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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

DEVELOPMENT AND DEVELOPMENT OF A CLOSED TYPE MILK CHILLER FOR SMALL FARMS

Specialty: **3102.01- Agro engineer**

Field of science: **Technical sciences**

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AZƏRBAYCAN RESPUBLİKASI KƏND TƏSƏRRÜFATI NAZİRLİYİ AZƏRBAYCAN DÖVLƏT AQRAR UNİVERSİTETİ

GENERAL DESCRIPTION OF THE RESEARCH

Relevance and degree of completion of the topic. One of the main provisions of the state program on Food Security adopted in the world and in our country is to provide the population with ecologically clean and reliable food products continuously. Milk and dairy products occupy a special place in the daily needs of people for food products.

The role of milk and dairy products in the organization of proper nutrition is paramount. Man is fed breast milk from the first day of his life. Doctors of ancient Egypt, Greece and Rome recommended milk and dairy products for therapeutic purposes. Milk production is known since ancient times. Milk and dairy products are one of the most important food products necessary for Man. In recent years, the production of milk and dairy products in our republic has been steadily increasing and its range is expanding.

At present, most milk refrigeration units produced for milk cooling are intended for use in large livestock farms with large production capacity and have high productivity and energy capacity and do not fully meet the demand in terms of resource-saving. Therefore, it makes it relevant to upgrade the milk cooling technology and devices with low operating costs, providing high quality and resource-saving, which can be used in family holidays for the development of medium and small businesses.

To this end, it is necessary to conduct theoretical and experimental research on milk soybean meeting modern requirements, which meets the needs of small-sized farms.

Taking this into account, we have prepared a milk cooler, the productivity of which does not exceed 1000 l/H. This cooling is cooled by special solution (salt solution) being compressor. Thus, since the compressor cooler works with Freon gas, the cold is up to 150. To cool the milk (-50...-80) enough. For this purpose, Freon's cold cooling is given to the milk section by cooling the salt solution, which ensures cooling the milk according to demand. A small size refrigerator was designed to meet these requirements and its research was carried out.

Purpose and objectives of the study. Optimization of the parameters of the equipment used to increase efficiency in the initial cooling of milk.Application of salt mixture in terms of reducing energy consumption in the process of cooling.

Research methods. Theoretical studies were carried out using agricultural mechanics, resistance of materials, theoretical mechanics and mathematical methods. Experimental-trial researches were carried out in laboratory and production conditions according to the state and special methods. The results of experimental-trial studies were analyzed and processed by statistical methods using computers.

Scientific novelty of the study. 1) an experimental device for primary cooling of milk has been developed on the basis of thermodynamic, thermophysical and feasibility optimization methods.

2) mathematical processing of the results of complex studies was carried out to determine the optimal parameters of the cooling process based on the new technology.

3) as a result of the production test of the milk cooling Experimental Unit based on the proposed new technology, the feasibility of the study was assessed.

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Approbation and implementation of the work. The main research results on the topic of the dissertation were discussed at the following conferences and published in scientific publications:

Actual problems and development prospects of the century in the context of globalization. International Scientific - Practical Conference, September 22-24, 2014, Ganja - Azerbaijan Azerbaijan State Agrarian University.

International cooperation in the development of Agrarian science, food security and Environmental Protection, Materials of the 8th International Scientific-Practical Conference, October 03-04, 2016, Ganja - Azerbaijan. Materials of the scientific-practical conference "Actual problems of scientific and technical progress in agricultural production" dedicated to the 100th anniversary of the Azerbaijan Democratic Republic, Azerbaijan State Agrarian University (October 16-17, 2018).

Scientific – practical conference dedicated to the 96th anniversary of national leader Heydar Aliyev on the results of scientific-research works of ASAU employees in 2018, Ganja 07 may 2019. Innovations in scientific and technical support of the agro-industrial complex of Russia (materials of the All-Russian (national) Scientific and practical conference, Kursk, February 5-6, 2020, part 3)

Publication of the work. 12 articles on the materials of the dissertation, of which 2 were published in the Russian Federation, 1 in Georgia, 9 in publications recommended by the Higher Attestation Commission. A patent certificate was obtained for an invention.

The main provisions put on defense. The main provisions put on defense include:

- Constructive-technological scheme and design of milk chiller based salt solution and reverse flow cooling system
- Refrigerant-energy consumption depending on the amount of milk being cooled, solution consumption spent on cooling, and refined formulas for determining thermal conductivity of working parts.
- Experimental dependences of the temperature of milk and water, the effect of the solution on the cooling temperature on the constructive and mode parameters of the milk cooler.
- Optimal design and mode parameters for refrigeration unit based on salt solution and reverse flow cooling system with low energy consumption.

The name of the organization in which the dissertation work was carried out. The dissertation work was performed at the Agro-mechanics Scientific-Research Institute.

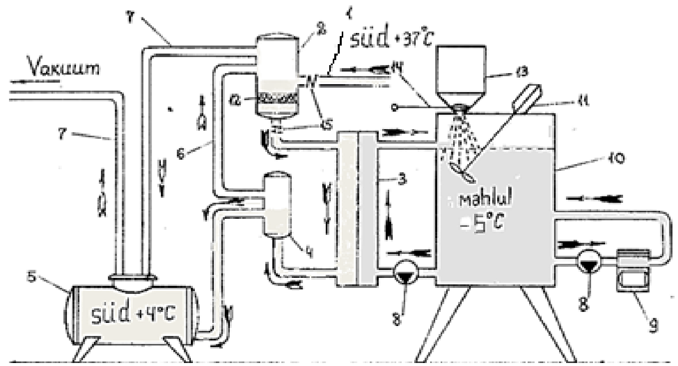
The total volume of the dissertation with an indication of the volume of the structural sections of the dissertation separately. The dissertation work consists of an introduction, four chapters, conclusions, a list of 140 used literature and appendices. There are 32 pictures, 17 tables and 10 appendices here. Introduction in the content of the dissertation is 4 pages 7899 characters, the first chapter is 36 pages 70933 characters, the second chapter is 34 pages 50750 characters, the third chapter is 17 pages 24676 characters, the fourth chapter is 12 pages 13613 characters, results are 2 pages 2161 characters, recommendations to production is 1 page 1143 characters and the list of 140 The volume of the dissertation consists of 136 pages of copywriting, and the total volume is 197346 characters (excluding the list of used literature and appendices, 174361 characters).

CONTENT OF THE WORK

In the introduction, the relevance of the topic, the problem statement and the general characteristics of the dissertation are given.

First chapter, there is a literature review, physical-mechanical and quality indicators of milk are given here, the main places of which are explained in detail in the initial processing after milking, as well as cooling system. Here, schemes of technological processes are ref-lected, revealing the essence of ordinary and forced processes in milk cooling. The essence of the studies conducted so far, their advantages and disadvantages have been shown. As a result of the analysis, the author has compiled a new technological scheme providing cooling with a solution with a small size forced cooling system and developed a device on its basis and conducted theoretical, ex-perimeter studies. The results of these researches are reflected in chapters II and IV.

The general technological scheme of the proposed device is given in figure 1.



air

milk

solution

Figure 1. Experimental milk refrigeration unit: 1-milk intake pipe; 2 expansion pipe; 3 - heat exchanger; 4 - flow regulator; 5 - milk tank; 6 - vacuum pipe; 7 - vacuum main pipe; 8 - solution pump; 9 - refrigerator; 10 – solution tank; 11 - stirrer; 12 – filter (purifier) ; 13 – Salt tank ; 14 – support regulating the yield of salt; 15 – key regulating the yield of milk.

For this purpose, as can be seen in the photo, we have prepared a tank for the preparation of solution by adding salt to the water. The liquid is mixed and a solution is prepared in this tank. The prepared solution is cooled by Freon refrigerant and I want to note that the solution is cooled to (-5 ^{0}C). The cooled solution circulates between the tank and the board, that is, the heated solution passing through the board is poured into the jaw again, cooled and cooled again through the board. Milk with the solution from the same plate moves without mixing with each other with the opposite flow. The process of cooling milk and dairy products is also formed on the same plate. Entering the cooling system of milk and dairy products (+37^{0}C) temperature, the product moves to the plate. Milk temperature drops slightly depending on the seasons of the year until the plaque when the product moves.

At the last moment, milk enters the plate, moving downwards without mixing into the solution, in this case, both the movement of milk in a downward direction and the process of cooling on the board in question, at the end, the outflow of milk from the lower part of the plate and the right movement of the jaw occurs. The temperature of milk entering the milk tank is (+4 ^{0}C). Keeping the milk in the insulated milk tank at a temperature of (+4^{0}C) for 48 hours or more, we can partially achieve the goal of ensuring the quality of milk. We will partially solve the problem faced by small farms by using milk and milk products in small farms (family farms) operating in our republic using this device, providing initial processing of milk, ensuring pro-fitability of the farm and increasing productivity.

At the same time, the analysis of the dosing devices of mixing aggregates made it possible to reveal not only the advantages of existing devices, but also their shortcomings. The most convenient is the use of a multicomponent dosing equipment of plate type, which has a simple cone-beam and high efficiency. In order to improve the quality of the dosing device, its design should be improved.

Second chapter. Based on the technology proposed here (in figure 1), milk coolers and their reporting; counter flow chiller, solution unit report, determination of cooling area, determination of fluid consumption in cooling, determination of specific heat capacity, determination of hydraulic resistance in refrigeration, report of reverse cooling, dependence of milk cooling temperature on various parameters, etc. done.

The main indicator in the report of milk coolers and their selection is the productivity and temperature regime. The amount of temperature obtained from milk or cooled solution is determined by the following expression:

$$Q = M \cdot C \ (T_b - T_{son}) \qquad (1)$$

here M – productivity, kg/s;

C – the specific heat capacity of the product is the coefficient,

Cooul/kq.K;

T_b, T_{son} - initial and final temperature.

The temperature of the cooling solution used in milk cooling should be several times lower than the initial temperature of milk. The ratio of the mass of the heat acceptor to the mass of the heat exchanger is called the coefficient of consumption. In the water section of the refrigerator, this coefficient is 2,5...3 on the solution tab 1,5...It is accepted between 2,5 prices. The sheet of the refrigerator is made in the same direction, either in one tab or in two tabs. Then the amount of cold (received heat) required in the water tab:

$$Q_{su} = M \cdot C(T_b - T_{son}) = n_{su} M \cdot C_{su}(T_{son\,su} - T_{baş\,su}) \quad (2)$$

For solution section

$$Q_{məh} = M \cdot C(T_0 - T_{son}) = n_p \cdot C_p M(T_{son\,p} - T_{baş\,p}) \quad (3)$$

here $Q = Q_{su} + Q_{məh}$ – the amount of heat received by water and solution, Vt;

$\tau = T_{baş\,su} - \Delta T$ - temperature of milk at the end of the water section

in most cases accepted T = 3...5K

$T_{baş\,su}$, $T_{son\,su}$, $T_{baş\,məh}$ - according to the initial and final tempera-

tures of water and solution, K

Number of parallel channels during continuous operation of the cooling process it is determined by the expression

$$m = \frac{M}{10^3 V \cdot b \cdot n} \quad (4)$$

here V - the speed of water moving in the channel of the refrigerator;

b – channel width, m;

n – the gap between the boards of the refrigerator, m.

The area of the water and solution unit of the refrigerator is determined according to the Newton-Fourier formula as follows:

$$S_{su} = \frac{Q_{su}}{k \cdot \Delta T_{op}} \; ; \qquad S_{məh} = \frac{Q_{məh}}{k \cdot \Delta T_{op}} \quad (5)$$

According to Gerskof's proposed expression, the average lagorifmic temperature

$$\Delta T_{op} = \frac{\Delta T_{max} - \Delta T_{min}}{2{,}3 lg_{min}^{max}} \quad (6)$$

here T_{max} – at the end of the refrigerator is the temperature difference between the solution that cools the milk;

T_{min} – temperature difference between milk and solution at the inlet.

Cooling area of the milk cooler with a circular width according to its constructive dimensions

$$F = (\pi d - 2i)B \cdot Z \qquad (7)$$

An ellipsoid with a cross section is defined by expressions F= 2SBZ.

here F- the area of the refrigerator, m^2;

d - diameter of pipe, m;

i - the width of the pipe connecting surface, m;

B – the length of the refrigerator, m;

Z - number of pipes;

S – the length of the ellipsoid curve, m.

In order to ensure normal cooling of milk in the refrigerator, the report of the solution section is given.

Parameters of salt tank should be designed in accordance with the solution tank constructed in the refrigeration unit. For this purpose, we initially prepared a 110-liter water tank. Figure 2 as can be seen, a salt tank was constructed at the top of the water tank. The purpose of the construction, as mentioned above, is to ensure that salt is poured from the salt tank into the water tank. Thus, salt is poured into a tank of water and mixed by means of a mixer and the resulting solution is obtained. As seen in figure 2, we called this tank a solution tank. Considering these, we get the following results.

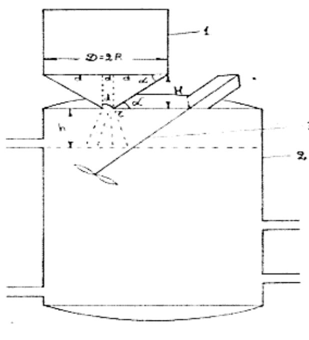


Figure 2. Scheme of the solution section of the refrigerator:
1 - salt hopper; 2 - solution tank ; 3-mixer propeller.

Mass of salt poured into the bunker;

$$G = V\rho\varphi \qquad (8)$$

here: V- volume of the hopper, m^3 ;

ρ – density of salt, 3 kq/dm^3 ;

φ – volume utilization coefficient.

To calculate the volume of the bunker, we use the following formula:

$$V = \frac{1}{3}\pi H(R^2 + Rr + r^2) \qquad (9)$$

here : H - height of conical part, m;

R – radius of the upper seat of the hopper, m;

r – radius of lower seat, m.

$$\frac{H}{R-r} = tg\alpha \, ;$$

Here α-when calculating the height of the bunker with a natural slope angle of 450, this angle creates conditions for pouring salt into the bunker.

According to a rectangular triangle

$$H = \frac{D-d}{2} tg\alpha = \frac{2(R-r)}{2} tg\alpha = (R-r)tg\alpha \qquad (10)$$

When these prices instead take.

$$V = \frac{1}{3}\pi(R-r)tg\alpha\,(R^2 + r^2 + Rr) \qquad (11)$$

The productivity of the hopper is determined by the following expression:

When you write the prices instead;

$$Q = \frac{V\rho\varphi}{t} = \frac{\mu\frac{\pi r^2}{4}\cdot\frac{1}{3}\pi(R-r)tg\alpha\,(R^2 + Rr + r^2)\rho\varphi}{\frac{v}{h}}, \qquad (13)$$

Table of dependence of cooling temperature on cooling distance in water and solution cooling of milk

We make a graph based on the prices of this table. Cooling the temperature change curves of milk with cold water and solution depending on the distance from the flow of milk aparırıq.Su we take the temperature of milk in cooling more than 50 ^{0}C, in cooling solution 16 ^{0}C

Tab 1.

Cooling with water				Cooling with salt solution	
The way milk *l,m*	Temperature of milk, ^0C	The way of milk *l*,m	Temperature of milk, ^0C	The way of milk *l,m*	Temperature of milk, ^0C
0,00	52,44	-	-	-	-
0,15	42,06	1,20	18,01	0	15,11
0,30	34,71	1,35	17,09	0,15	10,91
0,45	29,67	1,50	16,41	0,30	7,30
0,60	25,26	1,65	15,97	0,45	4.80
0,75	22,46	1,8.0	15,60	0,60	3,14
0,90	20,56	1,95	15,27	0,75	2,08
1,05	19,08	2,10	15,11	-	-

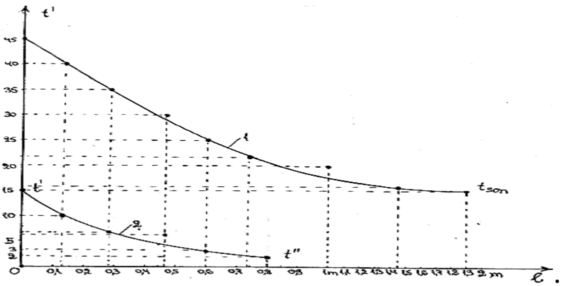


Figure 3. When cooling milk with water (1) and solution (2), the dependence curves depending on the distance

Third chapter is devoted to the plan and methodology of the study. Here, a plan corresponding to the topic of the dissertation is given and on their basis, the methodology of research, the consistent implementation of work are indicated. The chapter outlines the structure and principle of operation of the device, which performs the work on the basis of the previously provided technology. During the study, the use of new devices used for the determination of parameters, methods for determining physical, mechanical and chemical properties of milk are given. In addition, the regression equation was compiled to determine the study of the main parameters of the experiment. Grapho-analytical method of the regression equation was used for the first time. For the first time this method was developed by professor of the department of agricultural machinery, Doctor of tech. sciences Khalid Gurbanov and applied in research works. Its content is reflected as follows. First of all, the regression equation the amount of the required cold

$$Q_{um} = MC_m(t^{\text{l}}_{s\ddot{u}d} - t^{\text{ll}}_{son}) + nMC(t^{\text{son}}_{m\partial h} - t^{\text{əv}}_{m\partial h}) + KF\Delta t \quad (14)$$

here $t^{l}_{s\ddot{u}d}$- previous temperature of milk;

n – coefficient of consumption of solution compared to milk;

$t_{m\partial h}$ - temperature of solution;

F – cooling area of the refrigerator;

Δt – temperature difference;

K – coefficient of heat conduction;

t_{son} – final temperature of milk;

M – productivity of the refrigerator.

The parameters shown in the equation are placed in figure 4.

Based on the values of the table, we build a dependency chart of the change in the cold, i.e. 4Q = f (M, $t^{l}_{s\ddot{u}d}$, n, $t^{\text{əv}}_{m\partial h}$,F, K, Δt). For this purpose, curves are drawn on the basis of three prices, indicating the price of the cold on the ordinary axis, and the prices of the argument on the axis of the abscess. This graph was given the following picture qururuq.

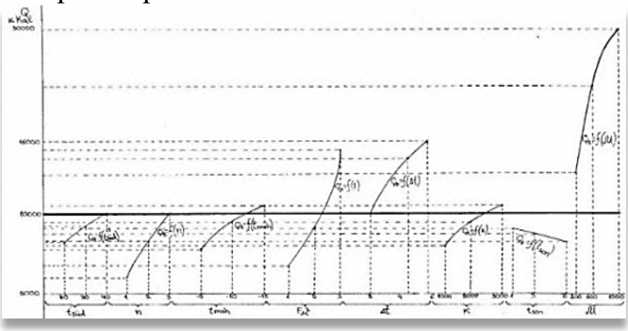


Figure 4. Graphs of dependence of the amount of cold required for milk cooling on parameters

From the lowest values of these dependencies, a straight line is drawn parallel to the axis of the abscess, and since the remaining parameter lines above that line are impressive, the experiment is carried out on their basis. Those parameters consist of M, Δt, N, F, K. These indicators, that is, the prices in the chart are the same as those indicated in the table. This method can be called grapho-analtic method.

The results of the experiment were determined by mathematical statistics according to the general methodology.

Fourth chapter is called ”Determination of physical and mechanical properties of cereals". The physical and mechanical properties of cereals used in experimental research have been determined on the basis of accepted methods.

Dedicated to the experiment of milk chiller. Changes in temperature of water and milk, influence of solution consumption on tempe-ratur difference, dependence of temperature difference on consump-tion coefficient, dependence of salt content (solution) on cooling, delivery of water from high temperature to cooling temperature etc. These issues are reflected as follows.

When cooling pasteurized milk with water, the temperature of milk increases depending on the distance traveled. For this purpose, hot milk is discharged and its temperature is measured by thermometer, at the same time water consumption is measured at the point corresponding to cooling milk with n = 2, the results obtained are recorded in the table below. This curve shows a change in temperature depending on the area of cooling (F) or the distance of movement (table 1).

Tab 2. Experimental resulte

The way the milk goes, *l*, sm	Temperature , t, C^0	
	Milk	Water
1	75,0	33,3
2	53,0	25,3
3	37,4	19,2
4	27,7	15,5
5	24,3	14,2
6	20,2	12,7
7	17,4	11,7
8	14,8	10,7
9	12,6	10,2
10	10,0	8,0

Based on the price of the table, a graph of that dependence is drawn up.

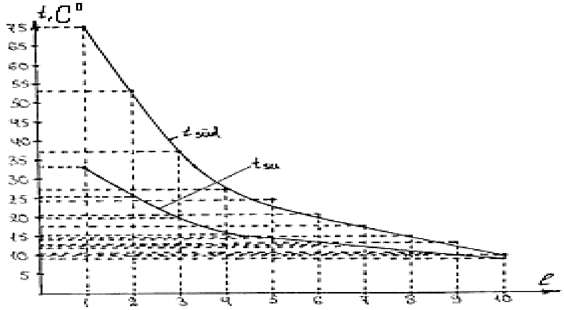


Figure 5. Curves of change in temperature of water and milk.

As can be seen from this curve (5), the change curves of water and milk flowing in the opposite direction change with the Hyperbola curve, i.e., when the temperature of milk (pasteurized milk) decreases from 75 ^{0}C to 10 ^{0}C, the water temperature ranges from 8 ^{0}C to 33 ^{0}C.

Based on the prices of the study, we draw up a graph of the change in temperature in the water section of milk and the solution section.

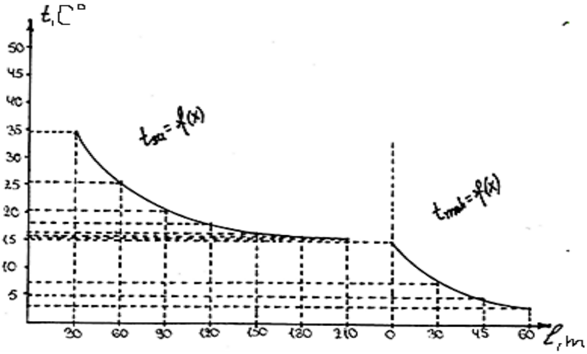


Figure 6. Influence of cooling solution consumption on temperature difference.

Cooling the milk in the refrigerator is cooled with water and solution.

We build the temperature difference τ schedule n depending on the disposal coefficient.

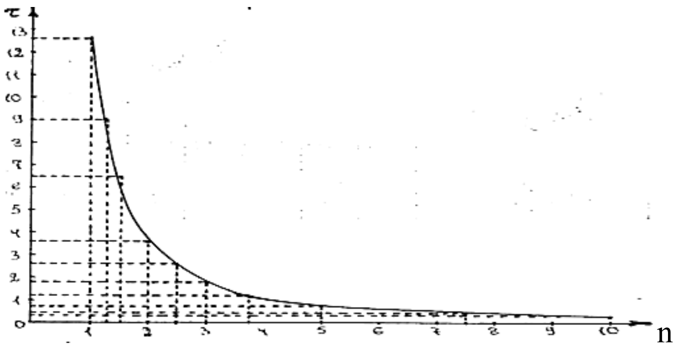


Figure 7. Schedule n dependence of temperature difference from disposal coefficient.

We draw a graph of the effect of the amount of salt on the final temperature of milk.

As can be seen from the graph, an increase in the amount of salt leads to a decrease in temperature.

The effect of milk on the temperature of the last cooling depending on the previous temperature is shown in Figure 9. For this purpose, the effect of milk on cooling temperature from previous temperature, i.e. pasteurization temperature to 800 ordinary room temperature was measured (in five repetitions).

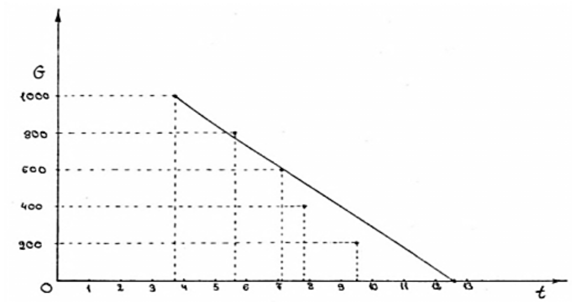


Figure 8. Cooling of milk depending on the mass of salt Ggraph of temperature change t

The graph shows the change in the last temperature of the milk depending on the previous temperature of the milk.

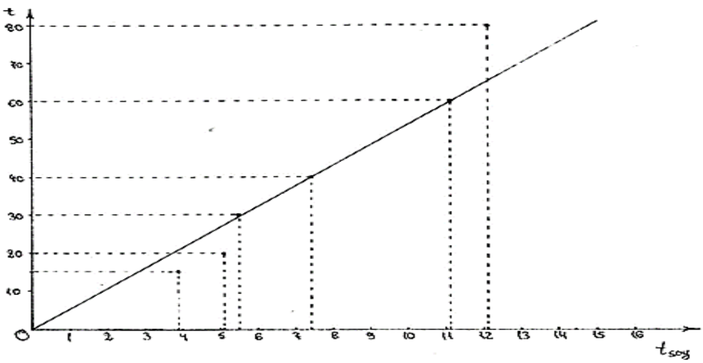


Figure 9. The temperature of milk cooling schedule of change depending on temperature.

As can be seen from the graph, the temperature of milk is reduced from 80 ^{0}C to 12,5 ^{0}C, and the previous temperature of milk is reduced from 15 ^{0}C to 3,8 ^{0}C, and this change is followed by the parabola law.

Fifth chapter. Determination of economic efficiency of milk refrigeration unit. Testing of the experimental unit was carried out at Happu farmer livestock farm in Samukh region. 150 those who pursue evil plans come near; Their 52 heads are milking cows.

To compare the experimental unit, the OM-400 Unit was taken as the base machine. Economic benefits were determined by a comparison of the resulting brought costs associated with the participation of the new device and the base machine in the mechanization of the technological process.

Thus, the economic efficiency of the introduction of the new device is calculated as follows.

$$S = G_1 - G_2 \text{ , man} \qquad (15)$$

here S- the benefit from the introduction of new technology, man;

G_1 - the costs of using the base machine, man;

G_2 – the costs brought by the use of new technology, man.

The costs are calculated as follows.

$$G = \dot{I} + EK \text{ , man} \qquad (16)$$

here İ – maintenance costs, man;

E – the normative efficiency coefficient of investment was, E = 0,15;

K – investment of used equipment, man.

We perform the report first for the base option. The operating costs associated with the use of the OM-400 facility are calculated from this.

$$İ_1 = Ə_1 + A_1 + R_1 + \varepsilon_1 \text{ , man} \qquad (17)$$

Here $İ_1$ – operating costs of base machine, man;

$Ə_1$ - salary of workers related to base machine, man;

A_1 - depreciation charges of base machine, man;

R_1-current repair and maintenance costs of base machine, man;

ε_1 - energy usage costs for base machine, man;

Comparative technical and economic indicators of the experimental unit with the base machine Table 3.- also listed.

Tabl 3. **Comparison table**

S/s	Indicators	Unit of measurement	Mechanical organization options	
			OM-400	Experimental device
1.	Productivity	l/saat	0,4	0,5
2.	The power required	kVt	5,3	3,7
3.	Duration of use	day	365	365
4.	Investment	Man	3700	850
5.	Depreciation expense	Man	518	119
6.	Current repair and maintenance costs	Man	666	153
7	Electricity costs	Man	628,71	351,13
8.	Cost of cooling 1 t of milk	Man/t	7,984	3,98
9	Operating costs	Man	3236,2	1761,93
10	Expenses	Man	3791,2	1889,5
11	Economic benefits	Man	-	1902

We conclude that the annual savings are 1902 man.

Results

1. The research work is devoted to the improvement of cooling technology and device, which is the primary processing process for

maintaining the quality of milk in the small scale enterprises of the Republic.

2. As a result of the research work, a device based on counter – flow cooling technology with a composite solution was developed, and its constructive and technological parameters were substantiated by theoretical studies.

3. In the dissertation, the following issues were touched upon by the author through theoretical research. Depending on the previous temperature, productivity and other indicators of milk, parameters meeting zootechnical requirements were determined and graphs were compiled on their basis. 3 in milk...To obtain a temperature of 4^0C, it is sufficient to use the solution with a temperature of -5 ^{0}C.

4.In order to save heat, the milk cooler is prepared in two sections, the first section is cooled with cold water and the second section is cooled with compressor solution.

5.As a result of the constructive report, overall dimensions ensuring the normal performance of the chiller, width 0.8 m, height 1m the cooling area is 0.8 m^2, and the cutting area of the pipes is proposed.

6.For the purpose of the experiment, the methodology for the research of physical and mechanical indicators of milk, the theory for the determination of the grapho – analytical method by a new method for the planning of the experiment are given. Based on the new theoretical approach, multi-factor indicators affecting were reduced according to the degree of impact and such indicators as the cooling area, temperature difference, temperature of the solution, coefficient of thermal conductivity, mass of milk were taken.

7. By evaluating the results of the experiment on the study of the parameters of the unit in the laboratory and the farm, it was determined the suitability of the solution cooling in cooling milk with water and solution depending on the length of the milk path. At a distance of 0,75 m , the temperature of milk in cooling with water was 22 ^{0}C, and in cooling with solution-2^0C.

8.The change in temperature difference (ε), consumption coefficient (n) was studied.At temperature difference τ = 2...4^0C, The coefficient of consumption is n = 2...3 It has been in the range.

9. It was determined to obtain 5% solution and consumption of 5 kg of salt in accordance with it to obtain the necessary cooling temperature.

10.Increasing the salt content in the solution causes a decrease in the cooling temperature of the milk. The temperature of milk when 200 g was 9,5^{0}C, according to 1000 g the temperature of milk was 3,7 ^{0}C.

11.The temperature of milk cooling has been studied from the previous temperature. So the temperature is also reduced by 80 ^{0}C to 12,5 ^{0}C, and at 15^{0}C to 3,8^{0}C.

12.The proposed experimental device was used in Happu farmer farm of Samukh region and 1ton milk cooling cost 4,004 man.The economic efficiency of the marrow is 1902 manats. The dissertation was discussed at the technical Council of the Agrarian University and a recommendation was prepared for use in farms..

Recommendations for manufacturing

Preparation of solution ratio and normal operation of the mixer is recommended to adjust the milk cooling unit based on reverse flow cooling system with salt solution according to the amount of milk cooled as the designated company composition.

In the process of cooling, it is recommended to add 100 kg of salt to 100 l of water for the preparation of the solution composition to cool 1 l of milk. 3 in milk..To obtain a temperature of 40 C, it is enough to use the solution at a temperature of 50c. In the process of reverse flow cooling it is assumed that the cooling area is 0,8 m2 with a width of 1 M and a height of 0,8 M2. The ambient temperature in accordance with the seasons of the year should be taken into account when preparing a flat solution

The main provisions of the dissertation are reflected in the following published articles:

1. Babaev Z.V.Development of a methodology for simplified reporting of a refrigeration unit with plates. // Scientific works of ASAU Ganja, 2012, No.2, - pp. 65-67.

2. Babaev Z.V. Actual problems of milk processing in the conditions of farming. // International Scientific and Practical Conference, 2014 Ganja, September 24, - pp.272-273.

3. Babayev Z.V. Ensuring quality indicators during milk storage. // Materials of the 8th International Scientific and Practical Conference, Ganja, 03-04 October 2016, - pp.243- 245

4. Babaev Z.V. Refrigerator report in reverse. // Scientific works of ASAU. Ganja, 2017, No.1, - pp.82-84.

5. Babayev Z.V. Methods of solving primary milk processing in small farms operating in Azerbaijan. // Collection of news, Ganja, 2017, No.2 (68), pp. 96-99.

6. Babaev Z.V. Dependence of milk cooling temperature on various parameters. // Collection of News, Ganja, 2017, No.3(69), - pp.143-156.

7. Babaev Z. V. Calculation of the solution section of the refrigeration unit // Internauka. Moscow, 2017, No. 8(12), - pp.10-12

8. Gurbanov H.H., Babaev Z.V. Milk in it, follow the coolant to conduct impressive parameters regression equation graphic-analytical method definition. Black sea Georgia. Tbilisi. 2018.- p.29-33.

9. Gurbanov H.H. Babaev Z.V. Compilation of the regression equation of the influencing parameters for the experiment of the milk refrigerator by grapho-analytical method. // Materials of the scientific and practical conference "Actual problems of scientific and technological progress in agricultural production" dedicated to the 100th anniversary of the Azerbaijan Democratic Republic (October 16-17, 2018) Ganja, 2018, - pp.35-40.

10. Babayev Z.V. Study of the dependence of the effect of water cooling of milk. // Scientific works of ASAU, Ganja, 2019, No.1, - pp. 75-78.

11. Gurbanov H.H.Babaev Z.V. Experimental study of a refrigerator for milk. // Scientific and practical conference on the results of the research work of ASAU employees in 2018, dedicated to the 96th anniversary of the birth of national leader Heydar Aliyev, Ganja, May 07, - 2019.

12. .Gurbanov H. H., Babaev Z.V., doctoral student. Experimental studies of a milk cooler.// Innovations in scientific and technical support of the agro-industrial complex of Russia (materials of the All-Russian (National) Scientific and Practical Conference, Kursk, February 5-6, 2020, part 3, - pp.103-109

The defense of the dissertation will be held on «***11***» ***February*** 2022, at ***14^{00}*** at the meeting of the Dissertation council FD 2.26 of under the Azerbaijan State Agrarian University.

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