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Effect of Recycled Polymer Waste on Paraffinic Oil

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Abstract: Plastics has become the necessity of our daily life. Its production and consumption has been rising rapidly due to its wide range of application in the domestic and industrial usage. But due to its non-biodegradable nature, it cannot be easily decomposed in the environment and hence is a major issue of Environment pollution. So, nowadays new technology is being used to treat the waste plastic by a known chemical reaction - pyrolysis. Under the pyrolytic conditions and cracking process, the plastic wastes can be decomposed into three different states thereby the converted product can be reused in different processes. The waste plastics consisting of high-density polyethylene (HDPE) was pyrolyzed using catalyst and the recovered crude was analyzed and used as flow improvers. The liquid hydrocarbons obtained from the Pyrolysis of waste polymer products was used as diluent to change the characteristics of crude oil. The aim of the research work is to evaluate the change in the flow when blended with the Crude oil of different place. The Crude oil was Blended with the recycled diluents were in different fractions of 5%, 15%, and 25% of diluent. The plastic pyrolysis oil were then tested in a with fractions of 5, 10 and 15 volume% of diluent and their performance and characteristics analyzed and compare with it.

Keywords: Catalyst, Paraffinic Oil, Recycled waste, Pour Point, Blended Oil

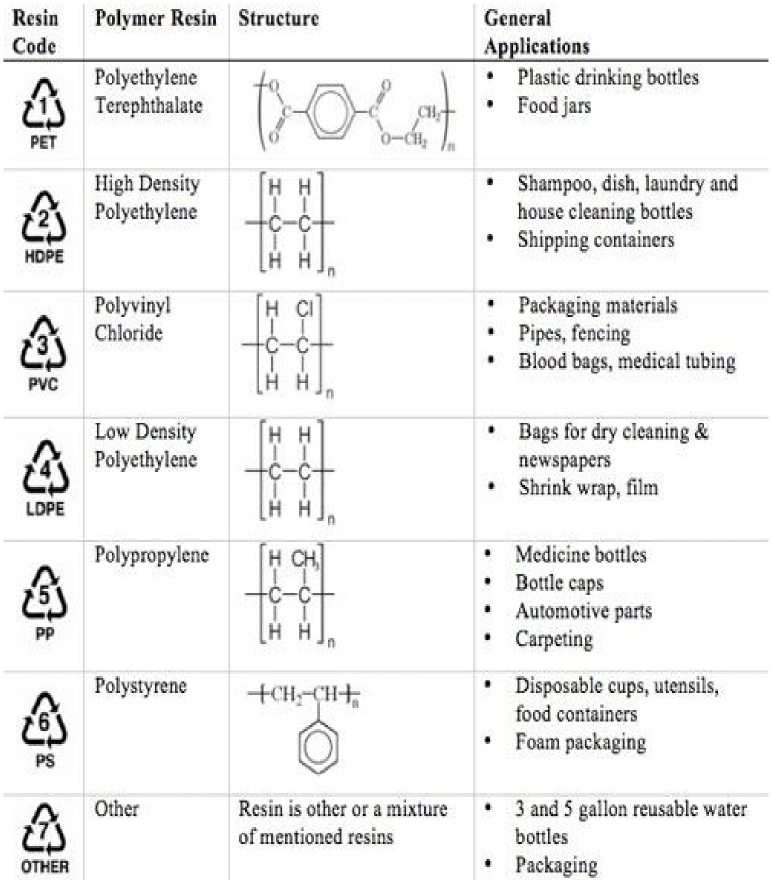
I. INTRODUCTION

A. Crude oil (Non Renewable sources)

Algae and plants thrived in shallow waters millions of years ago. The organic material mingled with other sediments and was buried after dying and sunk to the seabed. The remnants of these creatures were converted into fossil fuels over millions of years of intense pressure and high temperature. All fossil fuels, including coal, natural gas, and petroleum, were produced under comparable circumstances. Crude oil is often black or dark brown in colour, although it can also be yellowish, reddish, tan, or even greenish in appearance. Colour differences show the varied chemical compositions of different crude oil sources. Petroleum with less metals or sulphur, for example, is lighter.[1]Gasoline, a vital component in our daily life, is made from petroleum. It is also processed and used in a variety of products, including as tyres, freezers, lifejackets, and cosmetics. When petroleum products like gasoline are burnt for energy, poisonous chemicals and large volumes of carbon dioxide, a greenhouse gas, are released. Carbon regulates the temperature of the Earth's atmosphere, and adding to the natural equilibrium by burning fossil fuels has a negative impact on our climate.[2] Huge amounts of petroleum can be discovered beneath the earth surface and in tar pits that bubble to the surface, petroleum may be found well below the depths of the deepest that extract it. Petroleum, like coal and natural gas, is, nevertheless, a non-renewable energy source. It took millions of years to create, and once it is taken and consumed, oil resources will be depleted. The globe will eventually hit “peak oil,” or its greatest level of output. Peak oil, according to some analysts, may occur as early as 2050. Finding alternatives to petroleum is critical for global energy usage, and several businesses are working on it. [3]

B. Plastics

Plastics are macromolecules that are produced by polymerization and may be moulded with a fair amount of heat, pressure, or another type of force. Polymerization is a chemical reaction in which individual units of similar or distinct molecules ("mers") unite to produce big or macromolecules in the form of long chain structures with characteristics that are entirely different from those of the beginning molecules ("mers"). The macromolecules we term polymers are made up of hundreds of thousands of "mers" that combine to form macromolecules. Polymers are categorised into different classes depending upon the properties and uses as Plastics, Rubbers, Elastomers, and Fibres. But there are mainly two types of Plastics that is, Thermoplastics and Thermosetting Plastics. Thermoplastics generally when supplied external heat changes the shape but can be reshaped repeatedly, until it loses its property. [4]



Resin Code	Polymer Resin	Structure	General Applications
1 PET	Polyethylene Terephthalate		• Plastic drinking bottles • Food jars
2 HDPE	High Density Polyethylene		• Shampoo, dish, laundry and house cleaning bottles • Shipping containers
3 PVC	Polyvinyl Chloride		• Packaging materials • Pipes, fencing • Blood bags, medical tubing
4 LDPE	Low Density Polyethylene		• Bags for dry cleaning & newspapers • Shrink wrap, film
5 PP	Polypropylene		• Medicine bottles • Bottle caps • Automotive parts • Carpeting
6 PS	Polystyrene		• Disposable cups, utensils, food containers • Foam packaging
7 OTHER	Other	Resin is other or a mixture of mentioned resins	• 3 and 5 gallon reusable water bottles • Packaging

C. Crude Oil Transportation Issue

Due to its high viscosity and complicated composition, heavy and extra heavy crude oil has historically been marginally exploited, making it difficult and expensive to extract, transport, and refine.. Heavy crude oils have a high dynamic viscosity, ranging from 100 cP to more than 10,000 cP, and are resistant to movement in reservoirs. The problem is exacerbated during pipeline transit owing to wax and asphaltenes deposition on the pipe's inner walls. At room temperature, the maximum permissible viscosity for pumping via oil pipelines is 200–400 cP. [5]Heavy crude oil transportation is a complicated operation with a number of technological challenges that must be solved in order to be successful. Several strategies have been used in industry to save transportation costs, with viscosity reduction methods standing out. Dilution, thermal treatment, and emulsification using surfactants are among the most common .The viscosity and density of crude oil are the primary issues with crude oil transportation in pipelines[4]. The presence of asphaltenes and resins has been blamed for the high viscosity of heavy crude oil. When compared to normal crude oils, heavy crude oils have a higher percentage of asphaltenes, which has an impact on production, transportation, and refining. Asphaltenes concentration has a significant impact on the rheological behaviour of heavy crude oil change in viscosity can be caused by changes in the structure of asphaltenes aggregates. In the decrease of viscosity, two primary impacts of the diluents have been observed. The first pertains to the influence of basic dilution, which is just mixing with lower viscosity solvents, while the second refers to specific molecular interactions between solvent molecules and crude oil asphaltenes particles. Because the asphaltenes contained in heavy crude are insoluble in linear paraffins such as n-pentane and heptanes, the mixing of crude oil with paraffin-rich diluents produces asphaltenes precipitation, segregation, and aggregation during storage and transportation.. Diluents made up of compounds having aromatic properties allow for a more effective dilution of crude oil. Aromatics, such as toluene, can cause disruptions in the self-assembly mechanism of asphaltenes, preventing them from aggregating. Asphaltenes are made up of a variety of polynuclear condensed aromatics with different alkyl branching. Aromatic solvent molecules prefer to arrange themselves between the sheets of asphaltenes aggregates, decreasing the superposition between big asphaltenes molecules and causing the aggregates to dissociate. The removal of molecular entanglement of asphaltenes results in viscosity decrease by dilution with toluene due to the aromaticity of their molecules. Aromaticity in a solvent or diluents is a desirable feature. [6]

D. Paraffinic oil and wax

Waxy crude oils are those that have a lot of paraffin in them. The high molecular weight paraffins (wax) dissolve in the crude oil at higher temperatures. However, when the temperature drops, these wax molecules separate from the crude oil. Wax appearance temperature is the temperature at which wax begins to precipitate out of crude oil. As the temperature is reduced further, a condition is reached where crude oil ceases to flow, known as the pour point. The wax precipitation makes it difficult to produce, transport, and store these crude oils. As a result, the crude oil pumping rate is decreased, and significant start-up issues occur once the pipeline is shut down. The reservoir, well-bore, tubing, surface conveyance, and production facilities all show wax accumulation in crude oil. The expense of chemicals for prevention and clean-up, reduced or postponed production, caesura of wells, less capacity utilisation, choked flow lines, pipeline replacement, and other issues are costing the petroleum industry billions of dollars per year. Wax deposition is controlled and prevented using a variety of techniques, including thermal, mechanical, biological, and chemical processes. Hot oiling the well tube and flow lines is a common thermal technique. Scrapper carried by wire line, sucker rods, and work strings are among the mechanical methods used on a regular basis. Solvents, dispersants, surfactants, and wax crystal modifiers are examples of chemical techniques. To solubilise the paraffin fractions and eliminate paraffin-based skin damage from the well bore, microbial techniques use bio production of surfactant and paraffin solvents. Chemical methods, where polymeric materials are added or mixed in the crude oil to decrease the pour point as well as the rheological properties of the crude oil to increase its flow ability at lower temperatures, are the most convenient and cost-effective way to prevent wax precipitation from waxy crude oil.

II. MATERIAL & EXPERIMENTS

A. Material

1) Crude oil sample, PCO, LCO
2) EPO

(A)Crude Oil Sample

(B) Pyrolysis oil sample

B. Material Synthesis

(Pyrolysis Process)

1) *Construction:* The pyrolysis reactor construct for the experiment include cylindrical chamber of inner diameter 116 mm, outer diameter 111 mm, and height 200 mm which is totally insulated. LPG cylinder supplied to the reactor for external heating to burner. A thermometer observes the temperature of the reactor. The process is carried out at 450–550° C. The heating rate is maintained at 5 C^{0}/min. The time of the feedstock in the reactor is 110-120 minutes.
2) *Process:* The pyrolysis process is shown in simplified above pyrolysis chamber. First of the tyre cut into first small pellets 5mm to 20mm. The tyre cut are heated in a chamber between around 400°C – 500°C to start the pyrolysis process using an external source of heating. The feed reactor is heated in the reactor in absence of oxygen. Once this temperature is reached to 400°C, the tyre wastes are vaporised. Vaporized gas get condense in condenser. The products of pyrolysis in the phase of vapour are sent to a collector bottle.

III. CHARACTERIZATION RESULTS

A. *Analysis of Samples*

PARAMETERS	PCO	LCO	Pyrolysis Plastic oil
Pour Point	+32 C	+39 ^{0}C	+2^{0}C
Aniline Point	20 C	+10^{0} C	18^{0}C
Kinematic Viscosity	Not Determine	Not Found	3.08Cst
Specific Gravity	0.929gm/ml	0.817gm/ml	0.894gm/ml
API Gravity	20.81gm/ml	41.69gm/ml	26.77gm/ml
IBP	69^{0} C	95^{0}C	64 C
Water Content	3.15%	2.89%	0.19%
Carbon Residue	0.36%	15.02%	2.35%
Salt Content	NIL	NIL	Nil
Nitrogen Content	0.40%	0.50%	0.99%
Metal Content	0.15%	0.19%	0.05

B. *Blending of Crude Oil and PPO*

The liquid pyrolysis oil obtained from pyrolysis synthesis was used to blend with PCO and LCO crude oil, pour point is affected by the different ratio blending. We are doing both crude oil a total 6 blend test tube of crude oil and PPO with blending ratio 5%, 15% and 25%.

IV. BLENDING PROCESS

First of all for this blend heating the crude oil in water bath for make it melting, so we heating our both sample PCO and LCO up to 60^{0} C. PPO adding in crude oil drop by drop with continuous stirring. After blending again heating this blended sample into water bath at 60^{0} C. Then after cool down sample at room temperature, then observed the temperature ,but it is still not pour then we cooled down in pour point apparatus.

Water-bath

Pour at Room Temp.

Pour point analysis

Pour point analysis

A. Blend-1 (5%)

The Oil was blended with 20 ml of both (PCO and LCO) oil and 3 ml of PPO. PPO adding .The blended Crude was transferred into the pour point tube and then kept in the Pour point apparatus to find the temperature at which the oil ceases. The temperature at which the oil ceases was found to be 30^0 C and LCO is $32^{0.}$C

B. Blend-2 (15%)

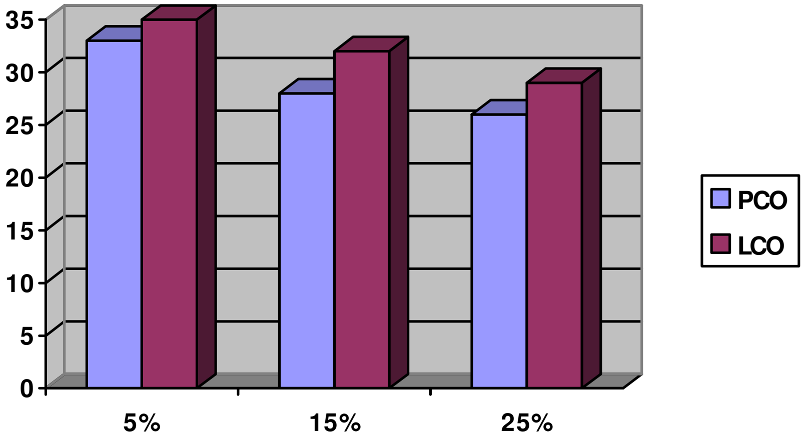
The Oil was blended with 20 ml of both (PCO and LCO) oil and 4 ml of PPO. The blended Crude was transferred into the pour point tube and then kept in the Pour point apparatus to find the temperature at which the oil ceases. The temperature at which the oil ceases was found to be25^0 C and LCO is 29 C^0 .

C. Blend-3 (25%)

For this blend we using of 20 ml of both (PCO and LCO) oil and 4 ml of PPO. We observed that pour point get down by the blending. PCO pour point is 23^0 C and LCO is 26^0 C.

V. RESULT

The Objective of this study to decreasing the pour temperature of two places of western onshore of Indian crude oil. We get PPO blending with crude oil, pour point of crude is decresed.by the percentage blending is 5% its reduce 3-4 C^0 temp,15%of blending reduce 3-5C^0 temp and 25 % decreased 5-6 tempC^0. It was observed that the blend was more effective for PCO crude oil than LCP crude oil.



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