EFFECT OF THE WHEY CONCENTRATION DEGREE ON THE ELECTRICAL PROCESSING WITH THE AIM TO ISOLATE ORGANIC ACIDS

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Summary: The purpose of this study assumes the production of more concentrated solutions of whey and organic acid preparations, since further processing of the acid with the aim of concentrating by traditional methods is energy-intensive and long-lasting.

Key words: whey, condensate, electric treatment, organic acids.

Introduction

The problems of environmental protection, development of wasteless technologies and techniques for their realization greatly increase and become more acute in recent years. One of the spheres of primary importance is food production and especially food stuff processing, which sometimes causes an enormous damage to the environment. The production sphere re-examines ecological requirements, and such a rebirth occurs in the dairy industry, namely, in the use of secondary dairy products.

Development of wasteless technologies of whey processing is a global-scale urgent problem.

Materials and methods

The experiments related to the whey condensation in a vacuum evaporator with an ejector were performed. The condensation allowed us to obtain the whey with the dry matter content from 7 % to 10.6, 12, 13 % in the condensate. The regime was maintained with the condensation temperature up to 40 ^{0}C and the pressure of the heating medium in the evaporator up to P = 6 kPa.

The preliminary studies indicate that some content of dry matter (12 %) in the whey provides cleaner organic acid solutions.

For this purpose a laboratory bench for whey condensation has been developed in accordance with the following requirements: it allows us to evaporate 50% of moisture, maintain the desired evaporation temperature and the condensed whey volume [1]. Practically the whey is concentrated to the dry matter content of 12 and 13 % [2].

The characteristic parameters that determine the condensation process by evaporation of free moisture from the whey are the temperature and the process duration. To maintain the native whey properties it is desirable to maintain the condensing temperature below 40 ^{0}C [3]. Further we describe the process of separation of organic acids generated in the diaphragm electrolyzer.

To reduce the energy consumption, the whey can be considered as pasteurized to the end of condensation in the vacuum evaporator.

Results and discussion

The results are presented in the spectrograms:

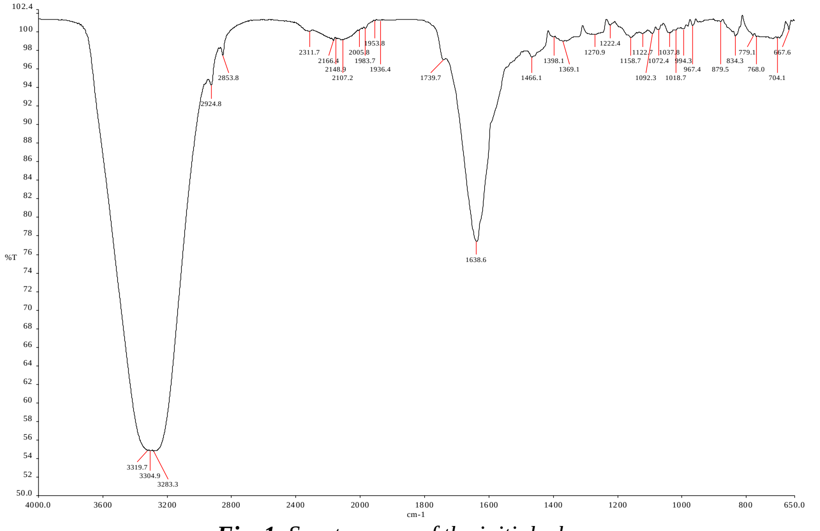


Fig. 1. *Spectrogram of the initial whey*

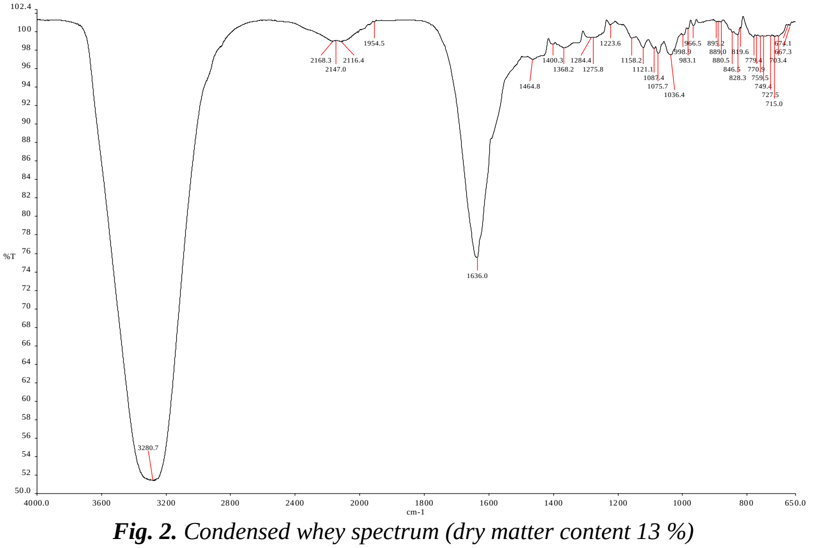


Fig. 2. *Condensed whey spectrum (dry matter content 13 %)*

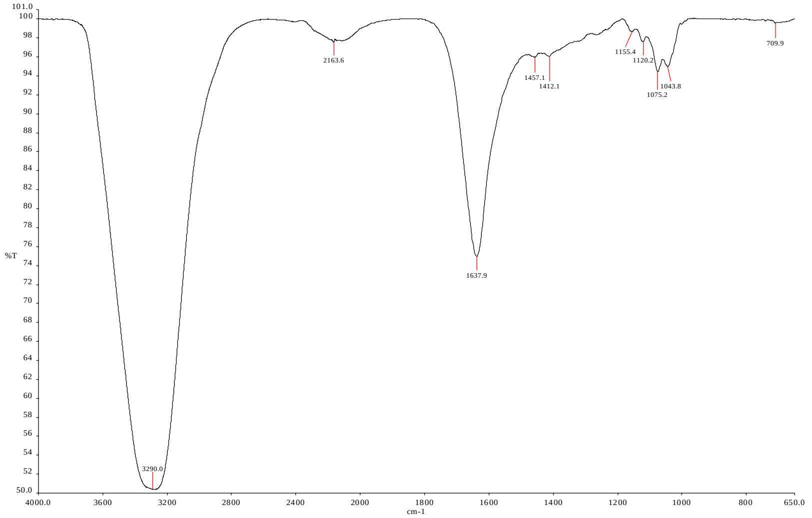


Fig. 3. *Condensed whey spectrum (dry matter content 12 %)*

Fig. 4. *Spectrogram of the initial and condensed whey*

The comparison of the spectral peaks presented in Fig. 4. shows the changes in the qualitative composition of the resulting solutions related to the content of lactic acid, acetic acid, ethanol, acetaldehyde, etc.

The whey is concentrated to the dry matter content of 12 % (Table 1.) and 13 % (Table 2).

After electrolysis of the condensed whey (12 %) for one hour in the cathode chamber, the content of the dry matter decreased to 10%. While treating whey, the Oxidation Reduction Potential (POR) is positive (Fig. 5.) for fermented whey and indicates the possibility of acid separation under the electric current action (from 1.2 to 0.5 A).

In this case, a longer process duration and a low processing temperature is used. The results after the electric current treatment are presented in Tables 1 and 2.

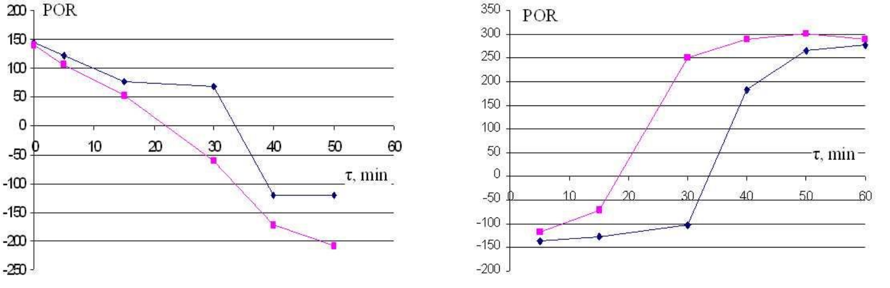
Table 1. *Processed whey with the dry matter content of 12 %*

τ, min	**I, A**	**U, V**	**pH**
10	*1,2*	*29*	*8.9*
20	*0,9*	*29*	*8.14*
30	*0,8*	*29*	*2.5*
40	*0,7*	*29*	*1.91*
50	*0,5*	*29*	*1.71*

Table 2. *Processed whey with the dry matter content of 13 %*

τ, min	**I, A**	**U, V**	**pH**
10	*1,4*	*29*	*9.1*
20	*1,6*	*29*	*8.69*
30	*1*	*29*	*3.67*
40	*0,6*	*29*	*2.28*
50	*0,4*	*29*	*2.04*

On the basis of the results related to the whey processing we conclude: when we treat the whey with an initial content of dry matter of 7 % to the dry matter content of 12% the current does not exceed 1.2 A at a constant voltage of 29 V. When the whey is treated to the dry matter content of 13 %, the current in the electrolytic cell increases up to 1.6 A.



Cathode chamber Anode chamber

Fig. 5. *Oxidation-reduction potential at the electrolysis of the concentrated whey. Dry matter content in unfermented whey ■ 12 % , ♦ 13 %*

While processing more concentrated whey we observe greater current intensities and increasing of the temperature in the electrolyzer cell; this negatively affects the organic acid production.

Infrared spectra are unique for each chemical compound, as well as for atomic groups. Thus, the group of unsaturated carbohydrates $-C-H$ is identified by the frequencies 3100-3000 cm^{-1} and 3340-3280 cm^{-1} and the carbonyl group $-C=O$ by absorption at 1800-1540 cm^{-1} [4]. Each class of carbonyl compounds exhibit specific absorption bands within the frequency range.

For example, the carbonyl group of saturated acid esters is characterized by absorption bands 1750-1735 cm^{-1}, fatty acid aldehydes of 1740-1720 cm^{-1}. An important class of compounds - amino acids - exhibit absorption bands characteristic of the two functional groups $-C=O$ in the 1600-1560 cm^{-1} region and NH_2- in the 3130-3030 cm^{-1} region, but no one group is fully isolated.

This results in some changes in the frequencies and band intensities depending on the chemical environment of the functional group. Introduction of more donor alternates into the molecular structure leads to a decrease in the frequency of oscillations, which are more acceptable - to increase them. This is observed when the whey is evaporated under vacuum. From the initial whey spectrum, we note the presence of ethanol in the group $-CH_3$, the 2936 cm^{-1} absorption band, glycerine in two defined bands $-CH_2$ and $-CH$ groups (2922 cm^{-1} and 2852 cm^{-1} bands). On the other hand, glycerine has three groups OH in its structure. This manifest itself by a more intense band 3299 cm^{-1}. In the condensate we observe an absorption band at 1156 cm^{-1} corresponding to ethyl phosphate, which contains a respective group $P-O-C_2H_5$.

The bands at 1464 cm^{-1} and 1378 cm^{-1}, which are present in the parental whey spectrum, belong to different types of vibration and deformation groups. Note that in the spectra of the concentrate, these bands changed slightly at 1958 cm^{-1} (decrease in the oscillation frequency) and 1381 cm^{-1} (increase), respectively. The 1378 cm^{-1} lines are found in nitrates (NO_2^+, NO_2^-), for example, in ammonium nitrate. If the concentrations are not high, the bands do not exceed the dimensions of 1410-1345 cm^{-1}. For the initial and concentrated whey, we notice the presence of ionized nitrates.

In the spectrum of the concentrate, an absorption band corresponding to an amino acid containing the group NH_3^+ - 2004 cm^{-1} appears. The latter is not present in the compounds with the group NH_2^+. In the initial whey spectrum, the absorption band of 1416 cm^{-1} indicates the presence of succinic acid (symmetrical vibration in the group).

A 1638 cm^{-1} band belonging to the carbonyl group ($-COOH$) of the carboxyl group of lactic acid is observed in the spectra for both the initial and the concentrated whey. Its intensity in the both samples is roughly the same. The deformation vibrations of the group are responsible for the 1638 cm^{-1} band [5]. Also in the original whey spectrum, we have a second frequency range; when comparing it is possible to obtain the data, which confirm the existence of a group $-COOH$.

Acetic acid absorbs at 1250 cm^{-1}, but it is not observed in the condensed whey. Absorption of COO^- remains close to 1600 cm^{-1}. The absorption bands of the carboxyl group depend on the modification of the optical form of the molecules [6].

Thus, the optimum content of dry matter in whey for electrolytic treatment with the aim of separation of components is 12%. The established regularities of these processes are necessary to develop and implement effective and environmentally friendly processes for the production of organic acid.

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