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22810

F I N A L   R E P O R T

on tests of the refrigeration pack, pursuant to the Contract No. 02/013 Project MP/YUG/01/160-2/005 Replacement of refrigerant CFC-12 with HFC-134-a and foam blowing agent CFC-12 with HCFC/141b in the manufacture of commercial refrigeration equipment with seven producers,

Entered into by and between:

1. The United Nations Industial Development Organization

And

2. Prva Petoletka in Trstenik

In the Project:

"Replacement of refrigerant CFC-12 with HFC 134-a"

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Contents:

1. Summary

This report contains the obtained test results of a sample of refrigeration pack at which the refrigeration cycle has been redesigned. Production of four types of refrigeration packs, which have used R12 refrigerant, shall be cancelled. The new installation employs R134-a refrigerant. The redesign of the refrigeration cycle employing R134-a, manufacture and testing of the pack have been performed pursuant to the criteria defined by the UNIDO in the Terms of Reference.

2 Introduction

The range of refrigeration packs of Prva Petoletka Trstenik involved:

634-30 000 Refrigeration pack driven by a diesel engine, and by an electric motor for refrigeration during transportation

634-60 000 Refrigeration pack driven by a diesel engine in transportation

634-70 000 Refrigeration pack driven by electric motor for stationary refrigeration, mono-block type for refrigeration and heating

634-72 000 Refrigeration pack driven by electric motor for stationary refrigeration, mono-block type for refrigeration

The main components of the thermodynamic cycle (compressor, condenser, evaporator, ...) are identical with these four types, which means that these four types of refrigeration pack are variants of one refrigeration system, differing from each other in the design of the driving part.

In order to implement the project of replacing the refrigerant R12 with refrigerant R134-a PPT has redesigned the refrigeration system with all the four types of the refrigeration pack and carried out tests with electric motor drive (redesigned 634-72000 is now 634-76000), and the test result apply to the other types of refrigeration packs.

This report contains the results obtained from testing the refrigeration pack 634-76000 with refrigerant R134-a. The test has been carried out pursuant to Contract 02/013.

The aim of this test was to determine the refrigeration capacity, power consumption and noise level. The obtained results can be used for making a comparison with those of refrigeration packs employing R12, with which the test has been carried out with the same calorimeter chamber.

The refrigeration capacity was determined at the temperatures of 28° C, 38° C, 43° C of the inlet air into the condenser and 0° C and - 18° C inlet into the evaporator.

3. Description of the test installation

Figure 1 shows the test installation scheme.

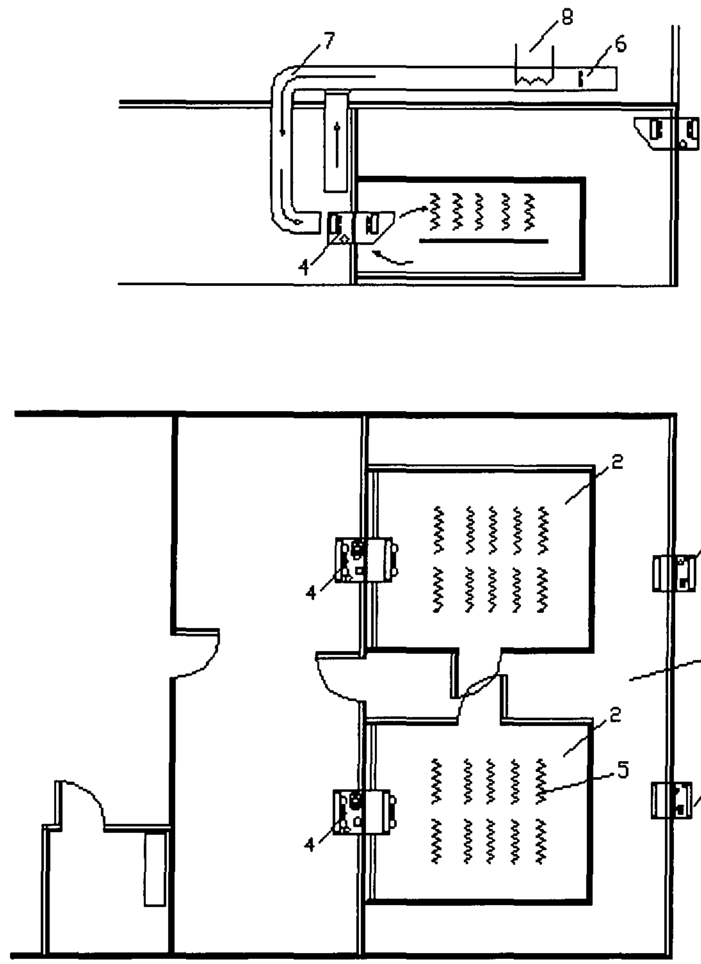

Fig. 1 Test installation scheme

Adiabatic chamber consists of two external chambers (1) insulated from the environment with two polyurethane plates 12 cm thick each, and two internal chambers (2) whose volume is V = 43 m^3 insulated from the external chamber with polyurethane plate 10 cm thick. The temperature inside the external chamber is maintained at the same level, and so is the temperature inside the internal chambers, through separate refrigeration packs (9). Thus is prevented the heat exchange between the internal and external chambers, which makes the internal chambers adiabatic chambers.

The tested refrigeration pack (4) is to be placed onto the support in the adiabatic chamber wall. Within the adiabatic chamber there are several electric heaters (5) of 0.85 kW, and they simulate the heat charge at testing the refrigeration pack.

The air is brought to the condenser by fans (6) through the air tunnel (7) and it passes over electric heaters (8) which heat the air to the temperature defined by the test programme (28°C, 38°C, 43° C).

Refrigeration capacity of the refrigeration pack is measured through the power of the heaters turned on (5), with stationary operation of the system (the tested refrigeration pack maintains a constant set temperature within the adiabatic chamber, without changing the power consumption and without changing the heat charge within the adiabatic chamber).

4. Description of the test method

The main goal of this test was to determine the refrigeration capacity and power consumption at various air temperatures inlet into the evaporator and condenser.

The balance method was applied. It is based at the fact that the set heat charge within the chamber is measured due to maintenance of the air temperature in the calorimetric chamber interspace at the same level as that within the chamber.

Thus the net refrigeration capacity is equal to the power input into the chamber.

A very important fact about this method is that the data are recorded while the process is stationary.

5. Description of the refrigeration installation of the refrigeration pack

The scheme of refrigeration installation is shown in figure 2.

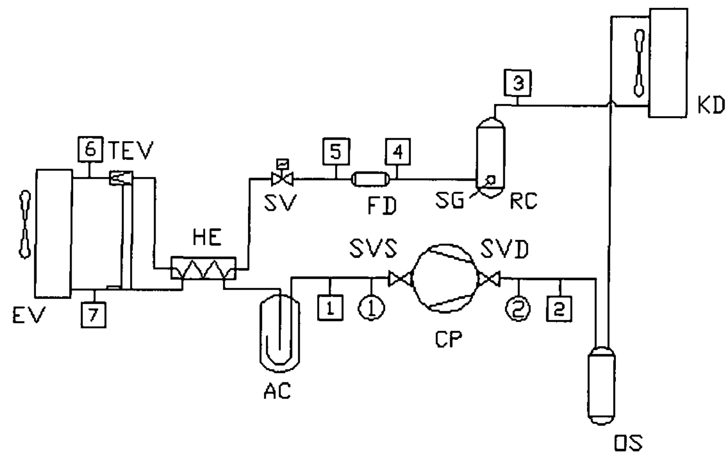

Fig. 2 - Scheme of refrigeration installation

1. CP Compressor Bock HGX 465-4s
2. SVS Service valve Suction
3. SVD Service valve discharge
4. OS Oil separator
5. CD Condenser ...,A = 52.01m^2, copper pipe ø12x0,5, 9 lines, pipe pitch 25 x 25 mm, Al lamella 460 x 150 dimensions of lamellar cels..812mm
6. RC Receiver
7. SG Sign glass
8. FD Filter drier
9. SV Solenoid valve
10. HE Heat exchanger
11. TEV Thermostatic expansion valve
12. EV Evaporator, A= 44,35m^2 copper pipesø12x5.., chess-pattern distribution of 9 lines, pipe pitch 27,5x32 Al lamella 576 x 220 dimensions of lamellar cels..760mm
13. AC Accumulator

The scheme shows the temperature and pressure test points positions (see also Table 1 to 4).

6. Refrigeration pack 634-76000 test results with R134-a

TABLE 1

Rashladni agregat sa R134-a			
1.	t_{vu}	°C	28
2.	t_u	°C	18
3.	t_i	°C	72
4.	t_{vui}	°C	1
5.	p_u	Bar	1
6.	p_t	°C	10.8
7.	P_{el}	KW	6,0
8.	Q_0	KW	9.85

TABLE 3

Rashladni agregat sa R134-a			
1.	t_{vu}	°C	43
2.	t_u	°C	25
3.	t_i	°C	92
4.	t_{vui}	°C	1
5.	p_u	Bar	1.1
6.	p_t	°C	13.8
7.	P_{el}	KW	6.9
8.	Q_0	KW	8.15

1. t_{vu} - Air temperature at condenser inlet
2. t_u - Refrigerant temperature at compressor suction port
3. t_i - refrigerant temperature at compressor pressure port
4. t_{vui} - Air temperature at evaporator inlet
5. p_u - Suction pressure
6. p_t - Discharge pressure
7. P_{el} - Electric motor power
8. Q_0 - Refrigeration capacity

TABLE 2

Refrigeration pack with R134-a			
1.	t_{vu}	°C	38
2.	t_u	°C	20.5
3.	t_i	°C	85
4.	t_{vui}	°C	0
5.	p_u	Bar	1
6.	p_t	°C	13
7.	P_{el}	KW	6.5
8.	Q_0	KW	8.6

TABLE 4

Refrigeration pack with R134-a			
1.	t_{vu}	°C	28
2.	t_u	°C	18
3.	t_i	°C	75
4.	t_{vui}	°C	-18
5.	p_u	Bar	0,18
6.	p_t	°C	10
7.	P_{el}	KW	3,8
8.	Q_0	KW	4,4

7. Refrigeration pack 634-60000 test results with R12

TABLE 1

Refrigeration pack with R12			
1.	t_{vu}	°C	28
2.	t_u	°C	14,1
3.	t_i	°C	85,4
4.	t_{vui}	°C	1
5.	p_u	Bar	0,9
6.	p_t	°C	9,6
7.	P_{el}	KW	11,1
8.	Q_0	KW	8.6

TABLE 2

Refrigeration pack with R12			
1.	t_{vu}	°C	38
2.	t_u	°C	19,5
3.	t_i	°C	96
4.	t_{vui}	°C	1
5.	p_u	Bar	1,0
6.	p_t	°C	12,1
7.	P_{el}	KW	11,3
8.	Q_0	KW	7,9

TABLE 3

Refrigeration pack with R12			
1.	t_{vu}	°C	43,1
2.	t_u	°C	23,5
3.	t_i	°C	103
4.	t_{vui}	°C	1
5.	p_u	Bar	1,0
6.	p_t	°C	13,6
7.	P_{el}	KW	11
8.	Q_0	KW	6,9

TABLE 4

Refrigeration pack with R12			
1.	t_{vu}	°C	28
2.	t_u	°C	16,6
3.	t_i	°C	97,2
4.	t_{vui}	°C	-18
5.	p_u	Bar	0,22
6.	p_t	°C	8,1
7.	P_{el}	KW	9,2
8.	Q_0	KW	4,9

8. Resume

The final report clearly proves that Prva Petoletka has redesigned the refrigeration system of the four refrigeration packs, which differ from each other in the driving part and purpose.

The obtained test results of the refrigeration capacity, power consumption and noise level prove that the redesigned refrigeration system has better technical characteristics compared to those of the identical refrigeration systems with refrigerant R12. These better technical characteristics are the result of well designed refrigeration cycle, more favourable thermodynamical properties of the refrigerant R134-a and application of the already verified compressor with refrigerant R134-a.

The obtained results prove that Prva Petoletka has successfully performed and completed their share in the Project MP/YUG/01/160 - Redesign and Conversion of Refrigeration Cycles of Refrigeration Units (Contract No. 01/013), and finalized the process of redesigning of the refrigeration system.