ISBN : 978-979-99723-9-2

ICET 2013

PROCEEDINGS

1st International Conference on Engineering of Tarumanagara

"Urban Engineering for Future Generation"

Jakarta, 2-3 October 2013

Faculty of Engineering
Tarumanagara University
Jakarta - INDONESIA

Published by:
FACULTY of ENGINEERING, TARUMANAGARA UNIVERSITY
2013

ISBN : 978-979-99723-9-2

PROCEEDINGS

1st International Conference on Engineering of Tarumanagara

"Urban Engineering for Future Generation"

Jakarta, 2-3 October 2013

Faculty of Engineering
Tarumanagara University
Jakarta - INDONESIA

Published by:
FACULTY of ENGINEERING, TARUMANAGARA UNIVERSITY
2013

PROCEEDINGS
1st International Conference on Engineering of Tarumanagara

2013

Published by:
FACULTY of ENGINEERING, TARUMANAGARA UNIVERSITY

Supported by:

ISBN: 978-979-99723-9-2

ME-23	Agus Halim, Didi Widya Utama, Jemmy Septiawan	Application For Rough Estimation Of Cutting Force
ME-24	Sobron Lubis, Rosehan, Denny Handoko	Effect of Rake Angle in the Turning Process on the Surface Roughness of Workpiece AISI 4340 Steel
ME-25	Muhammad Ade Irfan	The Split Of Engineering Development To Support Engineering, Procurement, Construction, And Commissioning Of Onshore Oil And Gas Receiving Facility (Case Study On Epcc Orf Bukit Tua)
ME-26	Yustiasih Purwaningrum, Medilla Kusriyanto, Lulu Supriyanto	Joint Properties Of Friction Stir Welded 6063 t3 Aluminum Alloys With Variation Of Preheat Method
ME-27	I Made Kartika Dhiputra, Numberi Johni Jonatan	Experimental Study Characterization Burner Gas Flame Bioethanol Sago Residual
ME-28	Prantasi Harmi Tjahjanti, Yudho Suryo W.	Comparative Of Factor Effectiveness Disc Brake Of Motorcycle Using Single Piston And Double Piston
ME-29	Richard Jonathan Salli, Agustinus Purna Irawan, Danardono A.S.	Design Of Fifo Pick And Deposit System
ME-30	Steven Darmawan, Ahmad Indra Siswantara, Budiarso	Reynolds Numbers Effects On Velocity Distribution In Combustion Chamber Inlet Of A Proto X-2 Bioenergy Micro Gas Turbine
ME-31	Sofyan Djamil	Polymer Matrix Composite Mechanical Properties of Two Types Woven
ME-32	Harto Tanujaya	Cooling Effect of Capillary Tube for Refrigerator
ME-33	Christian Wijaya, Johan Oscar Ong	Enhancing the Perfomance of Corrugated Panels Under Blast Loading: Numerical Analysis
ME-34	Azridjal Aziz, Herisiswanto, Afdhal Kurniawan Mainil	Energy Efficient Cold Storage As Hybrid Refrigeration Machine Using Heating Effect From Condenser With Hydrocarbon Refrigerant Substituted For R-22
UE-01	Priyendiswara	To Promote Jakarta City as one of an excited Tourist Destination in Asia towards the Asian Economic Community (AEC)
UE-02	Sylvie Wirawati	Innovative Use Wood And Bamboo Use As Renewable Finishing Materials In The Building Application
UE-03	Liong Ju Tjung, Suryono Herlambang, Indah Susilowati, Regina Suryadjaja	After 25 Years of New Town Development in Jakarta Metropolitan Area (JMA) - Profile and Transformation
UE-04	Adiwan Aritenang	The Lineage of ICT Development: The Case Of Batam Island

ISBN: 978-979-99723-9-2

Parallel Session Schedule

Day/Date	Time	Room No	Paper ID
Wednesday 2 October 2013	13.00-15.00	1	AE-01, AE-06, UE-04, CE-06, CE-19
	13.00-15.00	2	IE-02, IE-04, IE-05, IE-06, IE-07
	13.00-15.00	3	IE-19, IE-21, IE-22, IE-23, ME-07
	13.00-15.00	4	ME-10, ME-11, ME-18, ME-20, ME-27, ME-34
	15.00-15.30		*Coffee Break*
	15.30-17.30	1	CE-07, CE-09, CE-11, CE-14, CE-18, CE-21
	15.30-17.30	2	EE-01, EE-02, EE-03, EE-04, EE-06, EE-08
	15.30-17.30	3	IE-10, IE-11, IE-12, IE-13, IE-16
	15.30-17.30	4	ME-12, ME-13, ME-17, ME-19, ME-26, ME-33
Thursday 3 October 2013	09.00-12.00	1	AE-02, AE-04, AE-07, AE-08, AE-09, AE-12, AE-14
	09.00-12.00	2	AE-13, AE-15, CE-03, CE-16, CE-20
	09.00-12.00	3	ME-01, ME-16, ME-22, ME-24, ME-29, ME-30, ME-31, ME-32
	09.00-12.00	4	IE-08, IE-14, IE-15, IE-17, IE-24, UE-01, UE-02, UE-03

International Conference on Engineering of Tarumanagara (ICET 2013)
Faculty of Engineering, Tarumanagara University, Jakarta-Indonesia, 2-3 October 2013
ISBN: 978-979-99723-9-2

COOLING EFFECT OF CAPILLARY TUBE IN REFRIGERATOR

Harto Tanujaya, Richard Christian Chandra

Department of Mechanical Engineering, Faculty of Engineering
Tarumanagara University, Jakarta
e-mail: hart_tan18@yahoo.com, harto@tarumanagara.ac.id

Abstract

Capillary tube is one of the throttling device in the refrigeration such as a small refrigerator. In this research, the capillary tube is made of a copper tube with internal diameter of 0.0063 m and the length of 0.248 m. Performance of the refrigerator can be influenced by shape and dimension of the capillary tube. Precooling around the capillary tube is expected increase the performance of the refrigerator. Refrigerant 22 is used in the experiment. The highest and lowest of the Coefficient of Performance (COP) of the refrigerator are investigated at position F_{11} and F_{33}.

Keywords: Refrigerant 22, refrigeration effect, COP, capillary tube

INTRODUCTION

Refrigeration system is used in many applications such as domestic refrigeration, commercial refrigeration, industrial refrigeration and marine refrigeration. Generally, system refrigeration has 4 basic components, evaporator, condenser, expansion, and compressor. Expansion is used adhere on the refrigeration system. Expansion valve usually is used at the big scale refrigeration and the capillary tube is used for the small scale and simple refrigeration.

Generally, capillary tube made of a copper material that is used for refrigerant 22 with diameter of 0.5 to 2 mm, depend on the load of system refrigeration. The length of the capillary tube is also varied. Using capillary tube in the system of refrigeration has some benefit such as the shape of the expansion is very simple and also the cost to operate inexpensive compared with expansion valve.

Precooling of the capillary tube is expected increase of the performance of the refrigerator. Many researchers did the experiment about the replacement of the capillary tube in right place to increase and get more efficient of the performance of refrigerator. Akintunde (2007) did the research about capillary tube with difference shape as helical and serpentine shape using R-134a refrigerant. His results show the performance of the refrigerator is not influenced with the various pitch of the helical capillary tube. It is different with the serpentine capillary tube which is influenced with pitch.

Performance of the helical and serpentine capillaries tubes are influenced by the diameter and high, respectively. The results are indicated that the shape and dimension of the capillary tube can affect of the performance. This research investigate the effect of precooling of capillary tube in refrigerator using R 22 refrigerant.

MATERIAL AND METHOD

Vapour compression refrigeration system is a refrigeration simplest cycle. The basic principle of refrigeration is liquid or refrigerant absorb heat when changed from liquid to gas and gases give off heat when changed from gas to liquid. This phenomena is occurred when the gasses compressed and condensed. Vapour compression refrigeration system has four basic components; compressor, evaporator, condenser, and expansion. This research use capillary tube expansion. Compressor is used to compress the vapour refrigerant to increase the pressure of refrigerant in order can be decreased rapidly by

ISBN: 978-979-99723-9-2

expansion tube. Evaporator and condenser are used to evaporate and condense the refrigerant in the system with absorb and release the heat from environment, respectively. A installation diagram of the refrigeration system is shown in figure 1.

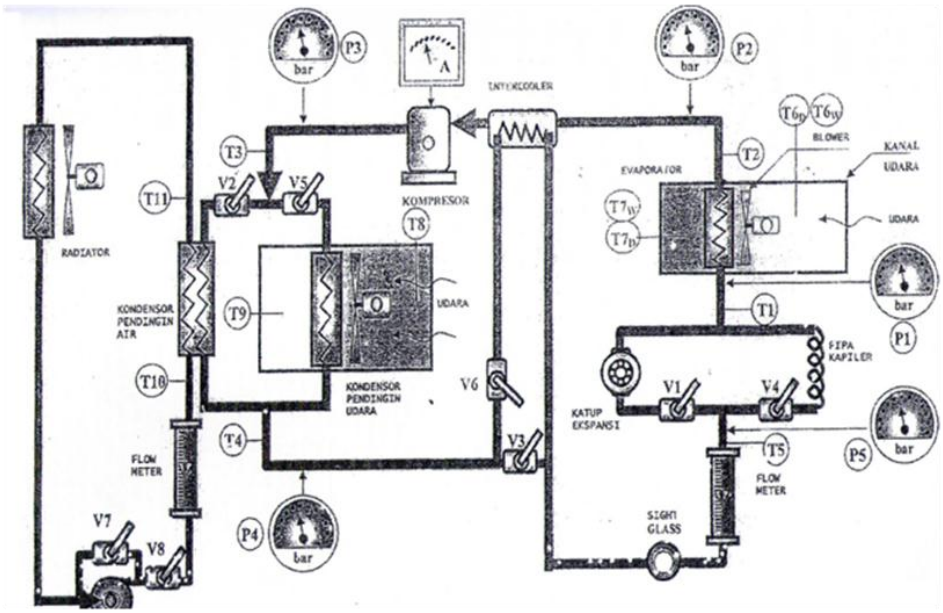

Figure 1. Installation diagram of refrigeration system

The experimental method is used in this research, the temperature of capillary tube is set below the environment temperature of – 70 ^{0}C. Diameter of the suction and discharge pipes of refrigerant are ½ in with the length 0.3 and 0.8 m, respectively. The inner diameter of the capillary tube is 0.0063 m with the length of 0.248 m. Single cylinder reciprocating compressor type AJ 4461A is used in this research with maximum power of ½ Hp and 300 rpm. The diameter, length, high, and width of the condenser are 3/8 in, 0.294 m, 0.27 m, and 0.143m, respectively. Capacity of the condenser is 1200 m^3/h with the amount of the pipe of 30. The high of evaporator is 0.28 m with diameter of pipe ½ in.

Variable area flowmeter is used to measure the discharge flow of the refrigerant with capacity maximum of 0 – 140 litre/h. Conversion table of the discharge flow using the flowmeter is shown at table 1.

Table 1. Conversion table of Refrigerant 22

Density R-22 (kg/m^3)	Coefficient Conversion
750	0,850
800	0,880
850	0,910
900	0,940
950	0,970
1000	1,000
1050	1,028
1100	1,056
1150	1,084
1200	1,111
1250	1,139
1300	1,166

ISBN: 978-979-99723-9-2

Flowrate of the air which are blow into the evaporator and condenser are variated. Velocity of the air are variated with three stage of each evaporator and condenser. Description of each stage is F_{11}, F_{12}, F_{13}, F_{21}, F_{22}, F_{23}, F_{31}, F_{32}, F_{33}.

F_{11} : fan velocity 1 in evaporator and fan velocity 1 in condenser
F_{12} : fan velocity 1 in evaporator and fan velocity 2 in condenser
F_{13} : fan velocity 1 in evaporator and fan velocity 3 in condenser
F_{21} : fan velocity 2 in evaporator and fan velocity 1 in condenser
F_{22} : fan velocity 2 in evaporator and fan velocity 2 in condenser
F_{23} : fan velocity 2 in evaporator and fan velocity 3 in condenser
F_{31} : fan velocity 3 in evaporator and fan velocity 1 in condenser
F_{32} : fan velocity 3 in evaporator and fan velocity 2 in condenser
F_{33} : fan velocity 3 in evaporator and fan velocity 3 in condenser

RESULTS AND DISCUSSION

In this experiment, we investigate the efficiency of refrigerator using extreme condition of temperature of capillary tube. Temperature and pressure of each condition are record and evaluation. Results of the experimental can be shown at the tabel 2.

Table 2. Results

	Compression Work (W) – kJ/m^3	Compression Power (P) - kW	Refrigeration Effect (q_e) – kJ/m^3	Q_e kW	Q_c kW	$Q_{cap\ tube}$ kW	COP
F_{11}	22	0,4748	242	5,2224	-4,5965	1,1006	10,99
F_{12}	24	0,5179	242	5,2224	-4,7260	1,0143	10,08
F_{13}	26	0,5611	242	5,2224	-4,7692	1,0143	9,31
F_{21}	34	0,7337	242	5,2224	-4,8555	1,1006	7,12
F_{22}	41	0,8848	242	5,2224	-5,0281	1,079	5,90
F_{23}	41	0,8848	231	4,9850	-5,0066	0,8632	5,63
F_{31}	50	1,079	234	5,0497	-5,2224	0,9064	4,68
F_{32}	50	1,079	240	5,1792	-5,1792	1,079	4,8
F_{33}	53	1,1437	241	5,2008	-5,2439	1,1006	4,55

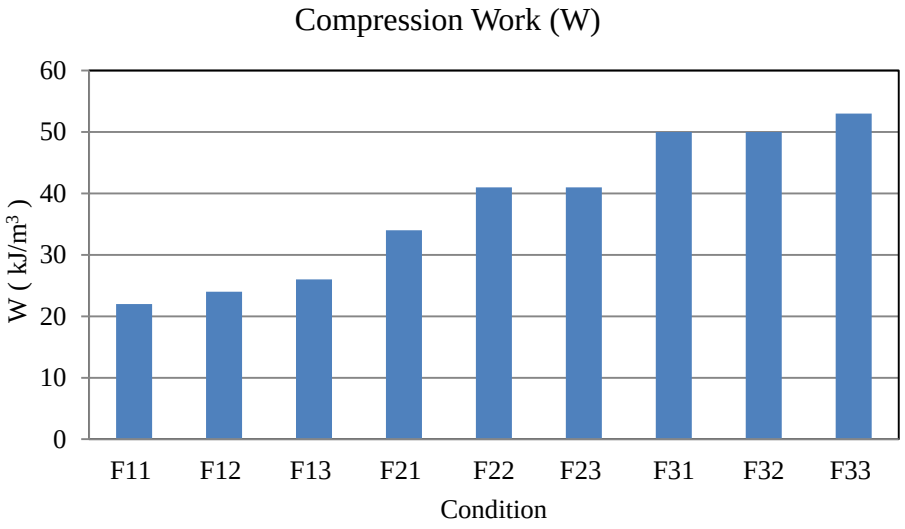

Figure 2. Compression Work

ISBN: 978-979-99723-9-2

Figure 2 show the graph of work (compressor). The graph shows that position at F_{33} has a biggest work of compressor of 53 kJ/m^3 compared with position of F_{11} 22 kJ/m^3 which has a lowest work of compressor.

Figure 3 show the compression power of the refrigerator. Compression power is influenced by compression work in the system. This indicates that the compression work will be increased as the result of increasingly the compression power. The power of the lowest and highest of compression power are 0.4748 kW and 1.1437 kW, which are shown at the position of F_{11} and F_{33} respectively.

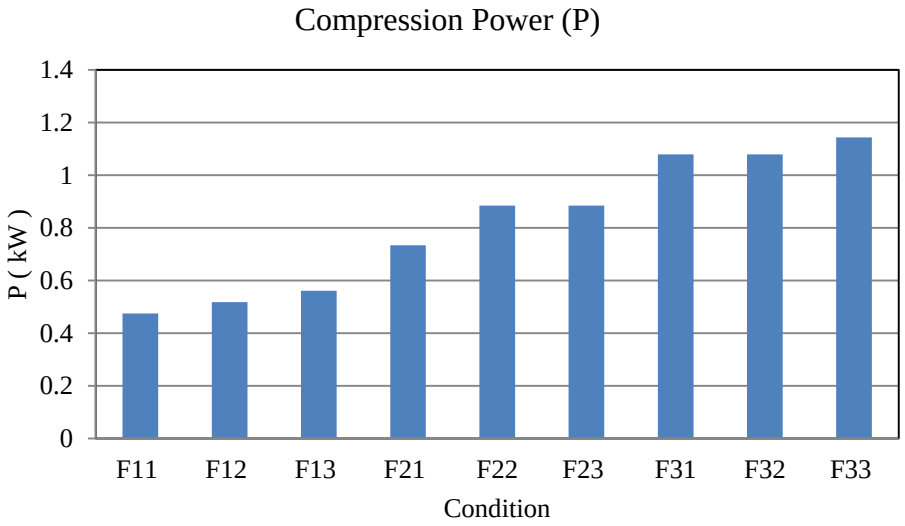

Figure 3. Compression Power

Figure 4 show the refrigeration effect of the refrigerator. Refrigeration effect is one of parameter to calculate the efficiency of refrigerator. Positions of F_{11}, F_{12}, F_{13}, F_{21}, and F_{22} have almost similar refrigeration effect of 5.22 kW.

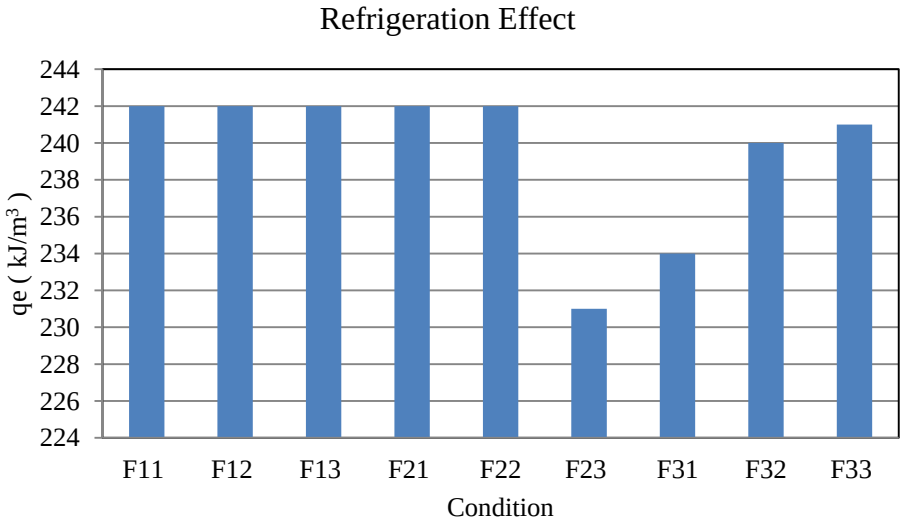

Figure 4. Refrigeration Effect

Figure 5 shows the coefficient of performance (COP) of the refrigerator. The graph show that the lowest and highest COP investigated at the position F_{33} and $F_{11.}$ COP at F_{11}

ISBN: 978-979-99723-9-2

and F_{33} are 10.99 and 4.55, respectively. This indicates that the refrigerator at the position of F_{11} has maximum efficiency.

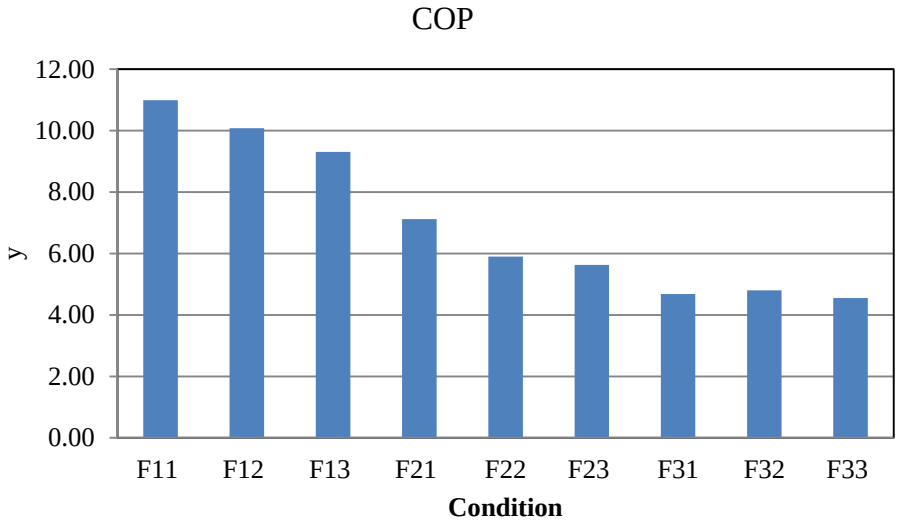

Figure 5. Coefficient of Performance

CONCLUSIONS

Compression power increases as the velocity of the fan at evaporator and condenser increases. Refrigeration effect has a maximum limitation value for conditioning at low fan rotation of evaporator and condenser. The highest and lowest of Coefficient of performance (COP) are investigated at position F_{11} and F_{33} of 10.99 and 4.55, respectively. This indicates that the conditioning of capillary tube will increase the performance of the refrigerator at lower fan rotation of the evaporator and condenser.

REFERENCES

[1] Akintunde, Mutalubi A, Effect of Coiled Capillary Tube Pitch on Vapour Compression Refrigeration, 2007
[2] Arismunandar, Wiranto, "Penyegaran Udara", PT Pradnya Paramita, Jakarta, 1995
[3] Jordan, Richard C, "Refrigeration and Air Conditioning", Prentice Hall of India, New Delhi, 1981.
[4] SMACNA, "HVAC System, Testing, Adjusting, and Balancing", SMACNA Inc, Virginia, 1993.
[5] Stoecker, W.F., "Refrigeration and Air Conditioning", Mc Graw Hill, New Delhi, 1992.
[6] System Performance, AU J.T. 11(1) : 14-22, July, 2007.

ICET 2013

Certificate

FACULTY of ENGINEERING
TARUMANAGARA UNIVERSITY

Presented to:

Harto Tanujaya

as

Presenter

1st International Conference on Engineering of Tarumanagara

"Urban Engineering for Future Generation"

Jakarta, 2-3 October 2013

Faculty of Engineering
Tarumanagara University
Dean,

UNIVERSITAS TARUMANAGARA
DEKAN
FAKULTAS TEKNIK

Dr. Agustinus Purna Irawan, S.T., M.T.