency of 99.9%. Supplemental combustion air is added to the gas stream at exit for smokeless operation. Supplemental fuel will not be added to the flare gas stream. The only fuel added is used to operate a pilot on the burner for ignition of flare gas streams.

The average expected heat content of the effluent (synthetic gas) during startup & operations is 50 °F

The pyrolysis oil (oil) will be stored in 8 portable storage tanks (Baker style) which will be nitrogen blanketed and have pressure vacuum vents connected to the flare. Nitrogen and the venting controls will eliminate emissions to the atmosphere as any vapors will go to the flare for combustion. Tanks will be in dikes to contain any spills. Oil will be sold and shipped by third party trucks. Truck loading will be a closed system to eliminate vapor emissions. Truck loading will have curbing to contain any potential spills. Trucks delivering plastic feedstock and shipping products will be weighed into and out of the facility.

A backup generator will provide backup electrical power to enable safe shutdown of the operations in the event of a power outage. This generator will reduce the possibility of flaring in the event of a power outage. The generator is intended for backup power and will be fueled by natural gas to reduce emissions.

Pyrolysis gases are the non-condensable gases, mainly methane, ethane, propane, butane, CO, CO₂ and H₂ that can be used as a fuel source to power the pyrolysis process or other industrial applications. Pyrolysis gases will be stored in cylinders for use in the pyrolysis process.

Solid residue will enter a covered bin to contain any dust. The residue will be sold for soil amendment or other applications.

The system consists of the following subsystems:

1. The Furnace:

An insulated enclosure which contains two burners that provide the heat needed to sustain the pyrolysis process. The hot flue gases flow up and around the three retort tubes inside of the furnace before exiting the stack. The material in the inside diameter of the retorts are isolated from the furnace environment so the hot flue gases cannot come into direct contact with the process material being conveyed through the retorts. The furnace is equipped with burners capable of operating with natural gas or pyrolysis gas. The heat from the burners travels across the outer diameter of three passes to efficiently heat the retorts. The flue gas temperature is normally 150 to 200 °F above the retort operating temperature. The furnace is designed to allow the retorts to thermally expand and contract during the operation.

2. The Retorts:

The retorts are installed within the furnace having an inlet and an outlet end. The material is fed to the retort via a double blade air sealed valve. This valve is important because it prevents the passage of air into the retort. The material is fed into the retorts from a manually loaded hopper, when the top blade opens it allows the material to enter the empty cavity of the valve below. Once the top blade has closed the bottom blade opens to feed the material into the retort. This valve is synchronized with an auger to introduce feed into the retort. As the feedstock material travels

through the retorts it gasifies. The gases are collected under a slight negative pressure and flow out of the retorts. As the gasification sequence of the material ends, the residue exits the retorts through a similarly designed double blade valve thus maintaining the slight vacuum during the discharge of this residue. This residue is passed through a water-cooled auger to reduce the temperature to a level which is safe for handling.

The solid residue, typically a maximum 5% of the original value, can be landfilled or diverted to industrial use. At initial start-up Clean-Seas will transfer to EPA approved landfill as we characterize the material and find a beneficial use for it.

3. The Augers:

The retorts are equipped with high temperature stainless steel augers which move the material from the inlet, through the retort, and finally to the discharge point. The speed of the augers can be changed at the Operator Control Panel to suit the material processed.

4. The Burners:

The furnace is equipped with burners fueled with either natural gas or pyrolysis gas. The burners are supplied with a flame safeguard control and can be modulated to a higher firing rate on demand. A temperature control installed on the retorts allows the burner to start and to modulate. Once the burners are turned on, they modulate to a firing position where they heat the retorts to the pre-set temperature. When the temperature demand is satisfied the burners modulate back to the lower firing rate. If the temperature exceeds its preset upper limit the burners automatically shut down. If the retort temperature falls below the lower set point the burner will automatically start and raise the temperature back to the upper set point.

5. The Cyclone Separator:

The Cyclone Separator is installed at the exhaust point of the gases. This unit will separate any particles from the gas before the gas travels to the gas Particle Wash System.

6. The Particle Wash System:

The Particle Wash System is installed after the Cyclone Separator. The Particle Wash System contains 10 to 15 gallons of light oil. The Wash Pump energizes as the unit starts to operate and recirculates the washing media. This washing process takes place in a venturi and any heavy

particles such as tar or wax can be removed from the gas and will be retained within the Particle Wash System. A glass level indicator is supplied with the Particle Wash System. The unit must be drained from time to time to keep the level low enough for the gas to travel through. Once the gas has been cleaned through the venturi it travels through the demister and liquid particles are stripped from the gas.

7. The Condenser:

As the gas exits the Particle Wash System, it enters a Vertical Condenser. All condensable gases or water is stripped from the gas and non-condensable gases travel through another demister to the gas blowers.

8. The Gas Blower

A Gas Blower is supplied to remove the gases from the system while maintaining the slight negative pressure within the system. It is a Roots-type positive displacement blower. The blower is controlled through the use of a pressure transducer installed on the retort. This transducer senses the rate of gasification. As the gasification process gas flow changes, the retort pressure rises or falls and sends a signal to the blower speed control to compensate. In this way the operating retort vacuum is maintained at a preset level. This ensures the quality and uniformity of the by-products.

9. PPO Product Storage

Once plastic pyrolysis oil liquid exits the process, it is then sent to storage prior to shipping to offtakers. The oil will be stored in (8) 21,000 gallon portable storage tanks (Baker Style) tanks with a maximum of 18,000 gallon storage capacity to allow freeboard space for thermal expansion of material. The tanks have an internal coil that will allow the flow of heated water to keep the contents above pour point temperature ~100F

10. PPO Loading Rack

The PPO will be transported via pipe to a loading rack. Trucks will enter the facility to transfer oil into approved tanker trailers supplied by the offtaker. The system will be closed loop, meaning that the vapors from the tanker will enter the process to eliminate venting of vapors to the atmosphere.