**ТОРАЙҒЫРОВ УНИВЕРСИТЕТІНІҢ**
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**ТОРАЙГЫРОВ УНИВЕРСИТЕТА**

# ҚАЗАҚСТАН ҒЫЛЫМЫ МЕН ТЕХНИКАСЫ

2001 ЖЫЛДАН БАСТАП ШЫҒАДЫ

TORAIGHYROV UNIVERSITY

# НАУКА И ТЕХНИКА КАЗАХСТАНА

ИЗДАЕТСЯ С 2001 ГОДА

ISSN 1680-9165

№ 4 (2020)

**ПАВЛОДАР**

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**СВИДЕТЕЛЬСТВО**
о постановке на переучет периодического печатного издания,
информационного агенства и сетевого издания
№ KZ63VPY00028965

выдано
Министерством информации и общественного развития
Республики Казахстан

**Тематическая направленность**
публикация результатов фундаментальных и прикладных научных исследований
по широкому спектру проблем в области металлургии, машиностроения, транспорта,
строительства и естественных наук

**Подписной индекс – 76129**

**Импакт-фактор РИНЦ – 0,344**



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SRSTI 61.01.11

https://doi.org/10.48081/XYEN7072

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## *OPTIMIZATION OF THE PROCESS OF PREPARING MOTOR FUELS AT REFINERIES*

*One of the key tasks of modern oil refining in Kazakhstan is the production of commercial oil products that meet international environmental standards K-4, K-5. Undoubtedly, this is facilitated by the modernization of primary and secondary production facilities of refineries, which allows you to expand the range of commercial products and improve their quality. The compounding process plays an equally important role in the formation of quantitative and qualitative indicators of commercial gasoline.*

*The article considers the main mathematical models for calculating the preparation of commercial gasoline, the main purpose of which is to select a recipe that ensures compliance of petroleum products with GOST requirements. The basis is a mathematical model for calculating the detonation resistance of gasoline, taking into account the intermolecular interactions of the mixture components. Currently, the modeling of mathematical models of various oil refining processes is of particular relevance, since this allows reducing the cost of the experimental part, calculate all possible scenarios and make the most appropriate choice.*

*Keywords: the process of compounding commercial gasoline, a mixing device, a computer modeling system, a high-octane gasoline.*

## INTRODUCTION

Gasoline compounding is not a universal process for various refineries due to the variety of oil refining technologies implemented at the enterprises, as well as the composition of raw materials. Each refinery has its own recipe for cooking from available intermediates.

Components involved in the compounding process:

– basic components – are carriers of the main properties of the resulting gasoline;

– additives and additives – are used to improve performance indicators.

The most important indicators for developing a commercial gasoline formulation are the saturated vapor pressure, octane number, and content of components such as sulfur, benzene, aromatic and olefin hydrocarbons.

## MATERIALS AND METHODS

The main difficulty in calculating the compounding process is that the detonation resistance is not an additive property, that is, the octane mixing numbers (OCS) of the flows differ significantly from the weighted sum of the octane numbers (OCS) of the individual components. The difference between PTS and PTS can be significant and up to 20 points [3].

The most appropriate and cost-effective ratio of components is found for each batch of gasoline. This problem is solved using a computer modeling system [2].

The authors of the study [4] claim that the cause of deviations is the presence of intermolecular interactions between the bonds of hydrocarbons in the composition of finished petroleum products. These forces of intermolecular interaction depend on the polarity of the gasoline mixture molecules. The value of the dipole moment can be used to judge the isomerism and conformation of organic compounds, the configuration of coordination nodes of complexes, and the mutual influence of atoms and bonds in the molecule. Since the detonation resistance is an integral characteristic of the reactivity, which directly depends on the structure of the molecules, the resulting intermolecular forces will affect the non-additivity of the octane numbers of gasoline mixing.

In conditions of constantly changing raw material composition and catalyst activity, experimental methods for determining the mixed characteristics of commercial gasoline are not applicable due to the multi-factor nature of this task. To solve the problem of multi-criteria optimization of the compounding process, the most effective method is mathematical modeling with the development and use of computer modeling systems.

Today, there are a number of commercial packages on the market of computer modeling systems, such as: Aspen Process Industry Modeling System (Aspen PIMS) of Aspen Technology Inc., Blend Ratio Control (BRC) and Refinery and Petrochemical Modeling System (RPMS) of Honeywell International Inc. and Blend Optimization and Supervisory System (BOSS) of Invensys plc., which allow you to optimize the use of raw materials for mixing. These programs make it possible to automatically calculate the optimal mixing formula from the economic point of view [5–7]. However, despite the significant advantages of such programs, their application in some cases is difficult, due to the fact that calculations often use not the actual properties of certain components, but the conditional characteristics of mixing, which can lead to significant errors in calculations and loss of resource efficiency of the compounding process.

## RESULTS AND DISCUSSING

In [8], we analyzed the developed mathematical model for calculating the octane numbers of commercial gasolines, based on the analysis of the reasons for the deviation of the mixing octane numbers from the additivity [9, 10]. In the practice of compounding, it has been observed that the more different the molecules of the components to be mixed, the greater the observed deviations from the behavior of ideal solutions. The key in the work [8] is considered to be the creation of a database on the octane numbers of components that make up commercial gasoline. Since the creation of a database that includes the individual hydrocarbon composition of gasoline is difficult due to the

multicomponent nature of gasoline, therefore, the aggregation of hydrocarbons into groups was carried out based on chemical affinity, similarity of structure, detonation resistance of components, etc.

The authors [11] in their work calculated the cost of gasoline with octane numbers 95, 98 in the Compounding modeling system developed in the Department of chemical engineering of TPU. The relevance of the work lies in the preparation of gasoline of a certain recipe, but with a relatively low cost. This was achieved by reducing the concentration of expensive components, such as MTBE, isomerizate, without compromising the quality of commercial gasoline.

The authors of the work have increased the efficiency of the gasoline compounding process by taking into account changes in the composition of raw materials of this process, which have a significant impact on the quality characteristics of commodity products [11]. This was achieved thanks to the introduction of the octane number calculation program «Compounding», with an up-to-date addition in the form of automated processing of chromatographic analysis data. This led to the creation of an extended formalized list of 110 hydrocarbon components that make the main contribution to the formation of the octane number of gasoline using the mathematical modeling method.

The implementation of this module makes it possible to take into account changes in the composition of raw materials,as well as to vary the mixing recipes and develop recommendations for involving different raw materials in compounding. The accuracy of the developed formulations provides savings in expensive components, which allows the oil refinery to get a significant economic effect.

## CONCLUSION

Mathematical modeling remains an urgent issue today, as it has a huge potential for application not only in compounding, but also in other processes of oil refining and petrochemistry. In-depth study and implementation of this process will reduce production costs and improve the quality of commercial petroleum products.

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Material received on 29.12.20.

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Материал 29.12.20 баспаға түсті.

## МӨЗ-ДЕ МОТОР ОТЫНДАРЫН ДАЙЫНДАУ ПРОЦЕСІН ОҢТАЙЛАНДЫРУ

*Қазақстанның қазіргі заманғы мұнай өңдеудің негізгі міндеттерінің бірі – К–4, К–5 халықаралық экологиялық стандарттарға сәйкес келетін тауарлық мұнай өнімдерін шығару. Бұған тауарлық өнімнің ассортиментін кеңейтуге*

*және оның сапасын арттыруға мүмкіндік беретін МӨЗ-дің бастапқы және қайталама өндірістерін жаңғырту ықпал ететіні сөзсіз. Компаундирлеу процесі тауарлық бензиндердің сандық және сапалық көрсеткіштерін қалыптастыруда маңызды рөл атқарады.*

*Мақалада тауарлық бензиндердің дайындалуын есептеудің негізгі математикалық модельдері қарастырылған, оның негізгі мақсаты мұнай өнімдерінің ГОСТ талаптарына сәйкестігін қамтамасыз ететін рецептті таңдау, қоспасы компоненттерінің молекулааралық өзара әрекеттесуін ескере отырып, бензиндердің детонациялық тұрақтылығын есептеудің математикалық моделіне негізделген. Қазіргі уақытта мұнайды өңдеудің әртүрлі процестерінің математикалық модельдерін модельдеу ерекше маңызды, өйткені бұл тәжірибелік бөліктің құнын төмендетуге мүмкіндік береді, оқығалардың барлық ықтимал нұсқаларын есептеңіз және ең қолайлы нұсқаны таңдаңыз.*

*Кілтті сөздер: тауарлық бензиндерді компаундирлеу процесі, араластыру құрылғысы, компьютерлік моделдеу жүйесі, жоғары октанды бензиндер.*

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Материал потупил в редакцию 29.12.20.

## ОПТИМИЗАЦИЯ ПРОЦЕССА ПРИГОТОВЛЕНИЯ МОТОРНЫХ ТОПЛИВ НА НПЗ

*Одной из ключевых задач современной нефтепереработки Казахстана считается выпуск товарных нефтепродуктов, соответствующих международным экологическим стандартам К–4, К–5. Несомненно, этому способствует модернизация первичных и вторичных производств НПЗ, которая позволяет расширить ассортимент товарной продукции и повысить её качество. Процесс компаундирования играет не менее важную роль в формировании количественных и качественных показателей товарных бензинов.*

*В статье рассмотрены основные математические модели расчета приготовления товарных бензинов, основное назначение которой подобрать рецептуру обеспечивающей соответствие нефтепродуктов требованиям ГОСТ, в основу положена математическая модель расчета детонационной стойкости бензинов с учетом межмолекулярных взаимодействий компонентов смеси. В настоящее время особую актуальность имеет моделирование математических моделей различных процессов нефтепереработки, поскольку это позволяет снизить затраты на экспериментальную часть, просчитать все возможные варианты развития событий и сделать выборна наиболее целесообразный вариант.*

*Ключевые слова: процесс компаундирования товарных бензинов, смесительное устройство, компьютерная моделирующая система, высокооктановые бензины.*

Теруге 29.12.20. ж. жіберілді. Басуға 10.01.21. ж. қол қойылды.
Форматы 297*420/2. Кітап-журнал қағазы.
Шартты баспа табағы 6,04. Таралымы 300 дана. Бағасы келісім бойынша.
Компьютерде беттеген З. С. Искакова
Корректор: А. Р. Омарова

Тапсырыс № 3721

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