ATMO sphere + DANISH TECHNOLOGICAL INSTITUTE

ONLINE

23-24/06/2020

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- Air/Water Heat Pump HT 10/20
- Method of Reducing R-290 Refrigerant Charge and COP Efficiency Increasing Methods

SPEAKER: Martin Lazar

Co-Owner & Board Member, HKS Lazar

HKS lazar®

Modern heating equipment

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MODERN TECHNOLOGIES

PANASONIC AMADA HYUNDAI

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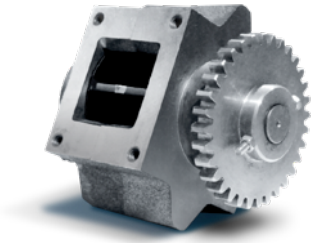
ALWAYS FIRST



Cast iron rotary valve

FIRST IN POLAND

This eliminates the possible ignition of the fuel in the pellet store.

Condensing pellet boiler

FIRST IN POLAND and SECOND in UE

104,4% condensation efficiency

NATURAL REFRIGERANT : R290 PROPANE

Natural refrigerant R290

FIRST IN POLAND and ONE OF THE FIRST IN THE WORLD

Global warming potential:
GWP 3

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SUCCESS STORY

… let me tell You about Our expierences with reversible air to water heat pumps with natural refrigerant R 290 ,on this presentation I will talk about problems we have met **during 3 year R&D project** and solutions we have found. Some of them become Our intellectual property some of them demand further investigation in new products.

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PROJECT FOCUS

Standards of heat pump working with hydrocarbons

1-reversible propane air-to-water heat pump for space heating ,domestic hot water ,cooling mode
2-COP **more than 4,0 (A2/W35)**,
3-Use 4 models of compressors 9, 11,13,16 (Copeland ZH) on-off
4-refrigerant charge limit less than 2,5 kg (PED ,leak test regulations etc.)
5-avoid f-gas regulations during heat pump installation

Refrigerant line improvement (evaporator, refrigerant separator) PART 1

1-use new type of evaporator developed for R-290
2-use new type of refrigerant separator developed for R-290
3-use thermostatic expastion valve (if its possible), oil separator, suction accumulator
4-use the biggest condenser as its possible

New design of air /water heat pump PART 2

1-external localisation of L type evaporator to avoid condensate tray and heater
2-external localisation of refrigerant separator (under the construction plate) ,
3-full covered fan with diffusor (dB reduction),
4-small cover

PROJECT FOCUS (PART 1)

Refrigerant line improvement (evaporator, refrigerant separator)

1-use new type of evaporator developed for R-290

2-use new type of refrigerant separator developed for R-290

PROJECT FOCUS (PART 1)

Refrigerant line improvement (evaporator)

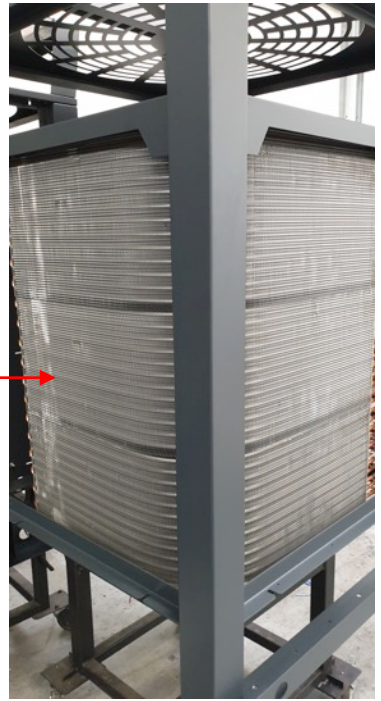
1-use new type of evaporator developed for R-290

1a Challenge

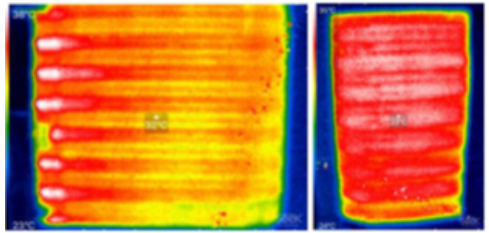
We noticed that R-290 expands very quick inside the evaporator tubes and brakes heat transfer **(even flow of refrigerant is needed)**

Solution

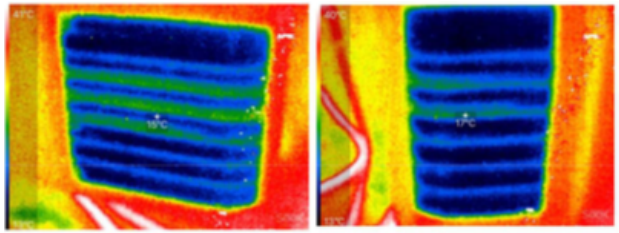
Special 3D internal modifications make that inside the evaporator tubes exists several ring chambers ,gas flows very close to the tube edge with different speed and expands slower **which give us better performance but the active surface is the same**.



CONDENSER



EVAPORATOR



PROJECT FOCUS (PART 1)

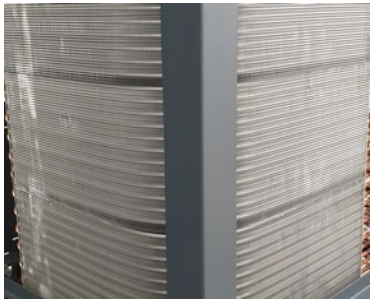
Refrigerant line improvement (evaporator)

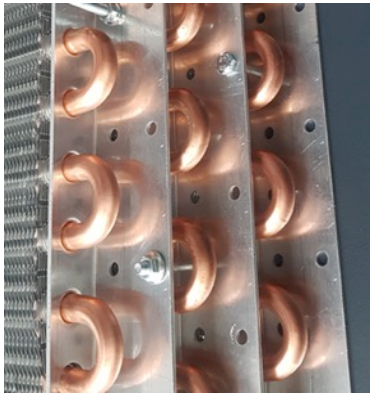
1-use new type of evaporator developed for R-290

1b Challenge - We noticed that because of PED regulations we cant use bigger evaporator
Solution - Special 3D internal modifications give **us 50% reduction of evaporators inner volume**

Type of calculation	Counterflow	**Total capacity [kW]**	**8,93**
Corrective factor	1,0	Sensible capacity [kW]	6,75
Additional equivalent length	0	Latent capacity [kW]	2,19
		Heat exchange coefficient [W/(m2K)]	74,27
Inlet air temp. [°C]	2,0	Condensing temp. [°C]	35,0
Inlet air R.H. [%]	85,0	Subcooling degrees [K]	5,0
Standard air density [kg/m3]	1,225	Temp. before expansion valve [°C]	30,0
Outlet air temp. [°C]	-1,9	Evaporating temp. Dew [°C]	-4,0
Outlet air R.H. [%]	97,3	Superheating degrees [K]	2,0
Volumetric air quantity [m3/h]	5.000,0	Mass fluid quantity [kg/s]	0,0303
Mass air quantity [kg/s]	1,7014	Total pressure drop [K]	0,39
Frontal velocity [m/s]	1,46	Header pressure drop [K]	0,03
Pressure drop [Pa]	32,1	Total pressure drop [kPa]	5,2
Barometric pres. [kPa]	101,3	Header pressure drop [kPa]	0,4
Altitude [m]	0	Capillary pressure drop [kPa]	110,0
		distributor pressure drop [kPa]	10,9
		Refrigerant quality at unit cooler inlet	0,233
Nr. of tubes per row	36	Geometry [mm]	25,00x21,65
Nr. of rows	2	Fin spacing [mm]	2,10
Nr. of unused tubes	0	Fin thickness [mm]	0,10
Nr. of circuits	9	Fin material	Aluminium
Tubes per circuit	8	HxLxP [mm]	900x1.060x43
Inner volume [l]	6,18	Exchange surface [m2]	35,62
Tubes diameter [mm]	9,52	Frontal area [m2]	0,95
Tube thickness [mm]	0,28	Header Øin/out [mm]	16 / 35
Tube material	Copper	Capillary: diameter and thickness [mm]	4,00 x 0,75
Approx. Weight [kg]	13,5	Capillary: length [mm]	900,00
		Distributor: Venturi orifice diameter [mm]	6,00

REAL INNER VOLUME 3,0 (l)





PROJECT FOCUS (PART 1)

Refrigerant line improvement (evaporator)

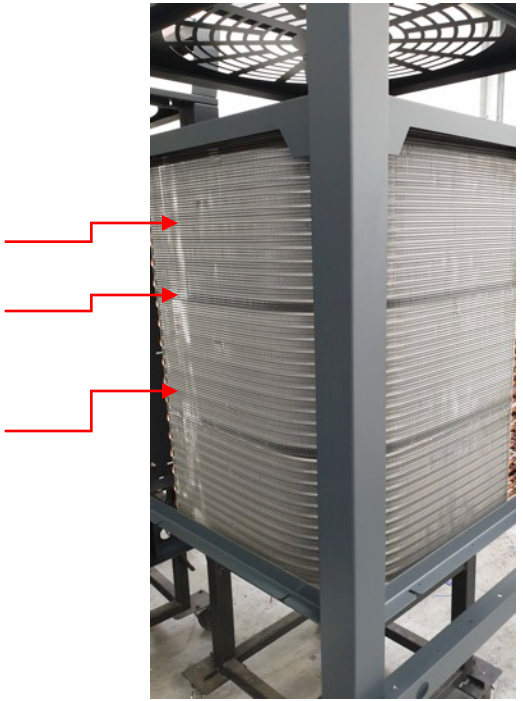
1-use new type of evaporator developed for R-290

1c Challenge

We noticed that espiecially in R 290 we have to pay attenion for every disturbance in air flow

Solution

External control system of air flow. Ussually horizontal/vertical fan position has got bad influence for air flow velocity ,differend pressure drop makes many problems (cover design is not only solution). Thats why We **divided L shape evaporator for 3 sections (upper middle bottom)** Each section consists of **3 segments** . Those segments have also **different fin space** to make additional corrections in air flow.



PROJECT FOCUS (PART 1)

Refrigerant line improvement (evaporator)

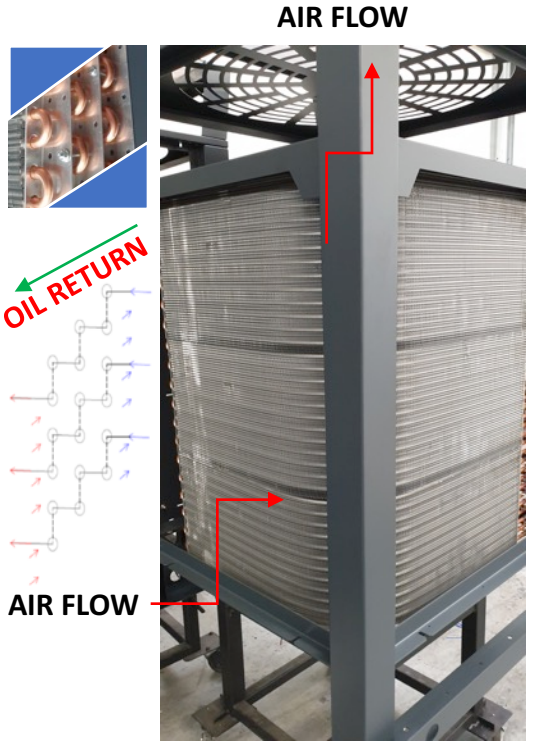
1-use new type of evaporator developed for R-290

1d Challenge

Oil return …

Solution

For R 290 refrigerant not only lubricant foaming and lubricant solubity is a challenge. Special circut design makes that oil returns smoothly **(gravity way)** from evaporator, without risk of that any ramains of lubricant would stay in evaporator during lonterm work (despite using oil separator).



PROJECT FOCUS (PART 1)

Refrigerant line improvement (refrigerant separator)

2-use new type of refrigerant separator developed for R-290

2a Challenge

We noticed that **regular refigerant separator increases refrigerant charge**

Solution

We designed Our own turbular Refrigerant separator to :

1-crash refrigerant drops

2-achieve low superheat without risk for the compressor damage

3-no expansion valve oscilations and quick valve reaction

4-reduce/control compressor temperature control lubricant solubity

5-not shut-off compressor during the defrost period

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OBSERVATIONS

Refrigerant line improvement (evaporator, refrigerant separator)

1-use new type of evaporator developed for R-290
2-use new type of refrigerant separator developed for R-290

Observations general

After **6000 working hours (full field operation 2x winter summer / heat pump 20kW)** and many improvements of evaporators and refrigerant separators we hadnt noticed any damages of compressor

Observations about evaporator

1a-even evaporator freezing (all rows at the same time)
1b-quick defrosting periond and less energy needed to defrost
1c-oil recovery from the evaporator is quaranteed during low refrigerant flow **(inverter)**
1d-COP increasing

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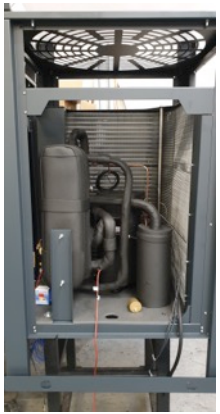
PROJECT FOCUS (PART 2)

New design of air /water heat pump

1-external localisation of L type evaporator eliminates condensate tray and heater (evaporator is elevated under fan construction)
2-external localisation of refrigerant separator under the construction plate to get rid of the condensate
3-full covered fan with diffusor (dB reduction),
4-all refrigerant line elements are insulated (with compressor) …no energy loses/ wet heat pump chamber/futher dB reduction
5-small cover internal module (with controller)



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COP EN 14 511

Air/Water Heat Pump HT 10/12
Pressure Directive PED :Module A2

COCH The Heat Pump Laboratory accredited according to **ISO/IEC 17025** standards and **ILAC ,MRA ,Cracow Poland**

Mierzone wartości / *Measured values*	*Oznaczenie Designation*	*Jednostka Unit*	**A7 W35**	A2W 35	A-7 W35	A-15 W35	A10 W35	**A7 W45**	**A7 W55**	A-15 W55	**A7 W65**
Woda / *Water*											
temperatura na wlocie / *inlet temperature*	t_{w1}	°C	30,06	30,27	31,36	31,85	29,78	40,00	47,07	50,06	54,97
temperatura na wylocie / *outlet temperature*	t_{w2}	°C	35,21	34,40	34,56	34,59	35,02	45,04	55,20	54,51	65,15
strumień objętości / *volume flow*	V_w	m^3/h	1,91	1,90	1,91	1,91	1,91	1,83	1,10	1,10	0,87
różnica ciśnień / *pressure difference*	Δp_w	Pa	-38029	-37738	-39296	-39466	-37885	-34490	-13438	-13209	-8854
wydajność grzewcza / *heating capacity*	P_H	W	11411	9086	7104	6107	11572	10651	10306	5618	10080
Powietrze / *Air*											
temperatura na wlocie, termometr suchy / *inlet temperature, dry bulb*	t_{ps}	°C	7,19	2,37	-6,93	-14,85	10,18	7,09	7,07	-15,03	7,19
wilgotność względna na wlocie / *inlet humidity*	φ_p	%	85,8	83,3	85,6	-	87,9	83,2	84,5	-	84,4
Czynnik chłodniczy / *Refrigerant*											
ciśnienie ssania/ *suction pressure*	p_k	bar	3,31	2,74	1,98	1,44	3,68	3,30	3,33	1,50	3,45
ciśnienie tłoczenia / *discharge pressure*	p_{ss}	bar	12,32	11,90	11,71	11,65	12,27	15,68	19,57	19,98	24,32
Wielkości elektryczne / *Electrical quantities*											
moc pobierana całkowita / *total power input*	P_T	W	2321	2206	2298	2241	2339	2708	3132	3156	3650
moc pobierana efektywna / *effective power input*	P_E	W	2389	2272	2367	2309	2406	2769	3157	3191	3665
Wskaźniki / *Ratios*											
COP	COP	-	**4,78**	**4,00**	**3,00**	**2,64**	**4,81**	**3,85**	**3,27**	**1,76**	**2,75**
Okres zbierania danych / *Data collection period*		-	70 min	148 min 15 s	185 min 15 s	144 min 15 s	70 min	70 min	70 min	149 min 25 s	70 min
czas odszraniania / *defrost time*	T_o	s %	0 0	405 4,55	450 4,05	300 3,51	0 0	0 0	0 0	150 1,67	0 0

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HEAT PUMP MODEL RANGE

HT10/12, HT10/14, HT10/16, HT10/20

high-temperature air-water heat pump with natural refrigerant propane R290 with a maximum heating power of up to 22.2 kW.

	HT10/12	HT10/14	HT10/16	HT10/20
Power / COP A7 / W35	11,5 kW / 4,78	14,1 kW	17,7 kW	22,2 kW
Power / COP A7 / W65	10,1 kW / 2,75	12,8 kW	15 kW	18,8 kW
Power / COP A2 / W35	9,1 kW / 4,0	13,2 kW	15,3 kW	19,2 kW
Power / COP A-7 / W35	7,1 kW / 3,0	9,7 kW	11,3 kW	14,2 kW
Power / COP A-15 / W35	6,1 kW / 2,64	7,5 kW	8,7 kW	11 kW
Power / COP A-15 / W55	5,7 kW / 1,76	7 kW	8,3 kW	10,2 kW
Operating temperature range:	-25C ÷ 35°C	-25C ÷ 35°C	-25C ÷ 35°C	-25C ÷ 35°C
Maximum flow temperature:	62°C	62°C	62°C	62°C
The amount of refrigerant:	2,0 kg	2,1 kg	2,2 kg	2,4 kg
Power supply:	3 x 400V lub 1~230 V	3 x 400V lub 1~230 V	3 x 400V	3 x 400V
Dimensions:	810 x 1380 x 810mm	810 x 1380 x 810mm	810 x 1380 x 810mm	810 x 1380 x 810mm
Weight:	180kg	180kg	185kg	190kg
Hydraulic connection:	G1	G1	G1	G1

COOPERATION 2020

Ready

1-DEALERSHIP PROPOSALS

2-OEM ODM of ready on/off models (CAREL soft /EEV valve in option)

spare parts: Emerson, Alco, GVN, Danfoss, Kelvion, Zegl-Abbeg, Plum

Upcoming

3-OEM ODM inverter models (up to 16 kW)

spare parts: Mitsubishi, CAREL , Alco, GVN, Danfoss, Kelvion, Zegl-Abbeg

4-OEM ODM tandem (up to 60kW)

spare parts: Emerson, Carel, Alco, GVN, Danfoss, Kelvion, Zegl-Abbeg, Plum

5-We are open for new R&Ds (heat pumps, chillers)

Thank you to all cooperators for help in the project!

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PED A2 CE Certificate FLYERS EN DE FR DK IT ES RU NL

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Thank you for listening!

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