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# Setting the Problem of Optimization of the Oil Extraction Process

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**Abstract:**

This article addresses the key issues in optimizing the oil extraction process. The separation and purification of oils are crucial in various industries and are widely utilized in agriculture, chemistry, and the food industry. The article aims to enhance process efficiency by identifying and analyzing input, output, and control parameters, as well as the factors influencing the process.

**Enter.** Oil extraction is one of the important processes in the industry. This process is used to extract oils from various raw materials, such as plants, grains or other biological materials. Oil extraction technologies must be constantly optimized to increase product quality, production efficiency, and economic profitability. In this article, the optimization of the oil extraction process is considered.

**Optimization Problems.** Optimizing the oil extraction process requires solving a number of issues[1,2-4]:

- **Improving efficiency**: To increase the efficiency of the extraction process, it is necessary to optimize the method and parameters (temperature, pressure, solvent concentration). This helps to get the maximum amount of fat and reduce waste.
- **Energy saving**: In order to save energy, it is necessary to revise the process and introduce technologies that improve energy efficiency. For example, energy consumption can be reduced by automating the process and modernizing processing systems.
- **Environmental considerations:** Solvents and other chemicals are adequately evaluated to ensure environmental safety. It is necessary to look for environmentally friendly alternatives and recycling methods.

- **Quality Control:** Perform quality control throughout the process to maintain and improve product quality. This ensures that the product meets the standards.

**Research object and method.** The following strategies can be considered to optimize the oil extraction process:

**Process modeling and simulation:** Optimization of process parameters and analysis of various conditions using computer models and simulation[3,5].

**Experimental studies:** testing various methods in laboratory conditions and determining the most effective parameters.

Introduction of new technologies: Improving efficiency by introducing new technologies such as supercritical $CO_2$ extraction.

Process automation: Reducing the impact of the human factor by introducing process automation and digital control systems.

Analysis and results. The process of extracting vegetable oils is complex and is a multi-parameter control object. A complete mathematical representation of the oil extraction process is constructed through mathematical models of the processes occurring through equations representing the biological, physical, substance and heat exchange processes and the state of hydrodynamic flow in extracting oil from the seed.

In order to further improve the extraction process of vegetable oils, it is necessary to build a mathematical model and search for factors that increase the amount of oil using it. And computer modeling allows to choose technological process control parameters.

Taking into account that the hydrodynamic model of liquid flow is based on the law of ideal mixing, the change in the concentration of substances contained in the extracted oil in the solid phase is expressed as follows:

$$\frac{dc_e}{d\tau} = \frac{1}{\tau_{o'rt}}[c_e^k - c_e^{ch}] \ (1)$$

Here $\tau_{o'rt}$ - solid phase particle solvent rinsing time;

$c_e^k, c_e^{ch}$ - respectively, the concentration of liquid phase components at the inlet and outlet.

Average time to flush particles with solvent:

$$\tau_{o'rt} = \frac{m_e}{(Q_e + Q_u)} \ (2)$$

Here $m_e$ – is the mass of the solvent, it is expressed in the following form: $m_e = v_e * \rho_e$

Here $V_e$- solvent volume; $\rho_e$ - solvent density. (2) representing the average rinse time looks like this:

$$\tau_{o'rt} = \frac{V_e * \rho_e}{(Q_e + Q_u)} \ (3)$$

We express the change in the concentration of substances in the oil extracted with the help of a solvent in the following form:

$$\frac{dc_e}{d\tau} = \frac{1}{\tau_{o'rt}}[c_e^k - c_u^{ch}] \ (4)$$

The amount of solvent used to extract oil from plant seeds is determined using the following formula

$$V_e * \rho_e \frac{dc_e}{d\tau} = Q_e * c_e - [Q_u^k + (1 - c_e^k) * Q_e] c_u^{ch} \ (5)$$

We express the amount of substances in the oil released under the influence of the solvent in the following form

$Q_u^{ch} = Q_e^k + [1 - c_e^k]\, Q_e$ (6)

Here $c_e^k, c_e^{ch}$ respectively, the concentration of substances at the inlet and outlet.

We express the rate of quantitative change of the extraction process as follows

$V_e * \rho_e \frac{dc_u}{d\tau} = Q_u^k * c_u^k + Q_e^k * c_e^k - Q_u^{ch} * c_u^{ch}$ (8)

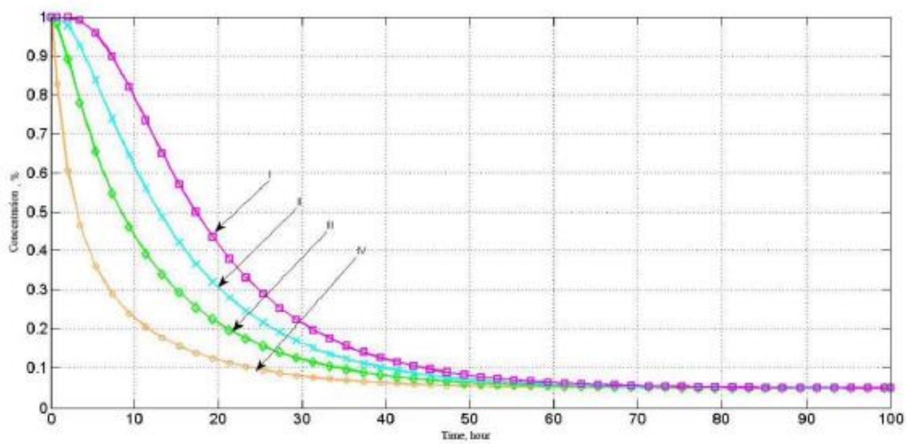
The macro-material balance equations of the process were created above, now we will create the micro-material balance equations of the process of particle separation in the innermost layer.

We express the small substances separated from plant seeds in the form of a balance equation

$\frac{dM_{yog'}}{dt} = Q_{kel} - Q_{ket}$ *(9)*

Here $Q_{kel}$ - amount of oil in micelles, $Q_{ket}$ – the amount of oil released from the micelle.

In order to effectively implement the process of extracting technical oil from plant seeds, the most important way to achieve optimality is to accurately study and analyze the mathematical expression of each successive step in the process. The studies were compared with several "OIL INDUSTRY" enterprises in the territory of Uzbekistan, and the most optimal solution was obtained. It confirms that the developed module has a significant effect on the change of concentration of solid and liquid phases. For example, if the hydromodule GM = 1: 3, the concentration of solid particles decreases by 22% after 5 hours after stage I of the process, up to 15% after stage II, 12% after stage III and after stage IV, the concentration of the final product in the process is 0 .5%.




**Graph 1.** Changes in the concentration of oil release from plant seeds over time in stages I, II, III, IV of the process.


**Summary.** It is important to optimize the oil extraction process, increase production efficiency and ensure environmental safety. Considering the advantages and limitations of different extraction methods, the development of effective strategies and the application of new technologies can further develop this process.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