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An experimental study of the Effect of capillary tube diameter and configuration on the performance of a simple vapour compression refrigeration system

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Abstract: *The study of the expansion device in the simple vapour compression refrigeration system is necessary in order to understand the parameters which can enhance the overall performance of the system. The experimental study was done on the capillary tubes of 31 gauge, 36 gauge and 40 gauge and each test section was studied with three distinct configurations i.e. helical coiled, straight coiled and serpentine coiled configuration. The effect of the configuration and the capillary tube diameter on the overall performance of the system was studied. The findings of the experimental study revealed that the mass flow rate is maximum for the straight configuration and is least for the helical coiled configuration. The refrigeration effect was found to be maximum for the helical coiled configuration and was found to be least for straight coiled configuration. The compressor work was found to reduce as the load was increased on the system. Decreasing the capillary tube diameter increased the mass flow rate in the system and decreased the refrigeration effect produced.*

Keywords: Capillary Tube, configuration, diameter, refrigeration system.

I. Introduction

A simple vapour compression refrigeration system consists of mainly five components namely compressor, condenser, expansion device, evaporator and a filter/drier. The following study is focused towards finding out the effect of the capillary tube on the performance of the refrigeration system. A capillary tube is a small diameter tube which is used for the expansion of the flowing fluid. The pressure difference between the entry and exit ends of the capillary tube is always equal to the pressure difference between the condenser and the evaporator. The diameter of the capillary tube used in the refrigeration appliances varies from 0.5mm to 2.3mm. the effect of the capillary tube has been investigated by many researchers in the past and encouraging results were obtained.

Hirendra Kumar Paliwal and Keshav Kant[1] (2006) developed a flow model for designing and studying the performance of helical coiled capillary tubes and to mathematically simulate a situation closer to one existing in real practice. Homogeneous flow of two phase fluid was assumed through the adiabatic capillary tube. The model included the second law restrictions. The effect of the variation of different parameters like condenser and evaporator pressures, refrigerant flow rate, degree of sub cooling, tube diameter, internal roughness of the tube, pitch and the diameter of the helix and the length of the capillary tube were included in the model. Theoretically predicted lengths of helical coiled capillary tube for R-134a are compared with the length of the capillary tube actually required under similar experimental conditions and majority of predictions were found to be within around 10% of the experimental value**.**

M.Y.Taib[2] et al. (2010) studied the performance of a domestic refrigerator and developed a test rig from refrigerator model NRB33TA. The main objective of the performance analysis was to obtain the performance of the system in terms of refrigeration capacity, coefficient of performance (cop), and compressor work by determining three important parameters which are temperature, pressure and refrigerant flow rate. The analysis of the collected data gave the cop of the system as 2.75 while the refrigeration capacity was ranging from 150 watt to 205 watt.

J.K.Dabas[3] et al. (2011) studied the behavior of performance parameters of a simple vapour compression refrigeration system while its working under transient conditions occurred during cooling of a fixed mass of brine from initial room temperature to sub-zero refrigeration temperature. The effects of different lengths of capillary tube over these characteristics were also investigated. The investigation showed that with constantly falling temperature over evaporator, refilling of it with more and more liquid refrigerant causes increase in heat transfer coefficient which maintains the refrigeration rate at falling temperature. The study revealed that larger capillary tubes decreases the tendency of refilling but offers less evaporator temperature while shorter capillary tubes ensure higher cop initially but it deteriorates at a faster rate in lower temperature range.

Ankush Sharma and Jagdev Singh[4] (2013) experimentally investigated about the effects simple and twisted spirally coiled adiabatic capillary tubes on the refrigerant flow rate. Several capillary tubes with different bore diameters, lengths and pitches were taken as test sections. LPG was used as an alternative for R134a. mass flow rates for different capillary tubes were measured for different degrees of subcooling with constant inlet pressure of the capillary tube. Experiments were conducted on straight capillary tubes as well so as to facilitate proper comparison. The test results showed that mass flow rate is greater in straight capillary tube and least in twisted spirally coiled capillary tube.

Sudharash Bhargava and Jagdev Singh[5] (2013) experimentally investigated the of pitch and length of the serpentine coiled adiabatic capillary tube on the flow of a eco friendly gas. The azeotropic blend (30% propane, 55% n-butane, 15% iso-butane) is used as refrigerant in the experiment. Various capillary tubes with distinct lengths, pith and bore diameter were used as the test sections in the experiment. Inlet pressure of the capillary tubes was kept constant and then mass flow rates for different capillary tubes with different lengths and pitches were measured. Straight capillary tubes were also investigated. The data from the experiments showed that mass flow rate of the refrigerant in the system was less for serpentine coiled capillary tubes and was grater for straight capillary tubes.

Thamir K. Salim[6] (2012) experimentally investigated the performance of the capillary tube expansion device using R134a as the refrigerant in the system. All the properties of the refrigeration system was measured for the mass flow rate ranging from 13 kg/hour to 23 kg/hour and capillary tube coil number (0-4) with fixed length (150 cm) and capillary tube bore diameter (2.5 mm). the test results showed that the theoretical compression power increases by 65.8% as the condenser temperature increases by 2.71% and the theoretical compression power decreases by 10.3% as the capillary tube coil number increases. The test results also showed that cooling capacity increases by 65.3% as evaporator temperature increases by 8.4% and the cooling capacity increases by 1.6% as the capillary tube coil number increases in the range (0-4). The cop decreases by 43.4% as the mass flow rate increases by 76.9% and the cop of the system increases by 13.51% as the capillary tube coil number increases in the range (0-4). The study showed that coil number 4 was the best for the lowest mass flow rate (13 kg/hour) and the highest mass flow rate (23 kg/hour).

M.A. Akintunde[7] (2007) investigated the effects of various geometries of capillary tubes based on the coil diameters and lengths alone. There was no any particular attention paid on the effect of coil pitch. This paper examined the effects that the pitches of both helical coiled and serpentine coiled capillary tubes have on the performance of a vapor compression refrigeration system. Several capillary tubes of equal lengths (2.03 m) and varying pitches, coile diameters and serpentine heights were used. Both the inlet and outlet pressure and the temperature of the test section (capillary tube) were measured and were used to estimate the COP of the system. In the case of helical coiled capillary tubes, the pitch did not have any significant effect on the system performance, while in the case of serpentine coiled capillary tubes , both pitch and height of the serpentine influences the system performance. Performance improved with increase in both the pitch and the height. Correlations were proposed to describe the relationships between straight and coiled capillary tubes and between helical coiled capillary tubes and serpentine coiled capillary tubes. The coefficient of correlation proposed was 0.9841 for the mass flow rates of helical and serpentine with straight tubes and 0.9864 for the corresponding COPs and 0.9996 for the mass flow rates of helical and serpentine coiled tubes.

II. Methodology

The experimental study was done in the refrigeration and air conditioning laboratory of Shri Ramswaroop Memorial Group of Professional Colleges, Lucknow, India in the best possible controlled environment. Hermetic sealed compressor unit and tubular condenser unit were used. The evaporator unit was properly insulated to the best of the effort so as to minimize the heat leakage into the system from the surrounding. Copper tubes of diameter ¼ inches were used for providing the supply and return lines to the flowing fluid in the system. Refrigerant R134a was used as the cooling fluid. A filter/drier, specific for R134a, was installed just after the condenser unit in order to avoid any situation of choking of the flow lines. The filter/drier does not allow the ice to be formed in the flow lines by absorbing all the moisture particles present in the flowing fluid. Two analogue pressure gauges were used to determine the pressure of the flowing fluid in the high pressure and the low pressure line. The pressure gauge in the high pressure line was installed just after the filter/drier and just before the capillary tube. Another pressure gauge was installed in the low pressure retun line to measure the pressure of the fluid returning back to the compressor. A digital temperature meter was used to determine the temperatures that were to be used in the analysis of the system. The readings of the temperature and pressure were plotted on the PH chart and the corresponding enthalpies were noted down and from the obtained values of the enthalpies, the parameters like the refrigeration effect and the compressor work were determined. The carnot COP of the system was determined by using the temperature limits of the system and the actual COP of the system was determined by taking the ratio of the refrigeration effect and the compressor work obtained from the PH chart.

III. EXPERIMENTAL OBSERVATION AND RESULT DISCUSSION

Capillary tubes of 31 gauge, 36 gauge and 40 gauge were used as the test sections. The length of each test section was kept constant to 3.5m. For each test section, readings were taken for three distinct configurations i.e. helical coiled configuration, straight coiled configuration and serpentine coiled configuration. Every set of readings consists of at least five readings, two for no load condition and one each for loaded condition of 600ml, 1200ml and 1800ml.

Readings for 31 gauge – helical coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/hr)
1.	No Load	32	250	7.8	-6.5	68	3.58	108.8	49	2.22	92.65
2.	No load	32	250	7.8	-6.2	68.2	3.59	109.4	48.8	2.24	92.14
3.	No load	25	240	9.6	-12.8	66	3.30	112.4	48.9	2.29	89.68
4.	600ml Load	28	239	8.54	-9.1	65.5	3.54	109.2	47.4	2.30	92.30
5.	1200ml Load	38	252	6.63	1.1	70	3.98	110.9	34.6	3.20	90.89
6.	1800ml Load	42	262	6.24	14.3	73	4.89	113.5	27.6	4.11	88.81

Table 1: Readings for 31 gauge – helical coiled capillary tube

Readings for 31 gauge – straight coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	38	274	7.21	-5	73	3.44	94.67	36.09	2.62	106.48
2.	No load	34	270	7.94	-6.5	72	3.39	94.23	40.38	2.33	106.97
3.	600ml Load	40	274.5	6.86	3	73.5	3.88	96.79	32.11	3.01	104.14
4.	1200ml Load	40	275	6.87	10	74	4.42	94.87	26.28	3.61	106.25
5.	1800ml Load	40	277	6.92	14	75	4.70	98.77	21.79	4.53	102.05

Table 2: Readings for 31 gauge – straight coiled capillary tube

Readings for 31 gauge – serpentine coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	28	250	8.92	-8.5	68	3.34	104.67	36.67	2.85	96.30
2.	No load	32	255	7.96	-8.2	69	3.43	102.33	36.33	2.82	98.50
3.	600ml Load	38	274	7.21	-1.4	72	3.70	100.00	29.67	3.37	100.80
4.	1200ml Load	40	278	6.95	4.6	74	4.00	101.33	29.34	3.45	99.48
5.	1800ml Load	40	280	7.00	5	74.5	4.01	102.00	29.00	3.52	98.82

Table 3: Readings for 31 gauge – serpentine coiled capillary tube

Readings for 36 gauge – helical coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	30	260	8.67	-12	70	3.18	97.95	38.19	2.57	102.91
2.	No load	30	260	8.67	-13	70	3.12	97.32	38.33	2.54	103.58
3.	600ml Load	32	265	8.28	-10	71	3.25	99.89	36.99	2.70	100.91
4.	1200ml Load	33	274	8.30	-1.8	72	3.67	100.61	35.19	2.86	100.19
5.	1800ml Load	34	275	8.09	1	73	3.81	102.90	28.67	3.59	97.96

Table 4: Readings for 36 gauge – helical coiled capillary tube

Readings for 36 gauge – straight coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	30	264	8.8	-8.3	71	3.38	96.64	36.34	2.66	104.31
2.	No load	30	265	8.83	-8.7	71	3.32	97.01	36.20	2.68	103.91
3.	600ml Load	28	260	9.29	-1.9	70	3.77	99.32	35.38	2.81	101.50
4.	1200ml Load	30	262	8.73	3.4	70.5	4.12	100.34	30.35	3.31	100.49
5.	1800ml Load	32	270	8.44	6.9	72	4.30	101.59	28.91	3.48	99.22

Table 5: Readings for 36 gauge – straight coiled capillary tube

Readings for 36 gauge – serpentine coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	32	264	8.25	-9	71	3.30	97.21	33.60	2.89	103.69
2.	No load	32	264	8.25	-8.5	71	3.32	97.54	33.25	2.93	103.34
3.	600ml Load	33	275	8.33	-3.7	73	3.51	99.41	32.34	3.07	101.40
4.	1200ml Load	34	276	8.12	2	74	3.82	100.48	29.60	3.39	100.32
5.	1800ml Load	34	276.5	8.13	4.8	74.5	4.01	102.16	27.94	3.66	98.67

Table 6: Readings for 36 gauge – serpentine coiled capillary tube

Readings for 40 gauge – helical coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/hr)
1.	No Load	30	265	8.83	-13.3	71	3.08	95.68	41.33	2.32	105.35
2.	No load	30	265	8.83	-13	71	3.10	96.54	40.61	2.38	104.41
3.	600ml Load	32	275	8.59	-11.2	73	3.11	97.31	38.4	2.53	103.59
4.	1200ml Load	34	273	8.03	-4.3	75	3.38	98.38	35.34	2.78	102.46
5.	1800ml Load	35	280	8	-2.5	77	3.40	101	33	3.06	99.80

Table 7: Readings for 40 gauge – helical coiled capillary tube

Readings for 40 gauge – straight coiled capillary tube:-

S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	32	268	8.38	-9.1	72	3.25	95.06	38.93	2.44	106.04
2.	No load	32	269	8.41	-9.3	72	3.24	95.89	38.72	2.48	105.12
3.	600ml Load	33	275	8.33	-4.5	73	3.47	97.12	37.54	2.59	103.79
4.	1200ml Load	35	278	7.94	-3.5	74	3.48	98.04	33.45	2.93	102.82
5.	1800ml Load	37	280	7.57	-1	75	3.58	99.12	31.89	3.11	101.70

Table 8: Readings for 40 gauge – straight coiled capillary tube

Readings for 40 gauge – serpentine coiled capillary tube:-

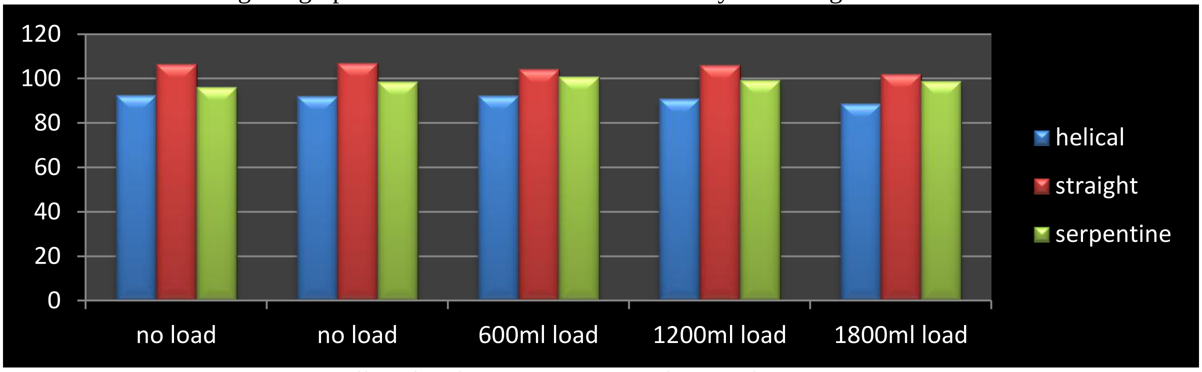
S.No.	Condition	P_1 (psi)	P_2 (psi)	P_2/P_1	T_e (°C)	T_c (°C)	COP_{carnot}	R.E. (KJ/Kg)	W_c (KJ/Kg)	COP_{actual}	$Mfr_{theo.}$ (Kg/s)
1.	No Load	30	268	8.93	-9.6	71	3.27	95.64	38.23	2.50	105.40
2.	No load	30	270	9	-9.9	71	3.21	96.01	38.33	2.51	104.99
3.	600ml Load	32	272	8.5	-4.9	72	3.49	97.34	36.98	2.63	103.55
4.	1200ml Load	33	276	8.36	-3.9	73	3.50	98.12	35.98	2.73	102.73
5.	1800ml Load	35	278	7.94	-1.5	74	3.60	99.34	34.89	2.85	101.47

Table 9: Readings for 40 gauge – serpentine coiled capillary tube

The above shown readings were used to plot bar graphs for comparing the system performance for different configurations for each capillary tube. The bar graphs were used to compare the effect of the capillary tube configuration and its diameter on the system performance. The bar graphs for the different test sections and their different configurations are drawn and shown below:-

Effect of configuration on the mass flow rate for 31 gauge capillary tube:-

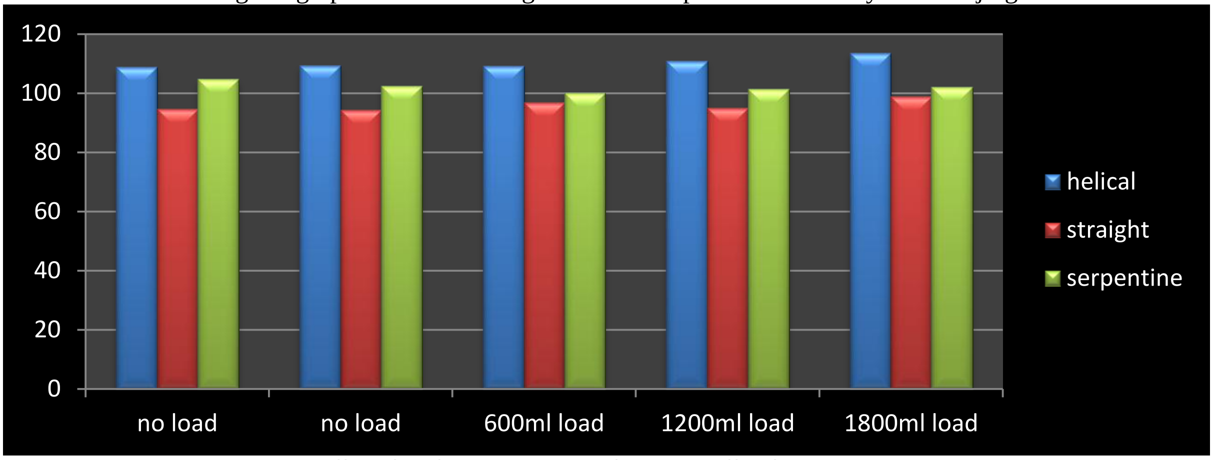
Y axis in the following bar graph shows the mass flow rate in the system in kg/hr.



Bar graph 1: Effect of configuration on the mass flow rate for 31 gauge capillary tube

Effect of configuration on the refrigeration effect for 31 gauge capillary tube:-

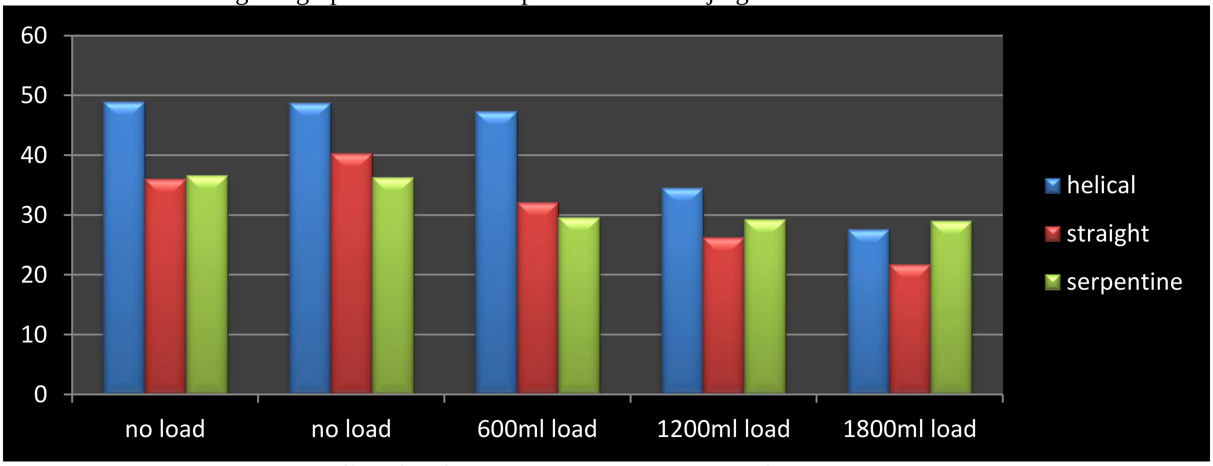
Y axis in the following bar graph shows the refrigeration effect produced in the system in kj/kg.



Bar graph 2: Effect of configuration on the refrigeration effect for 31 gauge capillary tube

Effect of configuration on the compressor work for 31 gauge capillary tube:-

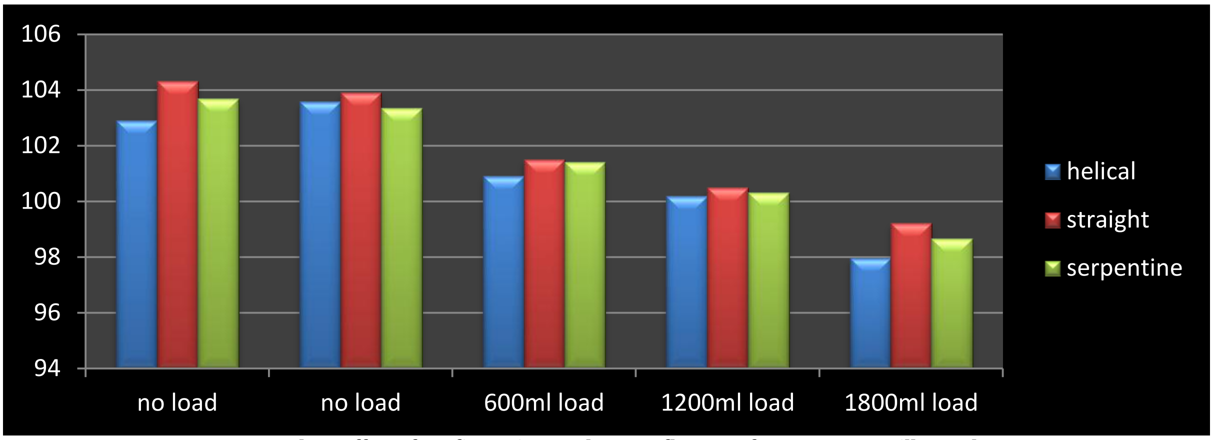
Y axis in the following bar graph shows the compressor work in kj/kg.



Bar graph 3: Effect of configuration on the compressor work for 31 gauge capillary tube

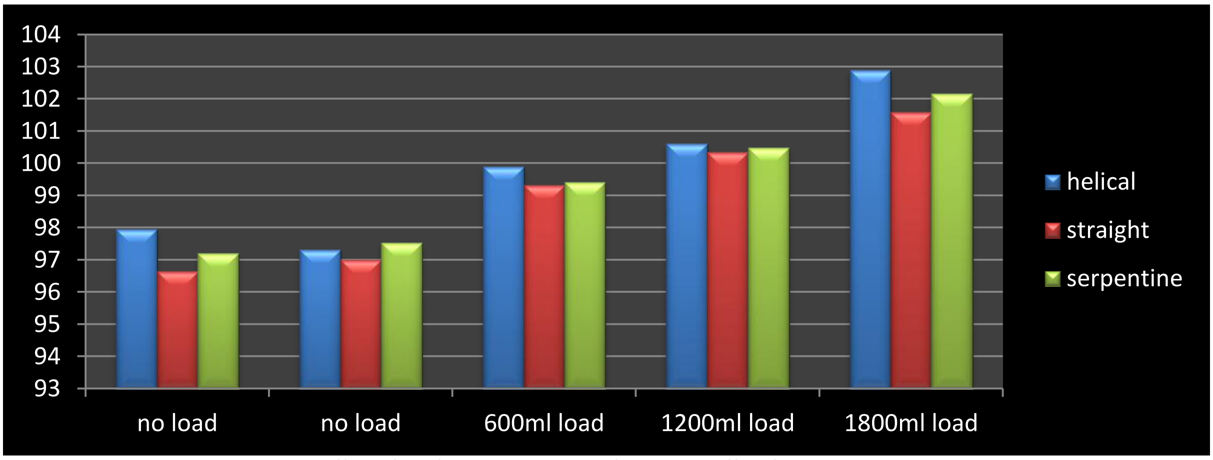
Effect of configuration on the mass flow rate for 36 gauge capillary tube:-

Y axis in the following bar graph shows the mass flow rate in the system in kg/hr.



Bar graph 4: Effect of configuration on the mass flow rate for 36 gauge capillary tube

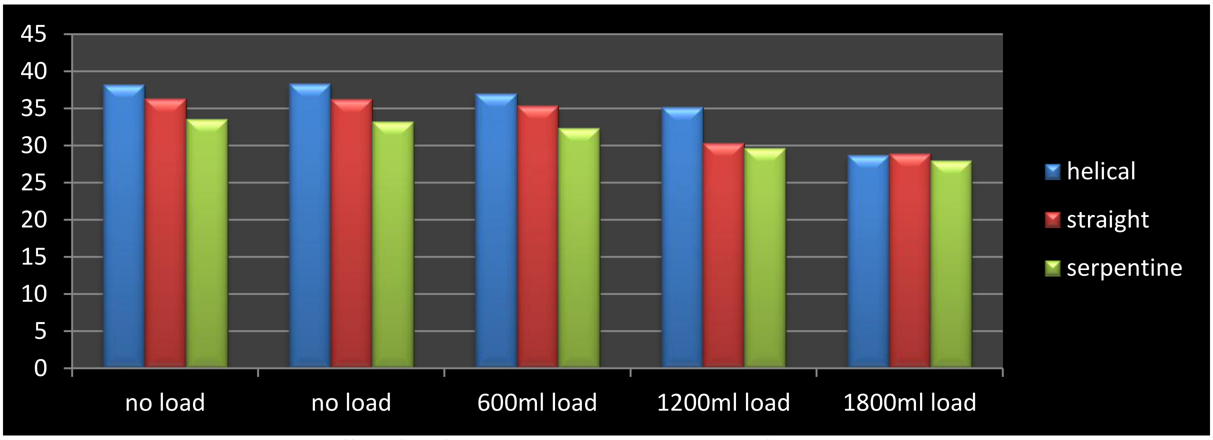
Effect of configuration on the refrigeration effect for 36 gauge capillary tube:-
Y axis in the following bar graph shows the refrigeration effect produced in kj/kg.



Bar graph 5: Effect of configuration on the refrigeration effect for 36 gauge capillary tube

Effect of configuration on the compressor work for 36 gauge capillary tube:-

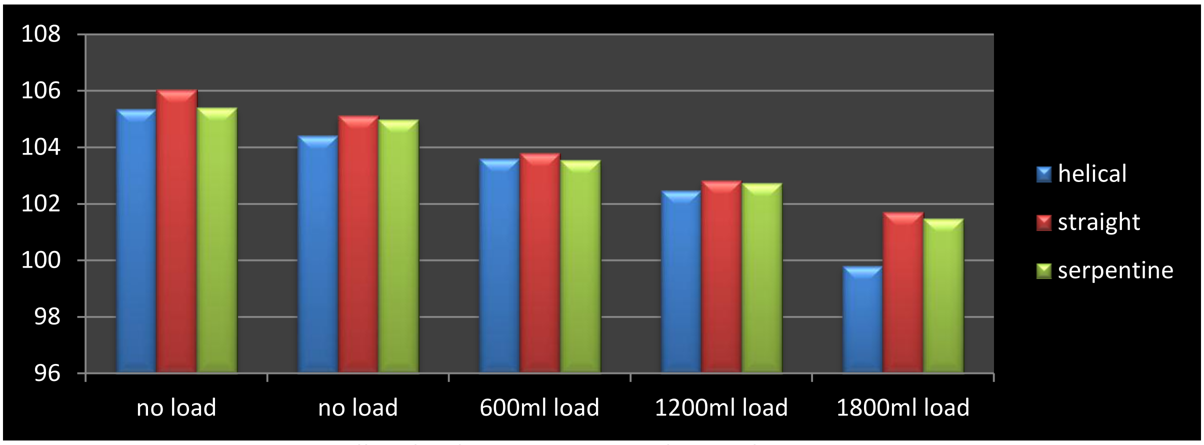
Y axis in the following bar graph shows the compressor work in kj/kg.



Bar graph 6: Effect of configuration on the compressor work for 36 gauge capillary tube

Effect of configuration on the mass flow rate for 40 gauge capillary tube:-

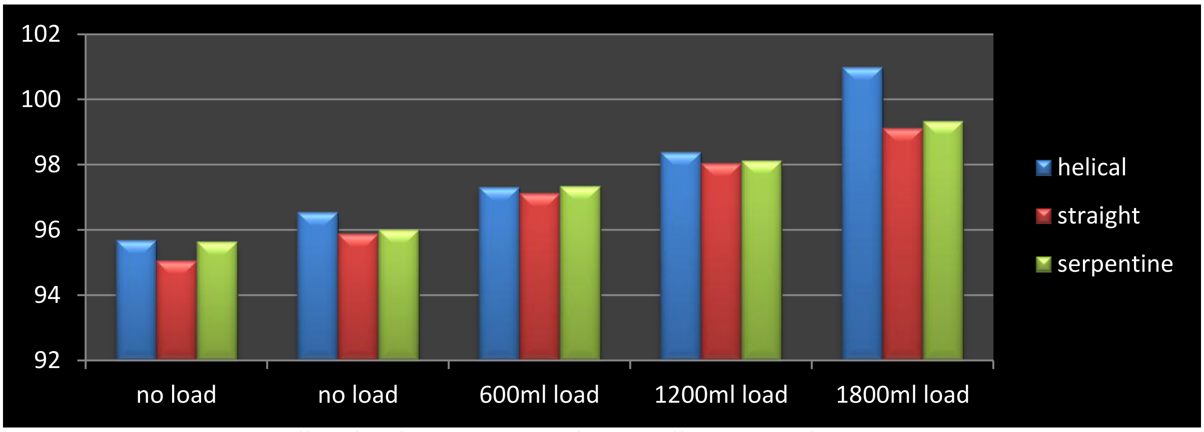
Y axis in the following bar graph shows the mass flow rate in the system in kg/hr.



Bar graph 7: Effect of configuration on the mass flow rate for 40 gauge capillary tube

Effect of configuration on the refrigerant effect produced for 40 gauge capillary tube:-

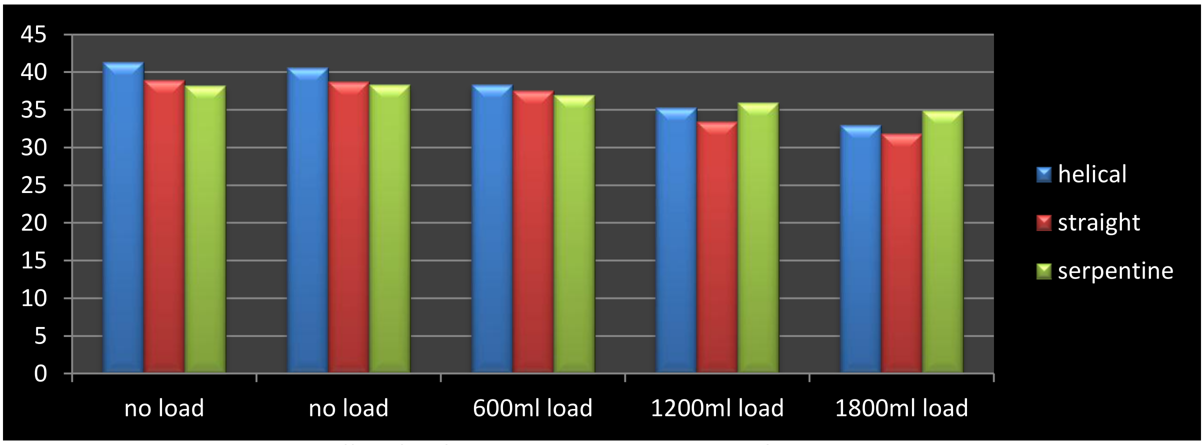
Y axis in the following bar graph shows the refrigerant effect produced in kj/kg.



Bar graph 8: Effect of configuration on the refrigerant effect produced for 40 gauge capillary tube

Effect of configuration on the compressor work for 40 gauge capillary tube:-

By axis in the following bar graph shows the compressor work for 40 gauge capillary tube in kj/kg.



Bar graph 9: Effect of configuration on the compressor work for 40 gauge capillary tube

On the basis of obtained data, curves are drawn between the pressure ratio and the (cop)a to eshtablish a general relationship between the both.

Relation between pressure ratio and (COP)a for 31 gauge helical coiled capillary tube:-

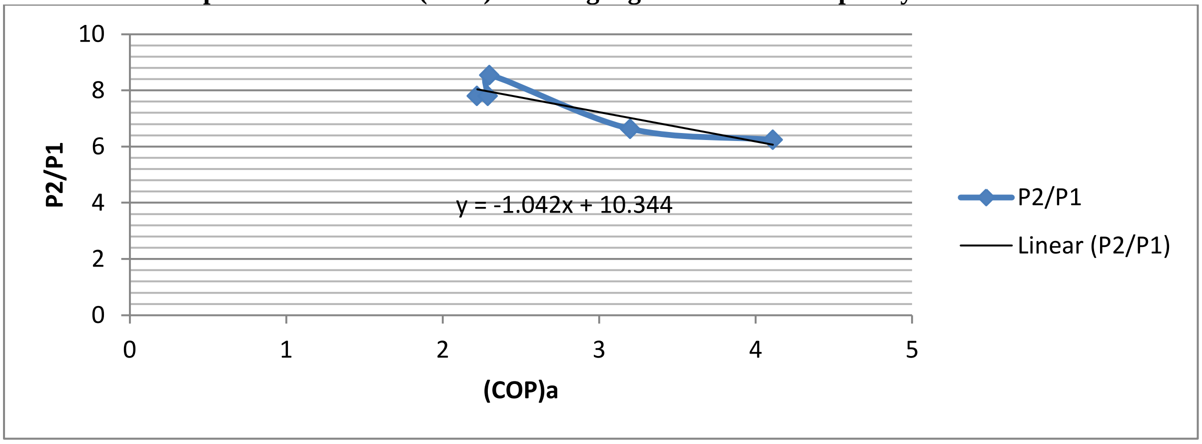


Figure 1: Relation between pressure ratio and (COP)a for 31 gauge helical coiled capillary tube

Relation between pressure ratio and (COP)a for 31 gauge straight coiled capillary tube:-

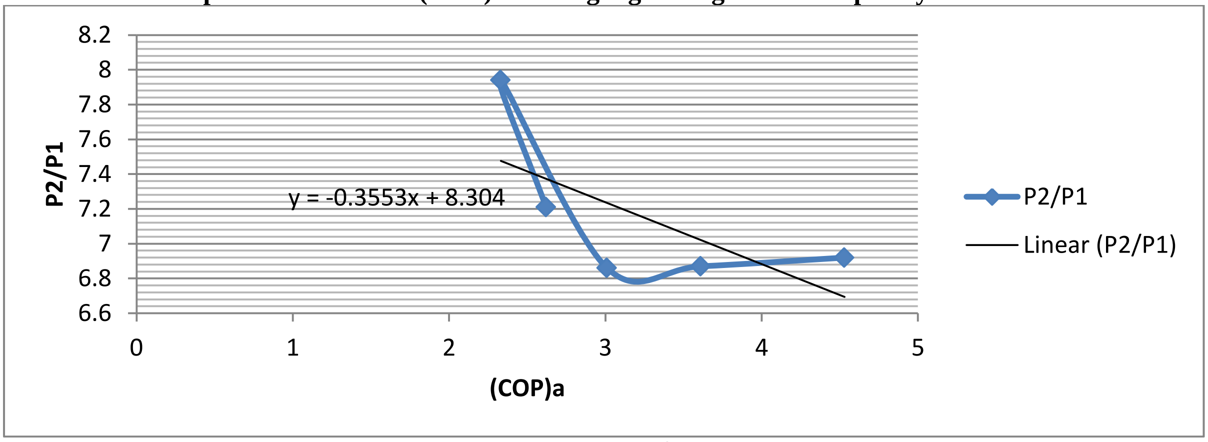


Figure 2: Relation between pressure ratio and (COP)a for 31 gauge straight coiled capillary tube

Relation between pressure ratio and (COP)a for 31 gauge serpentine coiled capillary tube:-

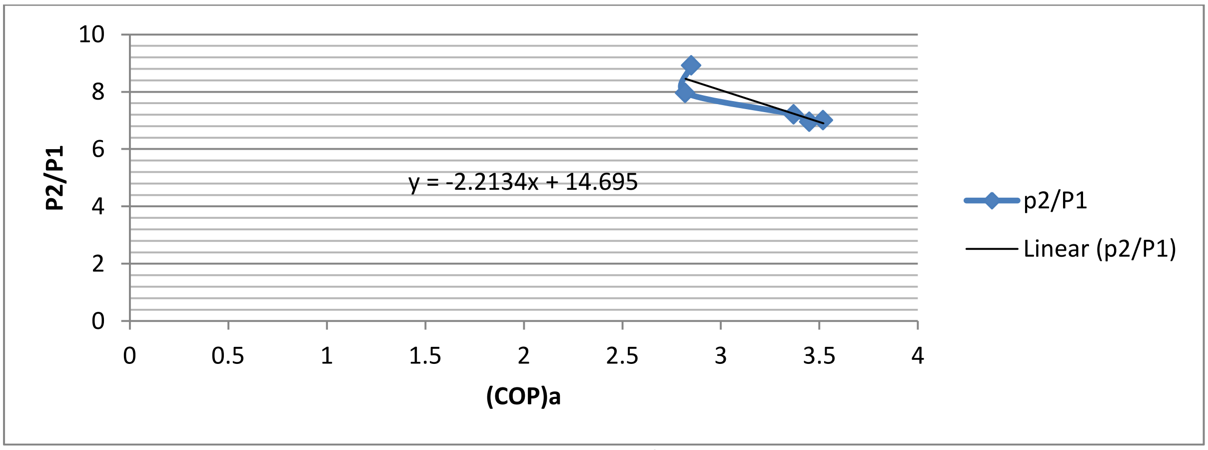


Figure 3: Relation between pressure ratio and (COP)a for 31 gauge serpentine coiled capillary tube

Relation between pressure ratio and (COP)a for 36 gauge helical coiled capillary tube:-

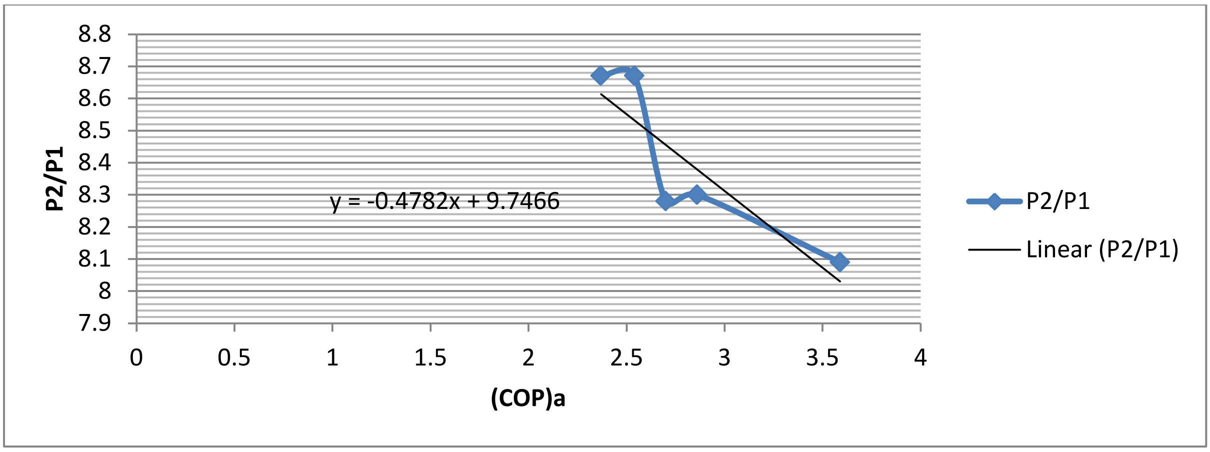


Figure 4: Relation between pressure ratio and (COP)a for 36 gauge helical coiled capillary tube

Relation between pressure ratio and (COP)a for 36 gauge straight coiled capillary tube:-

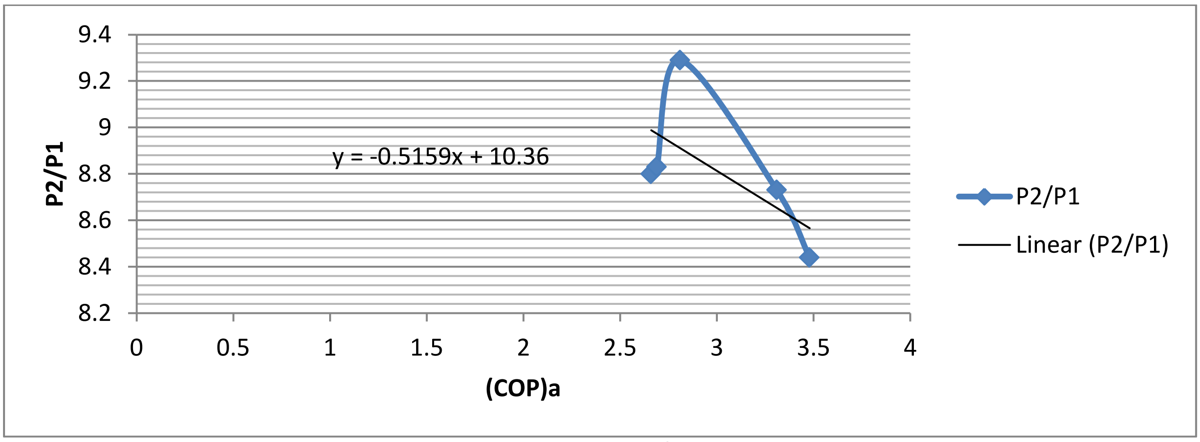


Figure 5: Relation between pressure ratio and (COP)a for 36 gauge straight coiled capillary tube

Relation between pressure ratio and (COP)a for 36 gauge serpentine coiled capillary tube:-

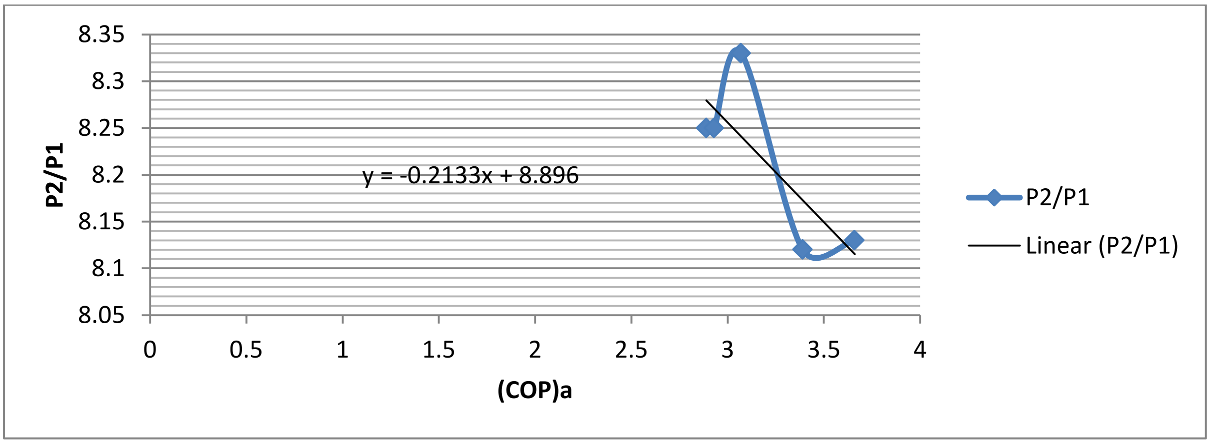


Figure 6: Relation between pressure ratio and (COP)a for 36 gauge serpentine coiled capillary tube

Relation between pressure ratio and (COP)a for 40 gauge helical coiled capillary tube:-

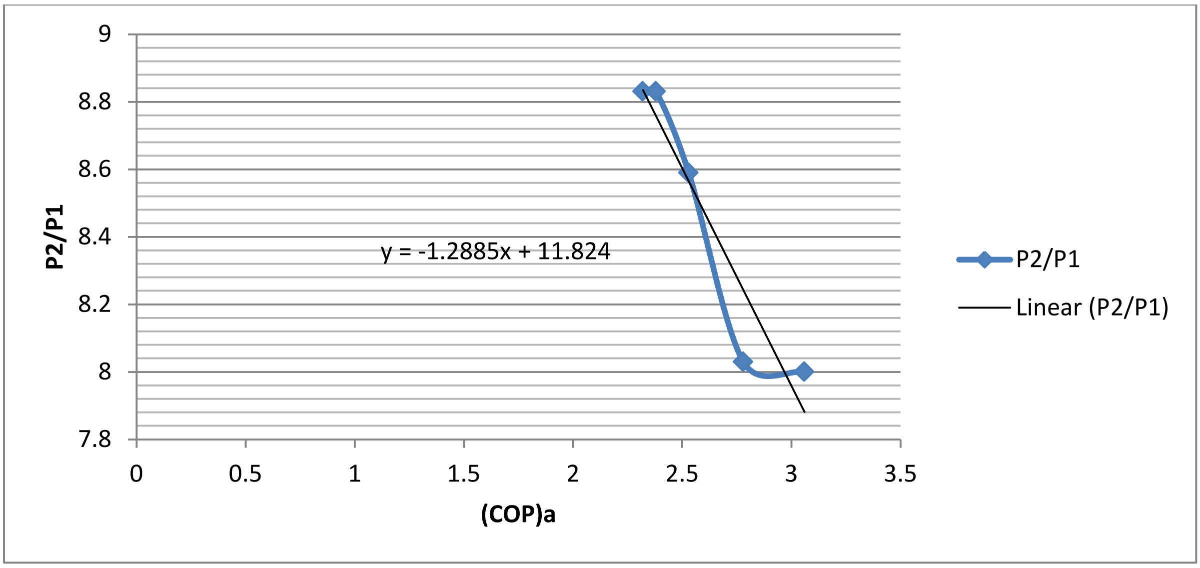


Figure 7: Relation between pressure ratio and (COP)a for 40 gauge helical coiled capillary tube

Relation between pressure ratio and (COP)a for 40 gauge straight coiled capillary tube:-

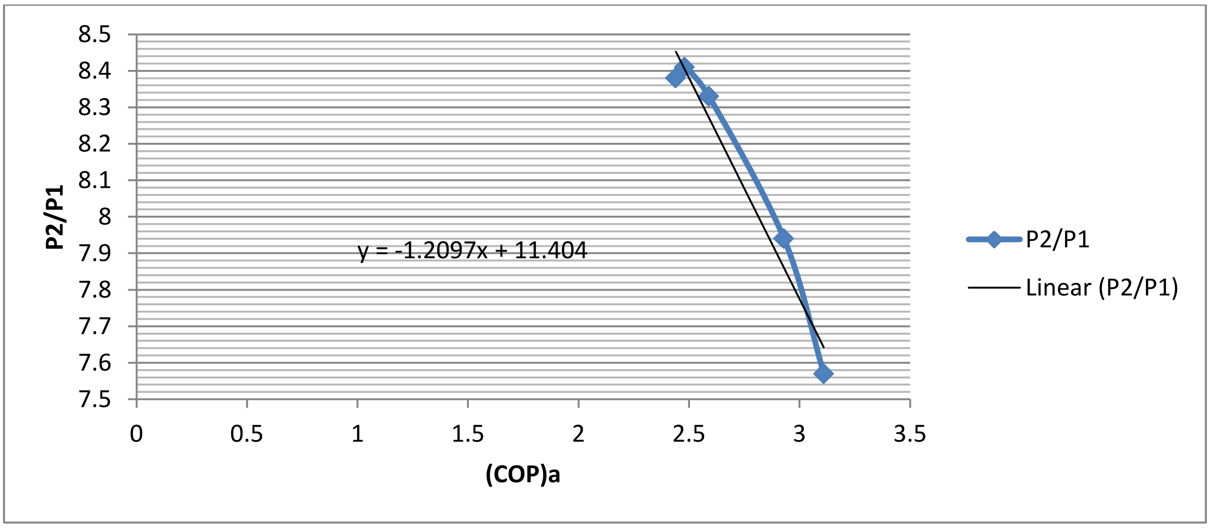


Figure 8: Relation between pressure ratio and (COP)a for 40 gauge straight coiled capillary tube

Relation between pressure ratio and (COP)a for 40 gauge serpentine coiled capillary tube:-

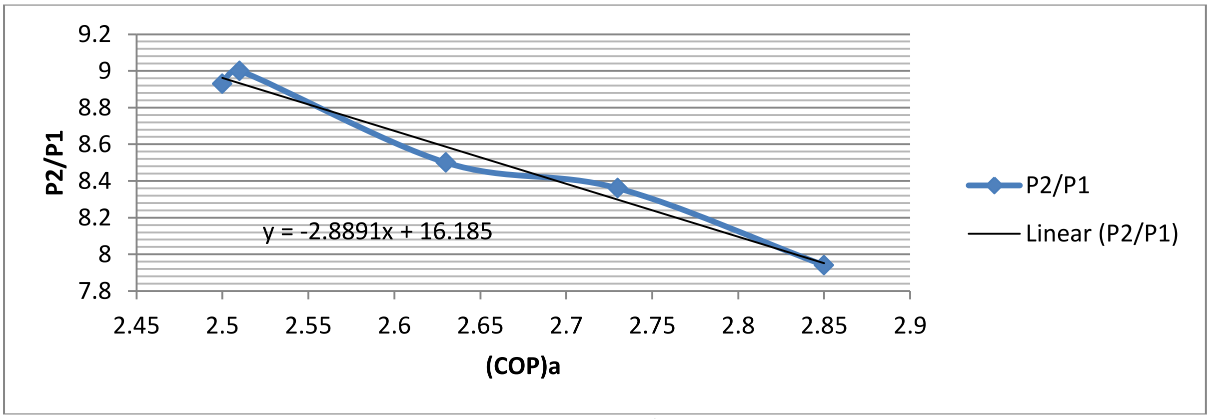


Figure 9: Relation between pressure ratio and (COP)a for 40 gauge serpentine coiled capillary tube

Error analysis for 31 gauge helical coiled capillary tube:-

Governing equation => Y = -1.042X + 10.344

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
7.8	2.22	2.44	9.02
7.8	2.24	2.44	8.20
8.54	2.30	1.73	32.94
6.63	3.20	3.56	10.11
6.24	4.11	3.94	4.31

Table 10: Error analysis for 31 gauge helical coiled capillary tube

Error analysis for 31 gauge straight coiled capillary tube:-

Governing equation => Y = -0.3553X + 8.304

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
7.21	2.62	3.08	14.94
7.94	2.33	1.03	126.21
6.86	3.01	4.06	25.86
6.87	3.61	4.04	10.64
6.92	4.53	3.90	16.15

Table 11: Error analysis for 31 gauge straight coiled capillary tube

Error analysis for 31 gauge serpentine coiled capillary tube:-

Governing equation => Y = -2.2134X + 14.695

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.92	2.85	2.61	9.20
7.96	2.82	3.04	7.24
7.21	3.37	3.38	0.30
6.95	3.45	3.5	1.43
7.00	3.52	3.48	1.15

Table 12: Error analysis for 31 gauge serpentine coiled capillary tube

Error analysis for 36 gauge – helical coiled capillary tube:-

Governing equation => Y = -0.4782X + 9.7466

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.67	2.57	2.25	14.22
8.67	2.54	2.25	12.89
8.28	2.70	3.07	12.05
8.30	2.86	3.03	5.61
8.09	3.59	3.46	3.76

Table 13: Error analysis for 36 gauge helical coiled capillary tube

Error analysis for 36 gauge straight coiled capillary tube:-

Governing equation => Y = -0.5159X + 10.36

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.8	2.66	3.02	11.92
8.83	2.68	2.97	9.76
9.29	2.81	2.07	35.75
8.73	3.31	3.16	4.75
8.44	3.48	3.72	6.45

Table 14: Error analysis for 36 gauge straight coiled capillary tube

Error analysis for 36 gauge serpentine coiled capillary tube:-

Governing equation => Y = -0.2133X + 8.896

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.25	2.89	3.03	4.62
8.25	2.93	3.03	3.3
8.33	3.07	2.65	15.85
8.12	3.39	3.64	6.87
8.13	3.66	3.59	1.95

Table 15: Error analysis for 36 gauge serpentine coiled capillary tube

Error analysis for 40 gauge helical coiled capillary tube:-

Governing equation => Y = -1.2885X + 11.824

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.83	2.32	2.32	0
8.83	2.38	2.32	2.59
8.59	2.53	2.51	0.80
8.03	2.78	2.95	5.76
8	3.06	2.97	3.03

Table 16: Error analysis for 40 gauge helical coiled capillary tube

Error analysis for 40 gauge straight coiled capillary tube:-

Governing equation => Y = -1.2097X + 11.404

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.38	2.44	2.50	2.4
8.41	2.48	2.48	0
8.33	2.59	2.54	1.97
7.94	2.93	2.86	2.45
7.57	3.11	3.17	1.89

Table 17: Error analysis for 40 gauge straight coiled capillary tube

Error analysis for 40 gauge serpentine coiled capillary tube:-

Governing equation => Y = -2.8891X + 16.185

P2/P1	Experimental (COP)a	Best fit (COP)a	Error(%)
8.93	2.50	2.51	0.40
9.00	2.51	2.49	0.80
8.5	2.63	2.66	1.13
8.36	2.73	2.71	0.74
7.94	2.85	2.85	0

Table 18: Error analysis for 40 gauge serpentine coiled capillary tube

IV. Conclusions

The above mentioned experimental study involved a thorough observation and analysis of the readings and values obtained. Every graph and curve is self explanatory in itself and points out towards a specific outcome from the study. The above shown readings, graphs and curves do point out towards some distinct conclusions and inferences which are stated below:-

1. The mass flow rate of the refrigerant is maximum in the case of straight capillary tubes and is least for helical coiled capillary tubes for each test section.
2. The refrigeration effect produced is maximum for the helical coiled capillary tubes and is least for straight capillary tubes for each test section.
3. The serpentine coiled capillary tubes do not have a very pronounced effect on the overall performance of the system and the performance in the case of serpentine coiled capillary tubes lies between to that with helical coiled capillary tube and straight coiled capillary tube.
4. As the diameter of the capillary tube goes on decreasing, the evaporator temperature goes on decreasing as well.
5. As we decrease the capillary tube diameter, the mass flow rate of the fluid in the system tend to increase.
6. As we decrease the capillary tube diameter, the refrigeration effect produced tend to decrease.
7. The helical coiled capillary tubes take the least space and the straight coiled capillary tubes take the maximum space. This makes the helical coiled capillary tubes the best alternative for domestic refrigeration systems.
8. Error analysis was done for the experimental and best fit results for actual (COP). On the basis of the difference between the two values the percentage error was determined and quoted in the above tables.

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