AERIATION OF CULTURE MEDIA WITH POWDER DISPERSERS WHEN CULTIVATING YEAST CULTURES DURING MILK WHEY PROCESSING

АЭРИРОВАНИЕ ПИТАТЕЛЬНЫХ СРЕД ПОРОШКОВЫМИ ДИСПЕРГАТОРАМИ ПРИ КУЛЬТИВИРОВАНИИ ДРОЖЖЕВЫХ КУЛЬТУР В ПРОЦЕССЕ ПЕРЕРАБОТКИ МОЛОЧНОЙ СЫВОРОТКИ

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Abstract: *The characteristics and structure of aerators based on titanium powders have been given, as well as the information about the effectiveness of their application when cultivating yeast cultures during milk whey processing.*

KEYWORDS: POWDER AERATORS, BIOSYNTHESIS OF YEAST CULTURE MEDIUM WITH AIR OXYGEN, MILK.

1. Introduction

One of the effective ways to use milk whey is its processing by means of aerobic microorganisms *Debaryomyces hansenii var hansenii* BIM Y-4 (D.h.v.) in order to produce feed protein [1]. An essential condition for the cultivation of these microorganisms is the aeration of the fermentation medium, that is, the process of its saturation with oxygen in the air.

The most common method that provides effective dissolution of oxygen in a liquid medium is the method of blowing through a fermentation solution of atmospheric air with simultaneous mixing of the solution with a turbine multilayered mixer.

In other equal conditions, the intensity of the oxygen dissolution is determined by the aerator properties, which directly distributes the air flow in the culture fluid. Compared to others, powder aerators made of titanium powders are the most preferred: they have high corrosion resistance and strength, are well regenerated, and provide a high uniformity of air flow distribution over the area of dispersion and the required size of air bubbles. Moreover, the manufacturing technology of powder aerators makes it possible to regulate the size and density of the bubbles [2].

The purpose of the work is to provide the efficiency of powder aerators for saturating the culture fluid with oxygen in the air at biosynthesis of yeast cultures during milk whey processing.

1. Research data.

Laboratory studies were performed in the State Scientific Institution "Institute of Physical-Organical Chemistry of NAS of Belarus on a laboratory bioreactor EDF-5.2 (Biotehniskais Centrs, Latvia) equipped with a sensor for measuring dissolved oxygen and a flowmeter with a valve for controlling and regulating air flow (Figure 1). Distilled water was used as a model fluid for testing powder dispersers. Studies in production conditions were carried out using a pure culture device with a volume of 6.0 m^3 at Bobruisk Biotechnology Plant. Concentrated milk whey diluted to four percent lactose, manufactured by Gormolzavod No. 1 in Minsk, was used as the base of the culture medium. Titanium powders of grades TPP-5 and TPP-8 manufactured by AVISMA, a branch of Public Joint-Stock Company CORPORATION VSMPO-AVISMA (Bereznyaki, Russia) were used to manufacture the aerators. When the adjustment of the particle size distribution of the powders was required, the specified fractions were obtained by sieving the indicated grades. The permeability coefficient of the samples was determined according to GOST 25283-93.

Fig. 1. *The process of dispersing air through a powder disperser*

The concentration of bacterial biomass in the culture fluid and fermentation media was determined by the value of optical density with a length of 400 nm on SF-46 spectrophotometer. The end of the cultivation process in production conditions was considered the time when the lactose content was less than 0.5%. The determination of the lactose content was carried out using Bertrand's method modified by Shorl.

2. Results and discussion

Porous powder materials (PPMs), from which aerators were made, surpass other types of materials in terms of corrosion resistance, strength, regenerability and efficiency [3]. Regulating the structure of PPM by changing the size of the particles of the initial powder and modes of manufacture, it is possible to change the characteristics of the resulting products in a wide range, ensuring the effectiveness of their application. In this case, it is the diameter of the gas bubbles and the throughput capacity.

Figure 2 shows the calculated dependences of the bubble size on the powder particle size for various PPMs given in ref. [4] and performed according to the methods ref. [2] and [4].

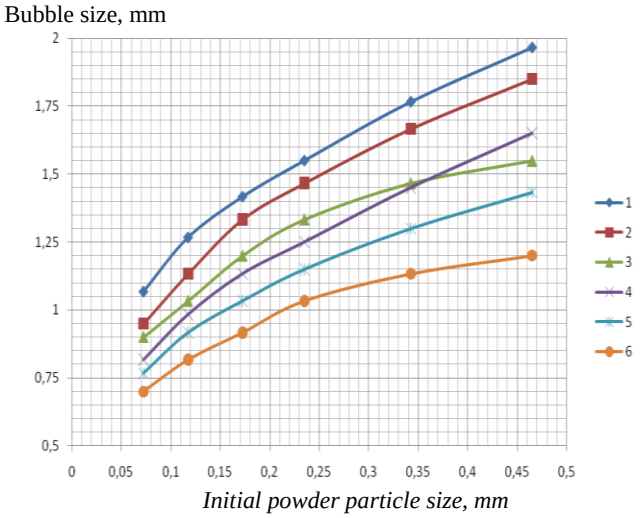


Fig. 2. *Calculated dependences of the bubble size on the powder particle sizes:*
1 – titanium [2]; 2 – steel [2]; 3 – bronze [2];
4 – titanium [4]; 5 – steel [4]; 6 – bronze [4]

Figure 2 shows the dependencies of the permeability coefficient on the technological modes of production (compression pressure) for three titanium powder fractions (the graph shows the average particle sizes calculated by Anderson's formula of the following particle size distribution: (minus 400 + 315), (minus 630 + 400) and (minus 1000 + 630) μm). The analysis of these dependencies indicates the possibility of regulating the throughput capacity in a wide range.

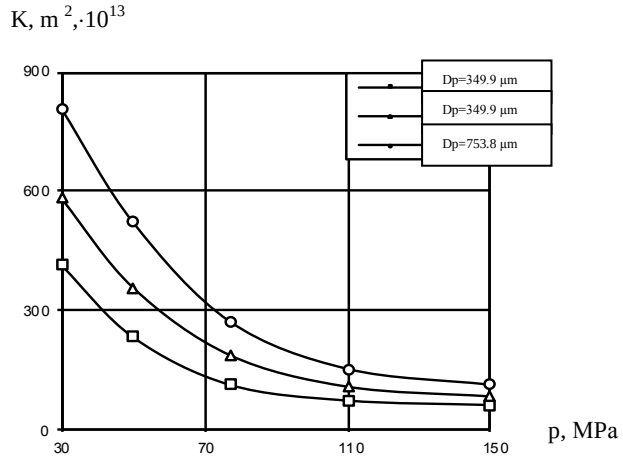
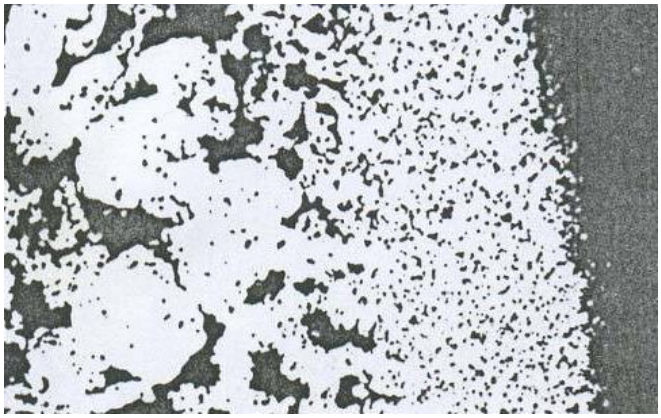


Fig. 3. *The dependence of PPM permeability on the compression pressure*

The efficiency of using PPM-based aerators can be improved due to the use of modern methods for creating two-layer porous structures [5, 6] shown in Figure 3. The pore sizes of such materials (determine the refining fineness during filtration or the size of bubbles during dispersion) are similar or close to the pore size of a monolayer material made of powder of a fine fraction, and the permeability coefficient (determines the throughput capacity) is an integral value and causes an increase in the efficiency of application of entire material. At the same time, a decrease in the thickness of the fine disperse layer (Figure 4 b) leads to an increase in efficiency, with some complication of the manufacturing technology and a slight deterioration in the uniformity of distribution of properties over the working surface.



a)

b)

Fig. 4. *Two-layer PPMs, obtained by joint pressing of powders of different fractions:*
a) by layering filling; b) by applying a layer of fine disperse powder to one of the forming elements

Studies have shown that a porous powder aerator based on titanium powder has a saturation rate 1.6 times higher than the standard (perforated) one. Comparison in the process of cultivation of yeast microorganisms *D.f.v.*, when dispersing air through standard and powder dispersers on a laboratory fermentor, has also showed an advantage of the latter: an increase in biomass was about 25% with the same air flow (1 l/min per 1 liter of culture fluid).
Studies in production conditions were carried out at the Bobruisk Biotechnology Plant in the pure culture device (a production fermentor for the preparation of *D.f.v.* seed material intended for processing milk whey in a operating device with the aim of producing a protein feed additive). A device was developed for saturating the culture medium with oxygen in the air. Its drawing is shown in Figure 5.

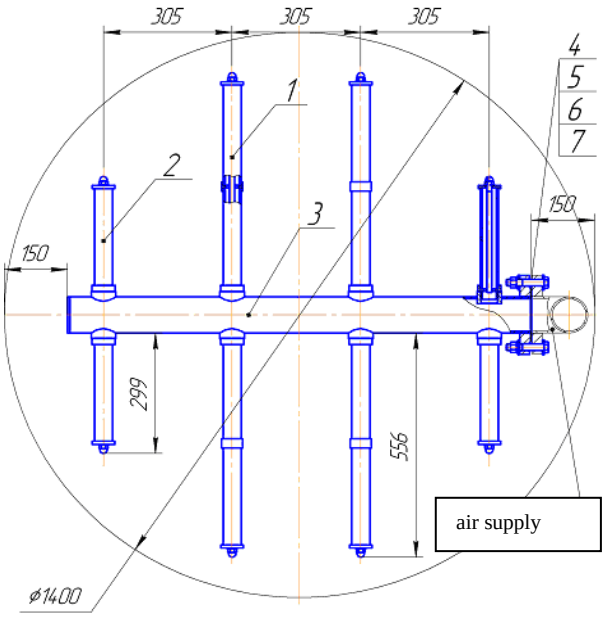


Fig. 5. *A device for saturating the culture medium with oxygen in the air:*
1, 2 – aerator; 3 – collector, 4 – bolt; 5 – nut; 6, 7 – washer

Tests have shown that the device for saturation of the culture medium provided the completion of the cultivation process in 12 hours, in comparison with 14 hours using the standard (perforated) disperser.

3. Conclusion

As a result of research, it has been established that the developed device for saturation of the culture medium with oxygen in the air based on powder material in comparison with the traditional perforated disperser provides a higher saturation rate (1.6 times) of biomass of the yeast microorganisms, significantly reduces the fermentation time (by 15%) and contributes higher biomass accumulation (up to 25%).

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