Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 6, Issue 04, April -2019

EXPERIMENTATION AND ANALYSIS TO DEVELOP POLYNOMIAL DESIGN FOR CONDENSER TUBE

Parekh Hirenkumar Deepkumar[1],Brahmbhatt Parthivkumar Yogeshkumar[2], Asst Prof Vivek Patel[3], Asst Prof Darshan Gajdhar[4], Asst Prof Krunal A Shah[5]

[1]*Mechanical Department, DJMIT College, Mogar, Anand.*
[2]*Mechanical Department, HGCE College, Vahelal.*
[3]*Mechanical Department, DJMIT College, Mogar, Anand.*
[4]*Mechanical Department, DJMIT College, Mogar, Anand.*
[5]*Mechanical Department, HGCE College, Vahelal.*

Abstract —*This research presents the theoretical and experimental analysis of the cross flow condenser selected based on Samsung compressor model no. DK172B having the displacement clearance of 0.2/0.15 containing the refrigerant as the R-134a. The study is primarily concerned with optimum design of air-cooled condensers. The study presents a generalized thermal design at different cooling loads for a finned-tube air-cooled condenser, which are based on7th order polynomial mathematical equations in inner designing for heat transfer and pressure drop. The condenser design was accomplished numerically and gives satisfactory results compared with commercial catalogue data. The numerical results present graphical charts giving the optimum size corresponding to cooling load at minimum cost. The present study shows the effect of ambient air temperature, condensing temperature, condensing loops and number of rows in the condenser on the condensing unit annual cost. The optimum design is based on the main parameters, namely, condensing temperature relative to local ambient temperature, number of rows, coil 7th order curve inner design, number of passes, as well as cooling load. NTU methods have been selected for obtaining the theoretical data. The main concept of this study is to apply the innovative 7th order polynomial equation curve towards the inner periphery of the condenser tubes so as to increase characteristically performance of the condenser assembly. We have validated our results by comparing the results of the analyses of the conventional and new condenser designs.*

Keywords- *Condenser design, polynomial equation, CFD of condenser tube, 7th order polynomial application, increased performance of condenser, etc.*

I.INTRODUCTION

OBJECTIVE

- The Existing Condenser Design and New Developed Polynomial Design Condenser and its CFD Results compare with different parameter measured with temperature distribution.
- The effect of number of rows, lower the power consumption. So, the recommended rows are found to be about 3 or 4 rows and reduce the rows. These Results found in 13 Rows assembly and Cost is reduced.
- Using the polynomial Theory apply in existing condenser design so the condenser area is decreased and increase the refrigerant pressure drop turn into the distinct drop in condenser temperature.

AIM OF THE PROJECT

- Increase the efficiency of condenser assembly by change in Design and with use of polynomial curve towards the condenser side.

II.EXPERIMENTATION

A typical domestic refrigerator consists of a hermetic compressor, an evaporator, a condenser, a capillary tube, a filter dryer, a thermostat switch, and a well insulated cabinet with racking and storing containers.
The refrigerator was of 177L capacity, single door, manufactured by LG. The modified household refrigerator was properly instrumented with temperature indicators, pressure gauges and digital energy meter. The temperature at various points was noted using calibrated K-type thermocouples.
An air-cooled condenser is one in which the removal of heat is done by air. It consists of steel or copper tubing through which the refrigerant flows. The size of tube usually ranges from 6 mm to 18 mm outside diameter, depending upon the size of condenser. Generally copper tubes are used because of its excellent heat transfer ability.
The heat exchanger under analysis was comprised of 19 tube passes of 6.5mm external diameter and of 65 pairs of wires of 1.5mm diameter, covering an area of 440 mm width by 1100 mm height. The water flow rate was kept at an almost constant value of 0.49 liters/min. Also, the room temperature was maintained at 32o C. The water temperature at the heat exchanger inlet was maintained at between 43.3 and 44.0 o C. The aim of this procedure was to minimize the variations of the temperature difference between the heat exchanger and the surrounding air.

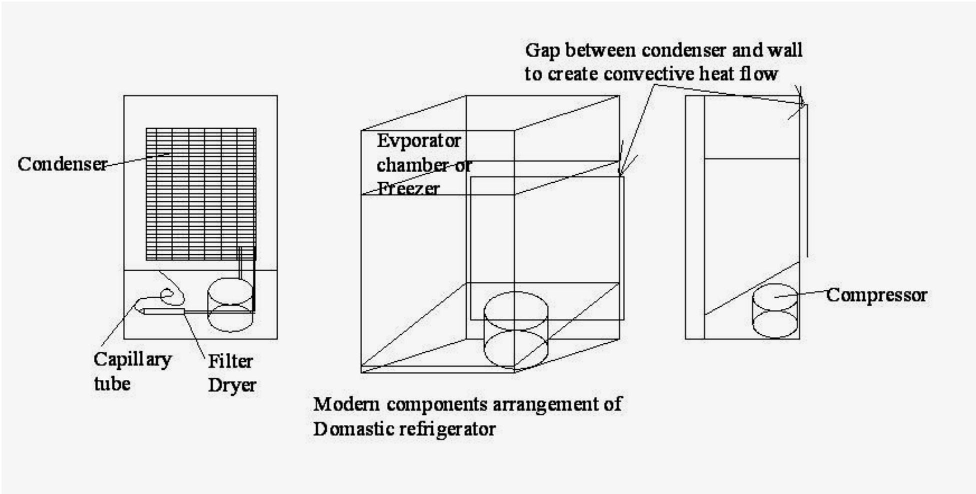
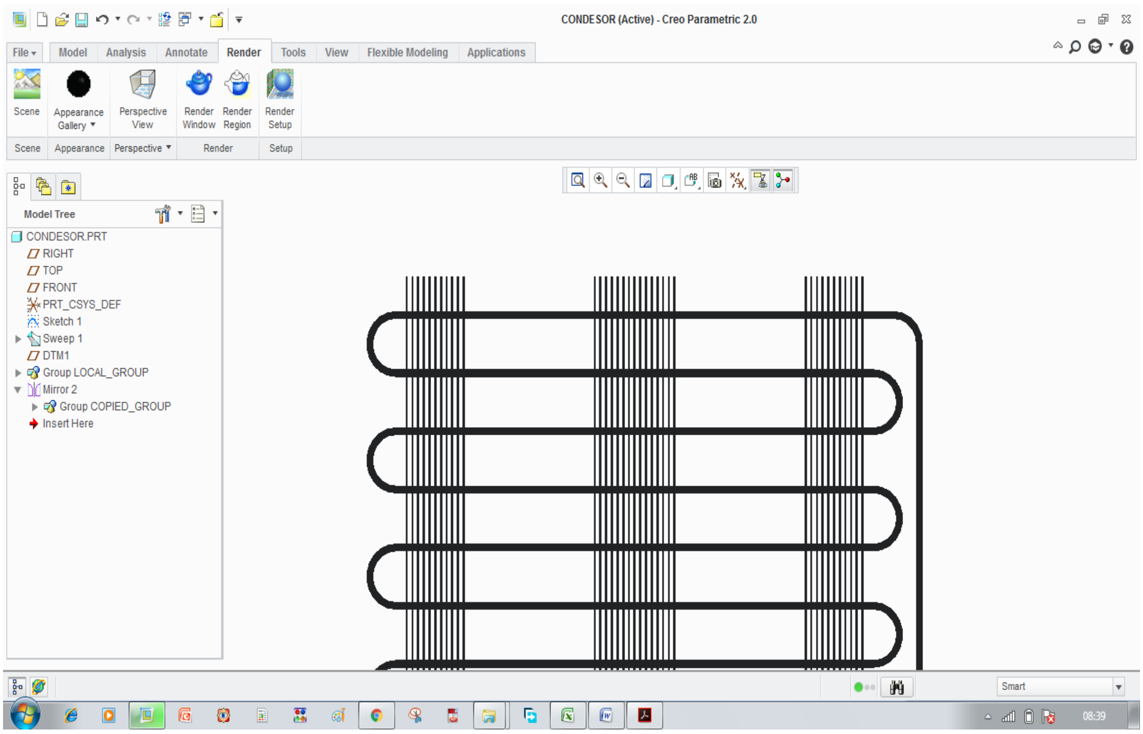


Figure 1. Components compact arrangement for a modern refrigerator

Figure 2. Experimentation and modeling in creo workbench



III. PROPOSAL OF NEW DESIGN AND CALCULATION

Heat transfer in curved pipes fully developed laminar flow in heated curved pipes, with circular cross section, were studied analytically by Yao & Berger (1978). The pipes were heated at a uniform rate, giving a constant temperature gradient along its axis, and the flow experienced both centrifugal and buoyancy forces (using the Boussinesq approximation). The buoyancy terms, as stated in the section for the straight pipe, will make the (cold) fluid in the core move downward and lead to two "vertical" vortices (when centrifugal forces are excluded). The resulting flow, including both centrifugal forces and buoyancy, can be considered to lead to approximate super positions of the different flow modes (vortices). Both horizontal and vertical pipes were considered, where perturbation expansions were made for small values of De and ReRa. The results were considered to be valid for De2. 500 and ReRa . 3000, and arbitrary values of P r. The Reynolds number should be considered small enough to ensure laminar flow. For the vertical 180◦ curved pipe ("U-bend"), the two forces may either enhance each other or suppress each other, depending on the location along the bend. At the entrance of the bend, given that the flow travels upward, the two forces point in the same direction and the maximum axial flow is displaced towards the outer side of the bend. In the middle of the pipe the centrifugal and buoyancy forces are perpendicular, and the maximum axial velocity is again shifted towards the outer side of the bend. After the 180◦ bend the centrifugal and buoyancy forces act in opposite directions, and the resulting profile depends on the relative strength of the two forces. The maximum axial velocity moves towards the outer part of the bend when buoyancy is weak compared to the centrifugal force and towards the inner part when the buoyancy dominates over the centrifugal force.

THERMODYNAMIC CALCULATION

Pressure

Compressor Suction Pressure P_1 =16.5 psi
Compressor Discharge Pressure P_2 =459.7 psi
Condensing Pressure P_3 =156 psi
Evaporator Pressure P_4 = 17 psi
Convert all the pressure in Bar
Convert all Pressure in to Bar
Conversion pressure Unit 1 psi= 0.069 bar
P_1 = 16.5 x 0.06 = 1.13 bar
P_2 = 165 x 0.069 = 11.38bar
P_3 = 156 x 0.069 = 10.76 bar
P_4 = 17 x 0.069 = 1.173 bar

Temperatures

Compressor Suction Temperature T_1=29.5°C
Compressor Discharge Temperature T_2 =89°C
Condensing Temperature T_3 = 48°C
Evaporator Temperature T_4=0.10°C

Current and Voltage

Current = 1.1 Amps
Voltage = 230 Volts

From pressure enthalpy Chart for r 134a, enthalpy values at state points 1, 2, 3, 4 .The state points are fixed using pressure and Temperature and each point.

h_1 = 428.1262 KJ/Kg
h_2 = 469.8887 KJ/Kg
h_3 = 268.52 KJ/Kg
h_4 = 200 KJ/Kg

CALCULATIONS PERFORMANCE PARAMETERS

1. Net Refrigerating Effect (NRE)

=(h_1-h_4)
=(428.1262 - 200)
=228.1262 KJ/Kg

2. Circulating rate to obtain one tone of Refrigeration,kg/min

$m_{r=}$ 210/NRE
=210/228.1262
=0.92

3. Heat of compression

(h_2-h_1)=(469.8887-4281262)
=(41.7625)

4. Heat Equivalent of work of compressor

=m_r x (h_2-h_1)
=0.92(41.7625)
=38.42

5. Compressor Power

= (38.42/60)
= 0.6

6. Coefficient of Performance (COP)

= =5.46

7. Heat rejected in condenser

= (h_2-h_3)
=
=

8.

=
=

9. Heat rejection Factor

=185.3685/210
=0.8827

10. Specific volume of suction gas

Vs =0.19 m^3/Kg

11. Volume of refrigerant to be handled by compressor

V= m_r x Vs
= 0.92 x 0.19
= 0.1748

12. Compression Pressure Ratio (P_1/P_2)

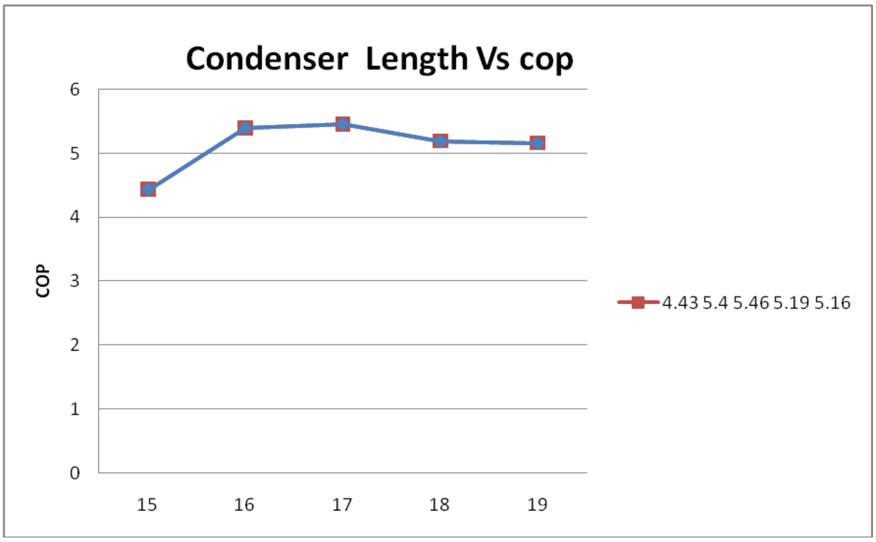


Figure 3. The length of condenser increases COP is gradually decreases.

POLYNOMIAL SPLINES

Now, we consider techniques designed to reduce the problems that arise when data are interpolated by a single polynomial. The first technique interpolates the data by a collection of low degree polynomials rather than by a single high degree polynomial. Another technique outlined in Section.

NEW DESIGN MESHING

To do this, FEA software typically uses a CAD representation of the physical model and breaks it down into small pieces called finite "elements" (think of a 3-D puzzle). This process is called "meshing." The higher the quality of the mesh (collection of elements), the better the mathematical representation of the physical model.

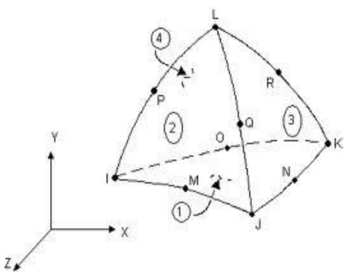


Table 1. Meshing Report Domain

Domain	Nodes	Element
All Domain	163426	126746

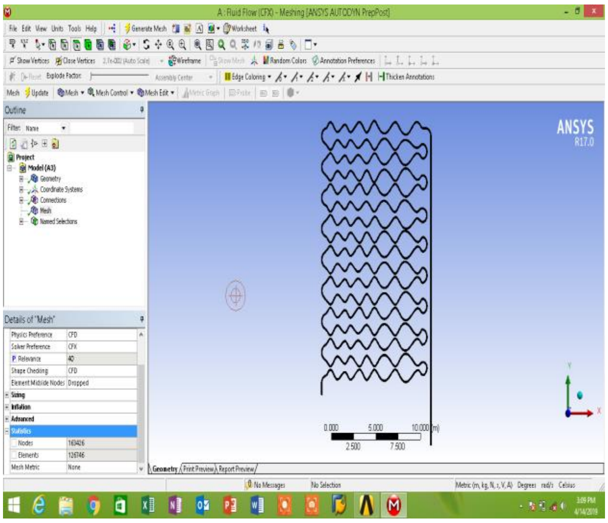


Figure 4. New design Condenser Meshing

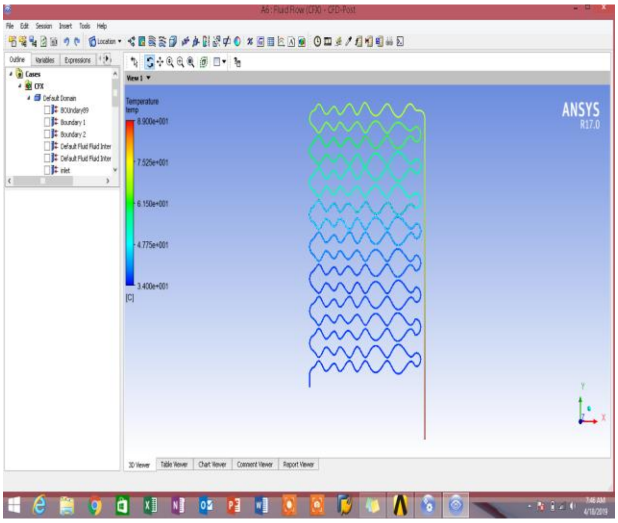


Figure 5. New design Condenser Result

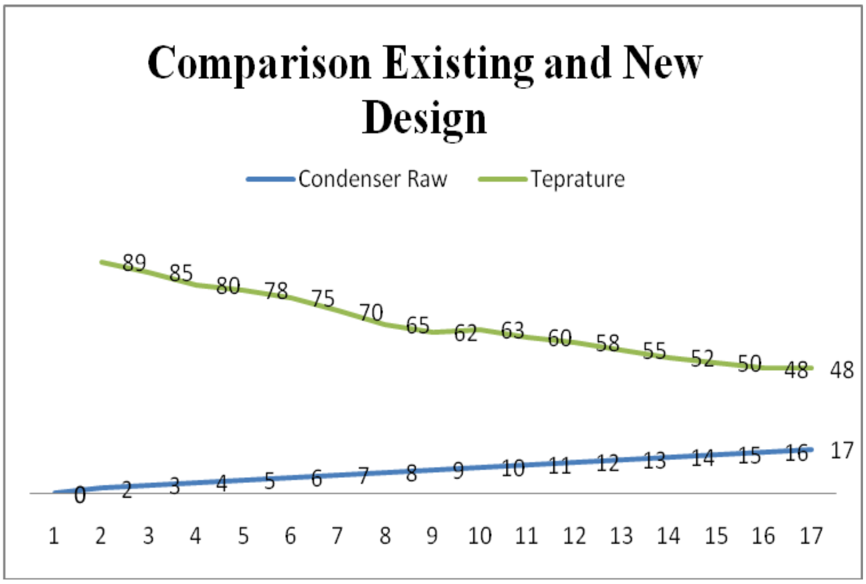


Figure 6. Condenser Raw Vs Temperature

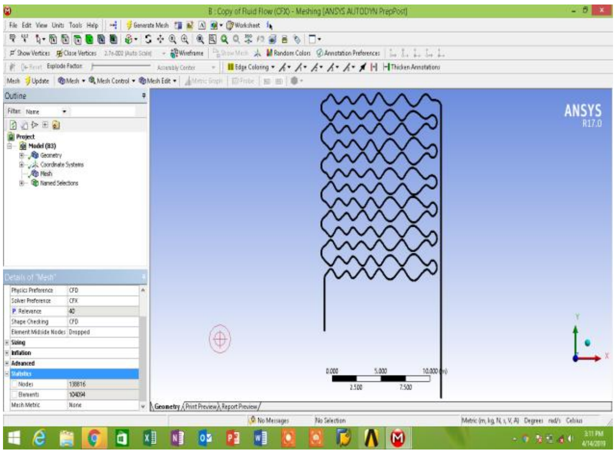


Figure 7. Reduce Condenser raw Meshing

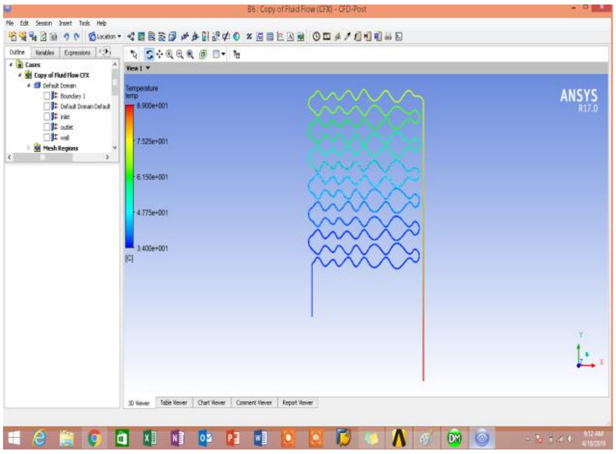


Figure 8. Reduction of condenser raw result

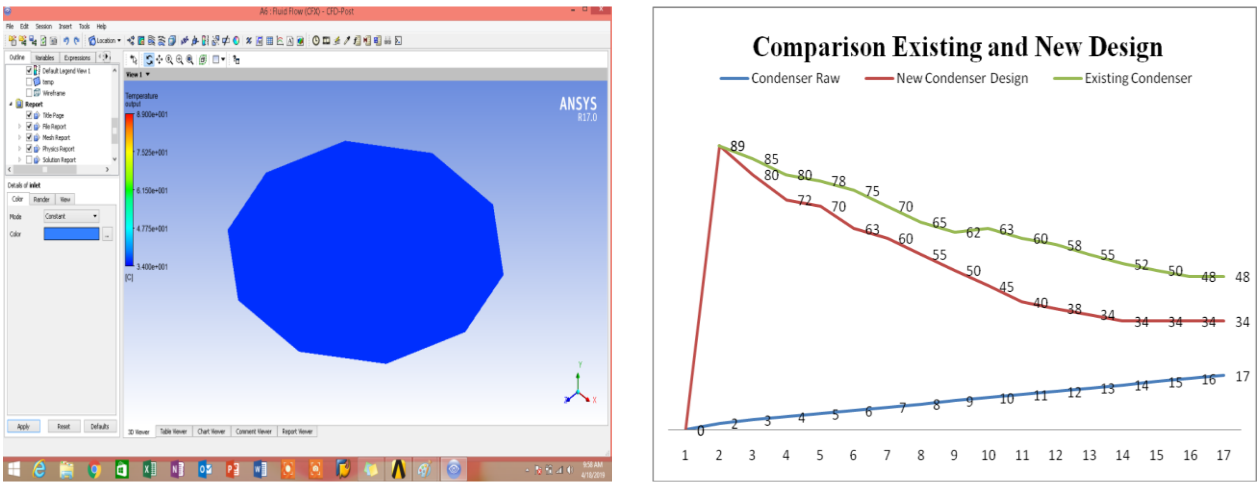


Figure 9. Comparison Existing and New Design

IV RESULT AND DISCUSSION

A comparative performance analysis was performed on Polynomial Splines .obtain the following points:

- The Polynomial Splines Condenser consumes less power in the compressor which ensures that this is energy saving refrigerant. Allows power reduction 2.33%.
- The COP of the Polynomial Splines has improved 5.46 to 5.66 which ensure better performance.

- The specific volume of the Polynomial Splines Condenser is less than the existing Condenser which means that the size of the compressor has reduced.
- Reduce condenser row material for same result allows material reduction 76.5%.
- Condenser cost reduction the design change allows us the higher efficiency, the output condensation temperature down by 48 ^{0}c to 34^{0}c.

The main concept of this study is to apply the innovative polynomial equation curve towards the inner periphery of the condenser tubes so as to increase characteristically performance of the condenser assembly. We have validated our results by comparing the results of the analyses of the conventional and new condenser designs. The optimum design is based on the main parameters, namely, condensing temperature relative to local ambient temperature, number of rows, coil 7th order curve inner design, number of passes, as well as cooling load rows, coil 7th order curve inner design, number of passes, as well as cooling load.

The effects of these parameters can be summarized as follows:

- Increasing the condenser assembly
- Increasing the condenser effectiveness
- Reducing the size of the condenser
- Cost reduction of the assembly
- Application of the polynomial curve towards the inner side.

REFERENCES

1. Hassan E.S. Fath, S.M.Elsherbiny, “Thermal analysis of air-cooled condensers of water chillerss’’ Alexandria University. Egypt, Vol,42 ,No.4 , July 2003
2. Dagmar I. Jähnig Douglas T. Reindl,”A Semi-Empirical Method for Representing Domestic Refrigerator/Freezer Compressor Calorimeter Test Data”
3. K. A. Manske, D.T. Reindl, and S.A. Klein, Evaporative condenser control in industrial refrigeration systems ’’Mechanical Engineering Department University of Wisconsin – Madison. 2001, 676-691
4. B. Kiran Naika, P. Muthukumara ”Empirical correlation based models for estimation of air cooled and water cooled condenser’s performance”
5. changeF.W. Yua, K.T. Chanb, Rachel K.Y. Sita,b, J. Yangb “Energy simulation of sustainable air-cooled chiller system for commercial buildings under climate change”
6. Christian Carlsson “ Heat transfer in curved pipes”
7. Tien-Shun Chan, Yung-Chung Chang, Cheng-Yu Chu, Wen-Hui Chen, Yuan-Lin Chen, Shun-Chong Wang, and Chang-Chun Wang “Evaluation of Chiller Power Consumption Using Grey Prediction”
8. Abdul Qayyum Mohammed and Kelly Kissock “Energy Efficient Design, Retrofit and Control of Evaporative Condensers in Ammonia Refrigeration Systems”
9. Prathu Nagar, Shreekant Tare, Mukesh Dole“Optimization through mathematical modelling of Irreversibility and other parameters in Simple VCR cycle for R-134a”
10. Dr. Shurooq Talib Remedhan Al-Hemeri “Experimental study and mathematical modeling of a vapor compression refrigeration system”