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SELECTION OF A HEAT PUMP WITH LOW LEVEL OF NOISE POLLUTION

У статті показано, що застосування теплового насосу є раціональним і прогресивним рішенням для вирішення проблем енергозбереження та забруднення навколишнього середовища. Приведено класифікацію теплових насосів за принципом їх роботи.

Також розглянуто переваги та недоліки використання теплових насосів. Одним із основних недоліків теплових насосів є підвищений рівень шуму. Обґрунтовано вибір теплового насосу типу «повітря–вода».

Ключові слова: *тепловий насос, шум, шумове забруднення, звуковий тиск, тепловий насос «повітря–вода».*

В статье показано, что применение теплового насоса является рациональным и прогрессивным решением для решения проблем энергосбережения и загрязнения окружающей среды. Приведена классификация тепловых насосов по принципу их работы.

Также рассмотрены преимущества и недостатки использования тепловых насосов. Одним из основных недостатков тепловых насосов является повышенный уровень шума. Обоснован выбор теплового насоса типа «воздух–вода».

Ключевые слова: *тепловой насос, шум, шумовое загрязнение, звуковое давление, тепловой насос «воздух–вода».*

This article shows that usage of heat pump is a rational and progressive resolution for solution of energy saving and environmental pollution problem. There is a classification of the pumps according to their principles of work.

Furthermore, the pros and cons of these pumps' exploitation are reviewed here. One of major cons is higher level of noise. The choice of heat pump of type "air-water" is justified.

Keywords: *heat pump, noise, noise pollution, sound pressure, heat pump "air-water".*

Introduction. Every year world's energy consumption grows. More than one third of extracted organic fuel is spent on heating of houses, pubic, and industrial buildings. The problem of energy saving is one of the most relevant

today. Among the energy expenditures for communal needs in buildings the main is the cost of heating. Traditional projects can't provide the necessary requirements for heating systems, while consuming a large amount of resources and energy. That is why it is now necessary to introduce alternative types of buildings' heating, among which solar heating and heat pumps can be provided.

Heat capacity of heat pumps by 80 % consists of renewable environmental energy and only 20 % of energy is used for the operation of the heat pump itself.

Heating systems, based on the use of a heat pump, are environmentally friendly, since they operate without burning fuel and do not produce harmful emissions into the atmosphere.

The heat pump as an alternative high-tech device can perform not only heating, but also cooling and air conditioning.

Thus, the urgency of the new alternative "green" technologies introduction grows each year.

However, when using a heat pump, there is a problem of increased noise during the operation of the equipment.

The purpose of this work is to select a heat pump with a low level of noise pollution.

Heat pumpis a device for transferring of thermal energy from a source of low-temperature thermal energy (with a low temperature) to a consumer (coolant) with a higher temperature. To operate the heat pump, you need to use external energy: mechanical, electrical, and chemical.

Classification of heat pumps according to their principles of work is shown on Fig. 1.

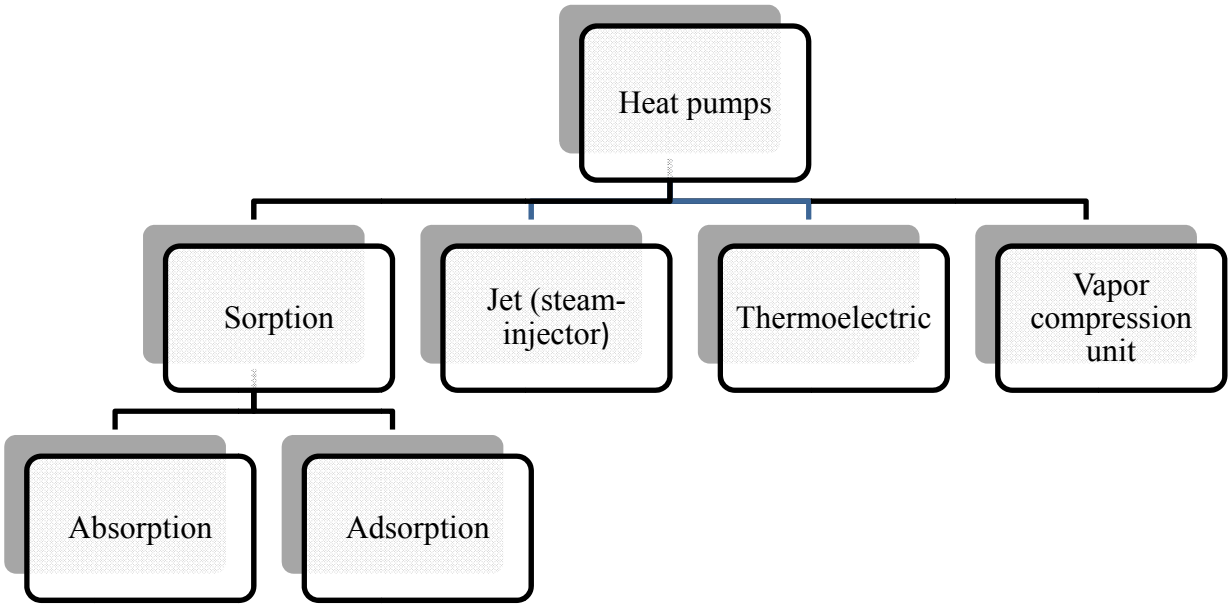

Fig. 1. Classification of heat pumps according to their principles of work

The condition of the operation of the heat pump is the presence of an energy source, the heat from which will be withdrawn and proceed to ensure the boiling process of the working fluid in the evaporator.

According to the type of heat source, the pumps are divided into the following groups:

- Thermal: using heat from soil or groundwater;
- Air: use of heat of the ambient air.

Another group form heat pumps that use secondary heat of another heat process, which needs to be utilized - for example, the heat of the technological process or sewage.

Main advantages of heat pumps are:

1. Safety;
2. Efficiency;
3. Low operating costs;
4. Operational convenience;
5. Produces eco-friendly heat;
6. Ability to work both for heating and cooling;
7. Requires minimum control from user;
8. Long service life;
9. Wide range of use.

In this case, one of the main disadvantages of heat pumps is the increased noise level.

According to clause 4.1.6 of The State Standard of Ukraine, DSTUB.V.2.5-44:2010 [1], noise radiation (sound pressure) caused by heat pump installation and it's additional components, shouldn't exceed maximum values, provided in [2–4]. That is, in residential zone (SL II) the noise level should not exceed 45 dBA, in mixed zone (SL III) – 50 dBA.

Norms of maximum noise level in the environment for permanently installed heat pumps shall be taken in accordance with SN 3077 [4] and DBN 3.3.6.039 [5], or according to the values in Table 1.

Table 1

Maximum noise level in residential and mixed zones (residential and trade)

Estimated values *Lr in dBA*	
Zone	At night time (from 9 p.m. to 7 a.m.)
Residential zone (SL II)	45
Mixed zone (SL III)	50

Sensitivity level (SL II) is used in zones, where it is not allowed to place enterprises that disturb the silence, that is, in residential areas and areas where public buildings and constructions are located.

Sensitivity level (SL II) is used in zones, where it is allowed to place modernized enterprises, that is, non-residential areas and shopping areas.

Requirements for noise protection for premises with inhabitants (living rooms, bedrooms, offices) are given in Table 2.

Table 2

Requirements for protection against noise generated by the operation of automatic equipment inside buildings, for multi-story and office buildings

Estimated values *Lr in dBA*	
Requirements	At night time (from 10 p.m. to 6 a.m.)
Minimum requirement	30
Maximum requirement	25

We will consider heat pumps (hereinafter HP), which use air as a source of thermal energy.

In such HP, noise effects occur as a result of sound through the enclosing structures and transmitted by air.

In this work we consider a heat pump with the principle of work "air-water".

Figure 2 shows critical points of sound transmission systems with heat pumps. That is, when designing and installing heat pump systems, it is necessary to take measures for the sound insulation of these places [1].

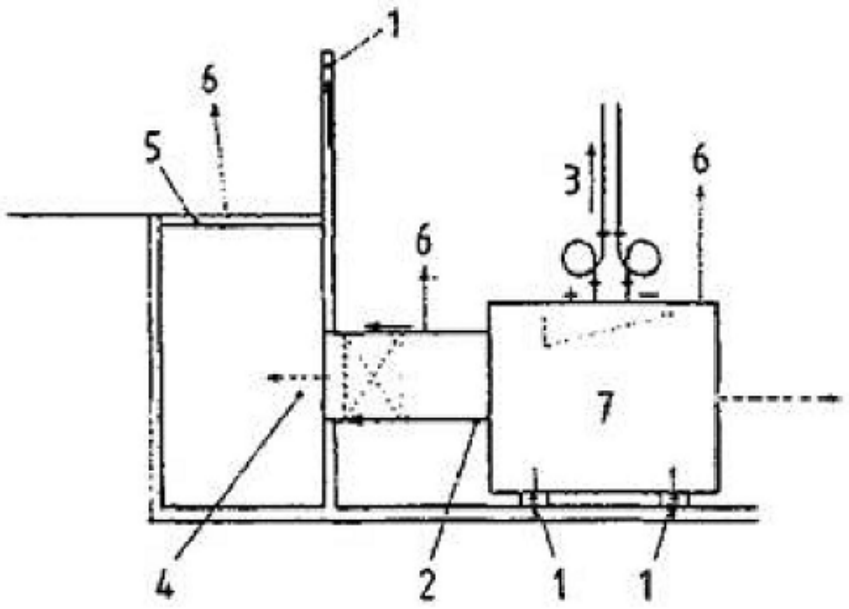

Fig. 2. Critical points of sound transmission systems in heat pumps with heat source :
1 – direction of spreading of sound passing through the enclosing structures;
2 – canal for taking or removing air; 3 –inflow airline; 4 – air shaft;
5 – bars;., 6 – direction of sound, transmitted by air ducts and canals;
7 – heat pump

The level sound pressure in the nearest residential buildings and in nearby territories shouldn't exceed the requirements of SN 3077, taking into account corrective 3.9 DBNV.2.2-15 [6]; and in the nearest industrial buildings shouldn't exceed requirements of DSN 3.3.6.039.

The vibration levels in the nearest industrial and residential buildings shouldn't exceed the requirements of DSN 3.3.6.039.

Table 3 shows levels of sound pressure, dB, in octave lines of frequencies with average geometric frequencies.

Table 3

Levels of sound pressure in residential buildings, dB

Assignment of the building or territories	Time of the day	Levels of sound pressure, dB, in octave lines of frequencies with average geometric frequencies, Hz								Sound levels, LA, and sound equivalentL, dBA Aequ	Maximum sound levels, LAmax, dBA
		63	125	250	500	1000	2000	4000	8000		
Rooms of apartments; residential buildings; restrooms, boarding schools, for elderly and disabled people, sleeping rooms, for children, establishments	From 7 a.m. to 11 p.m.	63	52	45	39	35	32	30	28	40	55
	From 11 p.m. to 7 a.m.	55	44	35	29	25	22	20	18	30	45

From Table 3 it follows that the optimal noise level in residential buildings, apartments, houses should be within 52–45 dB at daytime (with 125–250 Hz respectively), and 44–35 dB at nighttime (with 125–250 Hz respectively). This will ensure normal working and rest conditions.

In order to choose a heat pump that will be safe in terms of noise and vibration pollution, it is necessary to perform a comparative characteristic of the models.

The criteria for choosing will be: price policy, conversion factor of energy (COP), power consumption of HP and power of heating.

The heat pump with the principle of "air-water" works on solar energy at temperatures from -25 to +35 °C. These heat pumps are very practical in the

presence of an already existing district heating system, as they can significantly reduce the cost of heating. The ambient air from is always available in unlimited quantities, especially since installation of the system takes a little time and is not so expensive.

Today, there are a large number of heat pumps on the market. Below we will look at the most popular ones.

So, the following models were chosen for comparison:

- ✓ HimteksNewEnergy C-12 (L);
- ✓ Dimplex LI9TE;
- ✓ CTC EcoAir 406;
- ✓ Mycond MHCS 035 AHB;
- ✓ MammothMac 5.

We will compare heat pumps by the following indicators: heating power, power of consumption, COP, heating temperature, noise level, coolant flow, operating temperature range, coolant type, heating area and price.

Table 4 shows technical characteristics of different models of heat pumps.

Table 4

Technical characteristics of heat pumps

Model / Parameter	Mammoth Mac 5	Himteks NewEnergy C-12 (L)	Mycond MHCS 035 AHB	CTC EcoAir 406	Dimplex LI9TE
Heating power, kW	5,5	10,0	10,1	6,0	9,3
Power of consumption, kW	2,0	2,4	2,46	1,3	2,27
COP	2,8	4,1	4,1	4,9	4,09
Heating temperature, °C	58	60	63	65	58
Noise level, dB	52	50	56	56	48
Coolant flow, м^3/h	0,8	2,1	1,8	1,5	0,8
work temperature range, °C	-25…+35	-20…+43	-25…+35	-22…+40	-25…+35
Coolant	R407C	R407C	R410A	R407C	R404A
Heating area, m^2	100	150	140	110	110
Price, euro	2600	2900	3500	5900	6000

Analysis of table 4 shows that the most relevant in «price-noise pollution level» comparison we can highlight 2 models: Mammoth Mac 5, Himteks New Energy C-12 (L). The advantage of Mammoth Mac 5 is the ability of air conditioning.

Heat pumps «air-water» Mammoth series MAC convert low-potential heat from the ambient air into a high-potential heat through the Freon circuit and transfer it to the water circuit for heating premises and hot water supply. In

cooling mode there is a reverse process, that is, heat pumps cool the water that is fed to the air supply units or fan coils, then discharge heat through a condenser that is blown with air.

The basic scheme of work of the heat pump «air-water» is shown at Figure 3.

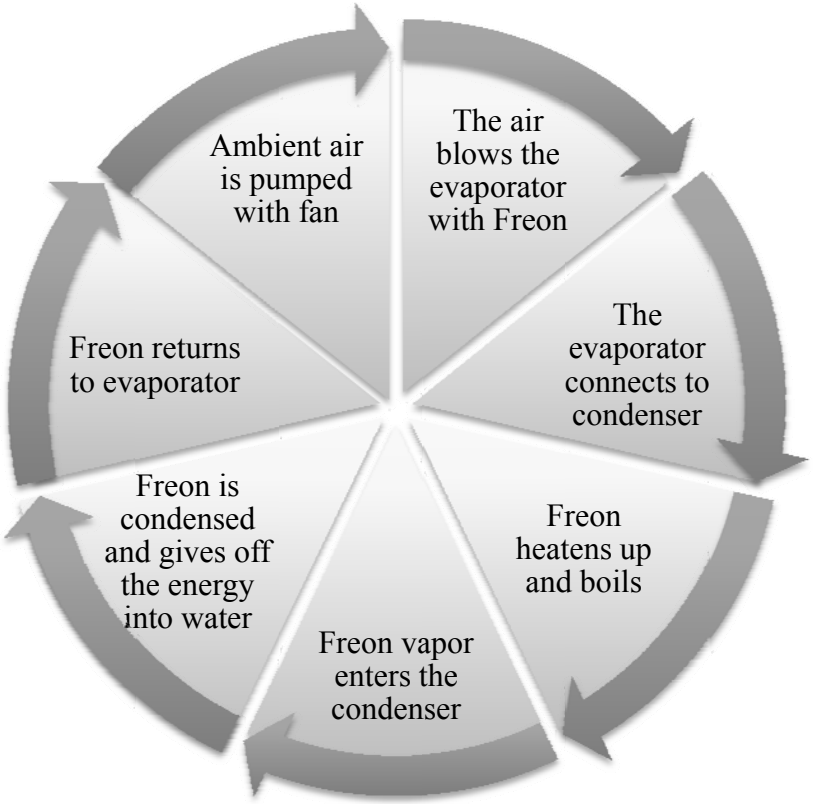

Fig. 3. Basic scheme of work of the heat pump «air-water»

The process of conversion of low potential heat into a highly potential occurs as follows.

The low-temperature energy carrier, which is the ambient air, is pumped with fan and blown off the evaporator, where there is a substance with very low boiling point (refrigerant, usually Freon). The evaporator is coupled to the condenser with which they form a closed system.

The coolant, when heated with the energy of external air, boils and in the form of a steam, under the existing circuit enters the condenser, where it again turns into a liquid, giving heat through the heat exchanger water circulating in the heating system.

Freon, when turned to liquid, again gets to the evaporator, and the cycle of it's transformations begins from the start.

Therefore, the use of a heat pump is a rational and progressive resolution for solving energy consumption and environmental pollution problems.

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