ISNN 3030-3907

2026
JUNE
ISSUE - 6
VOLUME -7

DEVELOPMENT OF SCIENCE

scientific journal



Development of science

Ilmiy jurnal

IYUN 2026
Issue - 6, VOLUME – 7

ISSN 3030 -3907

Ilmiy jurnal OAK rayosatining 2024 yil 27 sentabrdagi 361-son qaroriga asosan 02.00.00 kimyo fanlari hamda 2025 yil 12 fevral 367- son qaroriga asosan 05.00.00 texnika fanlari bo‘yicha falsafa doktori (PhD) va fan doktori (DSc) ilmiy darajasiga talabgorlarning dissertatsiya ishlari yuzasidan dissertatsiyalari asosiy ilmiy natijalarini chop etish tavsiya etilgan milliy ilmiy nashrlar ro‘yxatiga kiritilgan.

BOSH MUHARRIR:
Temirov Alisher Hoshim o‘g‘li – texnika fanlari falsafa doktori (PhD),Dotsent.
TAHRIRIYAT KENGASH RAISI:
Fozilov Sadriddin Fayzullayevich – texnika fanlari doktori, professor
TAHRIRIYAT KENGASH A’ZOLARI

TEXNIKA FANLARI/ TECHNICAL SCIENCES/ ТЕХНИЧЕСКИЕ НАУКИ

Bozorov G‘ayrat Rashidovich
Buxoro Davlat Texnika Universiteti, professor
Abdurahmonov Olim Rustamovich
Buxoro Davlat Texnika Universiteti, professor
Adizov Bobur Zamirovich
O‘zbekiston Respublikasi Fanlar akademiyasi Umumiy va noorganik kimyo instituti, professor
Hayitov Ruslan Rustamjonovich
Buxoro Davlat Texnika Universiteti, professor
Jumayev Qayum Karimovich
Buxoro Davlat Texnika Universiteti, professor.
Berdiyev Dorob Murodovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor
Maxmudov Rafiq Amonovich
Buxoro Davlat Texnika Universiteti, professor.
Tilloyev Lochin Ismatilloyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Raxmonov Qahramon Sanakulovich
Buxoro Davlat Texnika Universiteti, dotsent.
Barakayev Nusratullo Rajabovich
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti, professor.
Jo‘rayev Xayrullo Fayziyevich
Buxoro Davlat Texnika Universiteti, professor.
Panoyev Erali Rajabboyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Ataullayev Sherzod Nabiullyevich
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Malik Negmurodovich
Buxoro Davlat Texnika Universiteti, dotsent.
Axmedova Ozoda Bahronovna
Islom Karimov nomidagi Toshkent Davlat Texnika Universiteti.
Safarov Bahri Jumayevich
Buxoro Davlat Texnika Universiteti, dotsent.
Xaydarov Axtam Amonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Safarov Jasur Alijon o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.

KIMYO FANLARI/ CHEMICAL SCIENCES/ ХИМИЧЕСКИЕ НАУКИ

Axmedov Voxid Nizomovich
Buxoro Davlat Texnika Universiteti, professor
Umarov Baqo Bafoyevich
Buxoro Davlat Universiteti, professor
Kodirov Abduaxad Abduraximovich
Qarshi davlat Universiteti, professor
Qurbonov Mingniqul Jumagulovich
Qarshi davlat Universiteti, dotsent
Turemuratov Sharibay Naurizbaevich
O‘zbekiston Respublikasi Fanlar akademiyasi Qoraqalpog‘iston bo‘limi Bosh ilmiy kotibi, professor
Tursunov Kaxor Shonazarovich
Qarshi davlat Universiteti, professor
Do‘stov Hamro
Buxoro Davlat Texnika Universiteti, professor
Panoyev Nodir Shavkatovich
Buxoro Davlat Texnika Universiteti, dotsent.
Olimov Bobur Bahodir o‘g‘li
Buxoro Davlat Texnika Universiteti, dotsent.
Kasimov Sherzod Abduazimovich
Termiz Davlat Universiteti, professor.
Aliqulov Rustam Valiyevich
Termiz Davlat Universiteti, professor
Tropov Xamza Tursunovich
Samarqand Davlat Universiteti, professor

IQTISODIYOT FANLARI/ ECONOMICS/ ЭКОНОМИЧЕСКИЕ НАУКИ

Nizamov Aslitdin Badreddinovich
Buxoro Davlat Texnika Universiteti, professor.
Boboyev Akmal Choriyevich
Buxoro Davlat Texnika Universiteti, professor.
Ergashxojayeva Shaxnoza Djasurovna
Toshkent davlat iqtisodiyot universiteti, professor
Saidaxmedova Nodira Ilxomovna
Toshkent davlat iqtisodiyot universiteti, professor
Muxsinov Bekzod Toxirovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shakarov Qulmat Ashirovich
Renessans ta'lim universiteti,dotsent.
Jumaeva Zulfiya Qayumovna
Buxoro Davlat Texnika Universiteti, dotsent.
Norova Salomat Yusupovna
Buxoro Davlat Texnika Universiteti, dotsent.
Avezova Shaxnoza Maxmudjonovna
Buxoro Davlat Texnika Universiteti, dotsent.
Jalilov Jamshid G‘anijonovich
Toshkent davlat iqtisodiyot universiteti, dotsent
Xasanova Gulruh Djumanazarovna
Buxoro Davlat Texnika Universiteti, dotsent.

PEDAGOGIKA FANLARI/ PEDAGOGICAL SCIENCES / ПЕДАГОГИЧЕСКИЕ НАУКИ

Siddiqova Sadoqat G‘afforovna
Buxoro Davlat Texnika Universiteti, dotsent.
Zoyirov Erkin Xalilovich
Buxoro Davlat Texnika Universiteti, DSc, professor
Gaffarov Feruz Hasanovich
Puchon Universiteti, *professor*
Ruziyev Davron Yuldashevich
Buxoro Davlat Universiteti, professor
Muradova Firuza Rashidovna
Buxoro Davlat Texnika Universiteti, professor.
Yunusova Gulandon Samiyevna
Buxoro Davlat Texnika Universiteti, professor.
To‘xtayeva Zebo Sharifovna
Buxoro Davlat Texnika Universiteti, professor.
Navro‘zova Gulchixra Nigmatovna
Buxoro Davlat Texnika Universiteti, dotsent.
Uzoqova Laylo Polvonovna
Buxoro muhandislik – texnologiya instituti, dotsent.
To‘raqulova Marjona Qiyom qizi
Buxoro Davlat Texnika Universiteti, dotsent.
Muradova Zarina Rashidovna
Buxoro Davlat Texnika Universiteti, dotsent.
Murodov Sanjar Aslonovich
Buxoro Davlat Texnika Universiteti, dotsent.
Shodiyev Jahongir Jo‘raqulovich
Buxoro Davlat Texnika Universiteti, dotsent
Gaffarov Laziz Hasanovich
Buxoro muhandislik – texnologiya instituti, dotsent.

Tahririyat a’zolarning to‘liq ro‘yxati jurnalning www.devos.uz saytida keltirilgan.

Tahririyat hay’ati a’zolarining tarkibini o‘zgartirish hamda qo‘shimcha kiritish yoki tahririyat a’zoligidan chiqarish bosh muharrir tomonidan amalga oshiriladi.

ISSN 3030-3907

Development of science ilmiy jurnali 2024 yil 15 aprel kuni №256445 sonli guvohnoma bilan Davlat ro‘yxatidan o‘tgan.

To‘plam elektron ko‘rinishda (pdf formatida) mualliflarga taqdim etiladi. To‘plamga kiritiladigan maqolalarning mazmuni, ulardagi statistik ma’lumotlar va me’yoriy hujjatlarning to‘g‘riligiga hamda har qanday fikr - mulohazalarga mualliflarning o‘zlari mas’ul hisoblanadilar. Talablarga javob bermaydigan maqolalar to‘plamga kiritilmaydi. Tashkiliy qo‘mita maqola matnini qisqartirish, qisman tuzatish kiritish, seksiyalarga joylashtirish huquqiga ega.

ISSN 3030-3907

DETERMINATION OF OPTIMAL OPERATING CONDITIONS OF THE FRACTIONATION PROCESS AND MINIMIZATION OF ENERGY CONSUMPTION

B.Z. Ibragimov
Master's Student, Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan
R.O. Boboyorov
Professor, Tashkent Institute of Chemical Technology, Tashkent, Uzbekistan

Abstract. This paper considers the problem of determining optimal operating modes of a distillation column in the natural gas fractionation process. The main technological parameters affecting process efficiency, including reflux ratio, operating pressure, temperature regime, and vapor flow rate, were analyzed. In order to minimize energy consumption, an objective function was formulated, and optimal parameters were determined using a mathematical optimization method. According to the calculation results, the optimal value of the reflux ratio was found to be 2.5, at which the energy consumption reaches its minimum value.

Keywords: fractionation, distillation column, optimization, reflux ratio, energy consumption, mathematical model.

Annotatsiya. Ushbu maqolada tabiiy gazni fraksiyalash jarayonida rektifikatsiya kolonnasining optimal ish rejimlarini aniqlash masalasi ko‘rib chiqilgan. Jarayon samaradorligiga ta’sir etuvchi asosiy texnologik parametrlar, jumladan, флегма soni (reflux ratio), ishchi bosim, harorat rejimi va bug‘ oqimi sarfi tahlil qilingan. Energiya sarfini minimallashtirish maqsadida maqsad funksiyasi shakllantirilib, matematik optimallashtirish usuli yordamida optimal parametrlar aniqlangan. Hisoblash natijalariga ko‘ra, флегма sonining optimal qiymati 2,5 ga teng ekanligi aniqlangan bo‘lib, ushbu qiymatda energiya sarfi minimal darajaga erishadi.

Kalit so‘zlar: fraksiyalash, rektifikatsiya kolonnasi, optimallashtirish, флегма soni, energiya sarfi, matematik model.

Аннотация. В данной статье рассматривается задача определения оптимальных режимов работы ректификационной колонны в процессе фракционирования природного газа. Проанализированы основные технологические параметры, влияющие на эффективность процесса, включая флегмовое число, рабочее давление, температурный режим и расход парового потока. С целью минимизации энергопотребления была сформулирована целевая функция, а оптимальные параметры определены с использованием метода математической оптимизации. Согласно результатам расчётов, оптимальное значение флегмового числа составляет 2,5, при котором энергопотребление достигает минимального значения.

ISSN 3030-3907

Ключевые слова: фракционирование, ректификационная колонна, оптимизация, флегмовое число, энергопотребление, математическая модель.

INTRODUCTION.

In natural gas processing, the fractionation stage plays a crucial technological role. During this process, hydrocarbon components of the gas mixture are separated according to their physicochemical properties, and the required products for subsequent technological operations are obtained. The efficiency of fractionation columns directly affects product quality, energy consumption, and production capacity.

Since the rational use of energy resources in industrial enterprises is becoming increasingly important, determining optimal operating conditions of distillation columns is considered one of the key scientific and practical tasks. Improper selection of process parameters may lead to increased energy consumption, reduced product quality, and decreased operational stability of the equipment.

The aim of this study is to analyze the main technological parameters of a distillation column and determine its optimal operating regime based on the minimization of energy consumption.

MATERIALS AND METHODS.

The research object was a distillation column designed for natural gas fractionation. The main parameters describing the process were selected as follows:

- reflux ratio (R);
- operating pressure (P);
- temperature regime (T).

One of the main control parameters of the column is the reflux ratio, which is determined by the following equation:

$$R = \frac{L}{D}$$

L—the amount of liquid returned to the column;

D—the distillate flow rate.

To evaluate energy consumption, the following objective function was adopted:

$$F(R) = (R - 2.5)^2 + 5$$

This function describes the effect of the reflux ratio on energy consumption and allows determination of the minimum point.

The following values were considered in the calculations:

Table 1.

R	F(R)
1.5	6.00

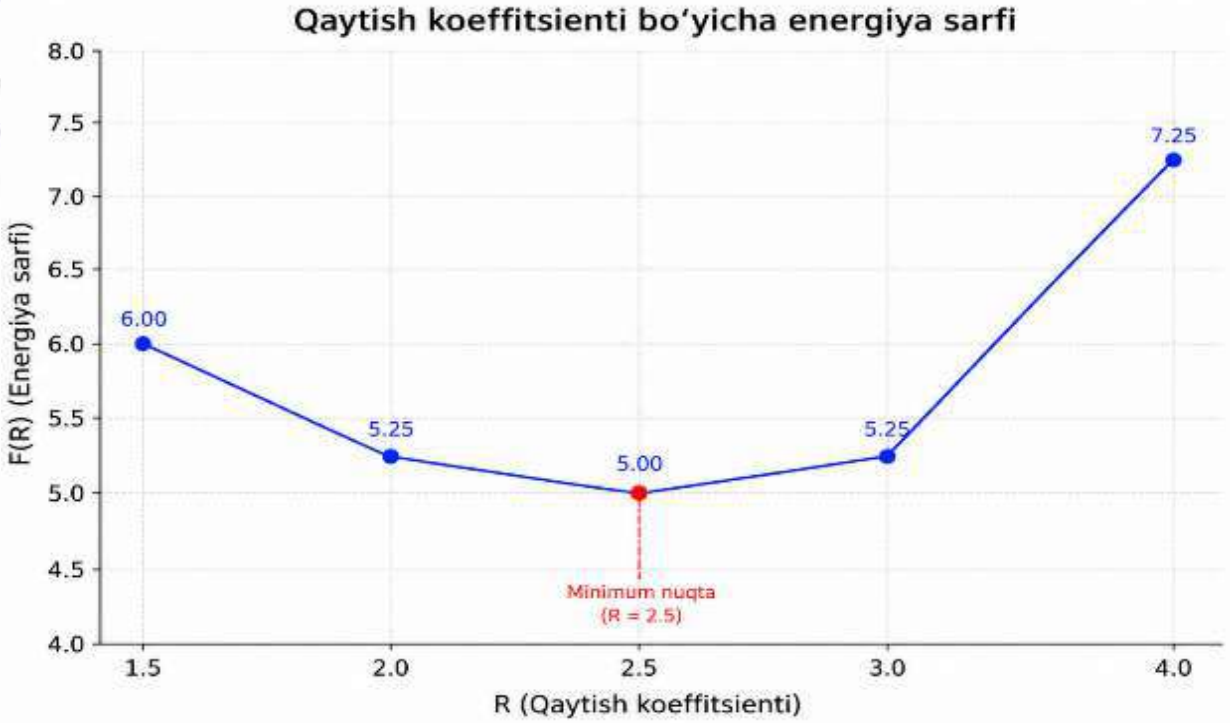
ISSN 3030-3907

2.0	5.25
2.5	5.00
3.0	5.25
4.0	7.25

The optimal value was determined using differential calculus methods.

RESULTS.

The calculation results demonstrated that energy consumption depends on the reflux ratio. Based on the obtained values, the energy consumption function was found to have a parabolic shape with a well-defined minimum point.



In order to identify the minimum point of the objective function, its first derivative was equated to zero:

$$\frac{dF}{dR} = 2(R - 2.5) = 0$$

As a result, the optimal value was found to be:

$$R = 2.5$$

Substituting this value into the objective function gives:

$$F(2.5) = 5$$

The calculation results showed that the energy consumption increases when the reflux ratio takes values either lower or higher than **2.5**. Therefore, **R = 2.5** can be considered the optimal reflux ratio, corresponding to the minimum energy consumption of the distillation column.

For instance, the energy consumption was calculated to be 5.25 units at reflux ratios of $R = 2.0$ and $R = 3.0$. However, when the reflux ratio increased to

ISSN 3030-3907

$R = 4.0$, the energy consumption rose to 7.25 units, indicating a significant increase in operating costs.

Based on the analysis, the following optimal parameters are recommended:

Table 2.

Parameter	Optimal Value
Reflux Ratio	2.5
Pressure	4–6 atm
Temperature Regime	Stable
Energy Consumption	Minimum

DISCUSSION.

The obtained results demonstrated that the efficiency of a distillation column is closely related to the reflux ratio. Although an increase in the reflux ratio improves product quality, it also leads to higher energy consumption. Therefore, determining an optimal operating point that simultaneously satisfies both economic and technological requirements is of great importance.

Pressure and temperature operating conditions also have a significant impact on fractionation efficiency. An increase in pressure raises the boiling temperature, resulting in a higher reboiler duty. Maintaining a stable temperature gradient throughout the column ensures effective separation of the components.

The proposed approach can be implemented as part of automatic control systems in industrial enterprises. Real-time determination of optimal operating parameters makes it possible to reduce energy consumption while maintaining consistent product quality.

CONCLUSION.

According to the research results, it was determined that the reflux ratio is a key control parameter in identifying the optimal operating mode of a distillation column. Based on the developed mathematical model, an energy consumption function was formulated and its minimum point was calculated.

The calculations showed that the optimal value of the reflux ratio is R = 2.5. At this value, energy consumption reaches its minimum level, ensuring both technologically and economically efficient operation of the column.

The obtained results can be applied in the optimization of fractionation processes and in the development of automatic control systems.

REFERENCES

1. Fogler, H. S. (2016). Elements of Chemical Reaction Engineering. Prentice Hall.
2. Busby, R. L. (Ed.). (2022). Natural Gas. Moscow: Olymp-Business Publishing House.

ISSN 3030-3907

3. Kidnay, A. J., Parrish, W. R., & McCartney, D. G. (2014). Fundamentals of Natural Gas Processing. CRC Press.
4. Boboyorov, R. O. (2023). Chemical Technological Process Control Systems. Tashkent: Ziyo Nashr-Matbaa Publishing.
5. Boboyorov, R. O. (2026). On the issue of automation of the alkylation process of benzene with propylene as one of the basic substances of petrochemistry. Journal of Food Science, 4(1), 115-118.
6. Boboyorov, R. O., & Ibragimov, B. (2026). Modeling of the natural gas fractionation process. Journal Development of Science, 2026(1).
8. Boboyorov, R. A., & Avezov, T. A. (2021). Modeling a tubular chemical reactor in the Matlab applied software package. Universum: Technical Sciences, 86(5), 80-83.
9. Boboyorov, R. A., & Ulmasbaev, A. S. (2021). The prospect of synergy of ultraviolet radiation with the coagulation method against pathogens. Universum: Technical Sciences, 86(5), 84- 86.
10. Babayarov, R. A. (1993). Intensification of the evaporation process of cottonseed oil miscella. Dissertation.
11. Boboyorov, R. A., & Ulmasbaev, A. S. (2021). Mathematical and computer modeling of the coagulation process during water purification. Universum: Technical Sciences, 87(6), 17-19.
12. Turakulov, Z., Kamolov, A., Eshbobaev, J., Turakulov, A., Norkobilov, A., & Boboyorov, R. (2023). Modeling and simulation of chemical absorption methods for CO2 separation from cement plant flue gases. Engineering Proceedings, 56(1), Article 142. https://doi.org/10.3390/ASEC2023-15352
13. Khusainov, R. R., Boboyorov, R. O., & Rashidova, D. G. (2026). Socio-economic issues of non-traditional and renewable energy sources in Uzbekistan. The Innovation Economy, 2(1). https://ojs.qmii.uz/index.php/ej/article/view/1080
14. Boboyorov, R. A., Usmanov, K. I., & Nuriev, J. I. (2024). Computer simulation of the dynamics of the evaporation process of vegetable oil solutions. Universum: Technical Sciences, 125(8), 17-20.
15. Babayarov, R. A., & Usmanov, K. I. (2022). Determination of the circulation velocity of a boiling solution of cottonseed oil. Universum: Technical Sciences, 97(4), 46-48.
16. Usmanov, K. I., Babayarov, R. A., Avezov, T. A., & Jabborov, A. O. (2020). Fuzzy control of non-linear dynamic objects. Universum: Technical Sciences, 74(5), 34-39.
17. Kohl, A. L., & Nielsen, R. B. (1997). Gas Purification (5th ed.). Houston: Gulf Publishing Company.

18. Speight, J. G. (2007). Natural Gas: A Basic Handbook. Houston: Gulf Publishing Company.
19. Green, D. W., & Southard, M. Z. (Eds.). (2019). Perry's Chemical Engineers' Handbook (9th ed.). New York: McGraw-Hill Education.
20. Gas Processors Suppliers Association. (2017). GPSA Engineering Data Book (14th ed.). Tulsa: GPSA.

ISSN 3030-3907