XI МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ,
ПОСВЯЩЕННАЯ 50-ЛЕТИЮ
ИНСТИТУТА ХИМИИ НЕФТИ СО РАН

ХИМИЯ НЕФТИ И ГАЗА

МАТЕРИАЛЫ КОНФЕРЕНЦИИ

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ИНСТИТУТ ХИМИИ НЕФТИ

ХИМИЯ НЕФТИ И ГАЗА

XI МЕЖДУНАРОДНАЯ КОНФЕРЕНЦИЯ,
посвященная 50-летию Института химии нефти СО РАН
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Издание содержит материалы докладов XI Международной конференции «Химия нефти и газа», посвященной 50-летию Института химии нефти СО РАН. В книге отражены аспекты решения фундаментальных научных проблем, связанных с решением геохимических вопросов формирования и эволюции природных углеводородных систем, исследованием физико-химических и реологических свойств поверхностных и объемных фаз в системе нефть – порода – растворы ПАВ и полимеров, регулированию коллоидно-химических и структурно-механических свойств высоковязких нефтей и водонефтяных эмульсий, направленностью превращений углеводородов, гетероорганических соединений и смолисто-асфальтеновых веществ нефтяного сырья различной химической природы в термических, каталитических, окислительных и суперкритических условиях, а также проблемам освоения нефтегазовых месторождений Арктического региона и экологическим аспектам добычи, транспорта нефти и газа.

Книга адресована научным сотрудникам, специалистам научно-исследовательских организаций, предприятий нефтегазодобывающей промышленности, преподавателям, аспирантам и студентам учебных заведений соответствующего профиля.

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THERMAL RECYCLING OF HIGH DENSITY POLYETHYLENE AND POLYPROPYLENE OLD/NEW CHALLENGE DURING COVID-19 PANDEMIC

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Polypropylene (PP) and high density polyethylene (HDPE) are the second and the third largest produced plastic materials in the world, after polyvinylchloride in terms of volume. The utilization of HDPE (plastic bottles and gloves) and particularly PP (masks and gloves) dramatically increased during last period due to the COVID-19 pandemic. Mentioned products are designed for one-shot usage and resulted in massive increase of plastic waste worldwide. HDPE and PP have high calorific values. However, direct burning of masks and gloves can be undesirable due to the melting during combustion. Pyrolysis e.g. thermal cracking of the polymeric materials by heating in the absence of oxygen results in the formation of a solid residue (char), liquid product and gas, and can be considered as valuable method for recycling of HDPE and PP.

In this study HDPE (plastic bottle) and PP (mask) were pyrolysed in the open system pyrolysis which prevent secondary processes such as further thermal oil cracking, coking of oil vapour on carbon residue, as well as recombination, condensation and aromatisation processes.

The thermal behaviour of HDPE and PP was evaluated by thermogravimetric analysis (TGA). In accordance, pyrolysis was performed at temperatures of 400 ^{o}C, 450 ^{o}C and 500 ^{o}C with heating rate of 100 °C/min and maintaining at final temperature for 30 minutes. The solid residues were characterised by elemental analysis. The composition of liquid pyrolysis products was determined by gas chromatography mass spectrometry (GC-MS), whereas qualitative composition of gases was estimated indirectly based on Fourier Transform Infrared Spectroscopy (FTIR) data from TGA.

As expected, increase of the temperature from 400 ^{o}C to 500 ^{o}C resulted in increase of plastic conversion into liquid and gaseous products. In the case of HDPE the yields of solid, liquid and gaseous products at 500 ^{o}C were 55.34 %, 31.89 % and 12.77 %, respectively, whereas under the same conditions more reactive PP yielded 70.38 % of liquid and 29.62 % of gas, without any solid residue. The main constituents of liquid pyrolysates of HDPE are terminal *n*-alkenes, *n*-alkanes and terminal *n*-dienes which are identified in range from C_{12} to C_{43}. Liquid products obtained by PP pyrolysis consist of C_{10}-C_{12} 2,4,6-trimethyl-1-alkenes, C_{13}-C_{15} 2,4,6,8-tetramethyl- terminal alkenes and dienes, C_{16}-C_{18} 2,4,6,8,10-pentamethyl- terminal alkenes and dienes, as well as very small amount of higher molecular weight hydrocarbons having the same methyl substitution pattern on alkane chain. The noticeable prevalence of C_{15} homologue was observed. Qualitative composition of gases based on FTIR indicated that main gaseous products of HDPE and PP destruction are methane, ethene and propene. Elemental analysis of solid products obtained by HDPE pyrolysis at all temperatures showed similar composition which is represented by ~86 % of C, ~13.5 % of H and up to 0.5 % of O. According to several proposed formulas for hydrocarbon fuels and waste materials (including plastic) [1 and references therein] the calculated net calorific value of solid residues ranged from 38 MJ kg^{-1} to 46 MJ kg^{-1}.

The obtained result suggests that pyrolysis of HDPE and PP under simple conditions produces valuable gaseous, liquid and solid (in the case of HDPE only) products which can serve as fuel, including pyrolyis its self, or valuable petrochemical feedstock.

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