THE ANALYSIS OF TYPES EVAPORATOR WITH REFRIGERANT LPG AGAINST THE PERFORMA ENGINE REFRIGERATOR

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ABSTRACT - Refrigeration system is a system working for cooling temperature some goods or room with absorbs the heat. Refrigeration process is very important for store a food and beverage so will be able to keeep up in certain time, refrigerator development has achieve characteristic improvement about non-ODP (Ozone Depleting Potential) and non-GWP (Global Warming Potential) refrigerant as well as alternative refrigerant until now. The purpose of this research is to know about effect from variation evaporator type using LPG refrigerant againts refrigerator performance. Experimental methode did for the direct test to analyzed how much effect from variation evaporator type that are used in (serries one space, ser series two space, parallel one space, and parallel two space) using C plate evaporator and compressor ¾ pk. This research are do it by installing an evaporator in each unit of refrigerator chamber top part and refrigerator chamber bottom part that arranged by series and parallel which is in each chamber have a breaker or without breaker. The result from the research variation of evaporator type for refrigerator is to know how much the effect of refrigeration, compression working, refrigeration capacity, and Coefficient Of Performance (COP). The lowest temperature is shown from evaporator type series one space, that have a value -21,2 ^{O}C. The lowest interval from both of chamber type is shown from evaporator type parallel two space, that have a value 3,64^{o} C. Coefficient Of Performance (COP) from series type is 9,06 for one space and 9,01 for two space, then from parallel type is 10,59 for one space and 13,43 for two space. Based from research the acquired result that is from using evaporator series type and parallel type is could be used for cooling down several room in refrigerator.

Keywords: Refrigerator, type evaporator, LPG refrigerant.

I. Introduction

Engine cooling system works by pulling or absorb heat from the substance or the room resulting in a change of air temperature in a material or a room to a lower temperature than the temperature of the surrounding environment. The cooling system is strongly influenced by the performance of the engine coolant. Engine cooling is one of the machines are used for preserving food or drink without changing the flavor and taste [1].

The three main things that influence the development of technology in the field of refrigeration is about how the energy savings, the use of refrigerant non-ODP (Ozone Depleting Potential), and the refrigerant non-GWP (Global Warming Potential). Scientists and researchers have attempted to innovate to answer these three needs to develop refrigeration technology with improved achievement and characteristics of existing refrigeration machine, research to produce non-ODS refrigerants and non-GWP, and the search for alternative refrigeration technologies [2].

One of the study of vapor compression cooling machine by using LPG as a refrigerant indicate that the engine cooling with refrigerant LPG can cool the room faster than the cooling machine using refrigerant R-12. The coefficient of achievement (COP) generated by the engine cooling with refrigerant these LPG refrigerant mass of 80 grams is 6.30 [3].

LPG (Liqufied Petroleum Gas) is one example of a hydrocarbon gas that can be used as a refrigerant. LPG is liquefied natural gas from the processing of petroleum products which functioned as a fuel for stoves in households. PT. Pertamina, Indonesia's oil company, has memprodukdi memesarkan gas and LPG as fuel is cheap in Indonesia. Kandaungan Gas LPG circulating widely in the community containing 50% propane and 50% butane, in accordance with the provisions of the aspects of the composition or the vapor pressure. The provision is calculated in accordance calories or burn the necessary power for the needs of the community. The composition is not intended to harm consumers but taking account of consumer safety LPG gas users.

Research to generate coefficients achievement better engine cooling has been done using a system of two evaporator and two

compressors. Research carried out by using two evaporator and two compressor results in improved efficiency of as much as 3,5% of its original efficiency. The efficiency value obtained showed that the variation of the superior when compared to standard cooling machines [4]

Research has also been carried out with the engine cooling system of another is by mennggunakan multi evaporator. The study involved multiple components such as evaporators, two expansion valves, compressor, condenser, heat exchanger, and a solenoid valve connected to the refrigerant flow to the evaporator freezer and freshfood. The result in the work cycle in series obtained an increase in efficiency of 8,5% [5].

Other research is research by varying the size of the evaporator on the performance of the engine cooling evaporator to produce that increase in size is not significant with increased COP. The only significant increase in the size of the evaporator to increase capacity at the two evaporator refrigeration performance [6].

The problems of the refrigeration machine and Previous research, be an excuse to do more careful research using several types of single and multi-storey evaporator (series and parallel) using liquefied petroleum gas as a refrigerant in the refrigeration system. This research is expected to result in enhancing work performance refrigeration machine is now significantly better, especially raising the coefficient of achievement, lowering energy use, and produce non-ODS refrigerants and non-GWP refrigerants using LPG according to the standard product.

II. Methodology

This research use experimental methodology that direct observation. The equipment and materials used in the test are as follows:

- Refrigerators one door
- Pressure gauge
- Manifold gauge
- A set of thermoreader
- Swaging tools
- Tube welding
- Brander las
- Cutting the pipe
- Stingy round
- Evaporator plate C (¼ inch diameter and a length of 110 cm)
- Compressor ¾ pk
- LPG (50% propane and 50% butane)

Testing procedure

a) Arranging engine components of refrigerant in correctly, using a variation of the series evaporators space
b) Installing the temperature measuring devices (thermoreader), a pressure gauge at the points are observed
c) Conducting the process of vacuum, in order to avoid a refrigerant or other substances that are still left inside.
d) Turn on the engine cooling with a discharged condition to ensure there are no leaks in all parts
e) Charge the refrigerant correctly and according to the procedure, in this study the refrigerant used is LPG
f) Further conduct testing up to 120 minutes.
g) Measure and record the temperature and pressure are the measurement tools to ensure the correctness of measuring the numbers listed on the tool, according variable a predetermined time
h) Conducting the experiment again by using various types of evaporators to suit different predetermined
i) Record back pressure and temperature indicated by the measuring instrument, at all points and a predetermined time.
j) collect the data, perform calculations and analysis

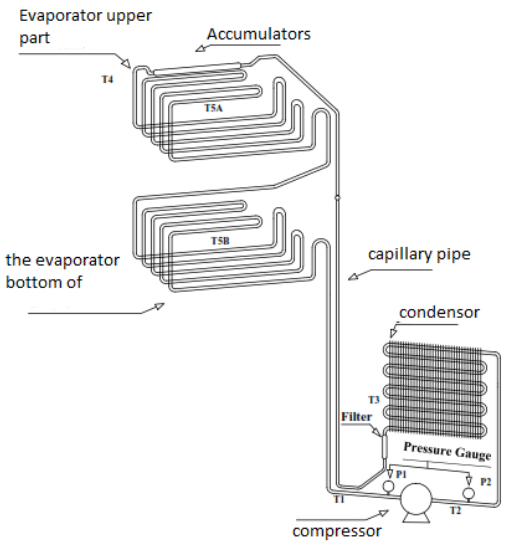

Figure 1. Evaporator series with one space

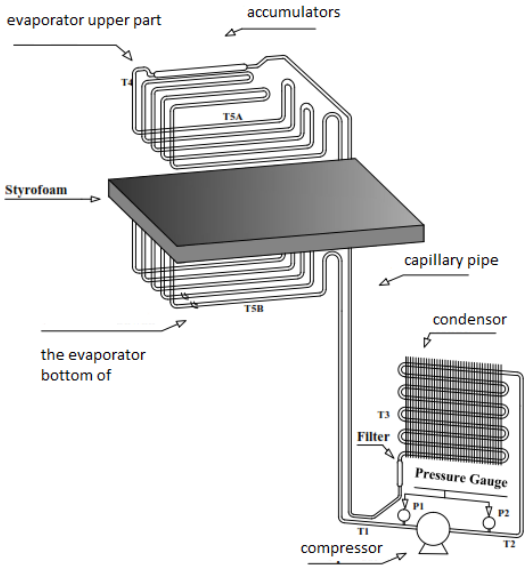

Figure 2. Evaporator series with two spaces

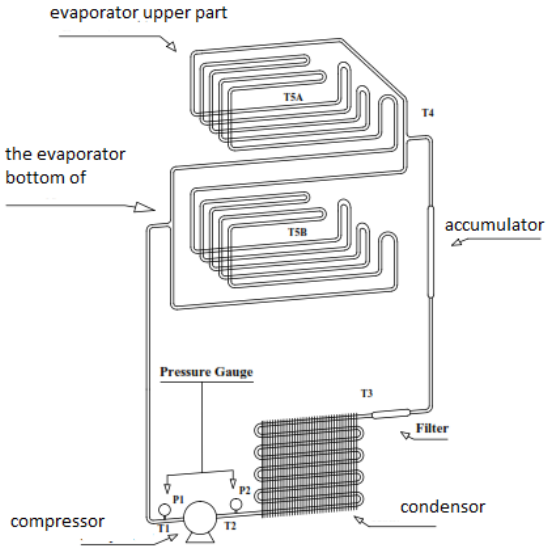

Figure 3. Evaporator parallel with one space

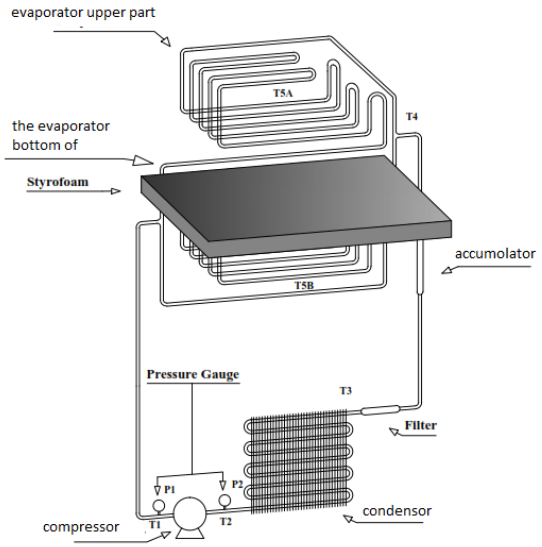

Figure 4. Evaporator parallel with two spaces

RESULTS AND DISCUSSION

Data Testing Results

After the testing process measurement data obtained. The data obtained in the form of temperature (T1, T2, T3, T4, T5a, T5B) and pressure (P1 and P2) every 10 minutes for 120 minutes. The data obtained will be used to calculate the performance of the cooling machine

Table 1.Results of the temperature on the evaporator series with one space

Time (minute)	Temperature (°C)						Pressure (Bar)	
	T_1	T_2	T_3	T_4	T_{5a}	T_{5b}	P_1	P_2
10	30,9	78,61	38,63	15,50	3,90	13,47	0,50	15,00
20	30,43	79,34	38,60	6,37	-3,37	10,50	0,50	15,00
30	29,97	75,23	38,20	-0,90	-11,67	3,70	0,50	13,00
40	30,37	76,27	37,50	-6,07	-14,77	0,70	0,30	13,00
50	30,20	77,65	37,70	-9,93	-15,93	-1,73	0,30	13,00
60	30,93	80,34	38,17	-6,83	-17,40	-3,50	0,30	13,00
70	30,37	80,34	38,83	-5,70	-17,90	-3,77	0,30	13,00
80	32,80	82,81	38,70	-6,80	-19,50	-5,17	0,30	13,00
90	30,10	80,73	39,17	-4,47	-19,50	-5,93	0,30	12,50
100	30,13	82,59	39,37	-7,73	-20,30	-6,83	0,30	12,50
110	29,30	83,16	39,07	-7,53	-21,60	-7,43	0,30	12,00
120	30,30	81,81	38,80	-5,03	-21,20	-7,00	0,30	12,00

Table 2. Results of the temperature of the evaporator series with two spaces

Time (minute)	Temperature (°C)						Pressure (Bar)	
	T_1	T_2	T_3	T_4	T_{5a}	T_{5b}	P_1	P_2
10	32,70	74,20	33,97	18,13	15,77	20,67	0,40	14,00
20	31,73	78,52	39,90	7,60	-0,17	6,23	0,40	14,00
30	30,50	75,23	35,53	10,63	-2,80	12,23	0,40	13,00
40	31,07	81,81	40,37	5,60	-5,23	3,03	0,40	13,00
50	31,40	81,90	41,70	2,40	-6,00	1,67	0,40	13,00
60	32,70	82,90	42,23	1,63	-7,10	-0,13	0,40	13,00
70	32,00	82,90	41,63	1,13	-8,03	-0,90	0,40	12,00
80	31,57	78,65	40,90	-0,67	-9,00	-1,27	0,30	12,00
90	30,80	78,87	39,80	-3,17	-10,67	-3,80	0,30	12,00
100	30,77	76,53	39,83	-3,17	-11,33	-4,77	0,30	12,00
110	29,90	81,55	39,40	-10,00	-13,37	-4,70	0,30	12,00
120	29,27	79,95	37,90	-12,00	-15,07	-6,53	0,30	12,00

Table 3.Results of the temperature on the evaporator parallel with one space

Time (minute)	Temperature (°C)						Pressure (Bar)	
	T_1	T_2	T_3	T_4	T_{5a}	T_{5b}	P_1	P_2
10	34,20	75,01	36,70	8,03	14,50	18,13	0,50	12,00
20	34,90	79,43	36,90	3,57	8,47	12,07	0,40	13,00
30	34,50	75,40	38,70	-0,60	3,33	9,37	0,40	12,00
40	35,00	76,83	38,20	-4,80	-0,07	5,20	0,30	13,00
50	34,90	76,96	38,70	-3,00	-2,47	2,07	0,30	12,00
60	35,20	79,04	38,90	-2,80	-3,40	1,20	0,30	13,00
70	34,80	80,47	38,80	-3,70	-4,33	0,50	0,30	12,00
80	35,10	79,69	38,60	-4,30	-5,17	-0,50	0,30	12,00
90	34,30	79,82	38,60	-4,80	-6,10	-1,30	0,30	12,00
100	35,80	81,12	39,10	-5,40	-6,63	-2,30	030	12,00
110	35,40	79,69	38,90	-6,10	-7,03	-2,57	0,30	12,00
120	35,00	79,43	39,20	-7,20	-7,67	-4,03	0,30	12,00

Table 4.Results of the temperature on the evaporator parallel with two spaces

Time (minute)	Temperature (°C)						Pressure (Bar)	
	T_1	T_2	T_3	T_4	T_{5a}	T_{5b}	P_1	P_2
10	30,7	62,30	29,20	10,50	19,40	23,63	0,40	13,00
20	31,00	63,98	29,10	6,60	17,50	21,73	0,40	13,00
30	31,40	66,50	29,40	3,800	13,50	18,50	0,40	13,00
40	31,80	74,20	31,40	0,40	6,53	12,10	0,40	13,00
50	32,40	70,56	34,50	-6,40	-1,40	4,13	0,40	13,00
60	32,40	71,40	34,70	-5,70	-3,53	2,10	0,40	13,00
70	32,80	74,06	35,30	-8,30	-5,40	0,30	0,40	12,50
80	33,20	74,90	35,40	-110	-6,57	-0,90	0,40	12,50
90	33,60	80,36	38,30	-7,80	-6,87	-2,17	0,40	12,50
100	33,80	81,76	37,50	-8,50	-7,80	-2,90	0,30	12,50
110	34,30	79,24	38,30	-7,00	-8,23	-3,43	0,30	12,50
120	34,10	78,82	37,80	-7,10	-8,63	-3,47	0,30	12,00

Discussion

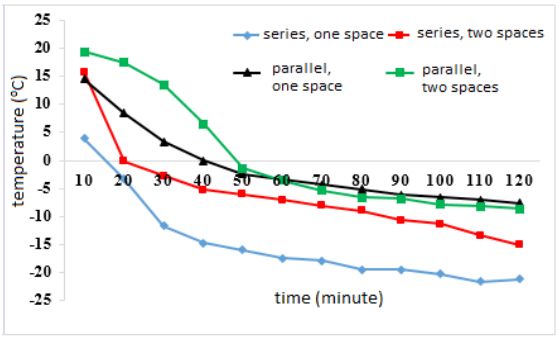

Figure 5. Graph of the value of the upper space temperature versus time

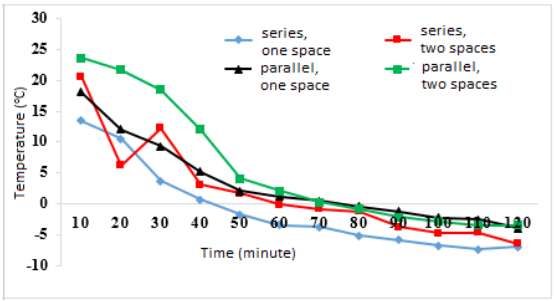

Figure 6. Graph of the value of the bottom space temperature versus time

From Figure 5 and Figure 6 shows that a decrease in the lowest temperature obtained by the type of the evaporator series with one room, it is because the use of two the evaporator in the cooling chamber smaller and all the refrigerant was focused to cool the upper part first, so that the temperature reached by type of series the evaporator is lower than the temperature reached by the type of parallel evaporator, such that the temperature is shown in a refrigerated space is the result of the redistribution of fluid between the two the evaporator [7].

The Performance of Refrigerator Machine

1. The Refrigerating Effect

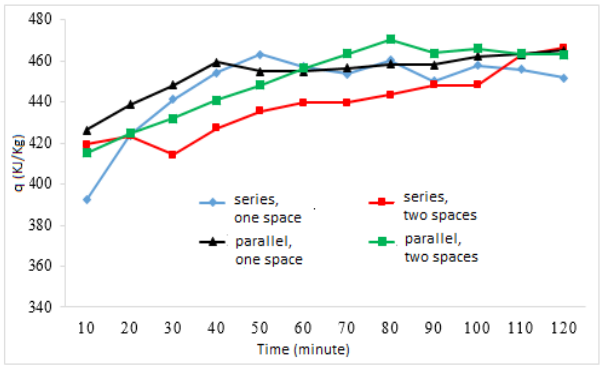

Figure 7. Graph of The Refrigrerating Effect

The result of the calculation of the impact of refrigeration on each of the various types of the evaporator increased as the time changes, the cause of the increase is among other things due to each variation has the ability to absorb heat better [8]. Impact value refrigeration which experienced the largest increase in minute 80 amounted to 470,605 kJ /Kg and began to stabilize in the next minute is a parallel-type two spaces, it is because the type of parallel evaporator huge flow of refrigerant passing through the the evaporator is concentrated in each room are cooled so the ability to absorb heat better

2. The Work of Compression

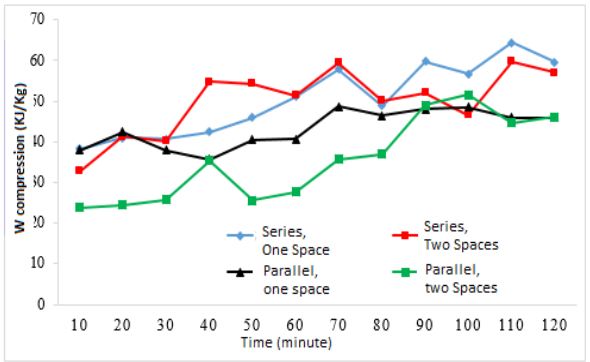

Figure 8. Graph of the work of compression

Pressure compression performed by the compressor on the type of an evaporator series is higher compared with a parallel-type an evaporator. Differences in the work of compression between the various types of an evaporator are in because of the type of an evaporator series has a distance of cooling longer for cooling the room top and bottom of dibandingakan type parallel evaporator, because of the type of parallel evaporator flow rate divided directly to a second room which is

cooled, so the work compression is not as heavy work of compression-type an evaporator series

3. The Refrigerating Capacity

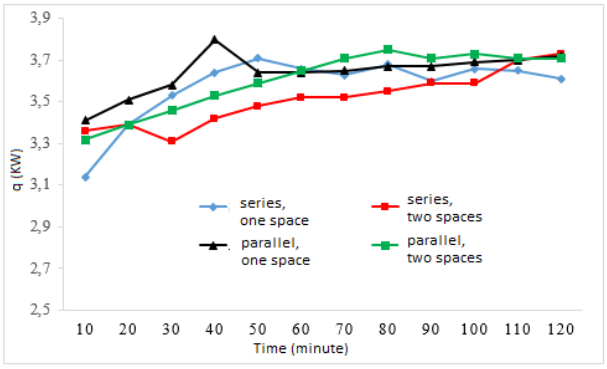

Figure 9. Graph of the refrigerating capacity

Refrigeration capacity values were achieved in all variations of type an evaporator (parallel or series) is almost the same or close to each other. Cause of the same refrigeration capacity values for the cooling process performed on same machine refrigerator, so the need for refrigeration machine is the same [9]. Type of parallel evaporator for a single room (borderless) began to reach stable at 50 minutes (around 3,6 kW) compared to the type of an evaporator series one space (borderless) that has not reached a stable state at the minute, also for two types of parallel evaporator room (with a divider) began to reach a steady state at 70 minutes (around 3,7 kW). The difference in time to reach steady state for the type an evaporator are arranged in parallel and in series-type an evaporator due at the evaporator in parallel flats have same length of pipelines and flow in time and the same state.

4. Coefficient Of Performance (COP)

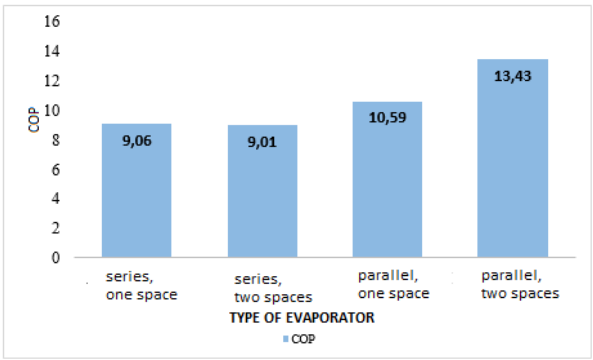

Figure 10. Graph of COP

From Figure 10 shows that the type of parallel evaporator has a value of COP is better than the COP values on various types of evaporator series, it is because the type of parallel evaporator flow barriers shorter and concentrated in each room are cooled. As a result of constraints on the type of parallel evaporator shorter and the cooling is concentrated to the second evaporator used was faster in the process cools the room, shorten the difference of temperature for both rooms were cooled, and accelerate to reach steady state, another influence that is at work lower compression value than the compression work done on the type of evaporator series, so that type of parallel evaporator has a higher COP values. The average value of the highest COP is owned by two parallel evaporator type of room (with a divider) which is equal to 13,34 and the lowest by type evaporator varasi series two rooms of 9,01.

CONCLUSION

From the results of research and analysis has been done, it can be concluded as follows:

1. Effect of time to decrease the lowest temperature obtained type evaporator series one space, namely equal to 21,2 ^{O}C. Speed evaporator temperature decrease on the type of series one space due to the evaporator series using two evaporator to cool the space is small and the rest of the refrigerant is used in its entirety evaporator upper part can be cooled faster.
2. The highest compression power obtained in the test series is a space evaporator reaches 64,85 kJ / kg at 110 minutes, it is because the type Evaporator channel series that must be passed is longer. Values refrigeration capacity generated on each type is not much different (3,14 kW – 3,73 kW), the cause is the engine coolant tested and refrigerants used are the same, so the cooling requirements are the same.
3. Research have shown the value of COP (Coefficient Of Performance) for parallel-type evaporator (with borders and without borders) is better than the type of evaporator series (with divider and without divider), type a space parallel evaporator can increase the COP by 1,17% higher than the COP type of series and parallel two-space space of 1,49% more than two series space, the cause is the parallel evaporator to cool the room down the top and bottom space of time to get in is almost the same refrigerant (s shorter) so that the lower compression work, and if a low compression work it produces better COP values.

Numenclature :
P1: Inlet pressure compressor (Bar)
P1: pressure compressor exit (Bar)
T1: Temperature out evaporator (^{O}C)
T2: Temperature entrance condenser (^{O}C)
T3: condenser exit temperature (^{O}C)
T4: Temperature sign evaporator (^{O}C)
T5a:The temperature of evaporator upper part (^{O}C)
T5b:The temperature of evaoprator battom of (^{O}C)

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