IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET)
ISSN(P): 2347-4599; ISSN(E): 2321-8843
Vol. 5, Issue 7, Jul 2017, 1-10

MAINTENANCE AND RETROFITTING BASIC TRAINER R12 TO HIDRO CARBON

EDIE SASITO SARWODIDOYO

Departement Refrigerasi, dan Tata Udara, Politeknik, Negeri Bandung

ABSTRACT

Maintenance and Retrofitting always busy to be the subject of discussion because the topic is related to the replacement of refrigrant materials, Although it will not replace materials and tools but in terms of his refrigeration science many interesting things. In terms of basic sciences the working principle of the system is still fixed, only the refrigerant is changed. In fact, there can be no changes in components and equipment. The existence of compressors, condensers, evaporators, and expansion valves still exist. In the case of retrofitting carried out as the initial determination is refrigerant R12 and in its place is refigerant Hydro Carbon In case retrofiting is treated as the initial determination is refrigerant R12 and its replacement is refigerant Hydro Carbon (HC). It is found that the Coeffisient of Performance COP R12 refrigerant is still higher than COP Hydrocarbon, but the refrigerant HC is more economical (the use of refrigerant and electric power is cheaper)

KEYWORDS: Maintenance, Retrofitting, Refrigerant R12, Refrigerant, Hydrocarbon, Compressor, Evaporator

INTRODUCTION

Basic Principle Refrigeration Prose's

The basic principle is a vapor compression refrigeration that uses a compressor as a compression refigeran device. In a low pressure the refrigerant is absorbed by the heat then the refrigerant is pressed so that it becomes high-pressure steam and discharged on the discharge side. Vapor compression refrigeration cycle is a system that utilizes heat transfer flow through refrigerant. The main process of vapor compression is; Compression process, process of condensation, expansion process and evaporation process.

The Compression Process

Physically occurs on the compressor. Here the refrigerant vapor phase is converted to superheat steam phase, and discharged by the compressor in high pressure. The compression process physically occurs on the compressor. Here the refrigerant vapor phase is converted to superheat steam phase, and discharged by the compressor in high pressure. In the compressor is considered no friction does not occur heat exchange between refrigerant and compressor.

Condensation Process

Physically the process takes place in the condenser. The refrigerant temperature is higher than the ambient temperature then the heat refrigerant heat is released through the condenser pipe wall to the surrounding environment .[1-4]

The heat release process occurs by natural convection or by force convection by the fan. In the condenser the steam will experience the desuperheat process so that the temperature becomes saturated and ready for condensation. While inside the condenser, pressure and temperature remain high but the refrigerant phase changes to liquid.

Expansion Process. [1-3]

Physically occur on expansion valve and capillary pipe, after refrigerant release heat dikondensor. After the temperature and pressure drops lower than the pressure and temperature of the environment so that it can be expected that the refrigerant is capable of heating the heat in the evaporator. In the process of expansion there is no process of receiving and releasing heat so that the enthalpy is constant.

Steam Compression Refrigeration Cycle

In simple terms there are four basic processes namely [1-3]; Evaporation Process, Compression Process, Condensation Process and Expansion process.

This process occurs in the evaporator. The refrigerant temperature is lower than the refrigeration chamber. In order to process the evaporation of the refrigerant it needs heat. The heat is taken from inside the cabin.

The Evaporation Process

This process occurs in the evaporator, where the refrigerant temperature in the evaporator is lower than the refrigeration chamber. In order for the evaporation process it takes heat, and the heat is taken from the surrounding environment. After the refrigerant is expanded irreversibly adiabatically the refrigerant will become a saturated, low pressure, and will enter the evaporator. In the evaporator the refrigerant will change the phase from the mixed phase (liquid - vapor) to a saturated vapor phase.

In the evaporator the refrigerant will change the phase from the mixed phase (liquid - vapor) to a saturated vapor phase. Mathematically the heat absorbed in the evaporator is;[1-4]

m = mass of refrigerant.

h1, h2 =. enthalpy at position 1 and position 2

Compression Process.

Work performed on the refrigerant by pumping pressure and temperature will rise, so the phase turns into superheat steam phase, and out of the compressor with high pressure. Assuming there is no friction and no heat exchange occurs then the heat that the compressor is [1-4]

h2 h3 = enthalpy at position 2 and position

Condensation Process

This process occurs in the condenser. In conditions of higher temperature refrigerant than environmental temperature, the heat will be released through the condenser wall. The heat release process is done by natural convection and can also be done by force convection. When the refrigerant vapor from the discharged compressor enters the condenser the vapor will be dewed under saturation. While inside the censor, the pressure and temperature remain high but the refrigrant will change from the vapor phase to the liquid phase [1-4]

The heat received by the condenser is

qC = Heat on condenser, qW= heat on evaporato

h3, h4 = enthalpy at position 2 and position 3

The four main components of a refrigeration system are: The process of thermodynamics on Ideal Cycle of Steam Compression Refrigeration that happenedOn the components of a refigeration system as follows: 2 isentropic compressions on the unit Compressors3 The heat dissipation at constant pressure (isobaric) on the condenser4 Decrease the pressure on the expansion valve Heat absorption at Constant pressure on the evaporator In the evaporator and condenser units there is no work required or which Produced because there is only the process of absorption and heat dissipation, which work Required only on the compressor unit.

Expansion Process

This process occurs on the expansion valve. After the refrigerant releases heat in the condenser, the liquid refrigerant derived from the condenser will flow toward the expansion valve to lower the pressure and temperature. Can be expected temperature can be lower than environmental temperature, so it can absorb more heat when in evaporator. Pada expansion process does not occur the process of acceptance and release of energy.

The Vapor Compression Cycle Is Ideal And Actual

The ideal refrigeration system refers to the Carnot Cycle, in which the amount of energy system used equals the energy obtained for use. The ideal vapor compression cycle needs to be known for; Standard refrigeration cycle, to determine the temperature temperature of the refrigeration cycle that needs to be maintained for maximum efficiency. Theoretically, the state can be known using Coefficient of Performance-COP. COP carnot= Evaporation temperature / (Condensation temperature-Evaporation temperature) COP actual = Effect of refrigeration / compression work. Ideal conditions are different from actual conditions. This is due to the actual condition of incoming energy is not entirely converted into energy work. For example the occurrence of pressure drop. To reduce the pressure drop in the ideal cycle is added, among others; Filter refrigerant (Filter), dryer refrigerant (dryer), heat exchanger (Hx).Ideal conditions will be achieved if the incoming energy equals the energy required to do the work. COP = 1. But in reality the refrigeration effect is always greater than the compression work, so COP> 1. ideal conditions of karnot cycle system is not reached.

Experiment

Test data. The system starts from a state of zeroThe thermostat is set within the limits of -20 C and 2 C and HLP between 0 bar to 10 bar with a diffrensial 1 bar. Observation data above shows the amount of environmental temperature and the voltage that occurs relatively constant, in other words the source voltage is not affected by the system work.

The magnitude of power and current that occurs is relatively constant all, in the experiment using the TXV above obtained current and power is influenced by the flow rate of refrigerant.

The cycle starts from the compressor to the condenser through the discharge line then to the TXV and the evaporator through the liquid line and back to the compressor. At the suction suction compressor input will occur heat heat (super heat), which is caused heat exchanger, so that the heat out is processed again and exchanged with heat from the condenser. In the compressor, the refrigerant vapor is compressed so that the pressure and temperature rise and the enthalpy changes occur. Compressor output is a high temperature steam advanced, maximum enthalpy and maximum pressure, expressed by Wk.The occurrence of irregularities in the ideal cycle due to the pressure drop on the pipe bend, friction refrigerant with pipe.Refrigerant into the condenser continues to liquid recceiver phase changes from saturated vapor to saturated liquid. The heat released in the condenser takes place at a fixed pressure (isobar). Liquid phase begins through; Hx, Filter drier, slight glass and solenoid valve.In thermal, the cooling process that occurs in the evaporator is the process of absorption of heat in the cabin, resulting in changes in phase, enthalpy and temperature. The heat absorbed in the cabin shows the working function of the evaporator known as the refrigeration effect, and which determines COP. The increase in COP values indicates the amount of heat absorbed by the system

Refrigeration Installation System Analysis

The first time MCB is confirmed ON. Next the main switch is turned on so that the motor compressor, the condenser fan motor and the delay time Relay-TDR starts to actively work. When the TDR starts ON the auxiliary contact starts opening slowly. After reaching 10 seconds the electric current will flow to the compressor, here also turn on the compressor lamp, SolValve lamp, thermostat, HLP and fan start to work. The compressor will compress the refrigerant starting from the low pressure suction line to the discharge line and condenser. Condenser cooling process is carried out by force convection (using air) which is regulated in speed. After reaching the refrigrant condensation temperature undergoes phase change from high pressure vapor to liquid all. So get out of the liquid fluid refrigerant condenser entirely.

The refrigrant then goes into liquid receiver which ensures that the refrigrant is 100% liquid, ie by trapping the air-mixed refrigrant into the top of the tube and the bottom of the tube is practically all liquid.

Trainers use vertical tube type liquid receivers Furthermore, refrigerant is flowed to HX where liquid line is touched by suction line so that subcool occurs in refrigerant and liquid liquefied gas line level can be lowered. Thus the liquid refrigrant processed undergoes a large and substantial heating loss at the subcooled level.

Compressor system is also equipped with filter drier, which serves to separate the foreign particles that may carry refrigrant. Next it will enter the sight glas without clogging, and flows into the expansion valve.In the expansion valve the refrigrant flows, the flow is large while the orifice hole is very small then if it is left the expansion valve overwork and there may be a blockage of TXV.

A solenoid valve is required to adjust the discharge and stop the flow rate if the flow is too large. Next the refrigrant flows back to the evaporator, the refrigrant re-absorbs heat from the cabin, in the cabin going on isothermal and isobar.

Equipment and Materials Used.

In general the apparatus for retrofitting R12 to Hydro Carbon is the same as the equipment used for service and refurbishment of the cooling machine in general mainly;

- Basic Trainer,
- Type Water Cooled Condensor,
- Vacum Pump,4.Hydro Carbone / PIB Refrigerant Tubes (AR12)5.
- pieces of Filter Drier.

Prosedur Retrofiting R12 to Hidro Karbon HC / PIB (AR12)

Make sure that the Trainer to be retrofit in a state to operate and perfect.

Check for control tools like;

Sol vave, hp / lp still working normally, the security system works well, working pressure refrigerant works in accordance with the provisions.[4-8]

- a.Avoid things that cause fires considering HC is flammable. But can be avoided not to burn.
- b.Turn on mechine with R12 refrigerant, take data every 15 minutes. Make sure the data captured shows the perfect thing. c.Take Refrigerant (Recovery) Contain Refrigerant into the tube, Or use special recovery tools.Perform filter drier

Replacement

- Test leakage using nitrogen gas and soap bubbles.
- Fill installation with t Hydro carbon HC / PIB (AR12) refrigerant with the appropriate typec.

Table 1: Record Data Relating To Refrigerant PIB (AR12) As Well As R13.4a.

No	Measurement Point	Meunites						Unit
		15	30	45	60	75	90	
1	Discharge Temp	54.8	67.1	68.7	71.1	72.9	72.6	^{0}C
2	Suction Temp	27.8	27.2	28	27.1	28.1	27.8	^{0}C
3	Evaporator Inlet Temp	11.6	10.9	11.3	10.3	9.3	10.1	^{0}C
4	Evaporator Outlet Temp	26.7	25.3	25.4	24.9	25.3	25	^{0}C
5	Condensor Outlet Temp	26.6	33	33.4	33.3	33.6	34	^{0}C
6	Liquid Line Temp	31.2	31.7	31.7	32	32	33.1	^{0}C
7	Evaporator Pipe Temp	20.7	23.1	21.1	21.1	21.1	19.3	^{0}C
8	Condensor Pipe Temp	33.1	33.5	47.8	41.3	49.3	50.3	^{0}C

Table 1: Contd.,								
9	TXV Inlet Temp	30.4	30.6	31.1	30.9	31.2	31.9	^{0}C
10	Environment Temp	28.7	25.2	25.6	25.5	26.2	27.2	^{0}C
11	Discarge Pressure	7.5	7.5	7.6	7.6	7.8	7.8	Bar
12	Suction Pressure	2	2.2	2.2	2.2	2.2	2.3	Bar
13	Current	2.05	2.1	1.5	2.17	2.2	2.3	Ampere
14	Voltage	205	202	202	202	200	200	Volt
15	Power	0.31	0.33	0.34	0.35	0.32	0.35	Watt

Refrigerant R12 Process Refrigeration Instalation.Refrigerant : R 12

Discharge Pressure : 4 Bar

Suction Pressure : 4 Bar

Environment Temperarature : 25.4 0, Time Delay : 12 Secons

Hydrocarbon (AR12)

Discharge Pressure : 3.6 Bar

Suction Pressure : 3.6 Bar

Environment Temperarature : 23.9 0C

Time Delay : 8 Seconds

Table 2: Data Process of the Basic Brainer Use Refrigerant R1

No	Measurement Point	Meunites						Unit
		15	30	45	60	75	90	
1	Discharge Temp	51	52.9	56.7	58.2	85.3	66.3	^{0}C
2	Suction Temp	24.6	23.7	24	24.5	26.7	26.5	^{0}C
3	Evaporator Inlet Temp	9.5	19.9	19.1	17	5.9	6.3	^{0}C
4	Evaporator Outlet Temp	24.5	23	23.4	23.7	25.3	25.1	^{0}C
5	Condensor Outlet Temp	24.9	23.4	23.5	24.4	27.1	27.9	^{0}C
6	Liquid Line Temp	25.1	26	25.2	25.5	23.6	22.5	^{0}C
7	Evaporator Pipe Temp	24.2	24.5	24.9	25	24.1	23.9	^{0}C
8	Condensor Pipe Temp	36.9	37.6	38.6	37.7	40.9	44.1	^{0}C
9	TXV Inlet Temp	23.2	22.8	24.1	23.6	25.2	25.6	^{0}C
10	Environment Temp	23.2	25.5	23.7	23.7	25.2	25.5	^{0}C
11	Discarge Pressure	6	6.2	6	6.8	7.5	7.8	Bar
12	Suction Pressure	1.5	1.45	1.45	1.8	2	2.18	Bar
13	Current	1.7	1.7	1.7	1.78	1.85	1.8	Ampere
14	Voltage	210	220	206	205	210	210	Volt
15	Power	0.25	0.25	0.24	0.26	0.28	0.28	Watt

Table 3: Data Process of the Basic Brainer Use Refrigerant R1

	Evap. Temp	Condensor.Tem	Enthalpil	Enthalpi 1'	Enthalpi 2	Enthali 3, 4	Disch Pressure	Suction Pressure	Compress Ratio	COP Actual	COP Carnot	Efisiensi Refrige
15	26.7	54.8	369.3	37.07	369.6	234.3	8.5	3	2.83	7.14	10.67	66.97
30	20.2	63.3	588	610	660	320	11	4	2.75	5.36	6.8	78.79
45	20.4	65.5	590	600	645	320	11	4	2.75	6.00	6.51	92.23
60	20.4	67.7	590	600	645	320	11	4	2.75	6.00	6.20	96.73
75	20	68	590	600	645	320	11	4	2.75	6.00	6.10	98.29
90	20.1	68.2	588	610	660	320	11	4	2.75	6.36	6.09	87.96

Table 4: Data Process of the Basic Trainer Use HC (AR 12)

Process Time	Temp. Out Evap.	Conden Temp	Enthal pi 1	Enthal pi 1'	Enthal pi 2	Enthal Pi 3, 4	Discharge Press.	Suction Pressure	Compress Ratio	COP Actual	COP Carnot	Efisiensi Refrige
15'	24.5	51	600	603	655.6	270	7	2.5	2.80	6.31	11.23	56.2
30'	23	52.9	602	606.67	662	270	7.2	2.45	2.94	5.96	9.90	60.25
45	23,4	56.7	600	693.3	655.56	270	7	2.45	2.86	6.31	8.90	70.94
60'	23.7	58.2	604.4	606.67	660	280	7.8	2.8	2.79	6.08	8.60	70.73
75	25.3	65.3	602.2	605.6	655.56	290	8.5	3	2.83	6.25	7.46	83.80
90,	25.1	66.3	600	606.67	655.56	292	8.8	3.18	2.77	6.30	7.24	87.07

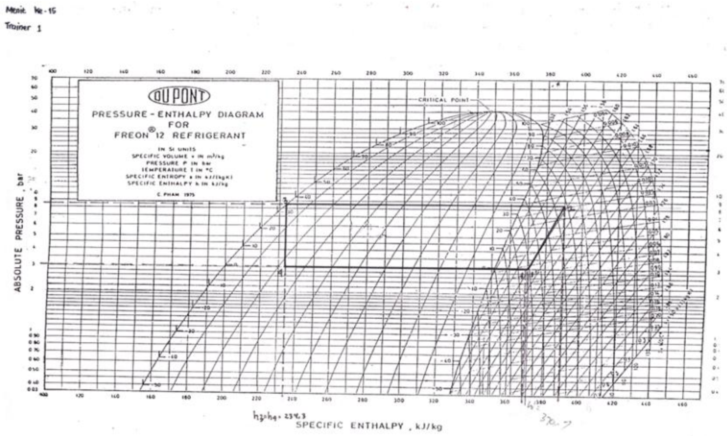

Figure 1: Operating Area of Rerigerant R12. at Temperature 15 ^{0}C

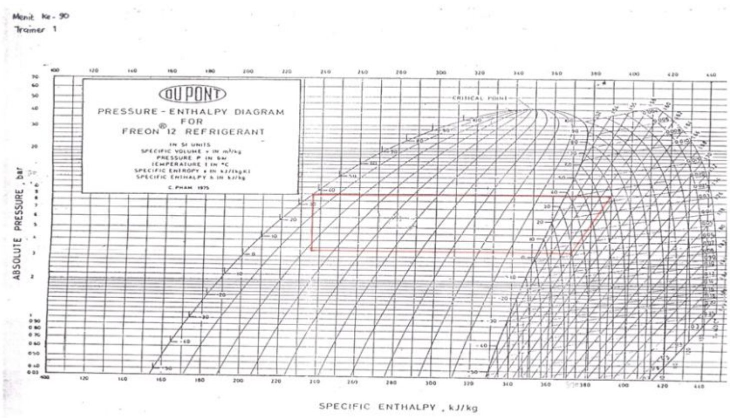

Figure 2: Operating Area of Rerigerant R12, at Temperature 90 ^{0}C

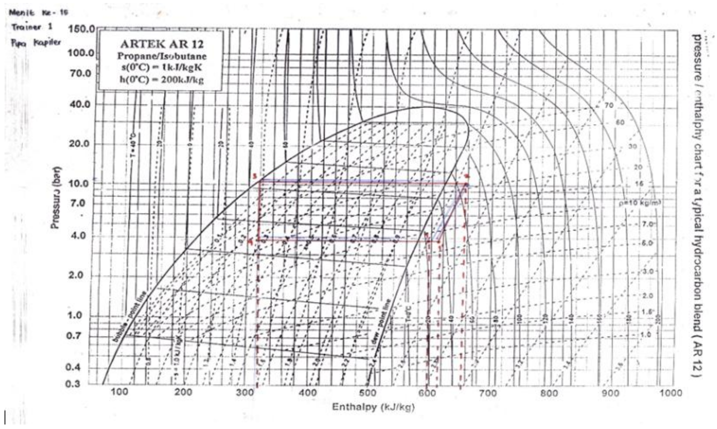

Figure 3: Operating Area of Rerigerant Hydrocarbone (AR12). at Temperature 15 ^{0}C

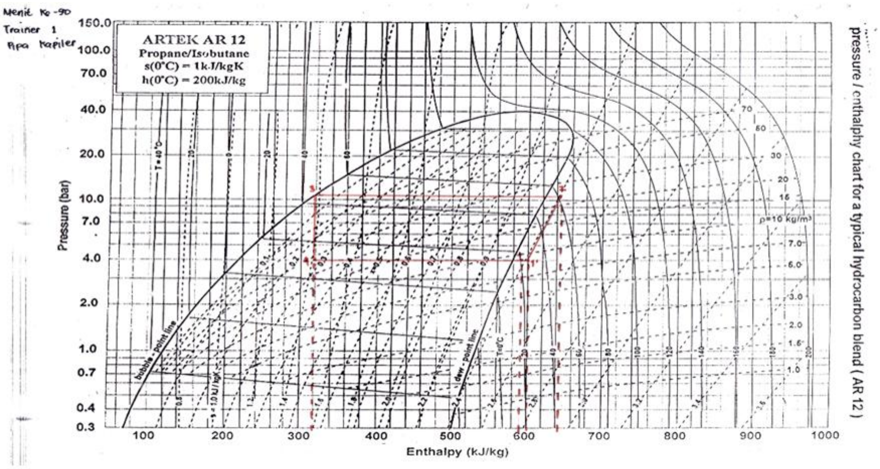

Figure 4: Operating Area of Rerigerant Hydrocarbone (AR12). at Temperature 90 ^{0}C

Comparison between Refrigerant R12 with Hydrocarbon Refrigerant

Based on experimental results and calculated to know the system work, compression ratio, and refrigeration efficiency can be stated that the use of hydrocarbon refrigerant instead of refrigerant R12 has advantages, among others; the evaporator temperature is lower and the time required is faster, the electrical power is lower and the refrigerant as the cooler is less. Other advantages are [9-11) ;

Another advantage of using HC (hydro Carbon) is; - Before retracting R12 to HC, system must be service first. - 40% refrigerant can be used. - There's nothing to keep in mind. - HC operation is easier.

Refrigerant Hydrocarbon is more efficient (> 15%) than other refrigerant.

HC Refrigerant is more natural and does not damage the environment (does not damage Ozone, and th Greenhouse effect.

Refrigerant Hydrocarbon is more efficient (> 15%) than other refrigerant. - HC Refrigerant is more natural and does not damage the environment (does not damage Ozone, and the Greenhouse effect.Things that harm the use of HC refrigerant. - Flammability, volume of HC <volume 2%, - 40 grams to 200 grams / m3

CONCLUSIONS

A successful trial of the Treatment and Retrofit process has been conducted using R12 refrigerant and Rerigrant Hydro Carbon. It says there is a process of care, considering the absolute process of retrofitasi require care process.

Thermodynamically it appears that after a 1 hour COP R12 actual is 6.00, carnot COP is 6.2, average refrigeration efficiency of R12 is 96.73, while COP actual HC 1s 6.08, COP Carnot HC is 8.60, average HC refrigeration efficiency 70.73,

REFERENCES

1. Yunus A Cengel, 1994, “Thermodynamic, an Engineering Approach
2. Harrington RL., ‘Marine Engineering Hand Book’, SNAME, Jersey City, 1992
3. Stoecker WF., Jerrold W., Supratman H.,’ Teknik Pendingin dan Pengkondisian Udara’, Edisi 2, Erlangga, Jakarta
4. William G., Neil RP. ‘Trane Air Conditioning Manual’
5. Wiranto AM., Heizo S.,’Penyegaran Udara’, Pradnya Paramita, Jakarta 1995
6. Karyanto, E., Emon Paringga, Teknik Mesin Pendingin, Volume 1, CV. Restu Agung, Jakarta, 2005.
7. Saito.H., Arismunandar, Penyegaran Udara, PT. Pradnya Paramita, Jakarta,1981.
8. Sumanto,Dasar-Dasar Mesin Pendingin, Andi Offset, Yogyakarta, 1994.
9. http://www.ASHRAE.org. [11]. http://www.UP-3.com.