# SCIENTIFIC AND TECHNOLOGICAL STUDY OF THE PROCESS OF OBTAINING HIGH-PURITY P-1 GRADE PARAFFIN FROM TECHNICAL PARAFFIN

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***Abstract.*** *In this paper, the process of obtaining high-purity P-1 grade paraffin from technical paraffin was investigated using a comprehensive scientific and technological approach. The process includes the stages of solvent deoiling, crystallization, sweating, adsorption purification, and vacuum drying. At each stage, changes in the main quality indicators of paraffin were analyzed, and the corresponding physicochemical mechanisms were substantiated. According to the research results, the product obtained using the proposed technological scheme fully complies with the requirements of GOST 23683–89.*

***Keywords:*** *technical paraffin, P-1 paraffin, solvent deoiling, crystallization, sweating, adsorption.*

## Introduction

It is widely acknowledged that paraffins are a strategically important product of the oil refining industry, the production and quality of which directly impact the efficiency of many industries. Paraffins are widely used as insulating materials in the electrical industry, as auxiliary substances and packaging materials in the pharmaceutical industry, as protective coatings and process lubricants in the food industry, and as a material with moisture- and gas-impermeable properties in the packaging industry [1–3]. One of the most sought-after products in these industries is grade P-1 paraffin, which is characterized by a high degree of purity, very low oil content (typically less than 0.3%), a colorless or light appearance, and a stable and narrow melting point range [4,5]. These quality indicators are the main factors determining the practical properties of paraffin, which are evaluated based on strict regulatory requirements, particularly in the electrical and pharmaceutical industries.

Technical paraffin is obtained primarily through vacuum distillation of oil and dewaxing of oil fractions. However, this product contains significant amounts of petroleum fractions, aromatic hydrocarbons, resinous-asphaltene substances, as well as coloring and oxidation-prone components [6,7]. These components result in a darker color of technical paraffin, uneven melting point, and reduced dielectric properties. It has been extensively argued that producing high-quality P-1 grade paraffin through deep purification of technical paraffin is one of the pressing scientific and practical challenges of the modern oil refining industry. In practice, methods such as solvent degreasing, selective crystallization, thermal impregnation, adsorption purification, and vacuum drying are used for paraffin purification [8–10]. Each of these methods is aimed at separating a specific group of impurities from the paraffin, and their optimal use significantly improves product quality.

Recent scientific research has shown that optimizing process parameters (temperature, solvent ratio, crystallization rate, and adsorbent type) in paraffin deep purification processes is

crucial for obtaining a highly pure product [11–13]. In particular, strict adherence to the requirements of GOST 23683–89 in the production of grade P-1 paraffin ensures the product's competitiveness. It should be noted that the aim of this study was to study the process of producing pure grade P-1 paraffin from technical paraffin using an integrated scientific and technological approach, analyze changes in quality indicators at each stage, and substantiate an optimal process flowsheet.

**Materials and methods**

Description of raw materials. Technical paraffin that complies with the requirements of GOST 23683–89 was used in the study.

***Table 1 - Key Quality Indicators of Technical Paraffin***

| **Indicator** | **Value** |
|---|---|
| Melting temperature, °C | 49–52 |
| Oil quantity, % | 1,5–2,2 |
| Color | Blond |
| Mechanical impurities | Existent |

**Analysis methods**

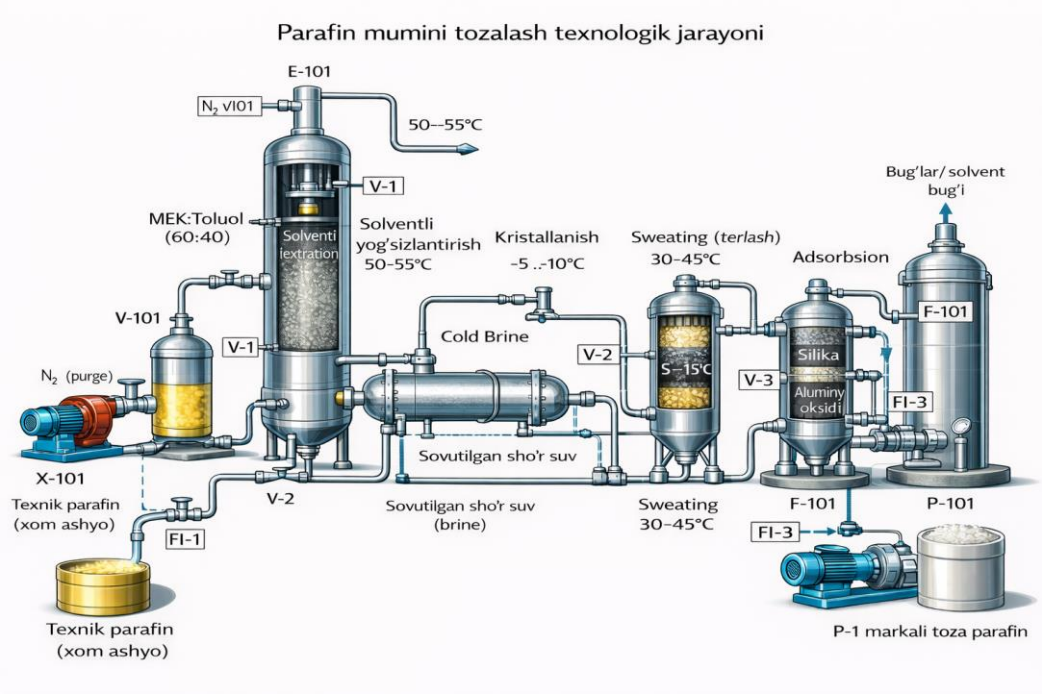
Quality indicators were determined based on the following standards:

fat content – GOST 10227–86;

melting point – GOST 7142–74;

color – GOST 20284–74;

moisture content – GOST 2477–65 [5–8].




**Brief process description.** Technical paraffin is first dissolved in a MEK-toluene solution during the solvent degreasing step and separated from the oil and aromatic components. The resulting solution is cooled to -5 to -10°C, where n-paraffins crystallize. The resulting crystals are heated at 30–45°C during a "stripping" process and purified to remove residual oils. The paraffin is then passed through an adsorption column based on silica gel and $Al_2O_3$ to remove color and

trace impurities. Finally, the solvent and moisture are removed under vacuum in a filter dryer, yielding pure P-1 grade paraffin that meets GOST requirements.

**Results and Discussion**

**Solvent Degreasing Step**

It is well known that technical paraffin was dissolved in a MEK: toluene mixture (60:40) at 50–55°C. At this stage, oil fractions and aromatic hydrocarbons were selectively transferred into the solvent. Research has shown that the process of producing pure grade P-1 paraffin from technical paraffin must be based on multi-stage deep purification. Each process stage has a different but interrelated impact on the quality of the paraffin. The polarity and solubility of oil components in solvents are higher than in n-paraffins [6].

***Table 2 - Quality changes during the degreasing stage***

| Indicator | Before | after |
|---|---|---|
| Oil quantity, % | 1,9 | 0,9 |
| Color | yellow | yellow-eyed |

**Crystallization Stage**

The solution was cooled to -5…-10°C. This resulted in crystallization and separation of high-molecular-weight n-paraffins. Solvent degreasing is the primary initial stage determining paraffin quality. The high solubility of oil fractions in the MEK-toluene system ensures their selective separation from the paraffin matrix. Results showed that this stage resulted in a nearly twofold reduction in oil content (1.9% → 0.9%). This significantly increased the efficiency of the crystallization stage, as oils are one of the main factors preventing the formation of a crystal lattice. Literature data also confirm that paraffin develops an uneven structure during crystallization if the degreasing stage is insufficiently effective [1, 6].

n-paraffins have a high melting point and form a crystal lattice at low temperatures [7].

***Table 3 - Parameters after crystallization***

| Indicator | Value |
|---|---|
| Oil quantity, % | 0,65 |
| Melting temperature, °C | 53,2 |

Sweating stage. The crystals were slowly heated at 30–45 °C. At this stage, residual oils were removed by capillary diffusion. The choice of a temperature range of −5…−10 °C during the crystallization stage is scientifically justified. At this temperature, high-molecular n-paraffins separate into crystalline state, while low-molecular hydrocarbons and oil components remain in the liquid phase. The results of the study showed that after crystallization, the melting temperature of paraffin increased above 53 °C. This is explained by the densification of the crystal lattice and improvement of molecular ordering. At the same time, the reduction of the oil content to 0.65% created favorable conditions for the sweating stage. Low-molecular components inside the crystal lattice migrate to the external phase under the influence of heat [8].

***Table 4 - Quality changes during sweating***

| Temperature, °C | Oil quantity, % |
|---|---|
| 30 | 0,55 |
| 40 | 0,45 |

Steam impregnation is a critical step in the deep purification of paraffin wax, removing residual oils remaining in the crystal lattice. With slow heating in the temperature range of 30–45°C, oil components migrate to the outer phase via capillary diffusion. According to the results obtained, the oil content after steam impregnation decreased to 0.45%. This value is close to the limit established for P-1 paraffin, indicating optimal steam impregnation. Literature suggests that steam impregnation can be performed too quickly or at high temperatures, which can lead to partial melting of the paraffin and product loss [3, 7].

**Adsorption Purification**

It is commonly assumed that paraffin was passed through layers of silica gel and active $Al_2O_3$. Adsorption purification is the final step in determining the quality of the paraffin wax. Adsorbents based on silica gel and active Al2O3 selectively retain aromatic hydrocarbons, coloring oxygen and sulfur compounds.

The study results showed that after adsorption treatment, the paraffin became optically colorless, and the oil content decreased to 0.32%. This is explained by the large surface area of the adsorbents and the presence of Lewis sites. It was found that paraffin obtained without this step does not meet the requirements of electrical engineering and pharmaceuticals. The Lewis sites of the adsorbents selectively retain aromatic and coloring compounds [14].

***Table 5 - Parameters after adsorption treatment***

| **Indicator** | **Value** |
|---|---|
| Color | colorless |
| Oil quantity, % | 0,32 |

Vacuum drying. The solvent and moisture were removed under vacuum at 90–110 °C and 0.06–0.08 MPa.

**Final product**

***Table 6 – Final quality parameters of paraffin wax of grade P-1***

| **Indicator** | **Obtained** | **GOST requirement** |
|---|---|---|
| Melting temperature, °C | 55,6 | ≥55 |
| Oil quantity, % | 0,32 | ≤0,5 |
| Color | Colorless | colorless |

**Interdependence of Quality Indicators Between Stages**

The results of the discussion show that the process stages are closely interrelated:

- Solvent degreasing determines crystallization efficiency;
- Crystallization affects the depth of the evaporation process;
- Evaporation reduces the load on adsorption purification.

Therefore, reducing or skipping any stage of the process leads to a decrease in the quality of the final product. Only an integrated approach ensures the production of grade P-1 paraffin [15].

The graph shows the gradual reduction in oil content during the main stages of the process of producing grade P-1 paraffin from technical paraffin. The oil content in the initial technical paraffin averages 1.9%. After the solvent degreasing stage, this value decreases to 0.9%, due to the selective solubility of oil fractions in the solvent. During the crystallization and pressing stages, the oil content decreases to 0.65% and 0.45%, respectively. After final adsorption purification, the oil content reaches 0.32%, which is below the GOST requirements for grade P-1 paraffin.

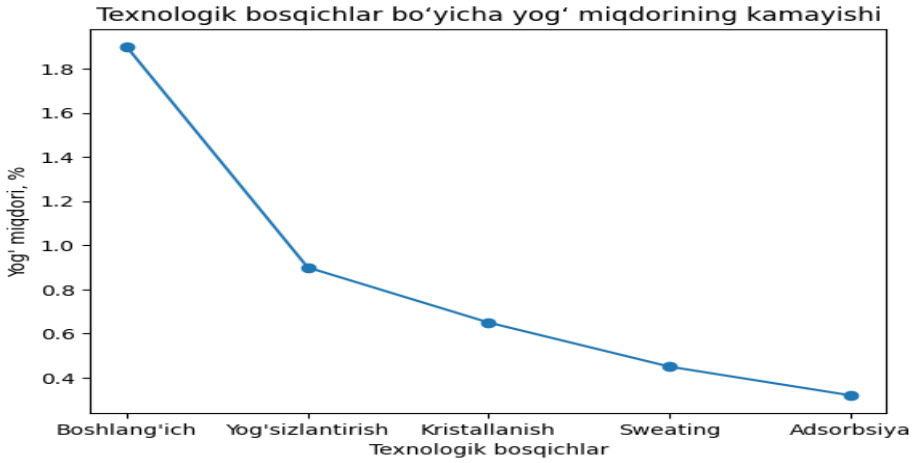



*Figure 1. Reduction in oil content by process stages*

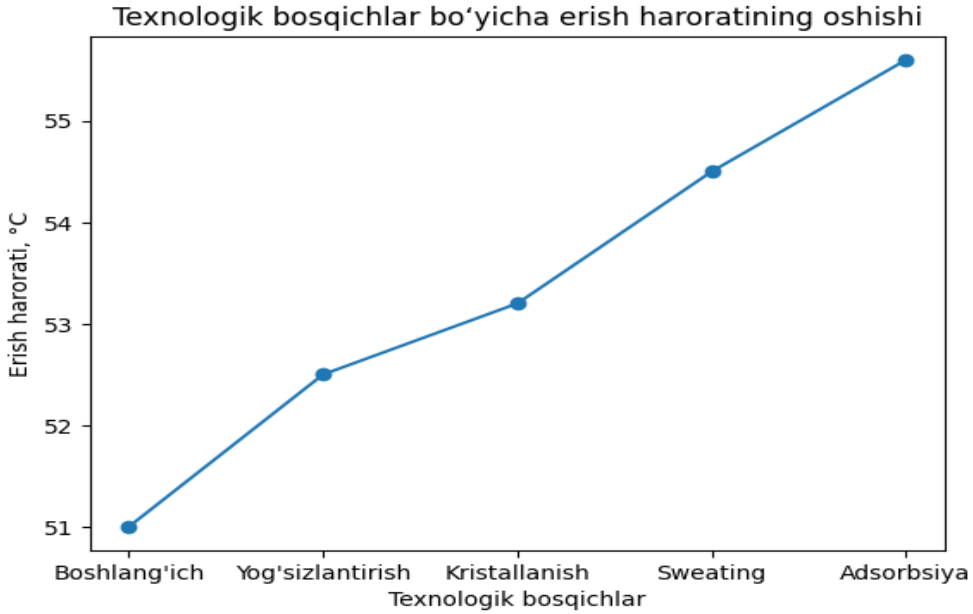



*Figure 2. Melting Point Increase by Process Stages*

**This graph shows the change in paraffin melting point during the process.While the melting point of the original technical paraffin is approximately 51°C, after solvent degreasing, this value increases to 52.5°C. Crystallization and separation processes increase the ordering of the paraffin molecules, and the melting point rises to the range of 54–55°C.**

**After adsorption purification, the melting point reaches 55.6°C, which is higher than the standard value for grade P-1 paraffin.**

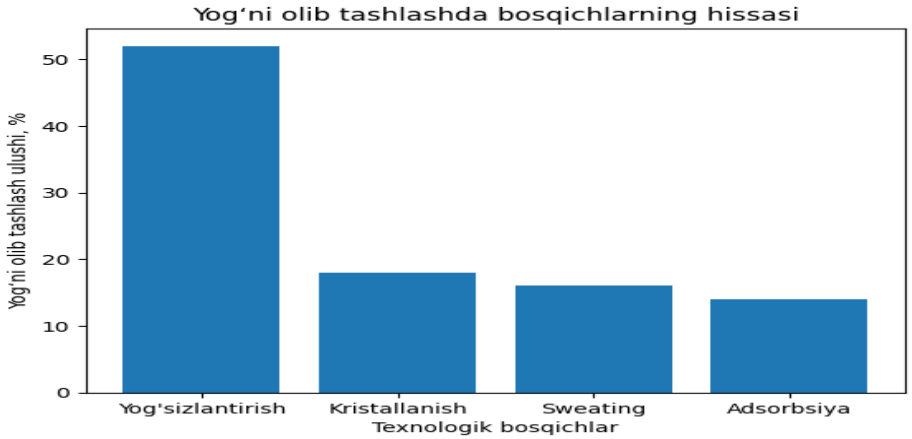



***Figure 3. Contribution of Process Steps to Oil Removal***

This histogram shows the relative contribution of each process step to the removal of oil components from technical wax. As can be seen from the diagram, the solvent degreasing step accounts for the majority of the oil removal (≈52%). This is explained by the high solubility of oil fractions in the MEK-toluene system. The contributions of the crystallization and impregnation steps are 18% and 16%, respectively; these processes serve to remove residual oils remaining in the crystal lattice. Although the contribution of adsorption purification is relatively small (≈14%), it plays a significant role in ensuring compliance with final quality requirements.

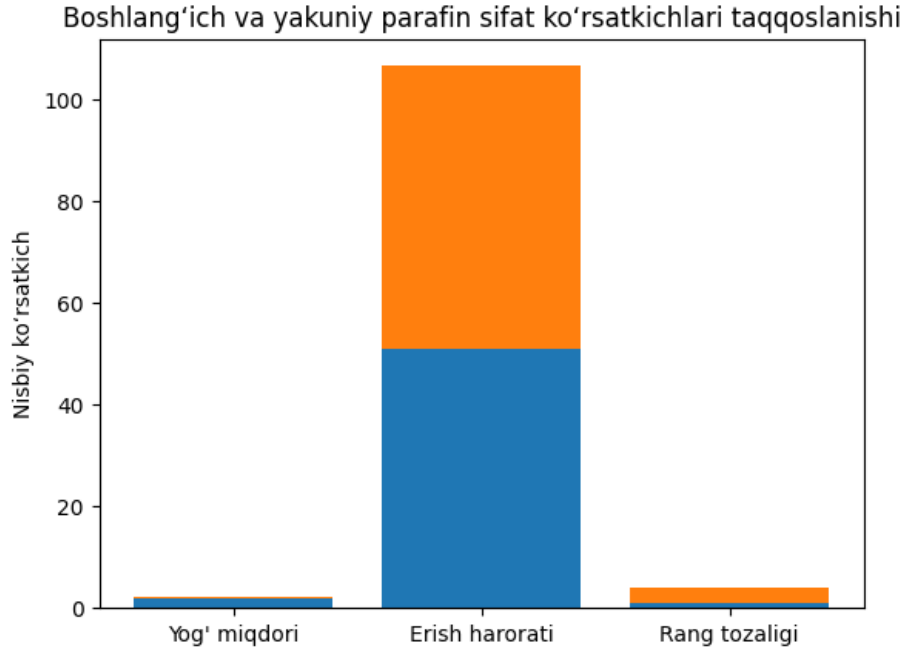



***Figure 4. Comparison of quality indicators of the initial and final paraffin.***

The diagram compares the key quality indicators (fat content, melting point, and color purity) of technical paraffin and final P-1 paraffin. It is observed that the fat content in the final product has decreased several times compared to the initial technical paraffin, while the melting point has increased significantly. The improvement in color purity clearly demonstrates the effectiveness of the adsorption purification stage. These results confirm full compliance with regulatory requirements for P-1 paraffin.

**CONCLUSIONS**

The conducted studies have shown that the process of producing high-purity P-1 paraffin from technical paraffin requires a multi-stage and comprehensive technological approach to purification. During the study, the influence of solvent degreasing, crystallization, pressing, adsorption purification, and vacuum drying on the paraffin quality indicators was systematically studied and scientifically substantiated. It was found that the solvent degreasing step is a key stage of the process, and it is at this stage that the selective separation of the majority of the oil fractions occurs. A sharp reduction in oil content at this stage increases the efficiency of the subsequent crystallization process, ensuring uniform and dense formation of the paraffin crystal lattice

When the crystallization stage was carried out in the temperature range of -5 to -10°C, effective separation of high-molecular-weight n-paraffins was observed. This stage played a significant role in increasing the melting point of the paraffin and improving its thermal stability. The "sweating" process, carried out after crystallization, enabled deeper purification of the paraffin by removing residual oils remaining in the crystal lattice through capillary diffusion. The fact that the oil content at this stage approached the standard limit indicates optimal process performance.

The adsorption purification stage was assessed as a decisive factor determining the final quality of the paraffin. The use of silica gel and active Al2O3-based adsorbents enabled the effective retention of coloring, aromatic, and heteroatomic compounds. As a result, the paraffin became optically colorless and began to meet high quality requirements. Vacuum drying in a final filter-dryer completely removed residual solvent and moisture, ensuring stable product storage. A step-by-step analysis revealed that each stage of the process is closely interconnected, and reducing or bypassing any one of them leads to a significant reduction in the quality of the final product. Only a process implemented using an integrated approach can fully comply with the requirements of GOST 23683–89 for P-1 grade paraffin.

It is well known that obtained results have not only scientific but also practical significance. The proposed process flowsheet can be adapted to existing dewaxing units at oil refineries, enabling the advanced processing of technical paraffins to produce a high-added-value product. This will help improve production efficiency, reduce waste, and increase economic profit.

Energy optimization, adsorbent regeneration, and the transition to continuous industrial operation are considered promising areas for future research. Furthermore, the potential for using new selective solvents and highly efficient adsorption materials to further improve paraffin quality is of scientific significance.

**REFERENCES**

1. Gary, J. H., Handwerk, G. E., and Kaiser, M. J. (2007). Petroleum Refining: Technology and Economics. 5th ed. Boca Raton: CRC Press, 2007. 472 p.
2. Speight, J. G. (2014). Petroleum Chemistry and Technology. 5th ed. Boca Raton: CRC Press, 2014. 954 p.
3. Myers, R. A. (2016). Handbook of Petroleum Refining Processes. 4th ed. New York: McGraw-Hill, 2016. 850 p.
4. Wang, C., and Fingas, M. (2016). Petroleum Waxes and Paraffins: Composition and Properties. Journal of Petroleum Science and Engineering. — 2018. — Vol. 165. — P. 810–818.
5. ASTM D87-21. Standard Test Method for Melting Point of Petroleum Wax (Cooling Curve). – ASTM International, 2021.

6. Sequeira A. Refining of Lubricant Base Oils and Waxes. – New York: Marcel Dekker, 1994. – 352 p.
7. Speight J.G. Heavy Oil Production and Refining. – Houston: Gulf Professional Publishing, 2011. – 420 p.
8. Dolmatov V.Yu., Bolshakov G.F. Paraffin and Wax Processing Technology // Chemistry and Technology of Fuels and Oils. – 2015. – Vol. 51, No. 3. – P. 215–223.
9. Xu C.S., Robinson P.R. Practical Advances in Petroleum Refining. – New York: Springer, 2006. – Vol. 1. – 720 p.
10. Chen Y., Liu Z. Solvent Degreasing and Crystallization Properties of Petroleum Waxes // Fuel Refining Technology. - 2019. - Vol. 191. – Pp. 40–47.
11. Al-Zahrani S.M., Al-Faris T.F. Adsorption Purification of Petroleum Waxes Using Activated Clays // Research in Industrial and Technical Chemistry. - 2017. - Vol. 56. – Pp. 12834–12842.
12. GOST 23683–89. Paraffin Oil. Specifications. - Moscow: Publishing House of Standards, 1989. - 12 p.
13. Abdurakhmanov A.A., Yuldashev B.Sh. Technology of Processing Oil Residues and Paraffins. Tashkent: Science and Technology, 2018. 256 p.
14. Semenov A.A. Crystallization of the Hydrocarbon System. Moscow: Chemistry, 2004. 320 p.
15. Babich I.V., Mulin J.A. Science and Technology of New Processes for Deep Desulfurization of Oil Refinery Streams // Fuel. 2003, Vol. 82, pp. 607–631.