Application of a by-product in the production of pressed baker yeast for separating rubber from latex

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Abstract. Synthetic rubbers are the most common polymers. They are widely used in the production of a wide variety of products. The requirements for the quality of the obtained polymers constantly are increasing with a corresponding reduction in the cost and environmental tension of these industries. One of the effective areas that allow the production of synthetic rubbers to meet the requirements is the search and application of new technologies for the manufacture of emulsion rubbers. One of the problematic stages in the production of emulsion rubbers is their isolation from latex. Agents that reduce the stability of latex dispersions have low resistance to biological oxidation and are capable of chemically binding the components of the emulsion system, as well as being almost completely removed from wastewater discharged to treatment plants, used to solve this problem. The work presents the results of the use of fertile, a by-product of the production of pressed baker’s yeast, in the technology of styrene-butadiene rubbers production. Its effect on the process of isolation of rubber SKS-30 ARC from latex has been studied. The costs of acidifying and coagulating agents have been determined. The effect of pH medium on the process of rubber isolation from latex at various dosages of fertile has been studied. Rubber compounds based on rubber SKS-30 ARC have been prepared using standard components and they have been vulcanized. The resulting vulcanizates in terms of performance have met all the requirements.

1. Introduction

Food industry enterprises annually produce a large number of by-products. Much of the waste is not used as a secondary raw material. As a result, not only valuable hydrocarbon raw materials are lost, but also the environmental load is significantly increased. Considering the fact that natural resources are now significantly depleted, the need to search for new sources of raw materials arises.

Fertile, a by-product of the production of pressed baker’s yeast, is interesting from a scientific and practical point of view [1]. The term "baker's yeast" or simply "yeast" usually refers to microorganisms that belong to the class of lower fungi. Among the minerals present in dry yeast, such elements as phosphorus and potassium can be marked; calcium, sodium, magnesium and iron are present in smaller amounts. There are some other trace elements, which are present in small quantities. In addition, the fertile contains organic compounds, including those containing nitrogen. The
compounds containing nitrogen can be used in the technology of rubber separation from latexes. Prospects for using other nitrogen-containing compounds present in other by-products of the food industry in the technology of isolation of synthetic rubbers from latex are shown in [2, 3].

The purpose of this research is to study the possibility of using a by-product of pressed baker yeast production, fertile, as a coagulating agent in the technology of the isolation of rubber SKS-30 ARC from latex.

2. Materials and methods
Fertile is produced by the natural deposition of concentrated yeast fluid crystals after separation of the yeast at the exit of the fermenters. It is recommended for use as a potassium-containing fertilizer by applying to the soil, followed by seeding, in autumn or spring, berry and flower and decorative crops in open and protected ground, both in pure form and mixed with wood sawdust and / or dolomite flour. In table 1 the main agrochemical characteristics are shown.

| Name of indicators                                      | Norm |
|---------------------------------------------------------|------|
| Mass fraction of dry substances, % not less than        | 70.0 |
| Mass fraction of organic matter, % not less than        | 20.0 |
| Mass fraction of total nitrogen, % at least             | 0.5  |
| Mass fraction of phosphorus (P2O5), % not more than     | 0.1  |
| Mass fraction of potassium (K2O), % at least            | 10.0 |
| Acidity: indicator of hydrogen ion activity (pH), not more than | 7.5  |
| The specific activity of technogenic radionuclides, cesium-137 and strontium-99, not more | 1    |

From the analysis of the fertile composition, it follows that it contains a number of components that can fulfill the function of coagulating agents (compounds containing nitrogen, potassium, etc.).

As an object of study, latex of styrene-butadiene rubber manufactured on an industrial scale, SKS-30 ARC grade, the indicators of which are presented in table 2, has been chosen.

| Name of the indicator          | Value |
|-------------------------------|-------|
| Solids, %                     | 20.5  |
| Content of bound styrene, %   | 22.5  |
| Surface tension, mN / m        | 64.2  |
| The radius of the latex particles, nm | 39    |

The objective of the study was to compare the coagulating ability of fertile, in comparison with such a coagulant as sodium chloride, with determining the properties of the resulting rubbers, rubber compounds and vulcanizates.

The isolation of rubber from latex has been carried out according to the method described in the work [4].

3. The results of the experiment and their discussion
The isolation of styrene-butadiene rubber from SKS-30 ARC latex has been carried out by dispersion of fertile, diluted water to a dry matter content of 15-20%. Sulfuric acid rubber isolation from latex has been performed with sodium chloride with a concentration of ~ 20%, and as an acidifying agent, an aqueous solution of sulfuric acid with a concentration of 2%.
The analysis of the experimental data shows that the yield of rubber crumb naturally increases with increasing fertile consumption (Table 3).

**Table 3. Effect of fertile consumption on the completeness of the discharge butadiene-styrene rubber SKS-30 ARC from latex**

| Consumption of fertile, kg/t of rubber | 20  | 40  | 60  | 80  | 100 | 120 | 140 | 160 | 180 |
|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Consumption of sulfuric acid, kg/t of rubber | 15,0| 15,0| 15,0| 15,0| 15,0| 15,0| 15,0| 15,0| 15,0|
| The pH of the serum | 3,0 | 3,5 | 4,0 | 4,5 | 5,0 | 5,5 | 5,5 |
| The output of coagulum, % | 35,2| 61,7| 72,4| 82,2| 86,1| 88,5| 90,2| 93,7| 92,4|
| Evaluation of the coagulation process | cnc| cnc| cnc| cnc| cnc| cnc| cnc| cc| cc |

Note: cnc-coagulation is not complete; cc-coagulation is complete

The action of fertile, as a coagulating agent, in many respects resembles the behavior of molasses when isolating rubber SKS-30 ARC from latex [5]. That is, the process of rubber isolation from latex proceeds actively at low fertile consumption (up to 80-100 kg / t of rubber). Preserving the acidic pH of the coagulated system (pH 3.5-4.0) contributes to this. A further increase in the consumption of fertile (more than 100 kg / t of rubber) in the coagulated system based on SKS-30 ARC latex leads to a decrease in acidity and an increase in pH to ~ 5.0. The decrease in the acidity of the coagulated system is accompanied by the decrease in the efficiency of the coagulation process.

The completeness of rubber isolation from latex has been achieved at a flow rate of 160 kg / t of rubber, which corresponds to the consumption of sodium chloride. The decrease in the medium acidity is due to the fact that the aqueous solution of fertile has a slightly alkaline medium (about 7.5) and the increase in its dosage in latex leads to a process of neutralization of the introduced acid, the flow rate of which has been kept at the same level (~ 15 kg / t of rubber ). In addition, the presence of organic compounds containing nitrogen (amino acids, etc.) in the system leads to an additional consumption of sulfuric acid for charging nitrogen with the formation of a quaternary salt:

\[
R_2N^+R\rightarrow COOH + H_2SO_4 \leftrightarrow (HSO_4^-)(R_2^+NH\rightarrow R\rightarrow COOH).
\]

It can be assumed that to reduce the consumption of fertile and to maintain an acidic pH of 3.0-3.5, an additional introduction of an acidifying agent, sulfuric acid, is necessary.

Subsequent studies have confirmed the above considerations. Simultaneous increase of fertile and sulfuric acid consumption to maintain the pH value at the level of 3.0-3.5 makes it possible to achieve complete isolation of rubber from latex at a fertile consumption of 110-120 kg/t of rubber (table 4).

**Table 4. Effect of fertile consumption on the completeness of the release of SKS-30 ARC rubber from latex**

| Consumption of fertile, kg/t of rubber | 20  | 40  | 60  | 80  | 100 | 120 | 140 |
|--------------------------------------|-----|-----|-----|-----|-----|-----|-----|
| Consumption of sulfuric acid, kg/t of rubber | 15,0| 15,0| 16,0| 17,0| 18,0| 19,0| 20,0|
| The pH of the serum | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 |
| The output of coagulum, % | 35,5| 59,6| 70,8| 83,8| 88,3| 91,7| 92,6|
| Evaluation of the coagulation process | cnc| cnc| cnc| cnc| cnc| cc| cc |
The excess of the injected acid is spent on charging the nitrogen atom in nitrogen-containing organic compounds in the fertile and neutralizing other, including inorganic components of the fertile. The consumption of sulfuric acid increases from 15 to 20-25 kg/t of rubber.

4. Conclusion
The allocated rubber crumb has been washed in water, has been dried and used to prepare rubber compounds and vulcanizates according to the generally accepted technique (TU 38.40355-99). The tests have shown that the vulcanizates, obtained on the rubber samples basis, isolated by fertile, meet the requirements and are similar to the control sample obtained from latex with the use of sodium chloride (Table 5). Rubbers extracted from latex using fertile can be used in the tire and rubber industry [6, 7].

Table 5. Physical and mechanical parameters of vulcanizates

| Indicators | Requirements for SKS-30 ARC rubber according to TU 38.40355-99 | Test (coagulant sodium chloride) | Experimental (molasses coagulant) |
|------------|---------------------------------------------------------------|----------------------------------|-----------------------------------|
| Mooney viscosity of rubber | 40 – 65 | 53,0 | 54 |
| Conditional tensile strength, MPa | 21,5 | 24,0 | 23,5 |
| Elongation at break, % | 380 | 500 | 490 |
| Relative residual deformation after rupture, % | – | 12 | 11 |
| The ageing coefficient of the vulcanizate (100°C, 72h) | | | |
| - on durability, | – | 0,51 | 0,54 |
| - by relative elongation | – | 0,37 | 0,35 |

Thus, according to the results of the study, the following conclusions can be drawn:
- both the consumption of fertile and sulfuric acid influence the process of rubber isolation from latex;
- the greater the consumption of fertile, the higher should be the consumption of sulfuric acid to maintain the required pH;
- the compounds containing nitrogen and mineral salts which are found in the fertile form the basis of its coagulating action;
- rubber compounds and vulcanizates, obtained on the basis of rubber isolated from latex with the use of fertile, meet the requirements.

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