

Processing of Polymeric Cord by Low-Temperature Catalytic Pyrolysis

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Introduction

The increase of cars production brings to the accumulation of used automobile tyres, which is a serious ecological problem. During the automobile tyres processing by mechanic crushing a large amount of polymeric cord is accumulated. The mixture of polymeric cord and resin crumb do not decompose for a long time in nature. The storage of cord results in the environment pollution with the products of polymers decomposition. However, the mixture of polymeric cord and resin crumb is a valuable source of organic material, which can be used for the production of liquid and gaseous fuels [1].

Catalytic pyrolysis is of special interest, as the waste treatment proceeds in a closed cycle, which makes the processing environment friendly [2]. The method of low-temperature catalytic pyrolysis of polymeric cord of used automobile tyres allows increasing the rate of polymer destruction and thus decreasing the process temperature. The use of the catalysts favors the increase of raw material conversion of the process.

In this paper the results of the investigation of catalytic activity of iron subgroup metals chlorides in the processes of thermal destruction of polymeric cord and rubber remains at a temperature range of 400-600 °C are presented. The main aim of this investigation was to obtain the greatest amount of combustible gas mixture and liquid fraction. The conversion and the yield of the target product changed during the process within a wide range depending on the process temperature and the catalyst concentration.

Materials and Methods

Polymeric cord pyrolysis was conducted at one stage for 100 minutes in the temperature range of 400 – 600 °C in fixed-bed reactor (see Fig. 1) (1) at an atmospheric pressure in the nitrogen medium. The catalyst concentration was varied from 1 to 12% (wt.).

The reactor was heated with an electric furnace (6) with a temperature control (7). Before the experiment the reactor together with the substrate placed into it was blown out with nitrogen; valve (2) controlled nitrogen feed. The gaseous products evolving during the thermal destruction went through hydraulic lock (4). Liquid products were hold back with the hydraulic lock and the gaseous products came into the eudiometer where they accumulated. The change of gaseous products volume was kept track of during the process flow. Gas samples for the analysis were taken from the sampler (3). The products mass were calculated on the basis of the difference between the reactor and the hydraulic lock masses before and after the experiment.

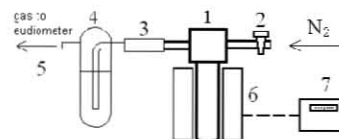


Figure 1. Scheme of the experimental plant

Results and Discussion

The influence of metals ions on the initial substrate conversion was found to increase from iron to nickel but the biggest volumes of gaseous hydrocarbons were formed in the experiments with cobalt chloride. This difference between catalytic properties of the compounds can be explained by secondary periodicity in the electron structure of iron subgroup metals. The best result was observed while using CoCl_2 , in the presence of which the rate of hydrocarbons formation increased twice. The volume of the produced gas was also increased up to 25 % in comparison to the non-catalytic process. The use of cobalt chloride, observing the process flow conditions found, also contributes to the increase of gaseous (see Fig. 2) and liquid products mass and to the decrease of solid residue.

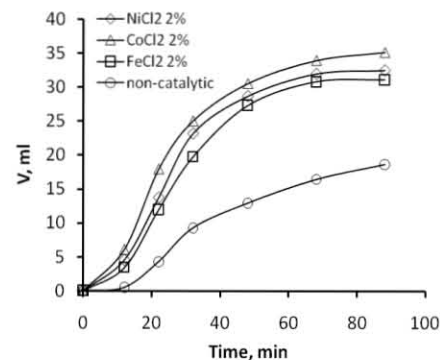


Figure 2. Kinetics of hydrocarbons C_1 - C_3 accumulation at a temperature of 450 °C

Significance

The use of iron subgroup metals chlorides in the processes of thermal destruction of polymeric cord and rubber remains was shown to allow increasing the rate of polymer destruction and thus decreasing the process temperature. Besides, the use of cobalt chloride was found to increase the liquid and gaseous products and the decrease of coke formation.

References

- Rodriguez, I.D., Laresgoiti, M.F., Cabrero, M.A., *Fuel Process. Technol.* 72, 9 (2001).
- Yaman, S., *Energy Conversion and Management* 45, 651 (2004).