The Effects of NIOMCO Iron Ore Dust Wastes on the Yield of the Pyrolysis of Rubber from Waste Tyres.

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ABSTRACT: The effect of National Iron Ore Mining Company (NIOMCO) iron ore dust waste on the yield of the pyrolysis of rubber from waste tyres was studied in this research work. 200g of the washed chipped tyre waste was weighed into a reactor (specially designed steel container that can withstand very high temperature) and connected to a distillation set-up. This was heated at a constant temperature of about 3000C and timed starting from when the distillate (fuel) started coming out, for 45 minutes. The temperature of the vapor was also monitored with a thermometer. The iron ore dust waste of a varied mass of 10g, 20g, 30g, and 40g were added to a fixed mass of 200g of the washed, chipped waste tyre respectively. It was observed that the higher the iron ore dust waste added to the waste tyre, the higher the yield and the lower the temperature at which the fuel started coming out. Flammability test was carried out on the fuel and it shows a typical burning to that of diesel.

Key words: NIOMCO iron dust waste, pyrolysis, waste tyre.

1 INTRODUCTION

The difficulty in the disposal of tyres and the environmental pollution caused by the accumulation of the waste tyres has lead researchers to source for alternative methods or means of disposing the non biodegradable wastes.

Disposal by massive stockpiling and land filling is one of the common ways of handling waste tyres, but this requires a large space as the volume of tyres cannot be compacted. These also pose the danger of the possibility of fire outbreak with the emission of harmful gasses (Julius et al, 2014) and it also serve as breeding ground for disease carrying vectors like mosquitoes and other harmful reptiles like snake.

Waste tyres have a high content of volatile matters as well as fixed carbon that makes them an interesting solid as a fuel for energy production or hydrogenation processes and in pyrolysis processes to obtain different fractions of solid, liquid and gaseous products. The energy content or fixed carbon content of waste tyres can be exploited by thermochemical processes via pyrolysis into a more valuable fuel and useful chemicals. Pyrolysis is a process of decomposing an organic substance of higher molecular weight to lower molecular weight products, liquids or tars, chars and some amounts of gases (volatiles), by subjecting the material to heat in a reduced or no oxygen environment. The products can be useful as fuels or chemical sources. Despite the fact that pyrolysis is considered a major alternative to exploit the useful chemicals and resources from waste tyre, the process is still not in high usage and this is largely due to the high amount of energy required for the process, various attempts have been made by researchers to make tyre pyrolysis an economic viable process (Mazloom et al, 2009). In this work, therefore, a fellow waste material (NIOMCO Iron waste) has been used to bring down the temperature of pyrolysis, this reducing drastically the energy needed for the process, and at the same time saving cost.

1.1 Composition of the niomco iron dust waste

The National Iron Ore Mining Company (NIOMCO) iron dust waste compose mainly of Fe_2O_3, Fe_3O_4, Al_2O_3, MgO, CaO and some other elements, all in SiO_2

2 MATERIALS AND SAMPLE PREPARATION

Waste tyre, iron dust waste, a specially designed reactor, liebig condenser, thermometer and a heating mantle.

The waste tyres were collected and segregated. Then the tyres are cut into small pieces (chips), steel wires and fabric fibers were removed. The chipped tyre was properly washed to remove impurities and dust then dried at room temperature to remove moisture.

2.1 Experimental procedure

200g of the dried, chipped tyre was weighed and fed into the pyrolysis reactor (a specially designed steel container that could withstand very high temperature) which was designed by the author of this work and connected to a distillation setup. The reactor was heated on a heating mantle at a constant temperature of about 350^0C and the temperature of the vapor was monitored in the process with a thermometer. It was ensured that the water passing through the condenser was ice cold in order to ease the rate at which the vapor was condensed into liquid.

The fuel began to come out in gaseous form and condensed through the condenser into the conical flask when the temperature was 84^oC and was timed to last for 45 minutes. The process was stopped and the liquid fuel was collected into the conical flask.

The pyrolysis process was repeated for four other samples of 200g of the shredded tyre, adding the NIOMCO iron ore dust waste in varying amounts i.e, 10g, 20g, 30g and 40g respectively and the temperature of the vapour when the fuel began to come out was taken. Also the yield of each sample collected was measured.

It was noticed that at about 25-30min of the pyrolysis process, the temperature reaches maximum and began to drop afterward.

2.2 Results and discussions

2.2.1 Results

Distillate from 200g shredded tyre only – sample A

Distillate from 200g shredded tyre + 10g iron ore dust waste – sample B

Distillate from 200g shredded tyre + 20g iron ore dust waste – sample C

Distillate from 200g shredded tyre + 30g iron ore dust waste – sample D

Distillate from 200g shredded tyre + 40g iron ore dust waste – sample E

Weight ratio of shredded tyre to iron ore dust waste

Sample A = 0g / 200g = 0:20

Sample B = 10g / 200g = 1:20

Sample C = 20g / 200g = 2:20

Sample D = 30g / 200g = 3:20

Sample E = 40g / 200g = 4:20

Table 1: Summary of result

Sample	A	B	C	D	E
Temperature (^{0}C) of first distillate	84	78	74	69	64
Yield (ml)	28.2	21.5	30.0	31.0	33.1

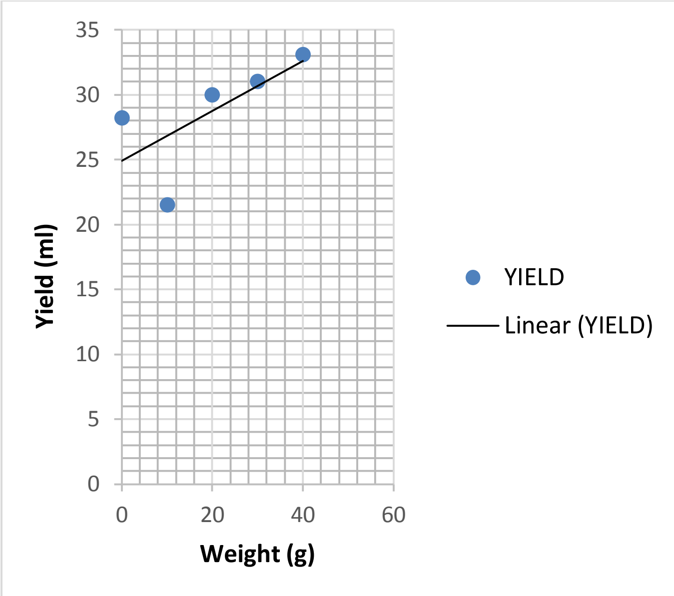

Figure 1: The graph of quantity yield (ml) against the weight of the iron ore dust waste (g).

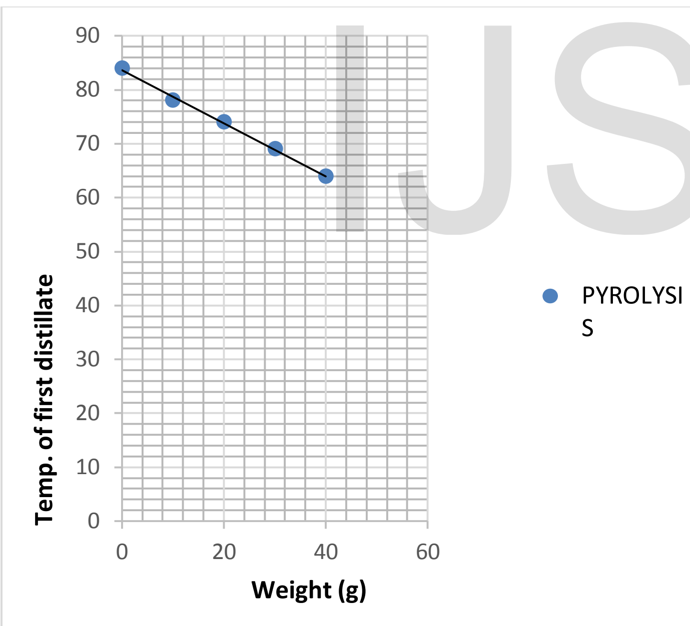

Figure 2: The graph of pyrolysis start temperature (^{0}C) against the weight of the iron ore dust waste (g).

2.2.2 Discussions

From the table 1 above, it shows that the NIOMCO iron dust waste had very much effect on the yield of the distillate (fuel) recovered from the pyrolysis of the waste tyre, and the temperature of first distillate i.e, it speeds up the rate of the reaction process.

The low yield from sample B was due to a decrease in the heating rate because of unstable supply of current during the heating of the sample B.

The graph in figure 1 shows a progressive increase in the yield of the derived fuel as the weight of the iron ore dust waste increases, i.e, as the weight of the iron ore dust waste increases, the yield from the fuel also increases.

The graph in figure 2 shows a progressive decrease in the temperature at which the pyrolysis starts as the weight of the iron ore dust waste increases, i.e, increase in the weight of the iron ore dust waste reduces the temperature of the pyrolysis process.

2.3 CONCLUSIONS

Waste tyres can be converted to fuel through pyrolysis which is considered a convenient and an environmental friendly way of disposing them.

The NIOMCO iron dust waste can serve as a catalyst to speed up the pyrolysis process of waste tyre.

Table 2: comparing some physical properties of typical kerozene fuel, diesel fuel and the waste tyre fuel

Fuel property	Kerozene fuel	Diesel fuel	Waste tyre fuel
Density at 29^{0}C (kg/m^3)	766	815	866
Specific gravity	0.77	0.82	0.87

2.4 Recommendations

Crude tyre derived oil contains significantly large amount of contaminants, water and total sulphur which makes it unsuitable for use as a combustion fuel without refining. Tyre derived fuel is distillable at temperature range of 115 to 327 °C, up to 50 and 83 vol.% of this fuel can be recovered at distillation temperatures of 225 and 300°C respectively. At this temperature range sulphur is more easily removed because, lower boiling oil fraction primarily contain sulphurous compounds that are in the form of mercaptans, sulphides, di-sulphides or lower member ring compounds which are relatively easier to de-sulphurise (Williams, 2005). Typical sulphur compounds such as mercaptans, sulphides and disulphides boil below 193°C and can easily be evaporated for effective gas phase desulphurization over an active surface layer of adsorbent such as molecular sieves or activated carbon (Pilusa, et al, 2014).

Therefore, It is recommend that further purification of the crude tyre derived fuel should be carried out and its characterization.

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