Increase in the output of light fractions of petroleum and their refinement

The head of scientists teams

Professor Gela Kipiani

Secretary-General of the Georgian National Committee
of Theoretical and Applied Mechanics
Full Professor of the Department of Engineering Mechanics
of Georgian Technical University
M.Kostava 77
TBILISI 0175
GEORGIA

gelakip@mail.ru

gelakip@gmail.com
Tel : +995 32 2371984 (office)
+995 32 2342571 (home)
+995(8)599 106263 (mob)

Summary of the project

The basic task of the present project is a study of new oil wells of Georgia and Azerbaijan obtained with contemporary instrument methods from petroleum products, for the purposes of expansion of the spheres of processing and using unique, not containing sulfur minerals with small debit.

For the bright fractions (gasoline, light ligroin, aviation kerosene, diesel fuel), obtained by the rectification of stable oil from new bore holes it will be established the indices and chemical group composition; the ways of their improvement and possibility of an increase in the output will be selected.

Among contemporary methods of an increase in the output of bright fractions a priority is given to the addition of activating additives in the rectification of oil in the place and time selected beforehand. Additives have an ability of displacement of low-molecular hydrocarbons contained in bright fractions by high-molecular hydrocarbons.

Additives weaken surface tension between low- and high-molecular hydrocarbons and they easily tear their connecting weak Van der Waals connections. As the additives there are used some agricultural waste and second products in a quantity of hundredth %. The additives contain hydrogen coalescences, which not only contribute to an increase in the output, but also increase the octane number by a minimum quantity.

An increase in the octane number of gasoline will occur also by the contact-catalytic transformation of benzine fraction on the beforehand selected and activated cheap catalyst (active and natural alumosilicates and zeolites), under the established optimum conditions and high temperature (450 ^{o}C), the isomerization reaction of partial hydrocracking, hydrogenation- dehydrogenation and aromatization. The processes indicated imply the isomerization of gasoline alkanes of normal structure contained in benzine with obtaining of alkyl-alkanes. The benzine obtained by isomerization is characterized with high density, calorific value, octane number, small volume and ecological cleanliness.

By the contact-catalytic transformation of the least utilized petroleum fraction is possible to obtain high quality reactive fuel and luminescent liquid and their use in the detection of microscopic cracks on the surface of articles made of metals and nonmetals.

For resolution of questions concerning the project it is important to improve the properties of diesel fuel with low freezing points and obtaining diesel fuel with high cetane number on a basis of use of catalyst which is cheap, easily obtained, local, natural and activated zeolites, by which Georgia is rich. Development of the methods of obtaining biodiesel by compounding of diesel fuel by oxygen-containing compounds is also planned.

II. Detailed Project Information

1. Introduction and Overview

The development of modern world economy considerably depends on converted products of petroleum.

Petroleum is a basic energy resource after atomic energy. It determines not only the economy and technical potential of the country, but often also its policy [1, 2].

Petroleum products are widely used in all spheres of industry, all forms of transport, military and civil construction, power engineering, everyday technology, etc. [3].

With invention of a internal combustion engine the new era of application of light petroleum products in the industry began [3-7].

The fundamental chemical elements of petroleum are carbon, hydrogen, sulfur, nitrogen, oxygen and almost all elements of periodic system in micro quantities. Carbon and hydrogen are constituent parts of all chemical compounds of petroleum.

Petroleum and petroleum products represent a mixture of hydrocarbons of different types, and, in the relatively smaller quantities of heteroorganic chemicals.

Petroleum has the highest heat of combustion, since it contains the greatest quantity of hydrogen.

Petroleum refining consists of two stages - primary and secondary processings [16].

On contemporary oil refineries of the world there is a third stage – the processes of petrochemical processing of second distillates for the purpose of obtaining BVK and surface-active substances from liquid paraffins; the production of phosphors; obtaining different solvents, aromatic hydrocarbons and so forth, etc. [4].

In recent years from petroleum it is obtained the large number of different chemicals, which are the basis of the development of chemical, petrochemical and oil-refining branches.

The existence of the mentioned branches is caused by the high conversion of raw material (petroleum and petroleum products), by the use of selective catalysts and improved reactor – regeneration unit. Catalysts, as a rule, ensure the depth of productivity and power of oil refinery [8, 9, 21].

Main catalytic processes of converting petroleum fractions: hydrogenation, isomerization, dehydrocyclization, hydrocracking, dehydrogenation, alkylation, etc. [11, 12, 13].

Petroleums from different oilfields considerably differ by the potential content both of hydrocarbon and heteroorganic compaunds.

At present 50% of consumed petroleum products consists of different forms of fuel. Yearly it is consumed approximately 1,5 billion tons of motor fuel in the engines of internal combustion of autos, railroad cars, aviation, cargo vehicles, seagoing and river vessels, etc.

Each petroleum product, except required general property, has its important properties, for example, for motor gasoline the most important performance property is – antiknock value, which is determined by octane number of gasoline [9, 13].

The determining properties of diesel fuel, together with a cetane number, are temperatures of solidification and flash, fractional composition, etc. [9, 13].

According to classical concept petroleum is considered as a solution and as a dispersal system. Solutions are molecular, and dispersal systems – associated liquids, in which high-molecular components are dissolved in the low-molecular.

As a result it is formed a complex structural unit (CSU), in the center of which are concentrated high-molecular and high-energy components (asphaltenes, solid paraffins and resins), while in its outer solvate layer low-molecular and low-energy components are located. Between the components interact Van-der-Vaals forces, which cause the high surface tension of CSU. CSU seizes (associates) the components of light fractions in the form of solvates, which are not separated from CSU in the process of rectification (distillation) of petroleum. The liberation of the components of light fractions of petroleum is possible in the process of distillation at atmospheric pressure with addition of effective additives; as a result the output of light fractions (gasoline, diesel fuel) from petroleum grows [10, 14, 20].

It is not less important the production of luminophor by the catalytic transformation of lighting kerosene of noncommodity designation, luminophor finds wide application during the detection of microscopic cracks on the surface of metallic and nonmetallic products [28].

The stiffening of requirements for ecological and operating characteristics of petroleum products poses the urgent task of petroleum refining – an improvement in the quality of petroleum products, first of all raise of the indices, connected with fuel combustion; an improvement in the low-temperature properties of average fuels, and also a reduction of the content of sulfur and other harmful impurities in all products of petroleum refining [13].

In connection with the latter fact a high value acquires the process of cleaning raw material and petroleum products under the pressure of hydrogen – hydraulic cleaning. It is important that together with the removal of sulfur in this process there occurs the total improvement of raw material and petroleum products – decrease of the content of nitrogen, saturation of olefins, and hydrogenation of aromatic hydrocarbons.

One of the fundamental urgent problems is an increase in the octane number of motor gasoline with a simultaneous reduction of the content of aromatic hydrocarbons, especially benzene [the sum of aromatic hydrocarbons - not more than 25-30%, and of benzol - not more than 1%]. For diesel fuels it should be raised the cetane number (not lower than 50) with limitation of the content of aromatic hydrocarbons; an improvement in the low-temperature properties of fuels (reactive, diesel) [12, 14].

Until now the reforming of straight run benzine fraction produces one of the fundamental high-octane components of commodity gasoline. However, a reduction of the content of aromatic hydrocarbons in the commodity gasoline requires a change in the role of the process of reforming, developing new catalysts, [8-10, 27] facilitating isomerization of paraffin hydrocarbons of normal structure, which will make it possible to obtain gasoline with reduced content of aromatic hydrocarbons with retention of high octane numbers [15, 19, 22, 23].

At present the installations of reforming in all oil refineries are reconstructed into the installations of isomerization of light benzine fraction.

The urgent problem is protection of environment from pollution. In connection with an increase of population and

improvement of the standards of living consumption of completely combustible energy carriers grows [13, 21].

Advanced technologies imply the alternative energy sources, which will be more reliable in comparison with traditional forms of fuels.

Such energy carriers are biobenzine and biodiesel, which are produced from agricultural plants and plant wastes [24, 25, 18, 26].

In the project it is planned to increase the output of light fractions (from the beginning boiling at 360 °C) in the presence of small quantities (0,02-0,05%) of agricultural wastes and second products with preliminary distillation of petroleum; the contact- catalytic improvement of distillation gasoline, lighting kerosene, diesel fuel in the established beforehand optimal conditions for the purpose of obtaining gasoline with increased octane number, aviation kerosene, phosphor and prima-diesel.

An increase in the octane number of straight run gasoline will be accomplished mainly by isomerization reaction with its reforming.

The results of the experiments carried out by us will be checked at Baku experimental plant in the institute of "Petrochemical processes".

At present an improvement of the light fractions of petroleum and an increase in their outputs are existing proposals.

At present we carried out the studies of petroleums of different oilfields of Georgia and partially of Azerbaijan.

More high-yield and low-sulfur petroleums are selected from them for fulfilling the works planned by project:

- obtaining gasoline with increased octane number, which will be carried out by the contact- catalytic transformation of straight run gasoline under the established beforehand optimal conditions, in the presence of catalyst developed by us;
- obtaining luminescent liquid by the contact- catalytic transformation of lighting kerosene under the established beforehand optimal conditions, at high temperature and pressure of hydrogen;
- obtaining reactive fuels from the lighting kerosene of the contact- catalytic transformation at high temperature and pressure of hydrogen;
- obtaining biobenzine and biodizel by compounding with the second food and nonfood products [16]
- obtaining high quality diesel fuel by treating the diesel fractions with zeolites of Georgian oilfields;
- an increase of the output of light petroleum fractions in the presence of additives in the small quantities with preliminary distillation of petroleum.

In the case of successful completion of the planned experiments, i.e. an increase of octane number of gasoline, of cetane number of diesel fuel; obtaining biobenzine; biodiesel; phosphor; and also increase in their outputs it will be created precedents in the development of contemporary petroleum refining.

The colleagues from GTU (Georgia, Tbilisi) and institute "Institute of chemistry of additives", Baku, participating in the project, have long-standing qualification, acquired during tens-year work experience in laboratories and practice, which is confirmed by publications and speeches at international conferences.

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