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NEW TECHNOLOGY OF BONES DEFATTING

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Improvement of bone defatting technology is associated with the intensification of the process, more complete fat extraction with minimum effect on its quality attributes. In the existing lines the intensification is carried out by increasing heating temperature with simultaneous mechanical agitation of bones and processing in thin layer. However, potentialities of these methods have practically exhausted as temperature increase doesn't necessarily contribute to a more complete fat extraction but certainly decreases the quality of fat and bone meal.

We have developed a completely new technology of fat extraction in which intensification of heat- and mass transfer at bones defatting is accomplished by vibration process. Vibration is an efficient method of additional energy supply. Experiments have shown that low-frequency vibrations in a medium liquid-solid body improve the external transfer through destruction of boundary layer and turbulization of flows. Moreover the wave and resonance effects arise in the pores of a bone, accelerating the internal transfer of both the heat and the mass. Cavitation arising in the liquid which was heated practically to boiling temperature also has an essential effect on the process.

Two kinds of vibration apparatuses have been created in Russia. In the first one preliminarily crushed bones move in a spiral mode, upwards, through a liquid. In the second type - linear, horizontal, turbulized flows are created.

By analytical methods the conditions of synchphase self-synchronization of two disbalanced vibrators on horizontal cylindrical body were determined. At harmonic vibrations this condotion is determined by the following relationship:

$$M\left[\frac{m^2+n^2\sin\beta}{J_x}+\frac{r^2+n^2\cos^2\beta}{J_y}+\frac{(r\sin\beta+m\cos\beta)^2}{J_z}\right]>2 \qquad (1)$$

where M - mass of vibrating parts
J_x, J_y, J_z - moments of inertia in coordinate axis
m and n - distance from the axis of the cylinder to the center of vibrations application along axes y and z respectively
β - the slope of vibrator

The axis x is directed along the axis of the cylinder, y - perpendicularly to it in the center of gravity of vibrating parts, z - horizontal axis.

The investigations of defatting process were accomplished on a pilot plant (Fig. 1). The plant consists of a cylindrical body 1 with 2 vibrators (4) attached at the ends at a definite slope β. The crushed bones are supplied through tube 7, hot water is being supplied through tube 8. The level of mixture in a tube is controlled by gate 6. The drowning particles under the action of vibrations make complex movements in a space of cylinder but with final direction of movement along the axis of the cylinder.

Through a collector 5 live steam which maintains the tempetarure of the mix and simultaneously transfers the swimming particles along the axis of the cylinder is delivered to the cylinder.

The layer of bones and water travels along the plant, reaches the gate, overflows it and goes to the grid 11, where the liquid phase is separated. The bones are unloaded through the pipe 2.

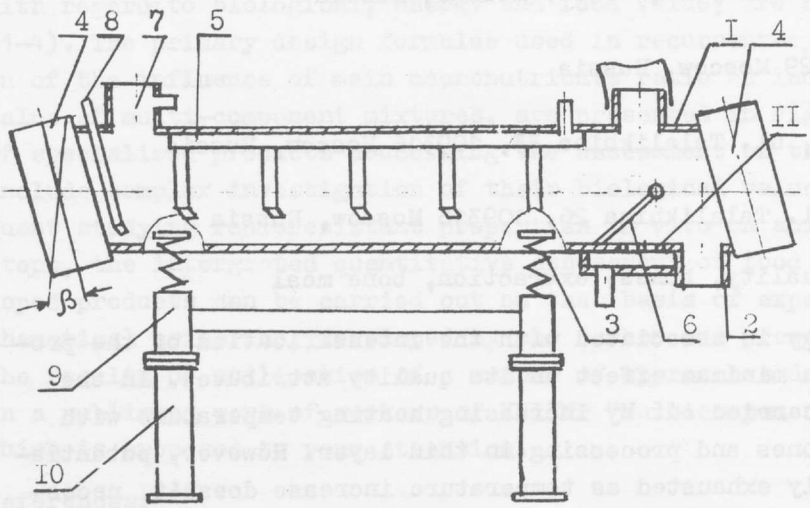

Fig. 1. Scheme of experimental vibration plant EVG-03: 1 - body; 2 - pipe for loading out bones; 3 - spring; 4 - vibrator; 5 - collector; 6 - gate; 7 - neck for bones loading; 8 - pipe for water supply; 9 - frame; 10 - rack; 11 - grid.

The factor analysis and experimental investigations allowed to propose a mathematical model of the process:

$$F_\tau = F_f + (F_i - F_f)\, e^{-m\tau}$$

where F_τ - residual content of fat, %
F_f - final fat content as depended upon the vibrator angle of rotation λ, %
F_i - initial fat content (22%)
m - fat content changing rate as depended upon the force of the vibrator, s^{-1}
τ - time length of the process, s

The factor analysis and experiments were carried out at a constant liquid coefficient 1:1, water temperature 358-363 K, bones particle size 12 mm. After processing of experimental data the formula (2) took the form:

$$F_\tau = (3{,}88 + 0{,}017\cdot\lambda) + [22 - (3{,}88 + 0{,}017\cdot\lambda)\cdot e^{-(0{,}0066 + 0{,}0003\cdot P)\cdot\tau}$$

In formula (3) the parameters changed in the following ranges:
λ from 45 to 90°, P from 4.5 to 20.5 kH, τ from 320 to 400 K.

Production tests have shown that at a capacity of the plant up to 1000 kg/h the average residual content of fat in bone meal is 4.5%. The short length of the process and moderate temperatures of the medium allow to obtain only the highest grade fa t and high quality meal. Based on the extractor a continuous flow line for processing of all kinds of bones was developed. This consists of the assembly of reception and initial crushing of bones, vibration extractor, rinser-separator of bones, screw convective drier for defatted coarsely crushed bones and a crusher with a meal sifter.

Water-fat emulsion is initially purified on a decanter, and then on separators.

The production capacity of the line-up to 600 kg of raw bones per hour, the length of the cycle - 0.75 h, fat content in meal - from 3.7 to 7.6%, meal output (related to initial mass of bones) - up to 48%.

Specific consumption of electrical energy per 1 t of raw materials - 0.75 kW/h, steam - 350 kg/h, hot water - 0.66 m^3/h . Floor area - 72 m^2; number of workers, servicing the line - 4. The residual content of fat in the waste water - 0.1-0.3%. All kinds of bones are processed at the line. The lines are working at a number of meat-packing plants of Russia.

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