consumers of naval stores, the demand for rosin is getting higher and higher and surpasses its production rate. All this leads to the necessity of invention of rosin substitutes in different branches of industry. Patent and technical documents, home and foreign technologies indicate that polymeric petroleum resins can help to reduce rosin consumption.

Prodction of tires and industrial rubber goods, meeting all modern demands, is impossible without effective ingredients in rubber mixes, plastifiers.. Polymer plastifiers or softeners - are substances that increase plasticity and elasticity of polymers during their processing and use. Coumarone-indene resins, which are so-called active softeners, contribute to even distribution of ingredients, in particular, they improve the dispersion in the mixture of fillers and that, in its turn, increases the elasticity of rubber mix and improves physicochemical properties of vulcanizers [3].

These softeners are also used in the process of rubber regeneration. Spent rubber and vulcanized rubber are usually subjected to regeneration in order to decrease production costs of manufactured goods and to use

In search of extra feedstock sources for the manufacture of resins-softeners, attention was paid to some wastes of coke-chemical technology, containing resin-like substances, similar in their composition and properties to indene-coumarone resins. Among these products residuals of raw benzene processing and polymers, obtained by regeneration of washing oil are of some practical interest. For the production of the styrene-indene resins residuals of hydrocarbon pyrolysis products distillation (heavy pyrolysis resins) are among the most successfully used [3].

Liquid products of pyrolysis, obtained as by-products during ethylene production are widely used as cheap feedstock for the manufacture of polymeric petroleum resins. Nowadays two factors determine the economics of ethylene production – feedstock cost and cost of obtained by-products. While feedstock cost is an external factor for ethylene production, cost of by-products is directly connected with the method of their processing – they can be sold like fuel or they can be further processed in order to separate some valuable components.

Phenolformaldehyde, rosin-maleic and alkyd resins were widely used as synthetic film-forming materials for the production of printing paints. Such expensive and deficit products as rosin, vegetable oils and alkylphenol were used as feedstock for their obtaining. Nowadays polymeric petroleum resins are finding increasing application for the production of print paints [4]ю

Both production of polymeric petroleum resins and their use in national economy is economically effective. In the first case economical effect is reached by afficient use of liquid by-products of pyrolysis and by gaining extra-profit from realization of polymeric petroleum resins. In the second case – by application of polymeric petroleum resins instead of such expensive products as vegetable oil, rosin, etc.

PEFERENCES

1. Дезактивация каталитической системы на основе хлорида алюминия в синтезе нефтеполимерные смолы эпоксидированными растительными маслами / Д.Г. Милославский [и др.] // Вестн. Казан. технолог. ун-та. – 2011. – Т. 14, № 18. – С. 254–259.
2. Думский, Ю.В. Химия и технология нефтеполимерных смол : моногр. / Ю.В. Думский, Б.И. Но, Г.М. Бутов. – М. : Химия, 1999. – 312 с.
3. Шиманская, Р.И. Химия и технология топлива и масел / Р.И. Шиманская, В.Г Плюснин., Н.С. Вайсберг. – 1962. – № 9. – С. 34–36.
4. Беренц, А.Д. Переработкажидких продуктов пиролиза / А.Д. Беренц, А.Б. Волъ-Эпштейн., Т.Н. Мухина. – М. : Химия, 1985. – 216 с.

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MECHANISM AND KINETICS OF ENGINE OIL AGEING AND MODERN RECYCLING TECHNOLOGIES

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At present, more and more attention is paid to waste-free use of all possible products. Re-use of waste oil will allow to make the most efficient use of oil resources, and to eliminate damage to the environment.

Introduction. Engine oils – are petroleum base lubricating oils and synthetic oils used in piston (carburetor and diesel), as well as in gas-turbine engines. Diesel engine oils applied to lubricating of autotractor, transport, stationary, diesel locomotive and ship engines are most widespread. Carburettor engine oils are used only in automobile engines. The oils intended for both types of engines, refer to universal. Special group of engine oils - aviation oils. On seasonal prevalence of application they distinguish winter, summer and all-weather oils.

Functions of engine oils:

1. Antifrictional and anti-wear action within operating temperature range.
2. Heat removal from frictional areas and some engine details.
3. Hermetic sealing of the space above piston.

Formulation of research tasks:

– To study the process of engine oil ageing, to define factors most strongly affecting the process of ageing and to define the mechanism and kinetics of engine oil ageing.

– To analyse the most successful technologies of engine oil recycling and perspectives of recycling.

The term "ageing" of oil stands for a set of various processes leading to changes of oil physical and chemical properties while in service or while storing. If we consider by convention that modern engine oil consists of base oil plus an additive complex, then all the phenomena happening during the process of oil "ageing" can be divided into the following parts: chemical and physico-chemical processes of oil basis ageing, oil contamination, wearability of additives and changes in their chemical composition and structure. (figure.1).

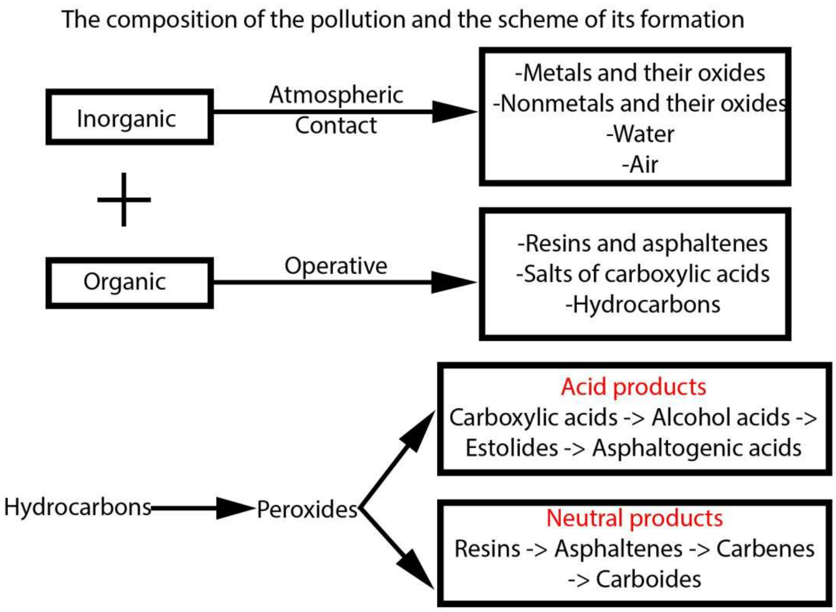

Fig. 1. Structure of contaminants and diagram of their formation

Ageing of engine oils is caused by oxidation processes occuring during intensive and long-term work of an engine. Coke, which is formed and also resinous, asphaltene substances, organic acids settle on piston, cylinder walls and lead to increased wear of engine and decrease its capacity. Products of deep oxidative polymerization, which are different in zones of a heat, return to crankcase, as well as other sediments, continue negatively affect the oil.

All mentioned products of engine oils oxidation tend to increase viscosity and acid number, lead to sludge and soot deposite formation. The consequences are the following:

1. Increase of oil consumption.
2. Engine power loss.
3. Overheating of details, increased wear and scuffing of details.

If the above mentioned processes progress, engine comes to emergency condition.

The factors influencing engine oil ageing:

1. During decomposition (cracking) of hydrocarbons which are present in oils temperature is a determining factor. The greatest temperature loads engine oils resist upon contact with pistons, valve train details and because of high heated gases breaking from engine combustion chamber through ring belt and into a crankcase. As a result of paraffins decomposition unsaturated compounds are formed which polymerize with formation of glazes and soot deposits on engine walls.

2. Oxidation occurs owing to oil contact with oxygen of air. Intensity of oxidation depends on temperature of oil, surface contacting with air, partial pressure of oxygen, speed and character of air movement (presence of stirring motion), catalytic action of metals and peculiarities of hydrocarbons which are present in oil.

Three basic reasons intensifying oxidation of oil in engines: washing by high-temperature gas stream of thin oil films on engine surfaces, roughness of frictional areas (contact oxidation) and great amount of crankcase oil mist.

Mechanism and kinetics of ageing process:

Under ageing of oil we shall consider oxidation of hydrocarbons. Liquid-phase oxidation proceeds by radical-chain mechanism and includes the following stages:

1. Initiation.
2. Progress of chain process.
3. Completion (chain interruption).

Consequences of oil ageing – such products of oxidation of hydrocarbons as gums, organic acids, which are present in oil in dissolved state, tend to increase viscosity and acid number, and asphaltene compounds, which cause glaze formation, lead to piston rings sticking. Fine stable mechanical mixture of oxidation products leads to soot deposit and sludge formation. Thus oil becomes unfit for service but before pouring it out it is necessary to a question: « is it possible to recycle it? »

Consumption of engine oils in the world makes about 60 million tons. It is reported that only about a fourth part of this quantity is re-used or burnt. This points to the fact that the branch of oil recycling can be very potential and effective not only from economical but also from ecological point of view. In fact 1liter of engine oil can turn 1 000 000 liters of potable water into technical water.

Under industrial conditions the most perspective directions are:

1) Regeneration: involves processing of spent oil, contaminants removal and further use as a basis of new lubricating oil. Regeneration makes oil resource working life unlimited. This technology of oil processing is preferential as the processing cycle is completed by re-using of oil for manufacture of the same product this spent oil used to be. This can save energy and natural oil. The diagram of the regeneration process is shown in figure 2.

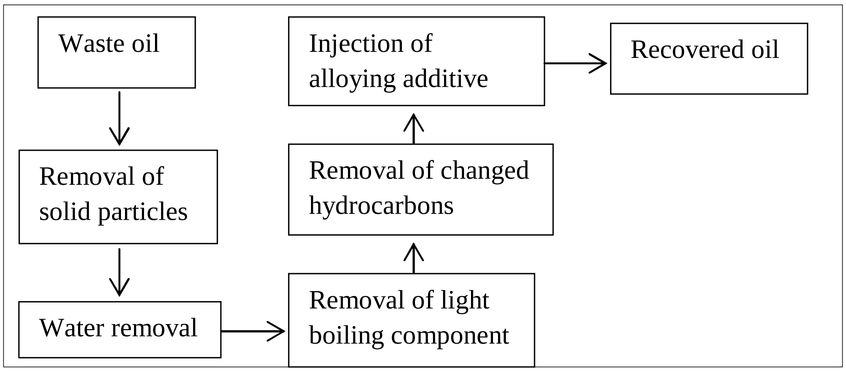

Fig. 2. Stage-by-stage regeneration of spent oil

2) Processing and burning for energy extraction: involves water and particles removal so that the spent oil could be burnt, as fuel for heat production or power supply of industrial operations. Valuable energy is generated (the same result is obtained by using standard fuel oil). Spent oil processing is carried out by means of highly effective separation. This technology of recycling has a number of advantages in comparison with regeneration of oils:

1) Economic mode of operation, even at rather small loads
2) Fast recoupment of processing unit.
3) Practically non-waste technology (since the remainder could be used for road pavement)

Results and perspectives. At the moment Belarus is in the initial phase of the state system of oil recycling development. And if recycling of production wastes is successfully carried out and reaches 80-90 %, only 10 % of consumption wastes are recycled. Main reason of this low level of spent oil recycling is logistics. There is no well-run logistics system of spent gathering and delivery to enterprises for further processing. Also a vital issue is the desire of many consumers to independently utilize spent oils by burning them in boiler installations without any pretreatment which is absolutely forbidden from the point of view of ecology. To overcome all these difficulties, regulatory and legal framework is being developed, imposing penalties for crippling economy by unauthorized utilisation of spent oils. The system of consumer products gathering and delivery to enterprises for further recycling is also being developed.

PEFERENCES

1. Кулиев, А.М. Химия и технология присадок к маслам и топливам / А.М. Кулиев. – 2-е изд., перераб. – Л. : Химия, 1985 – 312 с., ил.
2. Фукс, И.Г. Основы химмотологии. Химмотология в нефтегазовом деле : учеб. пособие / И.Г. Фурс, В.Г. Спиркин, Т.Н. Шабалина – М. : Нефть и газ РГУ нефти и газа им. И.М. Губкина, 2004. – 280 с.
3. Специальные технологии переработки природных энергоносителей : учеб.-метод. пособие / под ред. С.В. Покровская [и др.]. – Изд. 1-е. – Новополоцк : ПГУ, 2013. – 142 с.
4. Венцель, С.В. Применение смазочных масел в двигателях внутреннего сгорания / С.В. Венцель. – М. : Химия, 1979. – 240 с., ил.

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TRENDS IN DIESEL ENGINES

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Soaring oil prices and challenging emission regulations in the near future demand significant efforts on the part of engine builders to bring down emission levels. Both developments have attracted the notice of the Sulzer Metco cylinder bore coatings specialists in various markets.

More than 15 years ago, Sulzer Metco started developing materials and application processes to coat the cylinder walls of combustion engines. The goal was to decrease friction, increase fuel economy, and reduce oil consumption. However, with the low oil prices during the nineties and at beginning of the new century, the interest in the market to adopt the technology was low. Only one car manufacturer began applying an iron- based cylinder coating.

Diesel engines have long been popular in bigger cars and this popularity is now spreading to smaller cars. The diesel engine has undergone a technical revolution over the last twenty years. With the benefit of modern technology, today's diesel engine with a rating of 150 horsepower (hp) delivers basically the same performance, in terms of acceleration and actual top speed, as a turbocharged gasoline engine of up to 200 hp, but with significantly lower fuel consumptionand carbon dioxide emissions. Diesel engines have a high thermal efficiency,which leads to low carbon dioxide emissions. The main problem of diesel engines is the emission of nitrogen oxides (NO_x) and particulate matter (PM). These two pollutants are traded against each other in many aspects of engine design. Very high temperatures in the combustion chamber reduce PM emissions but, on the other hand, produce higher levels of nitric oxide (NO). By lowering the peak temperatures in the combustion chamber, the amount of NO produced is reduced, but the likelihood of PM formation increases[1].

An additional challenge facing the diesel car is the quality of diesel fuel. Sulfur in the fuel causes the exhaust to smell, is incompatible with the necessary exhaust aftertreatment technology, and can cause corrosion on the cylinder liner and the piston. The use of low-grade fuels can lead to serious maintenance problems because of their high sulfur content. The challenge is more pronounced in marine diesel engines, as the allowed sulfur content in the fuel is much higher than in fuel for on-highway applications.

Legislation forces the pace. In recent years, legislation concerning the emissions of diesel passenger cars has become increasingly restrictive, especially for NO_x and PM. This trend is predicted to continue in all different engine sectors as shown in [fig. 1]. One way the car industry is reacting to these requirements is by pushing the use of lightweight components, replacing steel or cast iron. The substitution of cast-iron engine blocks is an important part of this development. Even diesel engines— which continue to gain a substantial increase in market share in Europe—are now being cast in aluminum, although diesel engines run at up to three times the pressure of gasoline engines. Progress in aluminum alloy development and new casting techniques lead to improved material properties that enable aluminum to meet the requirements. The ability to produce high-quality aluminum engine blocks opens a large window of possibilities, especially bearing in mind that nearly 50% of all new cars in Europe have diesel engines. Apart from reduced emissions, this growth is accompanied by requirements such as lower fuel consumption, larger power output and torque, and, especially in passenger cars, more compact engines due to space limitations.

Weight reduction. The highest weight reduction on a crank case of a passenger car can be achieved by completely replacing the cast iron through aluminum, also omitting any cast-in cast-iron liners. This task can be solved by applying a hypereutectic high- silicon-containing aluminum alloy, which is expensive, is difficult to cast, and requires special honing techniques or by using a cheaper aluminum alloy with good castability and putting a thermally sprayed, protective coating directly on the aluminum cylinder wall. This will minimize the