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Recycling of Automotive Tyre waste using Pyrolysis

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Abstract – *In world Market Scenario billions of tons of wastages are available in all over the world. We can't burn or landfill those tyres due to pollution problems. There is no other use of these waste tyres. So few Engineers have found a solution for this wastage tyre. The process involve separation of all the contents from waste tyres and make it a complete renewable process. Tyre Recycling is a unique renewable technology that has come up with a concept of setting new standard in renewable energy that includes using of waste tyres as a raw material and producing green fuel oil, carbon black, steel and gas. With global warming and utilization of rubber, it has now become necessary to recycle the waste and convert it in fuel oil in such a way that it is environment friendly. This is a unique technology and can change energy market scenario in a big way.*

***Key Words*: Recycling, Pyrolysis, Gravity separation, Reactor, Gas separator, Condenser.**

1. INTRODUCTION

Tire recycling, or **rubber recycling**, is the process of recycling waste tires that are no longer suitable for use on vehicles due to wear or irreparable damage. These tires are a challenging source of waste, due to the large volume produced, the durability of the tires, and the components in the tire that are ecologically problematic.

Because tyres are highly durable and non-biodegradable, they can consume valued space in landfills. In 1990, it was estimated that over 1 billion scrap tires were in stockpiles in the United States. As of 2015, only 67 million tires remain in stockpiles. From 1994 to 2010, the European Union increased the amount of tires recycled from 25% of annual discards to nearly 95%, with roughly half of the end-of-life tires used for energy, mostly in cement manufacturing.

Newer technology, such as **Pyrolysis** and **Devulcanization**, has made tires suitable targets for recycling despite their bulk and resilience. Aside from use as fuel, the main end use for tires remains ground rubber.

1.1 Pyrolysis Process

The **pyrolysis** method for recycling used tires is a technique which heats whole or shredded tires in a reactor vessel containing an oxygen-free atmosphere. In the reactor the rubber is softened after which the rubber polymers break down into smaller molecules. These smaller molecules eventually vaporize and exit from the reactor. These vapors can be burned directly to produce power or condensed into an oily type liquid, generally used as a fuel. Some molecules are too small to condense. They remain as a gas which can be burned as fuel. The minerals that were part of the tire, about 40% by weight, are removed as solid ashes. When performed properly, the *tire pyrolysis* process is a clean operation and produces little emissions or waste, however, concerns about air pollution due to incomplete combustion as is the case with tire fires have been documented As a result of pyrolysis of wastage tyres, following things are obtained:

1) Fuel Oil (40 to 45%)

2) Carbon Black (30 to 35%)

3) Steel Wire (10 to 15%)

4) Gas (10 to 12%)

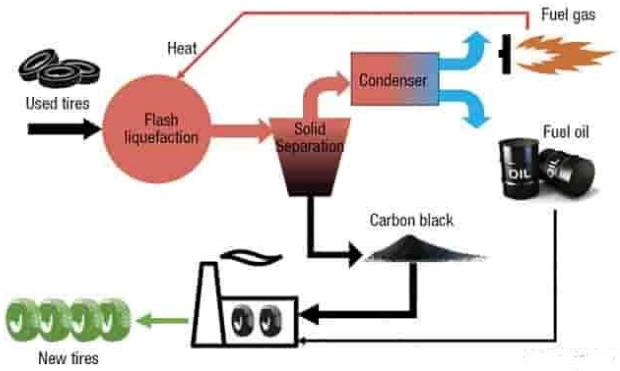

Fig - 1: Pyrolysis Process

1.2 Gravity separation

Gravity separation is an industrial method of separating two components, either a suspension, or dry granular mixture where separating the components with gravity is sufficiently practical: i.e. the components of the mixture have different specific weight.

All of the gravitational methods are common in the sense that they all use gravity as the dominant force.

2. Machinery Used

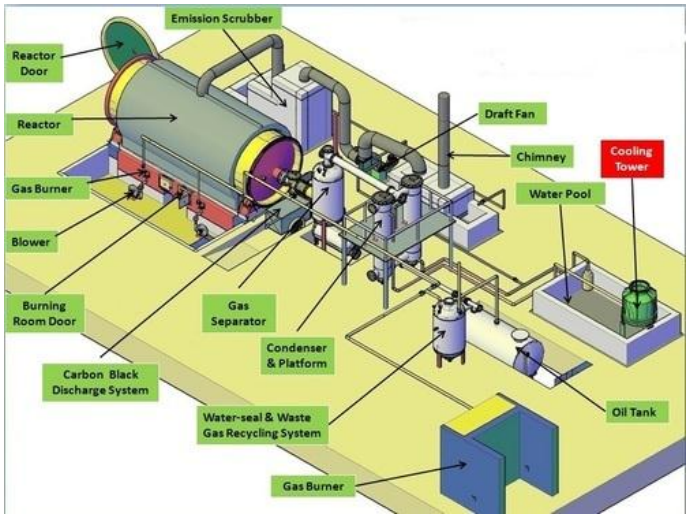

Fig -2: Plant layout

The three major parts of the Pyrolysis plant are:

- Reactor
- Gas separator
- Condenser

2.1 Reactor

Fig - 3: Circulating fluidized bed reactor

A chamber where the batch of tyres are heated at high temperatures in the absence of oxygen which in turn breaks down the complex composition of solid molecule of used tyres into simpler gaseous components leaving behind powdered carbon and steel scrap.

2.2 Gas separator

Fig - 4: Gas Separator

An oil/gas separator is a pressure vessel used for separating a well stream into gaseous and liquid components. Based on the vessel configurations, the oil/gas separators can be divided into horizontal, vertical, or spherical separators.

In teams of fluids to be separated, the oil/gas separators can be grouped into gas/liquid two-phase separator or oil/gas/water three-phase separator.

Based on separation function, the oil/gas separators can also classified into primary phase separator, test separator, high-pressure separator, low-pressure separator, deliquidizer, degasser, etc.

To meet process requirements, the oil/gas separators are normally designed in stages, in which the first stage separator is used for preliminary phase separation, while the second and third stage separator are applied for further treatment of each individual phase.

2.3 Condenser

Fig 5: Condenser

A condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance and transferred to the surrounding environment.

Condensers can be made according to numerous designs, and come in many sizes ranging from rather small (hand-held) to very large (industrial-scale units used in plant processes). For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air.

Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers.

3. Working Procedure

- This is a batch process system.
- The wastage tyres are fed into the reactor vessel and heated under controlled conditions of temperature and pressure.

- The process will bring about molecular restructuring of the rubber under the pyrolysis process as the result; furnace oil in gaseous form is produced along with other gases.
- These vaporized gases are passed through heat exchanges, where in the furnace oil is condensed into liquid form.
- During the process, carbon black and steel are also generated.
- The heat exchanger uses coolant water, as a condensing medium and this water is re-circulated through process.
- These systems can be operated 24/365.

4. Final Products

FUEL OIL(40% to 45%)

The oil has 40% to 45% of the amount of recycled scrap tyres, which will be carried with licensed tanker trucks.

CARBON BLACK (30% to 35%)

Carbon Black is the main product recycled by Pyrolysis technology. The amount of recycled carbon black is 30% to 35% (depending on the type of tyres) of the total amount of scrap tyres recycled in the system. Carbon black is used as raw material or main ingredient in many industries and the chemical structure of carbon black strengthens, lengthens the endurance, and improves the coloring features of the materials.

STEEL WIRE (10% to 15%)

Tyres contain steel wires and the amount range of 10% to 15% of the total tyre wastage. All of the steel present in the tyre can be detached after pyrolysis recycling process in completed

GAS (10% to 12%)

Non-Condensable gases arise during the pyrolysis process. The amount of gas generated in the system is 12% to 15% of the total amount of recycled tyres and considering the 10 ton scrap tyre/day recycling capacity, the facility generates 1200-1500 m3/day gas, which has an enormous energy potential when evaluated.

5. Application

Product	Percentage	Applications
FUEL OIL	40% to 45%	The main oil product produced by our recycling application is the fuel oil that is wide used for industrial and commercial purposes
CARBON BLACK	30% to 35%	Electric cable jacketing, Conveyor band, Carrier Bands, Hose and doormat, Black nylon bag, Rubber additive.
STEEL WIRE	10% to 15%	Valuable steel wires are pressed and sold to steel and scrap dealers
GAS	10% to 12%	It has higher calorific value as compared to Natural Gas. I can be replaced where Natural Gas and Propane are stored. The high-energy gas may be utilized as a source of energy for the Pyrolysis process.

Table - 1: Applications

6. Conclusion

It is the most cost effective wastage tyre recycling technology in the world. 100% wastage tyre recycling (No churn left after the process). No use of chemical ingredients (Environment Friendly).No case of soil, water or air pollution 100 % pollution free process Generate economically valuable products out of waste tyres Generated products have good market value and demand Raw material (wastage tyre) is cheap and easily available Each recycled ton of tyres preserves 10 tons of carbon dioxide (CO2) that is a major green house gas. The process can be applied to all rubber based materials the system creates an alternate source of energy to reduce theϖ burden on petroleum products and natural gases. The system gives an opportunity to the government and local administrations to deal with the wastage tyre problems. The Pyrolysis process has duration of 4 to 12 hours, based on quantity and size of tyre (car tyre, truck tyre, etc.). During the process different vacuum values are applied in predetermined temperatures and in different phases Different gases are obtained and the condensed gas is stored as a fuel oil in the tanks.

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