RESEARCH RESULTS OF ENERGY EFFICIENT VENTILATION SYSTEM OF SHEEPFOLD

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Abstract: *The article discusses the results of experimental studies of energy efficient ventilation system of sheepfold, using information-measuring system for remote registration of thermotechnical parameters of the ventilation systems.*

They are given the results of testing of the experimental energy efficient ventilation system in the winter and summer periods.

KEY WORDS: ENERGY EFFICIENT VENTILATION SYSTEM. SHEEPFOLD. UNDERGROUND HEAT EXCHANGER. AIR CONDUIT. SOIL HEAT. TEMPERATURE SENSORS. SENSORS OF THE RELATIVE HUMIDITY AND TEMPERATURE. MASTERSCADA SYSTEM.

1 Introduction

The work addresses the problem of energy efficient ventilation systems in agricultural buildings, due to the effective use of low-grade soil heat.

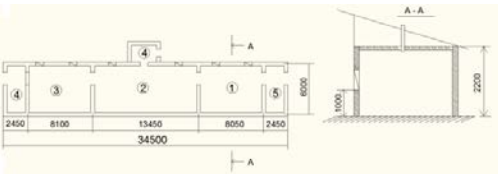
There are a number of examples of the use of soil heat for heating and cooling of livestock buildings through underground air conduits and heat exchangers. They are allowed to save 50 to 75% of the costs for heating and cooling of the buildings. [1]

Consequently, energy efficient ventilation systems and efficient use of soil heat in them are perspective and relevant in modern conditions.

The work has been carried out at the Department of Energy Saving and Automation of Kazakh National Agrarian University.

2 Materials and methods

The experimental energy efficient ventilation system was built into the sheepfold for lambing in Almaty region. Plan and photograph of the sheepfold are presented in Figures 1 and 2.



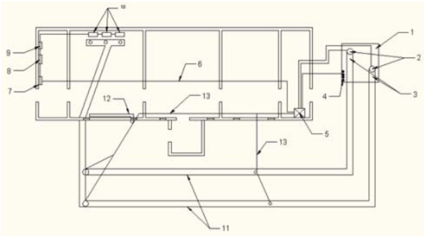
1 - maternity ward; 2 - compartment for keeping of the ewes; 3 - compartment for keeping of the lambs from 2 months; 4 - tambours; 5 - switchboard room.

Figure 1. *Plan of the sheepfold for lambing*

Figure 2. *Sheepfold for lambing*

For this sheepfold in accordance with an innovative patent of the RK number 26930 "The ventilation device" [2, 3] have been developed schemes and identified parameters of energy efficient ventilation system with heat soil.

Scheme of experimental energy efficient ventilation system for placing of the sheepfold is shown in Figure 3.



1 – placement of air-intake shaft; 2 - vertical forced air ducts; 3 - horizontal forced air ducts; 4 - soil temperature sensors; 5 - control cabinet; 6 - control wiring; 7 - power shield; 8 - electric meters; 9 - bucking transformer 220/22 V; 10 - closers – electric heating panels; 11 - underground heat exchanger-horizontal air conduits; 12 – ventilating shaft with air conduit; 13 – electric wire sensors.

Figure 3. *- Process diagram of the experimental energy efficient ventilation system for placing of the sheepfold*

Underground heat exchangers - air conduits are made of corrugated plastic pipe of "EPA Almaty" LLP production. Pipes are made from high density polyethylene, the nominal inner diameter from 110 mm to 630 mm. GOST18599-2001.

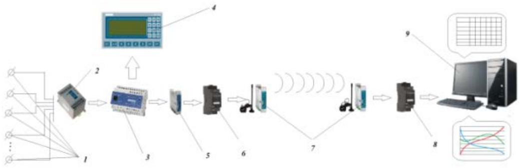
Profile ripple wall. Pipes are produced with socket and muff joints. They are connected via a sealing ring. They have a hollow structure in the form of rectangular section of hollow channels arranged perpendicularly along the axis of the pipe section, the inner layer is flat and smooth.

Specially designed outer surface of the pipe has a high ring stiffness and makes them more resistant to compressive loads (transport, soil water, frost and soil compaction), and elastic structure pipe protects them from damage when exposed to overload. As the material of high density polyethylene has: a high tensile strength, have higher thermal stability and is not subject to corrosion.

The pipe is produced in the segments of standard length of 6 m and 12 m and is designed for underground laying to a depth of 15 m.

For registration of thermotechnical parameters of ventilation system, that is temperature of the outer, inside air, soil and humidity external and internal air have been developed information-measuring system.

Block scheme of information-measuring system and automation study modes of modular energy efficient ventilation system for agricultural buildings is shown in Figure 4 and is arranged as follows: the sensors (sensor OWEN DTS3015 PT1000.B2.200 designed to measure the temperature in the air conduit of ventilation system, OWEN DTS3005 -PT1000.B2 designed to measure the temperature of outer air, relative humidity sensor and temperature DVT-03.RS are installed on a flat surface of the wall and connected to the analog input module OWEN MV110-8A.



1 - sensors (of temperature, humidity, air flow rate); *2* - analog input modules OWEN MV110-8A; *3* - programmable logic controller OWEN PLC 100-220. P-M; *4* - graphic operator terminal OWEN IP320; *5* - data acquisition module OWEN MSD200; *6* - Interface Converter USB / RS485 AC4; *7* - GSM / GPRS; *8* - Interface Converter USB / RS485 AC4; *9* - a personal computer.

Figure 4 - Block scheme of information-measuring system

The device operates in the RS-485 network under the protocols OWEN, ModBus-RTU, ModBus-ASCII, DCON.

Controller OWEN PLC is used as the master network. Device is given with OPC driver and standard library WIN DLL, which are used for connecting the device to the SCADA-systems and controllers from other manufacturers. Configuring the device is carried out on a PC via the interface adapter RS-485 / RS-232 or RS-485 / USB (for example, OWEN ASZ-M or AS4, respectively) using the "Configurator M110" included the supply package.

Then all the data from all the sensors are transmitted to the programmable logic controller PLC OWEN 100-220. P-M. OWEN PLC controllers allow you to organize a gateway between devices with the protocol OWEN (RS-485) and industrial networks with protocols, Modbus TCP, DCON.

At the control center of station operator received a personal computer. To communicate through (CSD) GPRS-connection, it is installed Modbus OPC / DDE server to a PC.

OPC supports the work with a modem and allows you to work both in Master mode and in Slave mode. To transfer data to the computer modem operator is connected working in master mode, then the signals are transmitted to the processing and visualization into "skadosystem» MasterScada. Operator views messages and parameters from the facilities and on his own initiative, makes communication and management of the facility, such as for the processing of emergencies.

3 Results of experimental studies

Testing of energy efficient ventilation system was carried out in two stages: winter and summer periods. Results of statistical processing of measurements are shown in Tables 1-4.

Table 1 *- Results of statistical processing of measurements of air temperature in the heat exchanger-air conduit (in winter)*

Indicators	temperature at entrance	temperature in the middle	temperature on the way out
Number of values n	72	72	72
Average value $X\ aver$	-14,2597	-5,04028	5,625
Standard deviation S	1,645965	0,756504	0,211467
The standard deviation of the average $S_{aver} = S/radical\ (n)$	0,193979	0,089155	0,024922
Student's t-test $(5\%, n-1)t$	1,993943	1,993943	1,993943
Confidence interval CI $= t * S_{aver}$	-0,71299	-0,25201	0,28125
Relative error $\delta = ДИ/X\ aver$	0,05	0,05	0,05

Table 2 *- Results of statistical processing of measurements of air temperature in the heat exchanger-air conduit (in summer)*

Indicators	temperature at entrance	temperature in the middle	temperature on the way out
Number of values n	802	802	802
Average value $X\ aver$	26,48999	20,52618	19,69433
Standard deviation S	2,496318	0,51628	0,530624
The standard deviation of the average $S_{aver} = S/radical\ (n)$	0,088148	0,01823	0,018737
Student's t-test $(5\%, n-1)t$	1,96293	1,96293	1,96293
Confidence interval CI $= t * S_{aver}$	1,324499	1,026309	0,984716
Relative error $\delta = ДИ/X\ aver$	0,05	0,05	0,05

Table 3 *- Results of statistical processing of measurements of soil temperature (in winter)*

Indicators	temperature at entrance	temperature in the middle	temperature on the way out
Number of values n	24	24	24
Average value $X\ aver$	15,11667	16,0875	16,6375
Standard deviation S	0,831273	1,536318	1,965089
The standard deviation of the average $S_{aver} = S/radical\ (n)$	0,169683	0,3136	0,401122
Student's t-test $(5\%, n-1)t$	2,068658	2,068658	2,068658
Confidence interval CI $= t * S_{aver}$	0,008484	0,01568	0,020056
Relative error $\delta = ДИ/X\ aver$	0,000561	0,000975	0,001205

Table 4 *- Results of statistical processing of measurements of soil temperature (in summer)*

Indicators	temperature at entrance	temperature in the middle	temperature on the way out
Number of values n	147	147	147
Average value $X\ aver$	16,11347	14,25299	12,68156
Standard deviation S	0,654286	0,618405	1,508083
The standard deviation of the average $S_{aver} = S/radical\ (n)$	0,053965	0,051005	0,124385
Student's t-test $(5\%, n-1)t$	1,976346	1,976346	1,976346
Confidence interval CI $= t * S_{aver}$	0,002698	0,00255	0,006219
Relative error $\delta = ДИ/X\ aver$	0,000167	0,000179	0,00049

During tests energy efficient ventilation system during the winter period found that the room temperature of the sheepfold ranged from +5,4 ° C to +6,0 ° C, on average + 5,6 ° C, with the number of measurements n = 72.

The relative humidity of the room of the sheepfold was in average 79.2% (for n = 72). The maximum and minimum value of relative humidity were respectively 93.4% and 64.1%. At the lowest outdoor temperature -18 ° C (04.02.2014) supply air temperature reached 6 ° C. Supply flow rate fluctuate depending on the outdoor temperature within 70-140 m3 / h. The maximum heat output of installation was 2.2 kW.

During tests energy efficient ventilation system in summer found that the room temperature of sheepfold ranged from +16,6 °C to + 27,29 °C on average + 22,3 °C, with the number of measurements n = 820.

The relative humidity of the room of sheepfold averaged 30.5% (for n = 820). Maximum and minimum value of relative humidity was respectively 58.88% and 10.37%. At the highest temperature of the outside air + 33,4°C supply air temperature reached + 19,6°C and humidity increased from 12% to 23%. Air flow rate was 140 m3/h. The cooling capacity of the installation was 2.6 kW.

Conclusion

In times of testing energy efficient ventilation system provided the required power saving mode and zootechnical parameters of the microclimate in the maternity ward of the sheepfold.

Energy efficient ventilation system has been adopted for economic use and recommended for implementation in the sheep farms.

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2. Innovative patent. №26930 from 25.04.2013 «Ventilation device», Issakhanov M.Zh., Alibek N.B., Doldayev O.Z., Dyusenbauev T.S. et al.

3. M. Issakhanov, N. Alibek, T. Dyusenbayev.Energy saving ventilation systems for sheep premises. International journal International scientific, scientific applied and informational journal mechanization in agriculture. 7/2014, Sofia, Bulgaria «Energy saving ventilation systems for sheep premises».