tematic data about reactivity of TFB in fluorination of aromatic compounds.

Methods and materials. As substrates of reactions, we choose following aromatic iodine reagents: CL–Ph–I , Br–Ph–I , NO_2–Ph–I CF_3–Ph–I, SO_3H–Ph–I , COOH–Ph–I. The fluorinating agent is tetrafluorobromate of barium. Tetrafluorobromates of alkali and alkali-earth metals (TFB) are compounds with high fluorinating and brominating ability, they are safer than BF3 in usage.

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METHANE FROM INDUSTRIAL WASTES AS FUEL FOR ROCKETS OF THE FUTURE

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One of the basic problems of space exploration is the development of optimal fuel for rockets and space ships suitable for long flights. In this study the choice of the most resource efficient, safe and less expensive fuel is discussed. The most economic ways of getting it are proposed.

As fuel, rockets use both liquid and solid chemical compounds. The fuel efficiency is assessed by the following criteria: availability, density, cost of production and storage, and specific impulse [1]. The first candidate as fuel for rockets is kerosene. It is one of the most widely used fuels after gasoline. It has a relatively high density, is not particularly toxic and not expensive. And most importantly, it has a high specific impulse, which indicates that such a fuel can accelerate the rocket very well. But there is one important problem: high quality kerosene suitable for rockets can be extracted only from certain grades of oil which are very few nowadays. Thus, we have to consider this candidate not optimal.

The next variant is hydrogen. It is a flammable exploding gas with the highest specific impulse of all our candidates in the list. But its low density spoils the great picture: it takes too much volume to carry enough hydrogen to escape from the Earth's atmosphere. The next big problem is its storage temperature. The liquid hydrogen exists only at temperature of –252 to –259 °C, which means that it will go high storage costs [2].

The third option is heptyl, also known as asymmetric dimethylhydrazine. It has the same properties as kerosene, but it is extremely toxic and dangerous for people and plants. In Soviet times it was widely used but now it can't be used due to its negative characteristics [2].

Thus, the most popular fuels do not meet the criteria of safety and resource efficiency and are not optimal. In this study we propose an alternative fuel for rockets which is more environmentally friendly and economical. It is methane, which was proposed as fuel for the first time in the research works of NPO Energomash named after academician V.P. Glushko, conducted since 1981.

Methane is easily accessible and relatively cheap gas, its density and specific impulse are high enough for both small and large space rockets. The future of space technology is aimed at the multiple use; space ships should be able not only to fly out of the Earth, but also fly back, too, in full force and without damage. In this case, methane could be an optimal fuel as it can be found on the others planets as well as almost on any asteroid which gives the possibility of refueling.

The most important feature of methane is the abundance of ways to get it: by chemical means, from natural gases, and also from industrial wastes.

It is possible to get it at low cost and in the shortest time by extracting it from the total composition of natural gases where the percentage of methane is 70–98 % [3]. But we propose the most efficient way which is also beneficial for the environment – to extract methane from industrial wastes. The proposed technology comprises sorting gases coming out from factories in the form of liquids by condensation. It is similar to the decomposition of oil into its constituent substances in the rectification tower by heating [4]. But our method provides decomposition of gases by condensing. As the temperature of condensation temperature of the gases forming part of the natural or waste gases is lower than –100 °C, it will be more rational to use refrigerants for cooling.

Conclusion

Methane has great prospects as the optimal fuel for the rockets of the future. Perhaps in time the humanity will discover neighboring planets and even become a multi-planetary race, settled on them, using space rockets with methane engines. The today's challenge to achieve it is the development of equipment for collecting methane from different sources including industrial wastes.

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SYNTHESIS OF MODIFIED AROMATIC PETROLEUM RESINS

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One of the fundamental treatment processes of raw hydrocarbons is pyrolysis. Liquid by-products are formed up to 20 % mass. It is known, to have synthesized petroleum resins (PR) from liquid pyrolysis products is the most rational way to increase the oil refining depth [1].

To improve both of the physico-chemical properties and the range of application PR are modified by different agents: ozone, hydrogen peroxide, maleic acid, etc. [2–4].

The aim of this research was a nitration of petroleum resins of the C_9 fraction, which was produced by "Angarsk Petrochemical Company".

In this study, 3 types of petroleum resins and their modified products are considered. The samples of petroleum resins were obtained by radical polymerization with thermal (PRC_9therm) and chemical (PRC_9in) initiation and ionic (PRC_9ion) polymerization. Radical polymerized resins were produced by OOO "Omsk-polymer" and ionic polymerized resin was produced by authors.

Ionic polymerization of the C_9 was carried out with the $TiCl_4:Al(C_2H_5)_2Cl$ catalyst in a 1 : 1 molar ratio at a temperature of 80 °C for 2 hours [5]. $TiCl_4$ was used in 2 % mass of total weight of the C_9 fraction. After polymerization the catalyst complex was deactivated with a 10 % excess of propylene oxide.

The modification was abided by the standard procedure for aromatic compounds [6]. Procedure of nitration of 30 % resin solution in chloroform was carried out at a temperature of 70 °C within 3 hours by two nitrating agents: 1) concentrated nitric acid (product – N-PR); 2) a mixture of concentrated nitric and sulfuric acids in a molar ratio of 1 : 1 (prod-