DISTRIBUTION OF SULPHUR INTO PRODUCTS FROM WASTE TIRE PYROLYSIS

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Annotation
Tire pyrolysis is getting growing attention as an effective waste tire disposal method in comparison to environmentally less friendly methods like dumping or incineration. But the scrap tire sulphur content can be a potentional obstacle to scrap tire utilization as a fuel. In this paper the distribution of sulphur into tire pyrolysis yields, solid (char) and liquid (tar), was investigated. The pyrolysis experiments were carried out under different conditions to determine the partitioning of sulphur into pyrolysis products. The influence of different temperatures and reaction times was investigated in a laboratory flow reactor under nitrogen atmosphere. Solid and liquid residues were collected and analyzed by elemental analysis. The sulphur content in residual char and tar was determined using an elemental analyzer and the sulphur forms in tar were characterized by the X-ray photoelectron spectroscopy (XPS).

Keywords
waste tire, pyrolysis, sulphur, distribution, tar, char

1 INTRODUCTION
The disposal of used waste tires is major environmental problem of today. The production of waste tires is about 5 x 10^6 tonnes/year worldwide, 2 x 10^6 tonnes of which is produced only in Europe and in North America the production is 0.5 x 10^6 tonnes [1]. The complicated nature of tires makes them difficult to reuse or recycle. Different methods of recycling such as retreading, reclaiming, incineration, grinding, etc. have been used in the past. However all of them have significant limitations or drawbacks. Pyrolysis can be considered a non-conventional method for tire recycling which currently is receiving new attention.

Pyrolysis of waste tires is one of the most reasonable alternatives by current environmental standards. This pyrolysis produces condensable hydrocarbons (tar), gaseous components and a solid residue composed mostly of carbon (char). Previous investigations have demonstrated that the liquid residue thus produced can be used directly as fuel oil and as a raw material in petrochemical processes. The gas can be used as fuel gas, while the carbon can be employed as carbon black in gasification processes and as a raw material for the production of activated carbon [2][3].

Sulphur is present in tires at varying concentrations as shown in table 1. During Pyrolysis, the solid partially decomposes and produces gaseous, liquid and solid residuals as products. Different pyrolysis conditions may have a great effect on the yield and composition of the tree pyrolysis products. Temperature and reaction time are the two most important parameters affecting the yield and composition of volatile fraction and would therefore be expected to affect the sulfur content in residues. Distribution of suplhur into char at different conditions is shown in Fig 1.

![Fig.1: Sulphur content in char at different pyrolysis conditions](image)

<table>
<thead>
<tr>
<th>Wt %</th>
<th>Sample 1</th>
<th>Sample 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>0.1996</td>
<td>1.4688</td>
</tr>
<tr>
<td>C</td>
<td>86.5516</td>
<td>73.4165</td>
</tr>
<tr>
<td>H</td>
<td>7.2369</td>
<td>6.9523</td>
</tr>
<tr>
<td>S</td>
<td>1.6186</td>
<td>1.9813</td>
</tr>
<tr>
<td>O</td>
<td>4.3933</td>
<td>16.1811</td>
</tr>
</tbody>
</table>

Tab.1: Elemental analysis of waste tire samples
2 EXPERIMENTAL EQUIPMENT

The pyrolysis experiments were carried out in a laboratory pyrolysis reaction unit in a nitrogen atmosphere. The main parts of the pyrolysis is a reactor, a cooling system and a GCM analyzer. The reactor is a flow reactor, where the flow of the solid particles is secured by a rotating metal screw. Solid residue, which contains mostly char, is collected after the reactor. The volatile fraction from the first reactor continues through the cooling system. The condensable volatiles (tars) and solid residues were collected at a room temperature and analyzed by an elemental analyzer. The instantaneous concentrations of gaseous products were obtained under experimental conditions and analyzed by the gas chromatography (Micro Box III). The main gaseous products were methane, carbon monoxide, hydrogen, carbon dioxide and light hydrocarbons.

Fig. 2: Flow diagram of experimental equipment

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4 REFERENCES

