**Comments/ suggestions are invited from Stakeholders and Public**

on

**Draft SoP on "Recycling of Waste Tyre Scrap for the production of Tyre Pyrolysis Oil in Tyre Pyrolysis Oil (TPO) Units" as below.**

**Comments to be sent on** - anand.cpcb@nic.in, wm3.cpcb@gov.in

**Last date for receiving comments/suggestions** – 31-10-2022

**DRAFT**

# STANDARD OPERATING PROCEDURE
# Recycling of Waste Tyre Scrap for the production of Tyre Pyrolysis Oil in Tyre Pyrolysis Oil (TPO) Units

## 1.0 Background

Pyrolysis is a thermal degradation process carried out in the absence of oxygen/air in a vessel or a chamber, so that the combustion of material does not take place. It is a process in which organic materials are thermally decomposed into simpler compounds in the temperature range of 400–500$^0$C in an oxygen-free atmosphere. Fig. 1 shows the schematic diagram of waste tyre pyrolysis process. Since the products of thermal decomposition is released at different temperature having varying molecular structure, the products are in all phases i.e. solid, liquid and gas. Pyrolysis of tyres and rubber products produce pyrolysis oils, pyrolysis gas (pyro- gas), carbon residue and steel. The product generated in tyre pyrolysis is as follows:

i. **Pyro Gas:** 20 to 35 percent of a tyre's energy content is typically converted into a combustible gas (Pyro Gas) that is used to fuel the pyrolysis process or is combusted in a flare before it is released. Typically, the components of pyro gas are H2, H2S, CO, CO2, CH4, C2H4, C3H6 and other light hydrocarbons.

ii. **Pyro Oil:** 35 to 50 percent of the output from the process is transformed into a liquid product that varies in quality from saleable fuel oil to lower-value oil blend stock.

iii. **Carbon Residue:** The residual solid product (referred as carbon residue constitutes 25 to 40 percent of the output and contains a mixture of carbon black, Titanium dioxide, Zinc & Steel.

iv. **Steel:** The thin wire, which is used for reinforcement of tyre is extracted out during pyrolysis and is collected at the end, sold in the market as scrap steel.

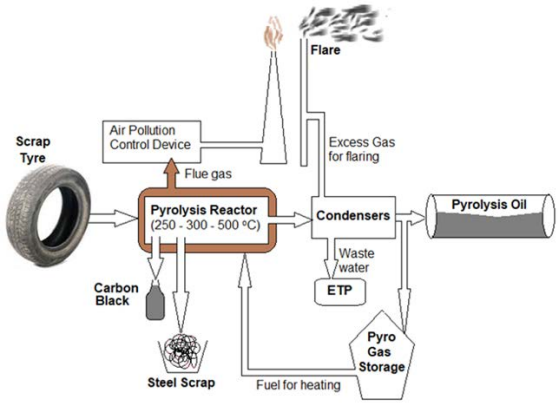


**Fig. 1:** Schematic diagram of waste tyre pyrolysis process

1.1 Pyrolysis Reactor Types

Two types of reactors are in operation in India. Batch Type and Continuous Pyrolysis Reactors. In both type of reactors, the final product remains the same. Most of the tyre pyrolysis units in the country are batch processes producing Tyre Pyrolysis Oils owing to lesser capital cost. There is a need to standardize the operations and facilities at Tyre Pyrolysis Oil Units to achieve environmentally safe operation of these units.

## 2.0 Siting Criteria, Carrying Capacity and Standard Operating Procedures (SOP) of batch type Tyre Pyrolysis Oil (TPO) Units:

### 2.1 Siting Criteria for siting of batch type Tyre Pyrolysis Oil (TPO) Units

Tyre Pyrolysis Oil (TPO) units shall meet the following requirements:

**(I) Location and siting guidelines for TPO Units:**

New TPO unit shall be allowed only within the designated industrial zones/ areas and should not be allowed in critically and severely polluted areas.

**(II) Criteria for siting:**

The criteria for siting of TPO units depends on the following facts:

a. There are no organized continuous process emissions in tyre pyrolysis process. The emissions are from burning of fuel for heating purpose and intermittent flaring of excess pyro gas or its emergency release;

b. The plot area of the TPO Unit carries more weightage as the emission from TPO unit does not affect far away community, instead it is the immediate neighborhood that is affected. Black carbon, being large size particle if spilled in the plant premises during its handling cannot travel to larger distance under the influence of wind;

c. The environmental concern from TPO units is fugitive emission of carbon fine particles in the work zone while removing it from reactor vessel and its packing into the bags. The influence zone due to fugitive emission of carbon fine particles is limited to premise of the unit; and

d. The odour from TPO units are localized and confined to premises and adjacent areas.

**Following are the criteria for site consideration:**

i. New TPO unit shall be allowed only within the designated industrial zones/areas;
ii. New TPO unit shall not be allowed in critically and severely Polluted Areas;

iii. Batch Reactor having capacity of 10 tonnes to 20 tonnes should only be allowed for new proposed TPO units;
iv. Considering the possibility of large quantity impacts in neighborhood, batch TPO unit having cumulative batch capacity up to 50 tonnes per day (TPD) only be allowed and this is applicable for both existing and new TPO units.
v. Beyond cumulative batch capacity of 50 TPD, only continuous TPO unit be allowed for both existing and new TPO units.
vi. For new proposed batch type TPO unit the minimum plot area shall be 3000 square meter for a single batch reactor of 10 tonne capacity and the area will increase by 750 square meter for every additional reactor and will increase up to 6000 square meter.
vii. For new proposed batch type TPO unit the minimum plot area shall be 4500 square meter for a single batch reactor of 20 tonne capacity and the area will increase by 750 square meter for every additional reactor and will increase up to 6000 square meter.
viii. The shed where batch reactors are installed should be located at the center of the Plot.
ix. For new proposed continuous TPO unit the minimum plot area should be 7000 square meter irrespective of number reactors.

**(III) Green Belt Requirement**

A green belt with minimum two rows of trees with sufficient foliage be established. Open paved road/space of 5.0-meter-wide to be left after the green belt to facilitate movement of the fire-tenders all around the plant. No material is allowed to be stored in this paved road/open space. While issuing CTE/CTO SPCBs/PCCs to ensure this requirement. In the existing plants, open paved road/space to be provided at least two side of the plant premises with access to material storage yard and shed of pyrolysis unit.

## 2.2 Carrying Capacity of the area for siting of New Tyre Pyrolysis Oil (TPO) Units

The committee is of the view that carrying capacity may not be required in case of individual Tyre pyrolysis units of capacity 10 - 50 TPD, since these are small pyrolytic operations with no process emissions and there are only flue gas emissions due to combustion of fuels for reactors or in flare stacks. However, such approach may be necessary in case of cluster of units. Permission to TPO plants shall not be allowed in cities or the areas not attaining ambient air quality standards. Clustering of TPO units are not allowed. Minimum aerial distance of 500 meter shall be ensured between two TPO units.

In order to minimize impact on adjacent areas, committee recommends a minimum plot area of 3000 square meters for batch pyrolysis reactor of size of 10 TPD and 4500 square meters for batch pyrolysis reactor of size of 20 TPD. Subsequently, for every addition of capacity by 10 TPD or 20TPD, the area shall increase by 750 square meter. Capacity of TPO shall not exceed 50 TPD unless it is based on continuous pyrolysis operation.

Operation of Tyre Pyrolysis Units shall be restricted during the period between November to February for the units located in the States of Himachal, Punjab, NCR, Haryana, Uttarakhand, Jammu & Kashmir, Uttar Pradesh, Bihar and West Bengal owing to poor dispersion and inversion conditions.

## 2.3 Threshold Limits for Tyre Pyrolysis Oil (TPO) Units (New and Existing)

Followings are the threshold limits for the TPO units:

i. Batch type TPO unit having cumulative batch capacity up to 50 tonnes only shall be allowed.
ii. Beyond cumulative batch capacity of 50 tonnes, only continuous type TPO unit shall be allowed.

## 2.4 Standard operating Procedure (SOP) of batch type (New & Existing) TPO Units

### A. Minimum Requirement for Environmentally Sound Operation:

2.4.1 Unit should have a valid Consent to Establish, Consent to Operate under Water and Air Act and Authorization under the Hazardous and Other Waste (M & TM) Rules,2016 issued by SPCB / PCC & Fire Safety Certificate issued by the concerned department.

2.4.2 Unit to comply with emission & effluents standards as prescribed by the concerned SPCBs/PCCs in consent to operate (CTO) under Air and Water Act. Further the management of Hazardous waste generated to be done as per the conditions prescribed in the authorization issued by the SPCBs / PCCs under the Hazardous and Other Waste (M & TM) Rules,2016.

2.4.3 The feed to batch reactor has to be either full waste tyres or two piece cut waste tyre or multiple cut waste tyres or waste tyre chips with steel or waste tyre mix with scrap rubber or industrial rubber waste or crumb rubber. Before feeding of raw material into the reactor nitrogen ($N_2$) purging to be done. All TPO units have to install Nitrogen purging system.

2.4.4 Initial heating of the reactor to be done either by using pyro gas stored during previous cycle or by use of pyro water / purge water (oil mix water) / oil water emulsion, or by tyre pyrolysis oil or any other fuel approved by concerned SPCBs /PCCs. After generation of pyro gas, the same is to be used for the purpose of heating reactor. Plants to install adequate APCD for controlling flue gas emissions. The flue gas should be vented out to the environment through an alkaline scrubber with mist eliminator attached to a chimney of at least 30 meters height.

2.4.5 A compressor has to be installed for mixing of air with pyro water for ensuring proper burning while using pyro water/purge water during initial heating.

2.4.6 In order to control fugitive emissions from the reactor during operation, proper sealing should be ensured.

2.4.7 TPO units have to construct a gated closed chamber over the canopy of the reactor, covering front door of the reactor and one fourth length of canopy with suction hood of sufficient capacity. The closed chamber should be of sufficient size so that operations such as feeding of tyres into the reactor or removal of steel from the reactor should not be affected. The gate of the chamber should of such size so that all the operations can be carried out

smoothly. The minimum dimension of the closed chamber should be 12ft x 12 ft x 12 ft.

2.4.8 The removal of carbon should be through a mechanized system. The unloading of carbon residue from the reactor is to be done under controlled conditions in such a manner that the contents of the reactor are not open to the atmosphere at any point of time. The carbon residue shall be bagged in the HDPE bags with proper sealing. It should be ensured that no spillage take place during the collection of the carbon in the bags.

2.4.9 The unloading of steel scrap from the reactor results into spillage of carbon black around the reactor area and generates fugitive emission. Plants to ensure no such spillage occurs by using suitable trays with wheels for transporting the steel scrap within the premise from generation points to storage points. This operation to be made cleaner by use of vacuum cleaner after each batch operation. The flooring from the generation point to the storage point shall be hard paved along with proper slope.

2.4.10 TPO units have to install water sprinkling system for prevention of fugitive emission during opening of the gate and unloading of steel scrap. Water sprinklers to be installed at the transfer points for arresting fugitives.

2.4.11 Suction hood also to be installed at the transfer points across the work zone such as at carbon black bagging area etc. to control fugitive emissions. All suction hood to be connected to a common manifold leading to alkaline scrubber with mist eliminator attached with stack of 30 m height (installed for venting out flue gas emissions).

2.4.12 Excess pyro gas if any should be flared through properly designed flaring system of adequate capacity considering the emergency situation in which the entire gas may have to be flared. The flaring should be done at a minimum height of 30 meter.

2.3.13 TPO units have to install Programme Logic Controller (PLC) based auto activation for stopping of gas supply to the burner and for switching off the burners in case of increase of pressure and temperature inside the reactor.

2.4.14 TPO Units have to install PLC based auto activation of bypass arrangements for bypassing the pyro gas from reactor to first separator tank in case of blocking/chocking of outlet vent inside the reactor or direct bypass for flaring.

2.4.15 TPO units have to install PLC based system for control of temperature and pressure inside the reactor.

2.4.16 TPO units have to install PLC based gas sensors connected with sirens (hooters) in case of release of carbon monoxide (CO).

2.4.17 The collection of the oil from the condensers should be in closed vessel and storage also should be in closed tanks with suitable vents. There should be no manual handling of oil. Transfer of oil should be carried out through pumps.

2.4.18 TPO units have to connect first separator tank with the oil storage tank for storing heavy oil fraction.

2.4.19 At the end of the pyrolysis process the reactor has to be cooled before the removal of carbon black. During cooling process, the reactor should be purged again with nitrogen.

2.4.20 The removal of carbon should be started after the reactor temperature comes down to below $50^{o}C$ or first separator tank temperature comes down to $40^{0}C$

2.4.21 The inside temperature of the reactor should not exceed $500^{0}C$ and the first separator tank temperature should not exceed $450^{0}C$ during the entire batch operation.

2.4.22 Waste water generated during the process should not be discharged anywhere and:

i. Should be treated in suitable ETP of sufficient capacity. Oily sludge should be disposed through TSDF or can used to make char briquettes, for subsequent transfer/sale to the cement manufacturing plants or other such industries having authorization for co-processing or;

   a. ETP discharge may be used for briquettes manufacturing. The briquettes so manufactured shall be disposed through co-processing in cement kiln
   b. ETP sludge may be used for briquettes manufacturing. The briquettes so manufactured shall be disposed through co-processing in cement kiln

ii. Oil mixed water may be converted into briquettes in a briquetting plant by mixing the waste water with sawdust and carbon black in suitable proportions. These briquettes manufactured using the waste water and carbon black are to be utilized only in processes where temperature is $1000^{0}C$ or more to avoid emissions of obnoxious gases; or

iii. Purge water/ oil mix water/oil water emulsion should be used for Initial heating of the reactor

2.4.23 TPO Units to ensure that treated water be re-used in unit itself & there is zero effluent discharge.

2.4.24 TPO units to have a separate storage tank for storage of pyro water/ purge water /oil mix water. The pyro water be transferred from final storage tank to pyro water storage tank in closed loop through pumps.

2.4.25 The unit should carry out stack and ambient air quality monitoring for SO2, PM and CO at least once in six months from a recognized laboratory at identified monitoring location. The unit shall maintain a log book for recording the plant, operation, monitoring of the stack emissions

and ambient air quality, generation & utilization of wastewater & sale of various products and by- products.

2.4.26 The transportation of Carbon residue(Char) should be done in bags (small or jumbo) in closed vehicles to ensure that there is no spillage of carbon black during their transportation. Manifest may be necessary for transportation of carbon residue (Char).

2.4.27 The transportation of Tyre Pyrolysis Oil (TPO) should strictly be done in closed tankers to ensure that there is no spillage of TPO during their transportation.

2.4.28 The carbon residue generated in the process shall be utilized only in co-processing in the cement industry and no third party should be involved in its disposal. Any other use may require further utilization studies.

2.4.29 The Tyre Pyrolysis Oil (Product) and carbon residue (Char) shall be stored in areas separate / distinct from the processing area (shed where the reactors are installed). The storage sheds will have cement concrete floors with a plinth height of minimum 0.5m. Tyres shall be stored in earmarked sheds / open area on a raised cement concrete platform.

**B. Safety Measure to be adopted**

2.4.31 Automatic control systems such as Programmed Logic Control (PLC) shall be adopted for measurement and control of temperature and pressure along with safety interlocks in case of increase of temperature or pressure to cut off heating of the reactor should be provided. It should be ensured that the reactor is under positive pressure at all the time.

2.4.32 A sensor for CO gas to be installed in the working area to ensure that concentration of CO in the working area does not exceed the prescribed limits for occupational safety and health as per Factory Act 1948. It will also be coupled with a warning/alarm system so that the plant operator can take adequate steps to rectify the situation.

2.4.33 Sensors along with alarm system should be provided at all the transfer points throughout the plant to detect any leakage of flammable vapors from the system.

2.4.34 Fire detectors, sprinklers and fire hydrant with necessary pumping system and water storage should be provided in the process area, product and raw material storage area.

2.4.35 The TPO unit shall possess fire clearance certificates issued by concerned departments.

2.4.36 That safety instruction for safe operation of plant will be displayed at the gate, plant working area and other critical places. Further, training will be imparted to the workers for safe operation of these plants.

2.4.37 On site emergency plan, as per the requirements under the Factories Act,1948, will be made and implemented to handle any accident, fire/ leakage or any other emergency situation. All such measures shall include raw material storage, product storage and handling thereof.

2.4.38 The plant will be operated under the continuous supervision of a qualified person having experience of running such units.

2.4.39 All the persons/workers in the premises should wear an air filter mask to avoid inhaling of the fine carbon black particles.

2.4.40 TPO Units will maintain good house-keeping and will ensure that no raw material products and wastes get spilled inside or outside the plant.

2.4.41 TPO Units to carry out annual health check-up of all the employees working in the unit & submit its report to concerned SPCBs/PCCs on annual basis.

2.4.42 TPO Units operators shall have insurance cover for workers, plant & machinery and materials.

## 2.5 Continuous Process (New & Existing):

### A. Minimum Requirement for Environmentally Sound Operation:

For the continuous pyrolysis plants the following facilities have to be ensured.

2.5.1 The Unit should have a valid Consent to Establish and Consent to Operate under Water and Air Act and Authorization under the Hazardous & Other Waste (M&TM) Rules, 2016 issued by SPCB/PCC & Fire Safety Certificate issued by the concerned department.

2.5.2 Unit to comply with emission & effluents standards as prescribed by the concerned SPCB/PCC in consent to operate (CTO) under Water and Air Act. Further the management of Hazardous Waste generated to be done as per the conditions prescribed in the authorization issued by the SPCB/PCC under the Hazardous Waste (M&TM) Rules, 2016.

2.5.3 Initial heating of the reactor to be done either by using pyro gas stored during previous cycle itself or by use of purge water (oil mix water)/oil water emulsion, or by tyre pyrolysis oil or any other fuel approved by concerned SPCBs/PCCs. After generation of pyro gas, the same is to be used for the purpose of heating reactor. Plants to install adequate APCD for controlling flue gas emissions. The flue gas should be vented out into the environment through alkaline scrubber with mist eliminator attached with a chimney of at least 30 meters height.

2.5.4 After initial heating, during the pyrolysis process, the pyro gas generated within the plant should be used as a fuel.

2.5.5 The feeding system should be provided with an air-lock arrangement so that no air enters the reactor during feeding.

2.5.6 Excess pyro gas if any should be flared through properly designed flaring system of adequate capacity considering the emergency situation in which the entire gas may have to be flared. The flaring should be done at a minimum height of 30 metre.

2.5.7 In order to control fugitive emissions from the reactor during operation, proper sealing should be ensured.

2.5.8 The collection of the oil from the condensers should be in a closed vessel and storage also should be in closed tanks with suitable vents. There should be no manual handling of oil. Transfer of oil should be through pumps.

2.5.9 The removal of carbon residue (Char) should be through a mechanized system. The unloading of carbon residue (Char) from the reactor is to be done under controlled conditions through a pneumatic /screw conveyor system in such a manner that the contents of the reactor are not open to the atmosphere at any point of time. The end of the conveyor system shall be attached to a bagging plant where all the carbon residue (Char) will be bagged in the HDPE bags with proper sealing. It should be ensured that no spillage taken place during the collection of the carbon in the bags. Moreover, an air-lock should be provided to ensure no entry of air into the reactor.

2.5.10 Water sprinklers to be installed at the transfer points for arresting fugitives

2.5.11 The carbon residue (Char) and the oil obtained from the process should be supplied only to actual users / co-processors.

2.5.12 Waste water generated during the process should not be discharged anywhere and:

i. Should be treated in suitable ETP of sufficient capacity. Oily sludge should be disposed through TSDF or can used to make char briquettes, for subsequent transfer/sale to the cement manufacturing plants or other such industries having authorization for co-processing or;

   a. ETP discharge may be used for briquettes manufacturing. The briquettes so manufactured shall be disposed through co-processing in cement kiln
   b. ETP sludge may be used for briquettes manufacturing. The briquettes so manufactured shall be disposed through co-processing in cement kiln

ii. Oil mixed water may be converted into briquettes in a briquetting plant by mixing the waste water with sawdust and carbon black in suitable proportions. These briquettes manufactured using the waste water and carbon black are to be utilized only in processes where temperature is 10000C or more to avoid emissions of obnoxious gases; or

iii. Purge water/ oil mix water/oil water emulsion should be used for Initial heating of the reactor

2.5.13 TPO Units to ensure that treated water be re-used in the unit itself & there is zero effluent discharge.

2.5.14 The transportation of Carbon residue(Char) and Tyre Pyrolysis Oil (TPO) should strictly be done in closed vehicles to ensure that there is no spillage of carbon black or oil during their transportation.

2.5.15 The generation, transportation and disposal of carbon residue to the cement manufacturing plants shall be recorded through proper manifest system and no third party should be involved in its disposal.

2.5.16 The Tyre Pyrolysis Oil (Product) and carbon residue shall be stored in areas separate / distinct from the processing area (shed where the reactors are installed). The storage sheds will have cement concrete floors with a plinth height of about 0.5m. Tyres shall be stored in earmarked sheds/open area on a raised cement concrete platform.

2.5.17 The unit should carry out stack and ambient air quality monitoring for SO2, PM, and CO at least once in six months from a recognized laboratory at identified monitoring location. The unit will maintain a log book for recording the plant operation, monitoring of the stack emissions and ambient air quality, generation & utilization of wastewater & sale of products and wastes.

**B. Safety Measure to be adopted**

2.5.18 Automatic control systems such as Programmed Logic Control (PLC) shall be adopted for measurement and control of temperature and pressure along with safety interlocks in case of increase of temperature or pressure to cut off heating of the reactor should be provided. It should be ensured that the reactor is under positive pressure at all the time.

2.5.19 A sensor for CO gas to be installed in the working area to ensure that concentration of CO in the working area does not exceed the prescribed limits for occupational safety and health as per Factory Act 1948. It will also be coupled with a warning/alarm system so that the plant operator can take adequate steps to rectify the situation.

2.5.20 Sensors along with alarm system should be provided at all the transfer points throughout the plant to detect any leakage of flammable vapors from the system.

2.5.21 Fire detectors, sprinklers and fire hydrant with necessary pumping system and water storage should be provided in the process area, product and raw material storage area.

2.5.22 The TPO unit shall possess fire clearance certificates issued by concerned departments.

2.5.23 That safety instruction for safe operation of plant will be displayed at the gate, plant working area and other critical places. Further, training will be imparted to the workers for safe operation of these plants.

2.5.24 On site emergency plan, as per the requirements under the Factories Act,1948, will be made and implemented to handle any accident, fire/ leakage or any other emergency situation. All such measures shall include raw material storage, product storage and handling thereof.

2.5.25 The plant will be operated under the continuous supervision of a qualified person having experience of running such units.

2.5.26 All the persons/workers in the premises should wear an air filter mask to avoid inhaling of the fine carbon black particles.

2.5.27 TPO Units will maintain good house-keeping and will ensure that no raw material products and wastes get spilled inside or outside the plant.

2.5.28 TPO Units to carry out annual health check-up of all the employees working in the unit & submit its report to concerned SPCBs/PCCs on annual basis.

2.5.29 TPO Units operators shall have insurance cover for workers, plant & machinery and materials.

2.5.30 In case the TPOs propose to utilize carbon residue in any other process other then co-processing in cement plant, they shall submit such proposal to CPCB for conducting trial utilization study.

**C. General conditions applicable to all plants (Batch & Continuous):**

2.5.30 All TPO Units to carry out annual health check-up of all the employees working in the unit & submit its report to concerned SPCBs / PCCs on annual basis.

2.5.31 In line with the policy adopted by MoEF&CC, Unit shall not to import waste tyres for the purpose of TPO production. Unit to use only indigenous generated waste tyre (i.e. Waste tyre generated in India only). Also unit to sell its products to Actual Users only.

2.5.32 Unit to maintain record on consumption of waste tyre along with details of its procurement source, Details & quantity of products, details of actual users to whom products have been sold.

2.5.33 Unit to submit its annual report to the concerned SPCB providing details on annual production of TPO, Carbon Residue(Char), Steel & other products including details of sources of purchasing waste tyre and also details of actual users to whom products have been sold by June 30. The annual report to be supported with electricity bills of the financial year for which annual return has been submitted.

2.5.34 All SPCBs/PCCS to submit consolidated annual report of all the Tyre Pyrolysis Units in their State to CPCB as per the rules.

2.5.35 Units have to report daily waste generation, disposal data on National Hazardous Waste Tracking system as and when such system gets implemented by CPCB.

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