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STRATEGIC EXPEDIENCY OF USING AN INNOVATIVE PRODUCT IN THE RESTORATION OF THE ENERGY SECTOR: THE EXPERIENCE OF TURKEY

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Nowadays, Ukraine is experiencing a full-scale military invasion by Russia, which is causing a large number of casualties among all segments of the population. Many Ukrainian cities have suffered quite heavy damage to their infrastructure. According to Bloomberg, companies from Austria, Germany and Turkey are already operating in Ukraine. An expanding number of foreign companies are increasing their presence in Ukraine, relying on Ukraine's post-war investment and innovation potential. Ukraine's post-war development will take into account the latest energy-efficient, environmental, social and economic trends in engineering and technology in various sectors. Considering the climatic conditions in Ukraine, one of the priority areas of reconstruction is to restore heat in buildings (both residential and non-residential) in winter and air conditioning in summer. According to the International Energy Agency for Heating, the use of heat pumps in various industries will continue to grow and should reach at least 75%. Such growth rates in the use of heat pumps are due to a significant reduction in heating or air conditioning costs, environmental safety, and their versatility in use. In this regard, the use of heat pumps in the reconstruction and restoration of Ukrainian residential and non-residential buildings has its advantages and is recommended by many scientists for use. In this study, an application of heat pump originating from aqua-air in Isəsan showroom existing in Antalya and some experiments with R514 type heat pump devices existing in air conditioning-cooling lab in Akdeniz University Technical Sciences Vocational High School have been carried out. In both devices in variable conditions water discharge entering into condenser on R514 type testing machine has been considered as 10–50 gr/h variable and accordingly it is observed that the real heating factor of action differ 2.25–7.40 values. On the other hand, the heating factor of action in theoretical state have been calculated and the correlation between them have been examined. Besides this, in LHK-10 type heat pump originating from aqua-air in Antalya Issan Showroom and the application is completed, temperature rating entering into condenser has been changed between 16 and 32^0C and the heating and cooling factor of action(for both theoretical and real occasions) affecting the heat pump have been calculated. The experimental and the practical results getting from two different places have been analyzed respectively.

Keywords: economic substantiation, investment, energy efficiency, energy crisis, modernization, post-war reconstruction.

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Introduction and statement of the problem

For the purpose of partially reduce the disadvantages brought by the energy crisis that gained importance world wide as well as in Turkey in this century; it is necessary to develop and practically use thermal systems that will reduce the thermal energy to minimum level. Heat pumps can be shown as a sample to this systems [1].

Analysis and research of publications

In the very simple expression, Heat Pumps are thermodynamic systems that are transferring low temperature from a resource to a resource with higher temperature. Heat pumps are working on a base by water, air or other fluids heating and ejaculating the high temperature from the condenser. The main purpose of this is to obtain hot water or air for heating, drying and similar actions. Aqua-Air heat pumps means a heat pump that is obtaining hot water by absorbing the heat from the air. It is also possible to avail the energy discharged by the heat pumps. However, it is not always possible to use the heat pumps everywhere. Especially regarded to the discharged heat energy, taking in consideration the size in W, the temperature, regaining ways, the cold environment where the heat is absorbed from, constructive specifications, the physical and chemical characteristics of the discharged fluid, etc that will be used, it is necessary to do a versatile analyze. Sometimes, heating pumps are the best solution when both, heating and cooling required places is requested. As an example to this, drying plants, sporting complexes and places like food and industrial plants where bi-directional applications are used can be mentioned [2].

The interest in heat pumps increased after the Energy crisis in year 1973, and in 1976 300.000 unites of heat pumps have been manufactured. Till the end of 1978 the manufactured heat pump total amount in America was more than 2.000.000 pieces. 25% of the buildings established after the year of 1978 have been planed and applied as to be heated with the heating pumps. Nowadays in worlds developed countries, like America, Canada, Germany, Switzerland, etc., heat pumps are being used widely in housing as well as industrial fields [3].

In Turkey, the activities about heating pumps are rising rapidly and they can be summarized as follows: Hepbasli (Hepbaюlэ) had explored the heat pump activity and performance evaluating criteria’s [4]. In a high efficiency of the application of a geothermal source using ground originated high pump study [5], the ground originated heat pump application sample was applied to Therme Maris Health Central Hotel located in Dalaman County, Mugla, the heating process was done with using thermal water and floor heated water by applying a geothermal source as the low temperature. The source temperature was 27^0C, and it is determined that when the device output of the water reaches the temperature of 42^0C the heat pump’s COP value is approximately 5.5—6.0.

Sen [6], in his study about the introduction and application of heat pumps, has given sample applications in Turkey trough examining the ground and water sourced heat pumps horizontal laying, hybrid and technical manners. Gunerhan [7], has placed his work on ground heat exchanger designs in ground and water resourced heat pumps and has made a detailed research about the vertical heat exchangers sizing’s in the ground sourced heating pumps.

Веюег [8], in his study about heat pumps and energy regaining systems invilla air conditioning systems, has analyzed the application of heat pumps solar collectors (3 m^2) established 2004 in Bornova County, Izmir. A device of 8.1 kW cooling and 8.6 kW heating capacity for a villa’s heating, cooling, ventilation, usable hot water, a whole systems main components that will satisfy the need of heating the pool water were analyzed.

Gungor [9], in his study about dryers with heat pump, has especially pointed out that this is also a potential technology for precious raw material and product during process, especially for the ones that must be dried out in controlled environment under low heat.

Dogan [10], in his study about aqua and ground sourced heat pumps, in order to realize how the flow of an aqua sourced principled heat pump will transfer the heat to ground based systems. For this he took in consideration a household under conditions of Ankara, an annual cooling and heating profile was developed for annual energy consumption forecasting the regarding

In his study about aqua soil heat pumps Dogan [10], has investigated how to transfer and apply the aqua resourced heat pumps operational principles to soil resourced heat pump systems. For this study he has established a yearly heating and cooling profile for a housing regarding conditions from Ankara. It has been also tried to forecast the Annual Energy Consumption calculation by using the “Thousand Method ”.

In another Dogan’s [11] study, he had worked on heat pump application for heat recovery from seawater to water and has also exanimate the conditions and operational principles of heat pump system finished in Antalya in 2005, knows as Turkey’s largest heat pump system.

Oktay [12], has made a study on examination of performance efficient factors in a heat pump supported dryer. For this study, a heat pump system was added to convectional hot air entranced dryer system. As a result of this study the effective parameters that are affecting the systems yield were estimated.

In their studies about energy and exergy analyzes solar sourced heat pumps Comakli and his friends [13]; experimental measurements were done in January, which is the coldest moth of the year in the energy laboratory in Ataturk University in Erzurum. As a result of this experiment, the heat pump and system performance coefficient and its exerjetic yields were estimated.

In this study experiments were based on R514 Type aqua-air heat pump devices current in Air Conditioning Cooling Laboratory of Vocational Technical Sciences High school of Akdeniz University and in Isэsan Showroom building in Antalya.

For both devices used in the experiments various conditions were applied; for R514 experimental device the water flow between 10–50 gr/sec trough the condenser was taken as the variable. In this study the variation of heat efficiency coefficient depending on the water flow was tried to be determined.

On the other hand, in the experimental study done with the LHK-10 type aqua-air soured heat pump current in Isэsan Showroom Building; the variation of water temperature entering the condenser between 16–32^{0}C was taken as parameter, and according to that the operatic and theoretical cooling and heating effective coefficient were computed.

The aim of the article

The aim of this study is to use the Turkish experience in the energy saving, analyze the both experimental results with engineering methods and to provide benefits in their practical use to applicants and engineers in the restoration of the energy sector of Ukraine.

Presentation of main material

Material – Method. The efficiency of the heat pumps is showing big differences according to the temperature of the external environments where the energy is pumped. On the other hand the confort conditions requested from people during the winter and summer moths are remaining the same. It is around +/– 24^{0}C. The warm water temperature used for shower/bath and similar application remain, s for both summer and winter months, around 45^{0}C. In case that the heating necessity reaches the maximum, this indicated that the exterior temperature has reached the minimum [14].

In order that they are more functional with the availability to be used in the traditional manner as one device for cooling and heating purpose, providing an important saving of energy consumption, their compact structure, adjustability to high control technology and other similar advantages the heat pumps are widely used in the market in the past years.

As known I the II Law of Thermodynamics, the heat transmission a colder heating source to a hotter environment can only occur when the second energy source energy is thermal or mechanic and the transmission from the cold heat device to the hot environment can occur in various ways. Accordingly the heat pump types can be ranged as follows: vapor pressed circular heat pump, absorption heat pump, absorption heat pump, gas circular heat pump, jet steam circular heat pump, Stirling circulated heat pump, resorption heat pump, Rankine/vapor pressed circular heat pump and Thermo electrical heat pump.

Thermodynamically Heat pumps. Although Carnot cycle is nonexisted it is a totally reversible cycle. Therefore it is used in the comparison of power cycles. Carnot cycle is, in given temperature range the highest heating exothermic cycle. It is also possible that change of states in Carnot cycle, the heat and working transaction reverse. This I called the reversed Carnot cycle. Heat pump and cooling machines are working according to the reverse Carnot cycle [15].

In heat pumps, the cooler heat is taken and this mentioned heat is by the refrigerant fluid transmitted to heat source, transformed to elevated temperature. As refrigerant in vapor pressed circular liquid steam is used. A heat pump is consisted of four main parts: 1 – Evaporator, 2 – Condenser, 3 – Expansion valve, 4 – Compressor.

The Fig. 1 presents schematically the heat pumps cycle.

Different sourced Heat Pumps. The low energy in heat pumps is obtained free of charge from different natural resources. During obtaining this energy neither the source temperature changed nor negative effects are added to the environmental conditions. The application can be grouped as follows [17].

In heat pup systems the environment that the evaporator is absorbing the energy is called the heat source. For using this energy source, which is very important for the heat pump, efficient in the system depends on the below mentioned conditions:

– to posses high resolute hat during the heating season;

– to be easy to find;

– not to have corrosive and pollutant effects;

– to have appropriate thermo physical characteristics;

– to have low investment cost for reaching the source.

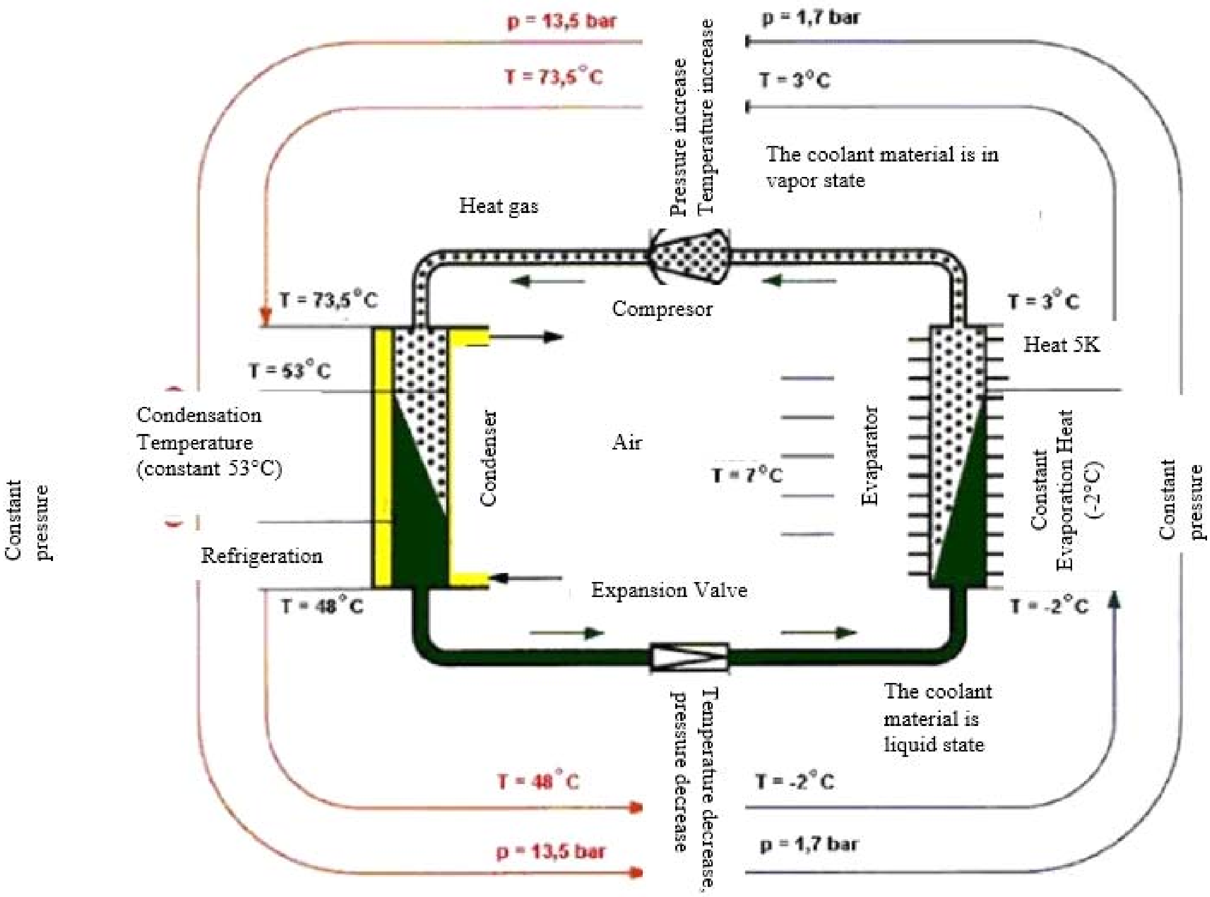

Fig. 1. A heat pump cycle based on typical and temperature variation. Work item R134a, Air 7⁰C / Water 50⁰C [16; 20]

The sources used for heat pups can be ranged as follows [15]:

a – ambient air: As it is the easiest and most economical, air is the most used heating source. The air sourced heat pumps annual coefficient of performance, is lower than in the ground sourced heat pumps around 10 – 30 %. Nowadays these losses are minimized by the application of variable capacity control compressors;

b – ground (soil): the reasons why ground sourced system are used are, the continental climate, where considering to the air temperature the soil temperature in not varying during the year and the usable temperature range that can be used during the winter. The disadvantages ground sourced heat pumps are factors like the current ground field, the ground compound, the density, the contained humidity amount and the pipes application depth;

c – surface waters: Sea, lake, pound, etc are used for this systems. Although the water of seas and lakes are altering during the seasons, in proportion to the air those differences are not so remarkable. For river and lake water sourced heat pumps it is necessary that the water depth is not less than 2m and that the where the settled capacity surface field is minimum 80 m^2;

d – subsurface waters: The temperature variety during the year is very low. The pumps use for transferring the water are presenting additional energy requirement. Burring the heat transformers underground cab cause corrosion and will increase the costs;

e – exhaust air: this is an important hear source for housing and commercial buildings. The heat pump is using the absorbed heat from the air conditioning to heat water and location. The exhaust air operated heat pumps, provide heating the ambient by regaining the used air heat;

f – effluent fluids: effluent water, treated and raw sewage waters, industrial effluent liquids, industrial engine/compressor coolants and condensates from coolant devices are typical examples for this kind of heat sources.

The Thermodynamically Comparison of Power Machines and Heating Pumps.

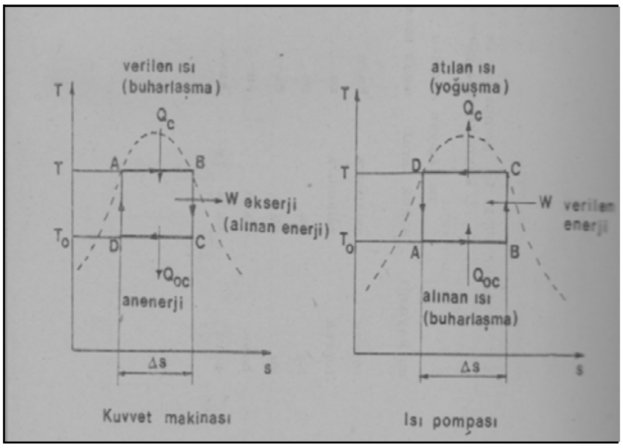

Fig. 2. The Carnot cycles of a powe machine and heat pump [2]

As it can be seen n the Fig. 2 the Carnot cycle in te power machines are:

Q_C: is given heat (evaporation), W: is received energy (Exergy), Q_{OC}: is anenergia.

$Q_C=W+Q_{OC.}$

As is known the usable part of energy is the Exergy. The non usable energy is named as anenergia. Regarding to this, the relation between Exergy and anenergia can be shown as:

Energy=Exergy+anenergia (1)

Along the cycle:

$$\eta_c = \frac{T - T_0}{T} = 1 - \frac{T_0}{T}, \quad (2)$$

with this expression the Carnot efficiency is determined.

Also $W=Q_C \times \eta_c$

In case of heat pumps it is like:
Exhaust heat=Given energy+received energy (3)
Heat Effect Coefficient HEC (IEK) is like [2]:

$$IEK = \frac{Q_c}{W} = \frac{T}{T - T_0}.$$

The experimental pump used in this study is a direct expansion pump, therefore it s possible to draw an InP–h diagram as shown below on Fig. 3.

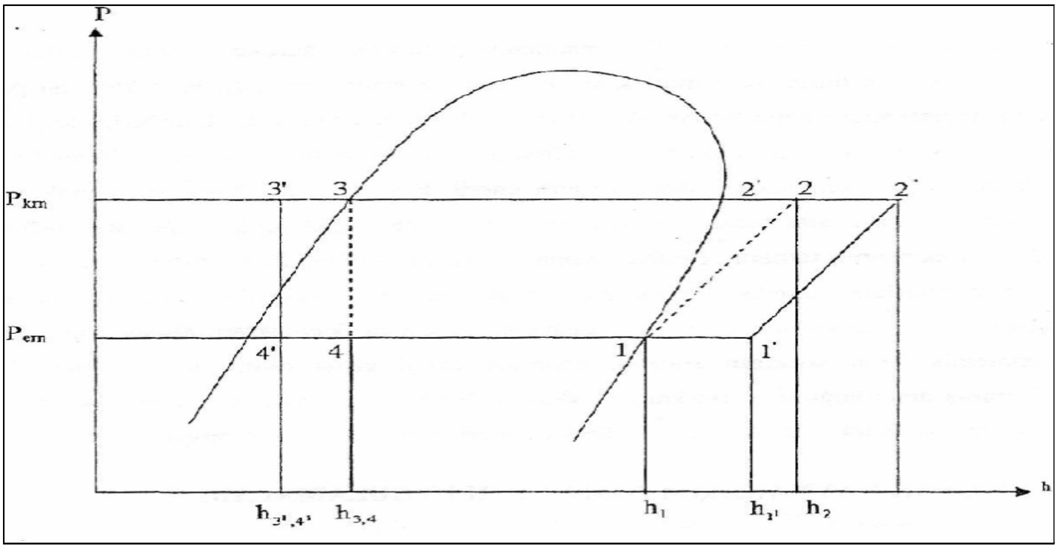

Fig. 3. The lnP–h diagram (presenting a single-stage systems with and without heat exchanger)

Reversible Carnot cooling cycle consist from two constant temperature and their operational procedure, total four thermodynamic operation (Fig. 3). In the diagram the 1–2–3–4 operations are reversible. The Carnot cycle, is not reversible to 1'–2'–3'–4' thermodynamic operations and shows the Carnot cycle. It is:

1–2: the adiabatic isentropic compression in the Compressor;

2–3: the constant pressure and temperature compression in the Condenser;

3–4: the isentropic extension of the Extension Valve;

4–1: the extension f the evaporator under constant pressure and teperture.

The 1–2 and 3–4 thermodynamic activities are based on transaction basis.

1–2: it is presenting the operation done over the working fluid with W_{el} operation out of system borders;

3–4: it is presenting the over border systems transferable operation in reversible and non reversible systems.

To prevent the fluid from the intake line to run into the compressor during the application the system is changed into heat exchanger. The heat exchanger transforms the coolant liquid at the entrance of the compressor by overheating first into the steam faze, than the fluid at the exit condenser by overcooling into overcooled and liquid faze [17].

In the reversible Carnot cycle, the entrance of the saturated vapor phase liquid into the compressor under constant pressure is considered as the 1 point, after compression with adiabatic constant entropy the transfer from the compressor to the condenser as the 2 point, the transformation under constant pressure in the condenser from superheated steam into saturated steam phase still as the 2 point and entering the extension valve in the phase of saturated liquid as the 3 point, after extending in the adiabatic entropy, the transfer from the extension valve to the evaporator as the 4 point, by absorbing heat under constant pressure in the evaporator the transformation to the saturated vapor and entrance to the compressor as the 1 point. If the mass flow of the coolant fluid in the system is chosen as m=kg/h and the enthalpy as kJ/h than the capacity evaluation can be calculated with the below mentioned equations:

$W=m_r(h_2-h_1)$ (Compressor's compression activity) (kJ/h); (4)

$Q_C=m_r(h_2-h_{3,4})$ (Condenser condensation capacity) (kJ/h); (5)

$Q_0=m_r(h_4-h_1)$ (cooling load) (kJ/h). (6)

Experiment Performing and Interpreting the Findings. Experimental Study carried out in the University Laboratory (Group I: GI). Photographs from a R514 aqua/air mechanical heat pump current in Air-conditioning – Cooling Laboratory, Technical Sciences Vocational High School, Mediterranean University are shown on Fig. 4 (a) and (b), Fig. 5.

(a)

(b)

Fig. 4. Heat pump belonging to a Laboratory device (a): general view, (b): coactionel, condenser with pipes and water

GI Experimental Device's Specifications. GI experimental heat pump device consists from: 1 piece of 1/3 HP hermetic type compressor, 1 piece of 1/3 type air cooler evaporator, 1 piece of water condenser with interpenetrated (coaxsionel) pipes, 1 piece of R134 gas measuring flow meter, 1 piece of rout meter type flow meter which is measuring the water flow (kg/sec) circulated in the condenser, 1 piece of annular balanced thermostatic extension valve, 1 piece of filter (dryer), 1 piece of pressure manometers showing low and high pressures, 1 piece of pressure automatic and 1 piece of condenser fan from power of 40W. Also one Wattmeter (it is measuring the system's total consumption of electrical energy as (Watt/sec), 8 pieces of temperature measuring sensors (trough this sensors the results of measurements are transferred to the Regulator switch indicator), one of each, water input and water output (drainage) lines are existing. In order not to be effected by the ambient conditions the temperature measuring sensors were isolated with polyurethane material during the 8 digital temperature measurements [18, 19].

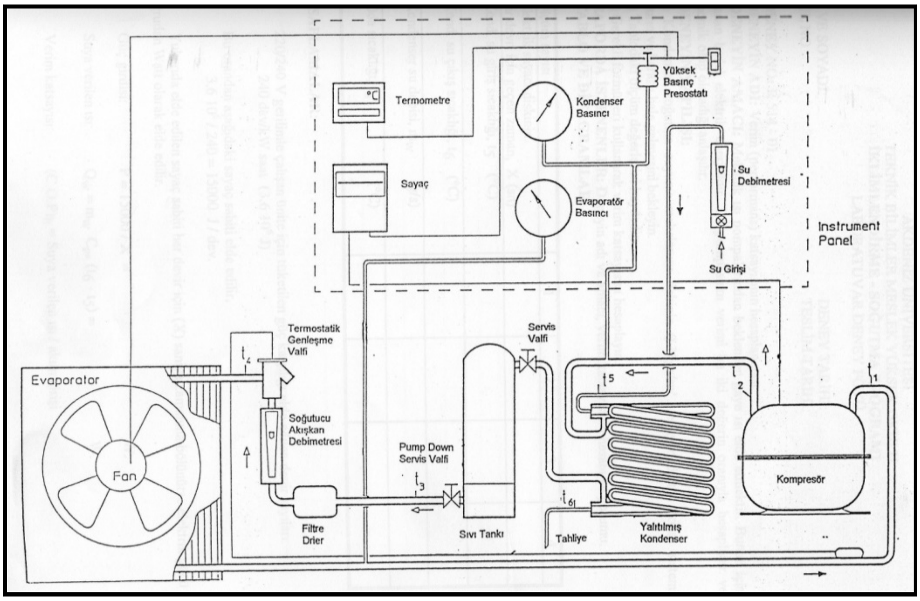

Fig. 5. Exploded view of the Mechanical heat pup device used in experiment of GI [18]

The temperature points taken from the GI device were respectively as follows; the coolant fluid’s compressor input (incoming) temperature (t_1), the coolant fluid’s compressor output (outgoing) temperature (t_2), the condenser condensation temperature (t_{ky}), the coolant fluid’s condenser output (outgoing) temperature (t_3), the coolant fluid’s evaporator input (incoming) temperature (t_4), the coolant fluid’s evaporation temperature in the evaporator (t_{eb}), the water input (incoming) temperature into the condenser (t_5), the water output (outgoing) temperature from the condenser (t_6), and the ambient temperature (t_7).

During the estimation, the air/aqua heat pump was activated and operated idle without load for one hour time. Later on for evaluation the elapsed periods for the determined load taken from the Wattmeter (each 0.5 kW from the total consumed electrical energy) were estimated with a chronometer. R134a was used as the coolant fluid. The estimation results are shown in the Table 1, Fig. 6–7 mentioned below.

Table 1

GI Experiments and evaluation results of the heat pump

Evaluation Parameters	1. Evaluation	2. Evaluation	3. Evaluation	4. Evaluation	5. Evaluation	6. Evaluation
m_{su} (gr/sec)	50	40	30	20	10	4
m_r (134 a gas, gr/sec)	6	6	6	6	6	7
P_k (High-pressure side, bar)	6	6.45	7	7.9	10.8	13.9
P_e (Low-pressure side, bar)	2.75	2.92	3	3.18	3.22	3.40
t_{ky} (Condenser condensation temp. ^{0}C)	28	30	32	34	43	55
t_{eb} (Evaporator evaporation temp., ^{0}C)	6	7	8	9	9	11
t_1 (Compressor income temp., ^{0}C)	16.6	13	10	7.5	8.5	9.6
Overheating (^{0}C)	–10,6	– 6	– 2	1,5	0,5	1,4
t_2 (Compressor outcome temp., ^{0}C)	51.6	54.1	52.9	53.4	57.3	61.8
t_3 (Condenser outcome temp., ^{0}C)	23.3	24.6	22.7	32.3	42.2	54
t_4 (Evaporator income temp., ^{0}C)	8.9	9.6	10.8	11.4	12.0	13.1
t_5 (Mains water income temp., ^{0}C)	18.6	18.7	19.1	19.3	20.3	22.6
t_6 (Condenser/evap. water outcome temp., ^{0}C)	24.3	26	29.2	34.3	45.3	55.1
t_7 (Ambient Temperature, ^{0}C)	20	20	20	20	20	20
Device’s operating time (min) (for 0,5 kW/h)	10.10	9.56	9.28	9.02	8.06	6.42
$Q_k=m_{su}\times Cp_{su}\times(t_{5}\text{–}t_6)$ (Kondenserden suya verilen ısı W)	1191.3	1220.5	1266.5	1254	1045	543.4
$W_{el}=m_r\times(h_2–h_1)$ (The action shared on Working fluid, W)	150	192	240	242	240	241
$IEK_g=Q_k/Wel$ (real heat effect coefficient)	7.4	6.3	5.2	5.18	4.35	2.25
$IEK_t=T_{ky}/(T_{ky}–T_b)$ (theoretical heat effect coefficient)	13.68	13.17	12.7	12.28	9.29	7.45

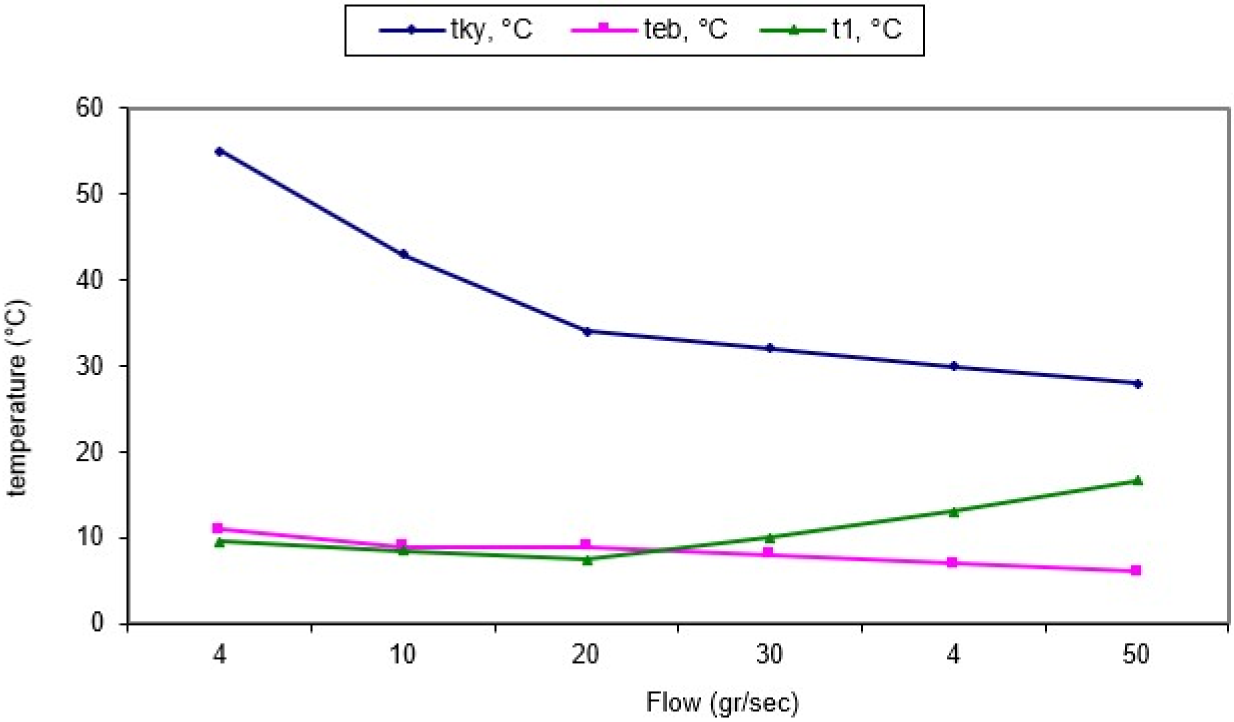

Fig. 6. The temperature differences appeared by using variable water flows for GI

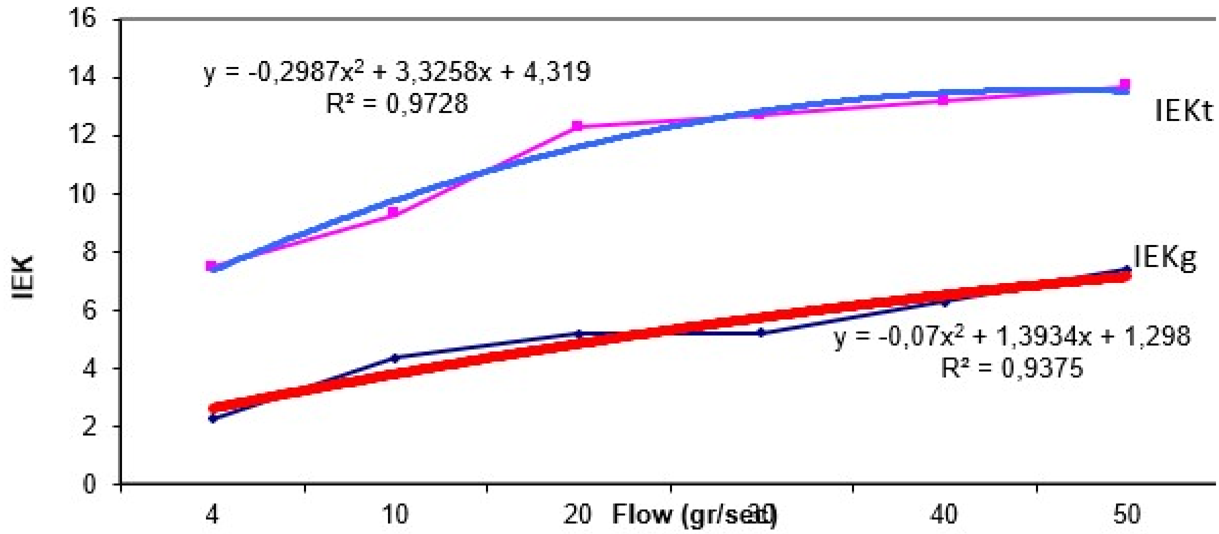

Fig. 7. The effect of the variable water flow to IEK in GI (IEK_g= real heating effect coefficient, IEK_t=Theoretical heating effect coefficient)

The experimental Activities in Antalya Isisan Showroom Building (Group II: GII).

The Characteristics of the Isэsan Showroom Building in Antalya. The Isisan Company showroom building in Antalya consists of a basement, ground floor an one normal floor. The ground floor has a clerestory. This buildings heating – cooling activities are fulfilled with an Aqua / air heat pump with additional Water VRV system (Fig. 8). For this one external unite from 10 BG power and in accordance to the gaining heat and losses calculation 8 system connected internal unites with appropriate volumes were placed. Three internal unites of 36000 BTU, 48000 BTU and 60000 BTU were placed in the same location where de current heat pump is placed.

GII Experiment Device Specifications. The specifications of the Buderus Logavent LHK Type 10 aqua/air hat pump current in Antalya Isэsan Showroom are as follows. The Isisan Buderus brand named LHK type 10 air/aqua sourced heat pump is using underground ater and for its use a 60 m deep artesian water well is opened for this building. The pump flow of the used artesian water is 5 m^3/h and as heat pump coolant fluid a R-410A type fluid is ussed. The air serpentine is 3 in – a – line with a surface of 0.325 m^2. 3/8” diameter copper pipes are used in the serpentine. The water circuit exchanger has a coaxional type condenser. The here used fan dimensions are 22.9×17.8 cm. the compressor used in the cooling/heating circuit is a piston type and its operation pressure is 4137 kPa (Fig. 9). The operation values of this heat pump are as follows: capacity for cooling 0.44 kW, the capacity value for the heat pump heating is 9.89 kW (Table 2, Fig. 10–11). Cooling effect coefficient is SEK=5.10, and the heating effect coefficient is estimated as IEK=3.82 [21].

Fig. 8. The Isisan showroom building, the general view of the heat pump and the measuring panel

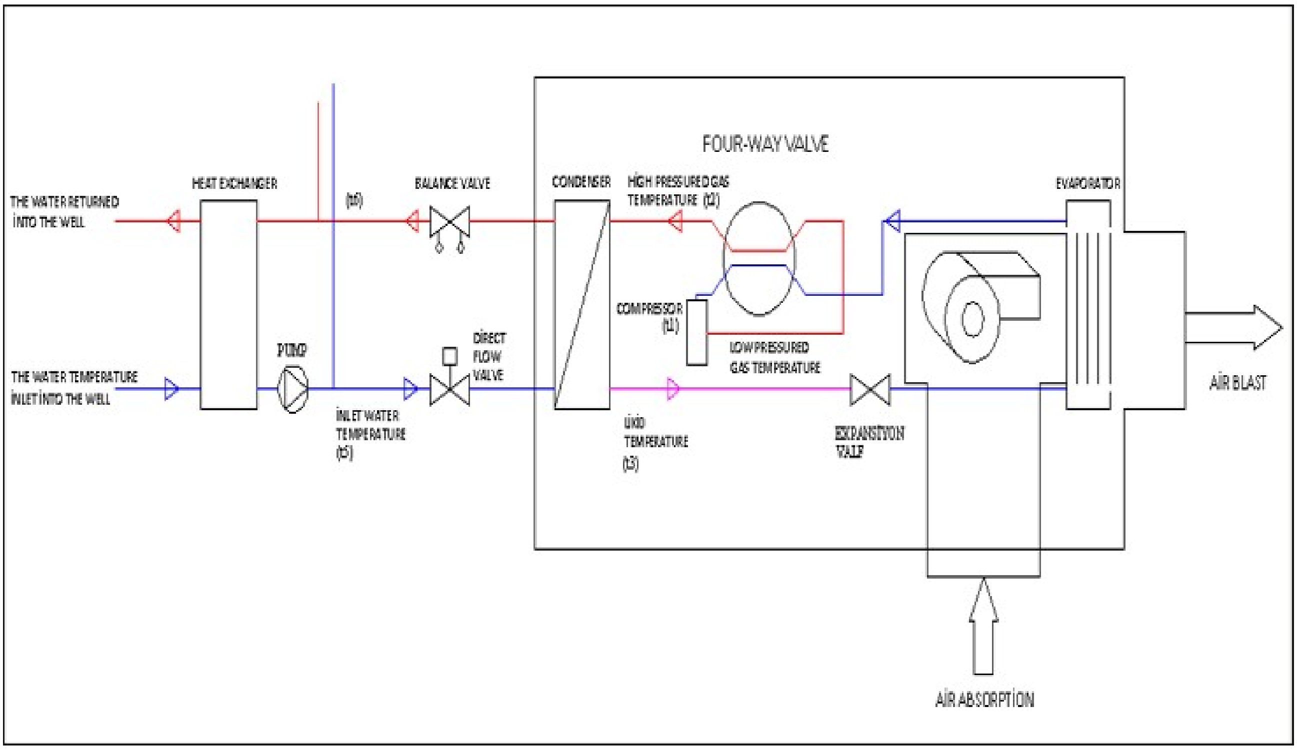

Fig. 9. The cycle scheme from LHK type 10 the aqua / water heat pump in Isэsan Showroom in Antalya city

Table 2

GII aqua / water pump evaluation results

Evaluation Parameters	The values taken when the device is operating (heating)				The values taken when the device is operating (cooling)			
Numbers of Evaluation	1.E	2.E	3.E	4.E	1.E	2.E	3.E	4.E
Pe (evaporator pressure, bar)	9.6	10.8	11.5	11.7	8.1	7.8	7.9	9
Pk (Condenser pressure, bar)	20.4	21.5	24.2	27.8	24	25.1	26	27.2
t_{eb} (Pe equal evaporation temperature, ^0C)	6	8	12	13	1	0	0	4
t_{ky} (Pk equal condensation temperture, ^0C)	33	36	40	46	40	41	43	45
m_r (410A gas, gr/sec)	400	400	400	400	400	400	400	400
t_1 (compressor income temperature, ^0C)	16	16.7	17.2	19.1	8.5	9.2	9.7	9.9
t_2 (compressor outgoing temperature, ^0C)	41.8	41.7	42	41.6	62.7	62.8	62.9	62
t_3 (condenser outgoing temperature, ^0C)	32.9	33	32.8	33.2	11.2	10.7	11.1	12
t_5 (mains water income temperature, ^0C)	16	21	27	32	16	21	27	32
t_6 (condenser/evap. Water output temp., ^0C)	32.8	31.1	30.6	30.9	12	16.2	23.1	25.1
t_7 (ambient temperture, ^0C)	20	20.7	20.4	21.1	20	20.3	20.4	20.6
m_{su} (the circulated water flow in cond./evap., m^3/h)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Absorbed air (^0C)	29.9	30	30.1	30.5	24.7	26.7	27.9	28.9
Blower air (^0C)	41	40.8	41.4	41.6	9.8	10.1	12.5	11.9
$Q_k=m_{su}Cp_{su}(t_5-t_6)$ (the heat given to water by the condenser, W)	37182	29317	9005	3195	–	–	–	–
$Q_e=m_{su}Cp_{su}(t_5-t_6)$ (the heat given to the water by evaporator, W)	–	–	–	–	11619	13943	11328	20043
$W_{el}=m_r(h_2-h_1)$ (the action shared on Working fluid, W)	8800	6800	7200	8000	12000	14000	12000	12800
$IEK_g=Q_k/Wel$ (Heating effect coefficient)	4.2	4.3	1.25	0.39	–	–	–	–
$IEK_t=T_{ky}/(T_{ky}-T_b)$	11.33	11.03	11.17	9.66	–	–	–	–
$SEK_g=Q_e/W_{el}$ (Cooling effect coefficient)	–	–	–	–	0.96	0.99	1.05	1.56
$SEK_t=T_b/(T_{ky}-T_b)$	–	–	–	–	7.02	6.65	6.34	6.75

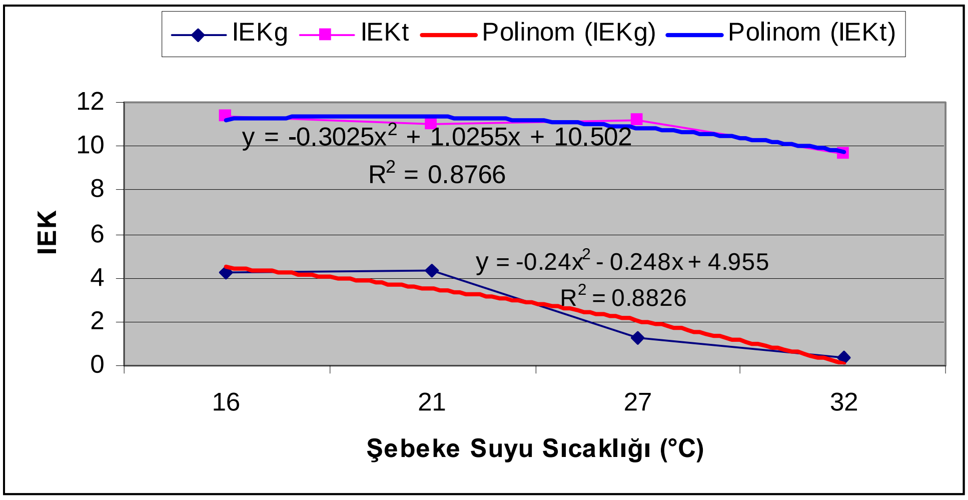

Fig. 10. The effect of variable mains water income temperature on heating effect coefficient

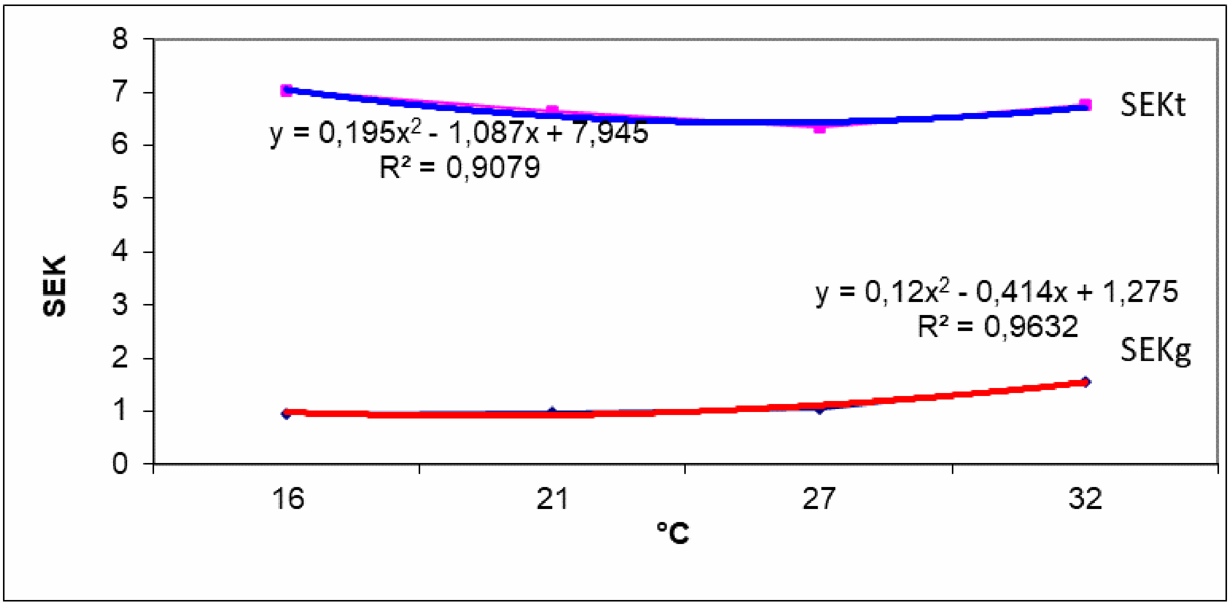

Fig. 11. Effect of variable mains water income temperature on cooling effect coefficient

Output measures of the aqua – air heat pump experiment in Vocational Technical Sciences High school of Akdeniz University in Antalya. According to the output measures applied to Group I (GI) in R514 type heat pumps; after 6 measurements done during the heating process of this experimental device the following results have been reached:

It is found out that as the water flow decreases, the high and low pressure, the condensation temperature in the condenser, evaporator evaporation temperature, the compressors' gas outflow temperature increases. The W_{el} value has increased in the first three measurements, while in the following ones it has decreased.

The gained effective heating coefficient estimated by theoretical calculation (IEK); it is shown that the Theoretic effective heating coefficient (IEK_t) is higher than the reel effective heating coefficient (IEK'_g) (according to the measurements done in GI).

This study has shown that only with the heat calculation assessment real results can not be reached.

It we take a look to the Effective heat Coefficient regarding the flow (IEK), the below mentioned correlations were developed for this study in accordance to the experimental results in theoretically and reel conditions.

$$IEK_t = -0.2987\ m^2 + 3.3258\ m + 4.319,\ (R^2 = 0.97).$$

$$IEK_g = -0.07\ m^2 + 1.3934\ m + 1.298,\ (R^2 = 0.937).$$

Conclusions

The Result evaluation from the aqua / air heat pump in Isэsan Showroom in Antalya City.

According to the evaluation results of LHK type 10 aqua / air sourced heat pump: in the four evaluating results of the device when the device is operating in the heating condition it is found out that the constant and variable water flow income temperature, low and high pressure, compressor gas entrance temperature is increasing while the heating effect coefficient with Q_k is decreasing. $IEK_t = -0.3025T^2 + 1.0255T + 10.502$, $R^2 = 0.88$, $IEK_g = -0.24T^2 - 0.248T + 4.955$, $R^2 = 0.88$.

When the results were analyzed it is found out that as the mains water entrance temperature increased the IEK (as real and theoretically) decreased. Variable water incoming temperature, low and high pressure values, the increase of the compressor entrance and despite the shown decrease of the cooling effect coefficient from a specific temperature to a lower one, we have accepted this as a situation caused from the operation environment. Form this point of view, it is appointed that the temperature is showing in general an increasing tendency and this is shown with the below mentioned relation:

$$SEK_t = 0.195T^2 - 1.087T + 7.945,\ R^2 = 0.91;$$

$$SEK_g = 0.12T^2 - 0.414T + 1.275,\ R^2 = 0.96.$$

Also another comparison for an air/aqua and aqua/air heat pump has been done as follows. The value IEK_g value from A R514 type m=1.39 gr/sec heat pumps aqua/air pump devices IEK 16^0C temperature is.

Despite the result out come as 3.099 by using the formula $IEK_g=-0.07m^2+1.3934\ m+1.298$ for calculation, as it can be seen from the Sheet No: 2, the IEK_g value under the 16^0C water entrance, for the GII aqua to air application device is shown as 4.14.

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СТРАТЕГІЧНА ДОЦІЛЬНІСТЬ ВИКОРИСТАННЯ ІННОВАЦІЙНОГО ПРОДУКТУ В ВІДНОВЛЕННІ ЕНЕРГЕТИЧНОЇ ГАЛУЗІ: ДОСВІД ТУРЕЧЧИНИ

Окуян Кемаль, Чуприна Наталія, Чернишева Олена

На сьогоднішній день в Україні відбувається повномасштабне воєнне вторгнення з боку росії, яке призводить до великої кількості жертв серед усіх верст населення. Багато українських міст зазнали досить серйозних втрат своєї інфраструктури. Деякі міста України потребують повного відновлення після закінчення війни. Вже зараз, повідомляє Bloomberg, в Україні працюють підприємства з Австрії, Німеччини та Туреччини. Все більша кількість іноземних компаній збільшують свою присутність в Україні, розраховуючи на післявоєнний інвестиційно – інноваційний потенціал України. Післявоєнна розбудова України буде відбуватися з урахуванням останніх енергоефективних, екологічних, соціальних та економічних тенденцій в техніці та технології різних галузей. З урахуванням кліматичних умов в Україні, одним з пріоритетних напрямків відбудови є відновлення тепла в зимовий період в будинках (як житлового, так і нежитлового призначення), а в літній період здійснення кондиціонування повітря. За даними Міжнародного Енергетичного Агентства опалення, гаряче водопостачання, кондиціонування за рахунок застосування теплових насосів в різних галузях буде зростати, та має досягти не менше 75%. Такі темпи зростання використання теплових насосів зумовлені значним зниженню витрат при опаленні чи кондиціюванні, екологічною безпекою, універсальність в їх використанні. В зв'язку з цим використання теплових насосів в реконструкції та відновленні українського житлового та нежитлового фонду має свої переваги та рекомендована багатьма науковцями для застосування. У статті розглянуто застосування теплового насосу, що працює на водно-повітряному середовищі у виставковому залі Isisan в Анталії, а також деякі експери-

менти з тепловими насосами типу R514 у лабораторії кондиціонування-охолодження в професійно-технічному училищі Акденізського університету технічних наук. В обох пристроях у змінних умовах витрата води, що надходить у конденсатор на випробувальній машині типу R514, розглядалася як змінна в межах 10-50 гр/год і, відповідно, спостерігалося, що реальний коефіцієнт теплоти дії відрізнявся на 2,25-7,4 величини. З іншого боку, було розраховано тепловий коефіцієнт дії в теоретичному стані і досліджено кореляцію між ними. Крім того, в тепловому насосі типу LHK-10, що працює на водно-повітряному середовищі в демонстраційному залі Isisan в Анталії, застосування якого завершено, було змінено номінальну температуру на вході в конденсатор між 16 і 32 °C, а також розраховано коефіцієнт нагріву та охолодження (як для теоретичних, так і для реальних випадків), що впливають на роботу теплового насоса. Проаналізовано експериментальні та практичні результати, отримані з двох різних місць, та доведено доцільність використання теплових насосів у кліматичних умовах України.

Keywords: економічне обґрунтування, інвестиції, енергоефективність, енергетична криза, модернізація, післявоєнна відбудова.

STRATEGIC EXPEDIENCY OF USING AN INNOVATIVE PRODUCT IN THE RESTORATION OF THE ENERGY SECTOR: THE EXPERIENCE OF TURKEY

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Nowadays, Ukraine is experiencing a full-scale military invasion by Russia, which is causing a large number of casualties among all segments of the population. Many Ukrainian cities have suffered quite heavy damage to their infrastructure. According to Bloomberg, companies from Austria, Germany and Turkey are already operating in Ukraine. An expanding number of foreign companies are increasing their presence in Ukraine, relying on Ukraine's post-war investment and innovation potential. Ukraine's post-war development will take into account the latest energy-efficient, environmental, social and economic trends in engineering and technology in various sectors. Considering the climatic conditions in Ukraine, one of the priority areas of reconstruction is to restore heat in buildings (both residential and non-residential) in winter and air conditioning in summer. According to the International Energy Agency for Heating, the use of heat pumps in various industries will continue to grow and should reach at least 75%. Such growth rates in the use of heat pumps are due to a significant reduction in heating or air conditioning costs, environmental safety, and their versatility in use. In this regard, the use of heat pumps in the reconstruction and restoration of Ukrainian residential and non-residential buildings has its advantages and is recommended by many scientists for use. In this study, an application of heat pump originating from aqua-air in Isəsan showroom existing in Antalya and some experiments with R514 type heat pump devices existing in air conditioning-cooling lab in Akdeniz University Technical Sciences Vocational High School have been carried out. In both devices in variable conditions water discharge entering into condenser on R514 type testing machine has been considered as 10-50 gr/h variable and accordingly it is observed that the real heating factor of action differ 2,25-7,4 values. On the other hand, the heating factor of action in theoretical state have been calculated and the correlation between them have been examined. Besides this, in LHK-10 type heat pump originating from aqua-air in Antalya Issan Showroom and the application is completed, temperature rating entering into condenser has been changed between 16 and 32 °C and the heating and cooling factor of action(for both theoretical and real occasions) affecting the heat pump have been calculated. The experimental and the practical results getting from two different places have been analyzed respectively.

Keywords: economic substantiation, investment, energy efficiency, energy crisis, modernization, post-war reconstruction.

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