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TECHNOLOGICAL SCHEME FOR EXTRACTING NAPHTHALENE FROM PYROLYSIS OIL BY THE EXTRACTION (PHASE SEPARATION) METHOD

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Abstract: The aim is to determine the optimal method for extracting naphthalene compounds from pyrolysis oil, to investigate the synthesis processes of naphthaleneacetic acid based on naphthalene, to identify the factors that increase product yield, and to develop an improved technology for the production of naphthaleneacetic acid.

Keywords: Pyrolysis, Hydrocarbon, Oxygen-containing compound, Aromatic compound, Fraction.

Introduction. Globally, aromatic hydrocarbons are among the most important products of the petrochemical industry. Extensive scientific research is being conducted on the extraction of natural resources, their rational utilization, large-scale modernization of industrial production, and the implementation of innovative developments into practice, including in the agricultural sector. In this context, particular attention is being paid to the technical and technological upgrading of existing industrial facilities, the rapid adoption of modern scientific achievements and advanced innovative technologies, and the establishment of competitive enterprises capable of producing import-substituting products that are in stable demand on the global market.

Main part.

Phase separation of pyrolysis oils is a crucial step in the processing of these complex multicomponent mixtures. In this process, the fractions of pyrolysis oil—representing a complex mixture of organic compounds formed during the thermal processing of hydrocarbon compounds—are separated. These mixtures include aromatic hydrocarbons, oxygen-containing compounds, resins, and light volatile components. Phase separation is based on differences in the physical properties of the components of pyrolysis oil, such as density, solubility, and polarity. During the pyrolysis of hydrocarbon feedstocks, the following products are formed:

- Nonpolar hydrocarbons (aromatic and aliphatic compounds)
- Polar and oxygen-containing compounds (indene and azulene derivatives, alcohols, acids, phenols)
- Water (present in the feedstock or formed during the reaction process)
- Solid and resinous substances (residual carbonaceous materials)

Phase separation is carried out through an extraction process, which is used to divide the oil into various fractions, each of which can be utilized for specific industrial purposes.

The essence of separating pyrolysis oil by extraction lies in differences in the solubility of components in various solvents or in the separation of polar and nonpolar

compounds. The selected solvents are employed to effectively isolate target fractions such as light hydrocarbons, aromatic substances, or heavier resinous components.

The main applications and methods of phase separation of pyrolysis oils are presented below:

1. Industrial processing:

- Pyrolysis oils are frequently processed to obtain valuable hydrocarbons such as aromatic compounds, phenols, and light hydrocarbons (gasoline-like fractions).

- Fractionation facilitates the subsequent processing and utilization of these components in the production of fuels, solvents, and chemical products.

2. Fuel production:

- One of the primary objectives of processing pyrolysis oils is the production of liquid fuels suitable for use in power plants.

- Light fractions (C5–C10) can be used as components for gasoline production.

- Heavier fractions are further processed into heavier fuels or utilized as petrochemical feedstocks.

3. Production of chemical compounds:

- Aromatic hydrocarbons such as benzene, toluene, and xylenes obtained from pyrolysis oils are of significant importance in the chemical industry and are used as raw materials for the production of plastics, solvents, and synthetic fibers.

- Naphthalene, phenols, and oxygen-containing compounds can be used in the production of polymers and specialty chemicals.

1. Stabilization and improvement of oil quality:

Pyrolysis oils are often unstable mixtures prone to polymerization or resin formation. Phase separation helps to isolate high-molecular-weight and chemically active components, thereby enhancing the stability of the oil.

The removal of water and oxygen-containing compounds also improves oil quality, making it more suitable for use as a fuel.

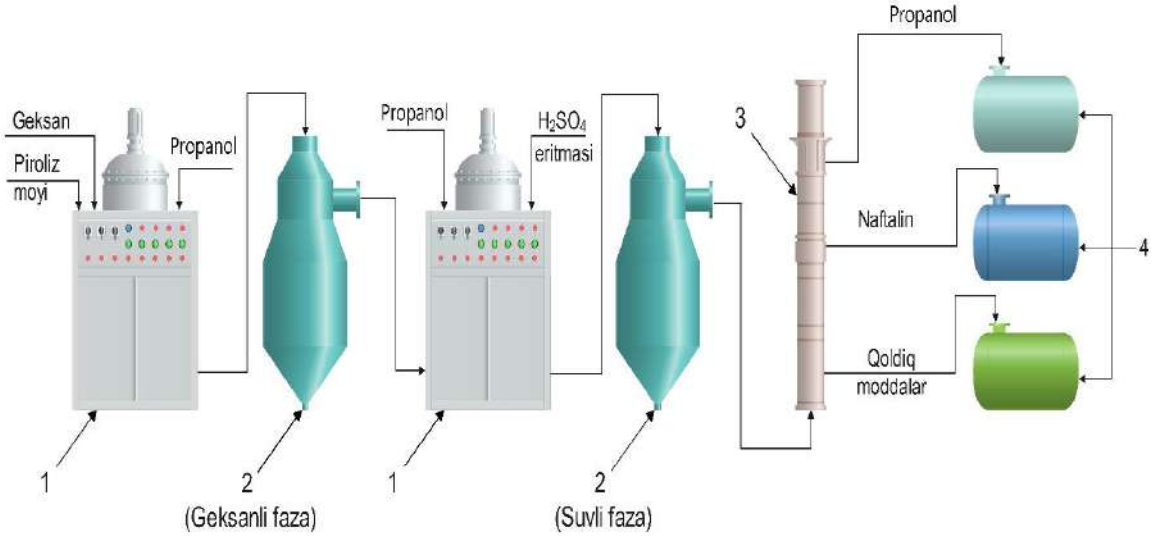

Figure 1. Technological scheme for the separation of naphthalene from pyrolysis oils
1 – extractor–homogenizer; 2 – separator; 3 – rectification column; 4 – collecting vessels

The technology for separating naphthalene from pyrolysis oils by extraction (phase separation) is schematically illustrated in Figure 1.

The extraction method for separating naphthalene from pyrolysis oils is based on differences in the solubility of components in polar and nonpolar solvents. This approach effectively separates naphthalene and other aromatic hydrocarbons from polar and resinous compounds that are commonly present in pyrolysis oils.

Principle of the extraction method. The extraction process involves phase separation of pyrolysis oil using specially selected solvents. The isolation of naphthalene is based on its solubility in organic solvents and its ability to crystallize under certain conditions. The main objective of the process is to separate the oil components into two stages:

- Nonpolar phase: saturated hydrocarbons, including alkanes.
- Polar phase: containing naphthalene, azulene, indene, and other compounds.

Main stages of naphthalene production technology.

1. Preparation of pyrolysis oil:

- Filtration: Removal of solid substances, resins, and other mixtures that may interfere with the extraction process.

- **Heating:** The pyrolysis oil is heated to a temperature that ensures fluidity and improves interaction with the solvent (up to 60°C).

2. Addition of solvents:

- An organic solvent with high naphthalene solubility, such as propanol, is added to the pyrolysis oil. The solubility of naphthalene in propanol at 60°C is 100 grams per 100 grams of solvent. To ensure the selective dissolution of saturated hydrocarbons, nonpolar solvents such as hexane or toluene can be used.

- The ratio of solvent to oil is selected based on the oil composition and naphthalene concentration. According to literature, naphthalene content in pyrolysis oil is typically 40–42%. Therefore, the pyrolysis oil, hexane, and propanol were initially mixed in a 1:1:1 ratio.

Mixing and Contact Time:

- To ensure maximum naphthalene recovery, the oil–solvent mixture is intensively stirred for a specified period (up to 30 minutes).

- Maintaining temperature is important: the process is carried out at 60°C to enhance the solubility of naphthalene.

Phase Separation:

- After mixing, the mixture is allowed to settle, resulting in two phases:

- Upper phase: organic, containing saturated hydrocarbons.

- Lower phase: polar, containing naphthalene and other aromatic hydrocarbons.

The phases are separated using a separator.

Naphthalene is isolated from the organic phase by filtration or decantation.

Solvent Regeneration:

- The solvent from the organic phase is recovered and returned to the extraction process. This reduces overall costs and increases economic efficiency.

Naphthalene Purification: The obtained naphthalene crystals can be further purified by recrystallization or vacuum distillation to achieve the high purity required for industrial use.

Advantages of the Method: The extraction method for separating naphthalene from pyrolysis oils is an effective and economically advantageous approach for isolating aromatic hydrocarbons. Using appropriate solvents for phase separation allows naphthalene to be obtained at high purity, making it suitable for subsequent industrial applications. Optimizing extraction conditions such as temperature, solvent selection, and contact time plays a key role in achieving high process efficiency.

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