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Design & Analytical Investigation of the Performance of Dual Pressure Condenser in a Thermal Power Plant

Puli Venkatesh
Machine Design
Department of Mechanical Engineering
Malla Reddy College of Engineering &Technology
(Autonomous Institution)
Hyderabad, India – 500100.

Mr.K. Rajasekhara Reddy
Professor
Department of Mechanical Engineering
Malla Reddy College of Engineering &Technology
(Autonomous Institution)
Hyderabad, India – 500100.

Abstract

In this thesis, analytical investigations are done to determine the efficiency of the dual pressure condenser in a thermal power plant for two fluids water and R600a. 3D model of the condenser is done in Creo. CFD and thermal analysis are done on the condenser by applying parameters calculated for high pressure condenser and low pressure condenser calculated theoretically. Thermal analysis is done to determine heat transfer rates by varying materials of the condenser. Analysis is done in Ansys.

1. DUAL PRESSURE CONDENSER

Large power plant condensers are usually 'shell and tube' heat exchangers where the two fluids do not come in direct contact and the heat released by the condensation of steam is transferred through the walls of the tubes into the cooling water continuously circulating inside them. In a“Dual pressure condenser” the two shells operate at different pressures. The bottom sides (hot well) of both the condensers are connected. For the convenience of cleaning and maintenance, cooling water flows through the tubes and steam condenses outside the tubes. These condensers can be classified based on the cooling water flow as single or multi pressure, depending on whether the cooling water flow path creates one or more turbine back pressures and thereby increasing the turbine efficiency. Dual pressure condensing system is incorporated with two condensers. These condensers have different internal pressure from each other and are installed below the each low pressure turbines LPT-A &LPT-B.

2. LITERATURE SURVEY

This paper is intended to review the literature on research, development and projects related to gas turbine combined cycle. It focuses on summarizing several research investigations carried out by the author and associates, during the past years, in the field of gas turbine combined system. The performance of gas-steam combined cycle power plant depends on various operating parameters. [4] In this study, the analysis has been applied to the typical 210MW (LMZ) plant in India. Designed of thermal power plant is based on conditions (like a good quality of steam, pressure and temperature of steam etc.), but actual outlet conditions are not as per the designed values. In practical, when power plants are installed there are lots of constraints. It has been observed that the design specified condenser vacuum is not maintained in most of the Indian thermal power stations, consequences of which invariably remain the poor efficiency, more costly generation and financial burden to the consumers. This paper deals with the factors or parameters which reduced the efficiency of the condenser.

3. THEORETICAL CALCULTAIONS

Performance of low pressure condenser

Cooling waterside ‘Q’ is calculated from the relationship:

QGain = mC X Cp (Tw2 - Tw1) -------- (A)

Where

Tw1 is the inlet cooling water temperature (0C)

Tw2 is the outlet cooling water temperature (0C)

mC is the cooling water flow rate (kg/sec)

Cp is the specific heat of water, which may be assumed to be 4.19 kJ/kg 0C

Calculation of LMTD for series flow configuration

LMTD of LOW pressure condenser (ΔTm) - B:

Tw1 is the inlet cooling water temperature (oC)

Tw2 is the outlet cooling water temperature (oC)

Let us assume that the inlet temperature of steam & the out let temperature of condensate below the condenser are same (since the latent heat alone is removed in condenser).

$$\text{Tm (LP condenser-B)} = \frac{(Tc-Tw1)-(Tc-Tw2)}{\ln\frac{(Tc-Tw1)}{(Tc-Tw2)}}$$

LMTD of HIGH pressure condenser (ΔTm)-A

Tw2 is the inlet cooling water temperature (0C)

Tw3 is the outlet cooling water temperature (0C)

Let us assume that the inlet temperature of steam & the out let temperature of condensate below the condenser are same (since the latent heat alone is removed at condenser).

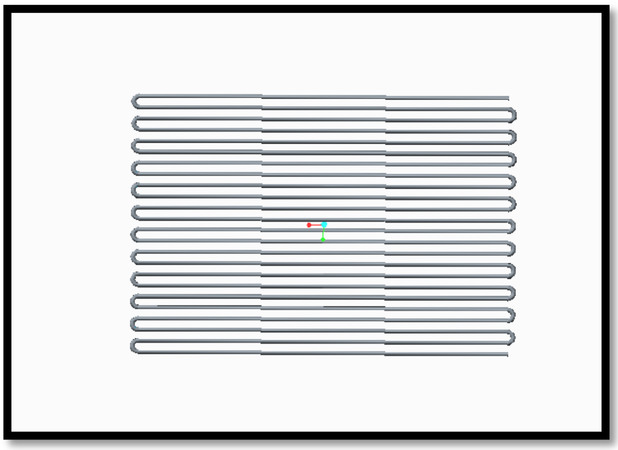
Effectiveness of condenser in series flow

$$\text{(For design value)} = \frac{(Tw2-Tw1)}{Ts-Tw1)}$$

4.MODELING OF DUAL PRESSURE CONDENSER

The model is designed from based on journal of plate-fin-and-tube condenser performance and design for refrigerant R-410A air-conditioner.

A. 3D Model of Condenser

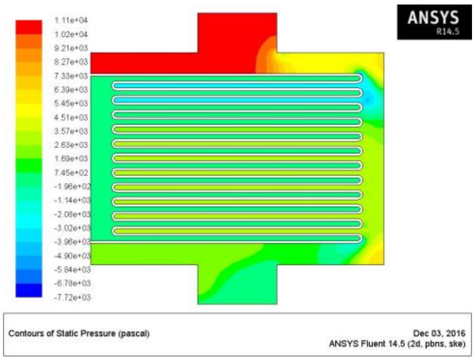


5. CFD ANALYSIS AND THERMAL ANALYSISOF HIGH PRESSURE AND LOW PRESSURE CONDENSER

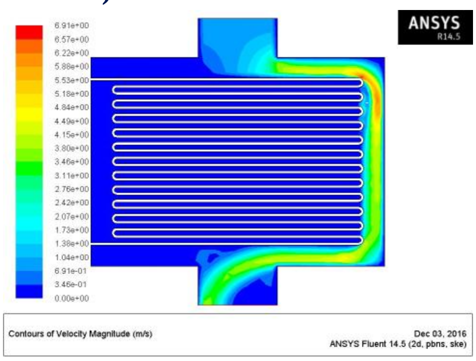
Analysis is done based on journal of ISSN 0976 – 6340 (Print) ISSN 0976 – 6359 (Online)

A. CFD ANALYSIS OF FLUID –R600aFOR HIGH PRESSURE CONDENSER

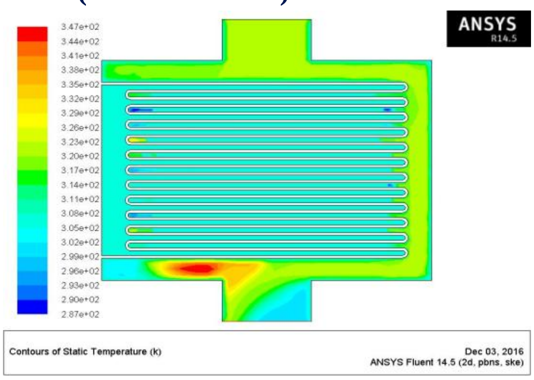
(i) PRESSURERESULTS FOR CFD ANALYSIS (FLUID –R600a)



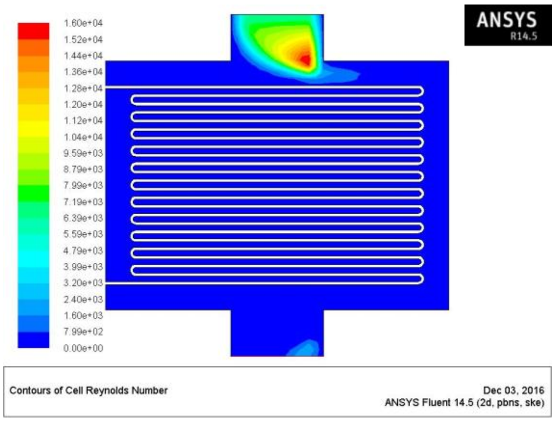
(ii) VELOCITYRESULTS FOR CFD ANALYSIS (FLUID –R600a)



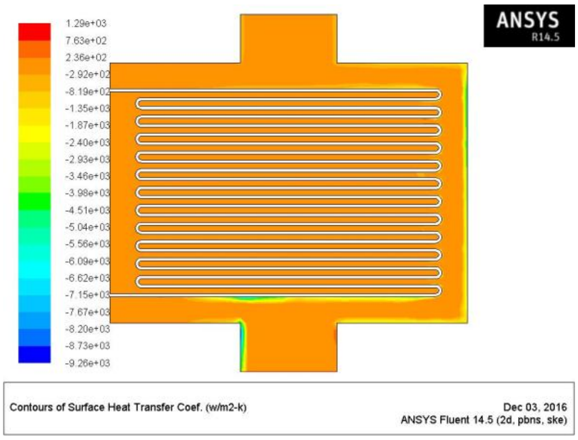
(iii) TEMPERATURE RESULTS FOR CFD ANALYSIS(FLUID –R600a)



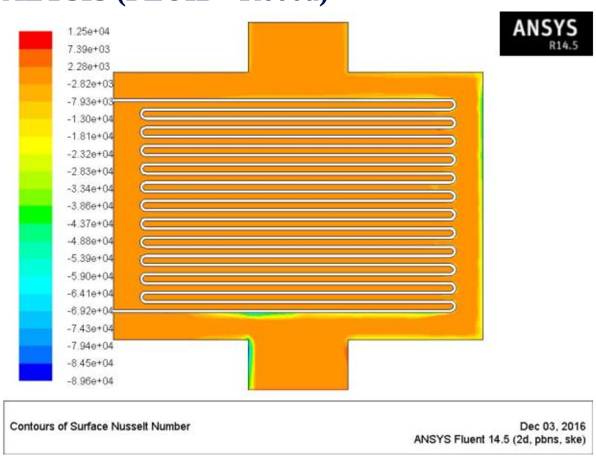
(iv) REYNOLD NUMBER RESULTS FOR CFD ANALYSIS (FLUID –R600a)



(v) SURFACE HEAT TRANSFER CO-EFFICINT RESULTS FOR CFD ANALYSIS (FLUID –R600a)



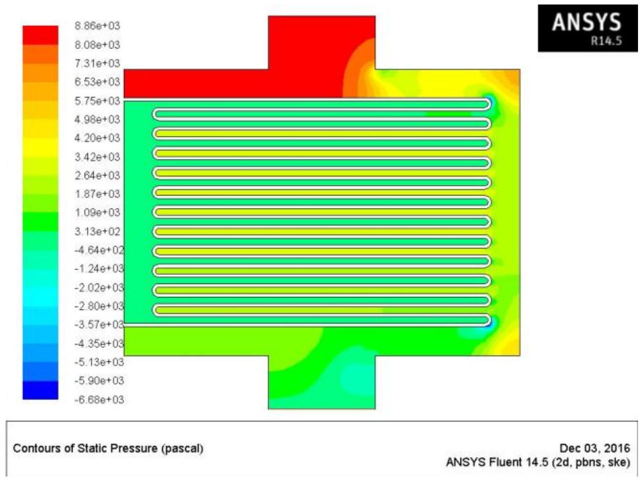
(vi) Nusselt NUMBER RESULTS FOR CFD ANALYSIS (FLUID –R600a)



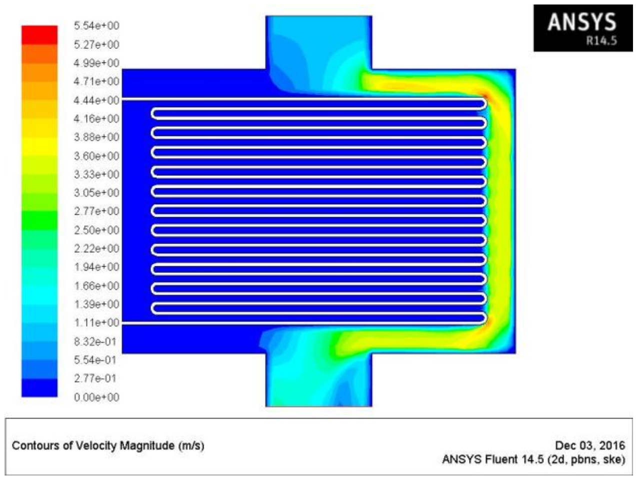
Total Heat Transfer Rate	(w)
steam_inlet	8072870.5
steam_outlet	-7803734.5
wall-_trm_srf	-110746.66
water_wall_surface	-115334.73
Net	43054.617

B. CFD ANALYSIS OF FLUID –R600a FOR LOW PRESSURE CONDENSER

(i) PRESSURERESULTS FOR CFD ANALYSIS (FLUID –R600a)



(ii) VELOCITYRESULTS FOR CFD ANALYSIS (FLUID –R600a)



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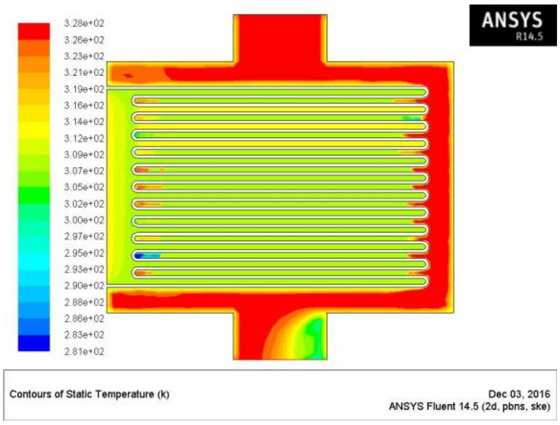
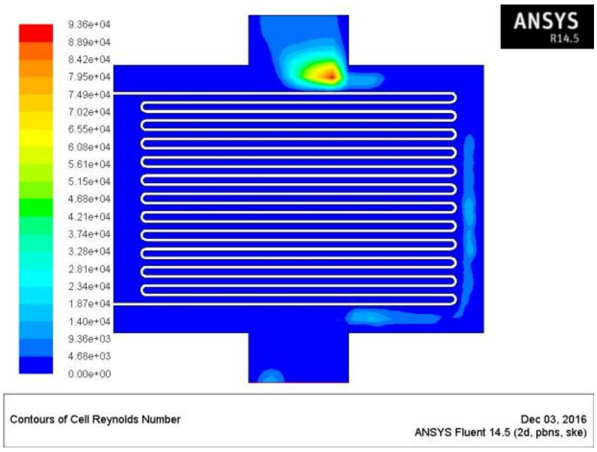
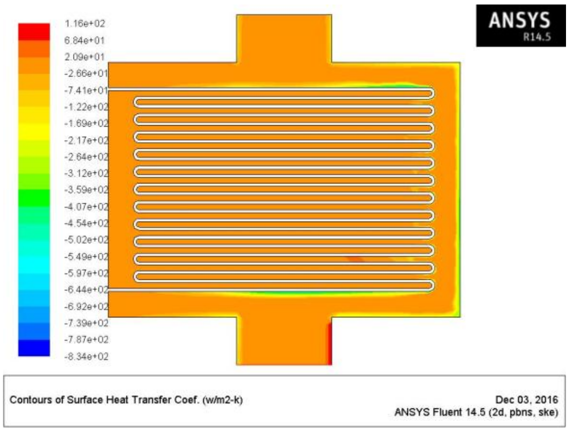
(iii) TEMPERATURE RESULTS FOR CFD ANALYSIS (FLUID –R600a)



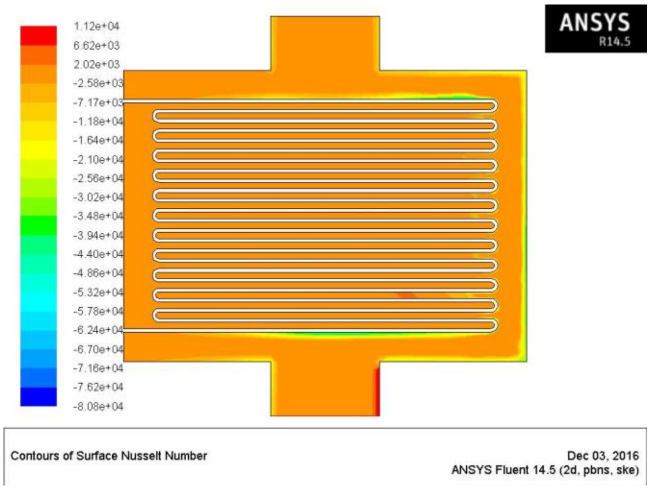
(iv) REYNOLD NUMBER RESULTS FOR CFD ANALYSIS (FLUID –R600a)



(v) SURFACE HEAT TRANSFER CO-EFFICINT RESULTS FOR CFD ANALYSIS (FLUID – R600a)

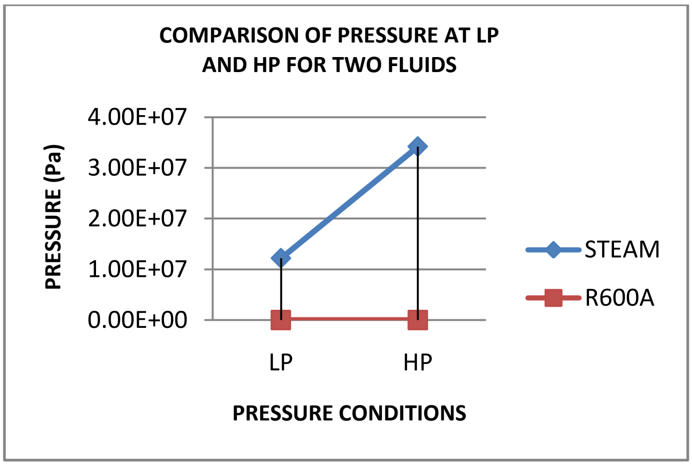


(vi) Nusselt NUMBER RESULTS FOR CFD ANALYSIS (FLUID –R600a)



Total Heat Transfer Rate	(w)
steam_inlet	10369299
steam_outlet	-11213735
wall-_trm_srf	-13229.405
water_wall_surface	-19743.186
Net	-877408.59

GRAPH COMPARISONS FOR TWO DIFFERENT FLUIDS FOR BOTH HIGH PERESSURE AND LOW PRESSURE CONDENSER



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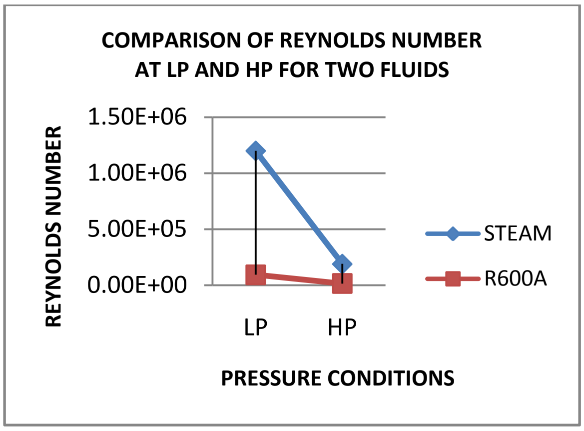
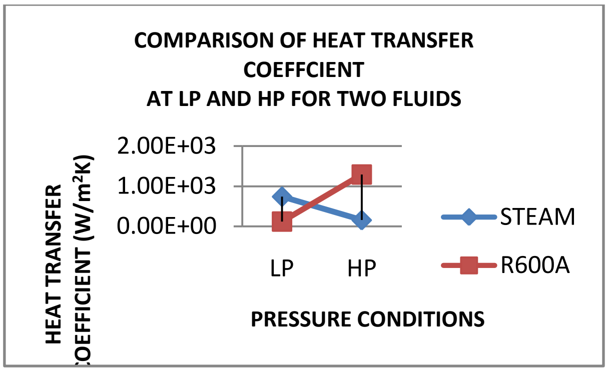
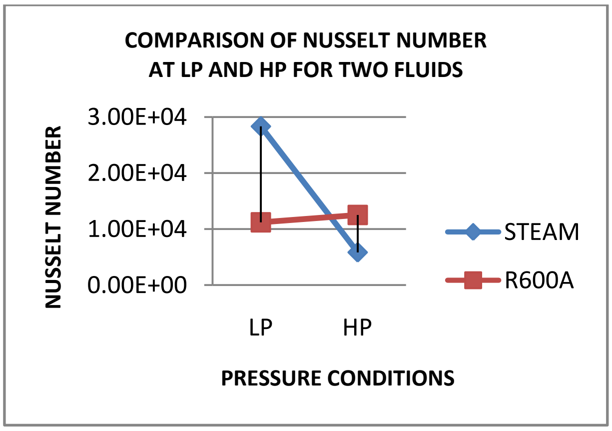
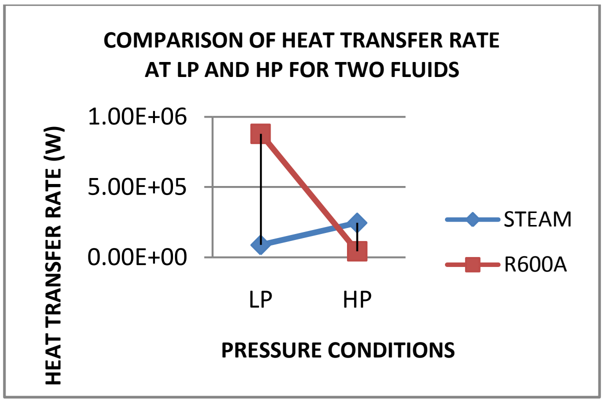






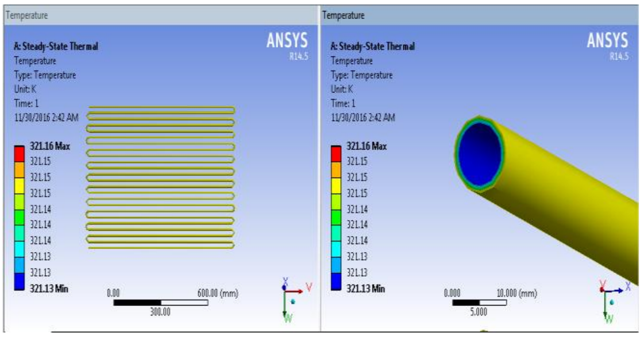


C.THERMAL ANALYSIS FOR DUAL PRESSURE CONDENSER

(i) TEMPERATURE RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)

HIGH PRESSURE CONDENSER

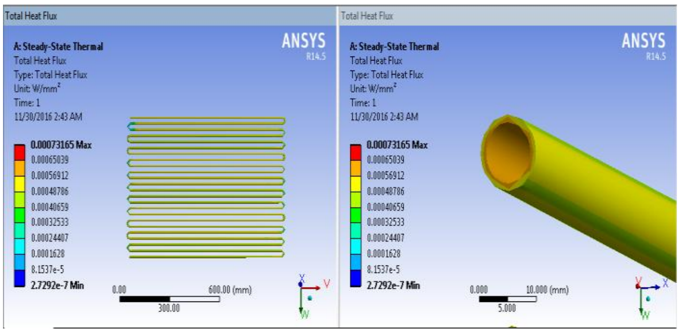
MATERIAL – ALUMINUM



(ii) HEAT FLUX RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)

HIGH PRESSURE CONDENSER

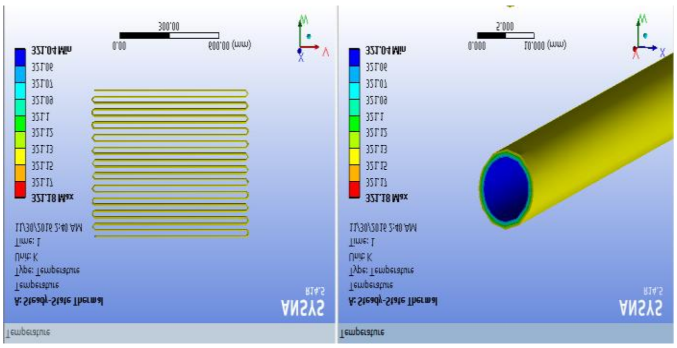
MATERIAL – ALUMINUM



(iii) TEMPERATURE RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)

HIGH PRESSURE CONDENSER

MATERIAL – BRASS



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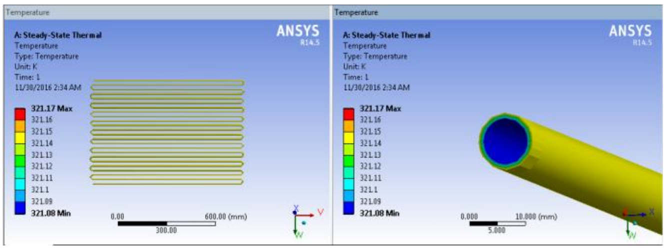
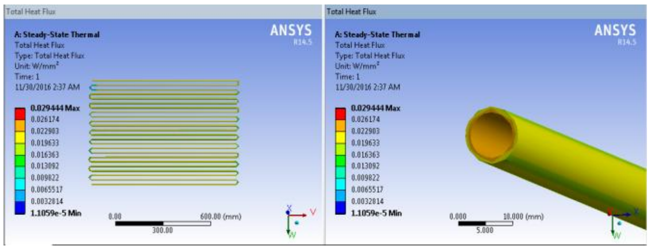
(iv) HEAT FLUX RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)
HIGH PRESSURE CONDENSER
MATERIAL – BRASS

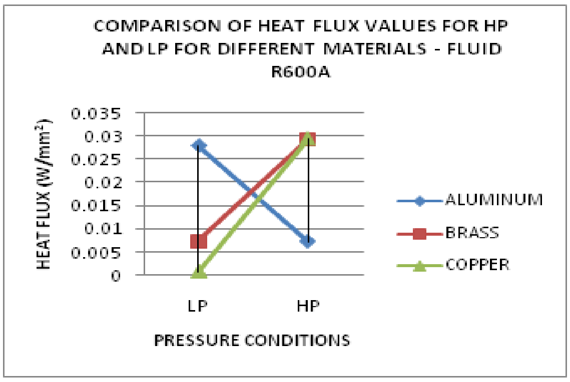
(v) TEMPERATURE RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)
HIGH PRESSURE CONDENSER
MATERIAL – COPPER



(vi) HEAT FLUX RESULTS FOR THERMAL ANALYSIS (FLUID –R600a)
HIGH PRESSURE CONDENSER
MATERIAL –COPPER



GRAPH COMPARISONS FOR THREE DIFFERENT MATERIALSAT LOWPERESSURE AND HIGH PRESSURE.



6.CONCLUSION

The thermal efficiency of a power plant can be increased by enhancing the heat transfer rate of a condenser; this can be achieved by reducing the temperature and pressure of the condensate while leaving the condenser. From the CFD analysis results, the pressure is reduced from high pressure condenser to the low pressure condenser, the velocity is increasing from high pressure condenser to low pressure condenser. The temperature is reduced from high pressure condenser to the low pressure condenser. The heat transfer rate is also increasing. By observing thermal analysis results, the heat flux is increasing in Low pressure condenser. That is the heat transfer rate is increasing when the condensate is leaving the condenser.

7. ACKNOWLEDGMENT

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8.REFERENCES

[1] Theoretical analysis of the performance of dual pressure condenser in a thermal power plant K.K.Anantha Kirthan, S. Sathurtha mourian, P. Raj clinton

[2] R.K. Kapooria, K.S. Kasana and S.Kumar, “Technological investigations and efficiency analysis of a steam heat exchange condenser: conceptual design of a hybrid steam condenser”, Journal of Energy in Southern Africa, Vol 19 No 3, 35-45, Aug.2008

[3] Zhang C., Souse A.C.M., Venart J., The Numerical and experimental study of a power plant condenser, J.Heat Tran 115 (1993) 435 – 445. Heat Exchange Institute, standards for steam surface condensers, 9th edition, Heat Exchange Institute, Inc., Ohio, USA, 1995

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

[4] R.P.Roy, M.Ratisher, V.K.Gokhale, A computational model of a power plant steam condenser, J. Energy Resour. Technol.123 (2001) 81 c 91

[5] M.M. El-Wakil, Power plant technology, McGraw-Hill Book Company, New York Obert, E.F: Concepts of Thermodynamics. McGraw-HillBook Company, New York, 1960

[6] Chakrabarti S., 2005, 'A case study on availability losses in a condenser for a 210 MW thermal power unit in India". Journal of Energy & Environment, 5: 144-148.

[7] Arman J. and Ghosal A.K., 2007, " Performance analysis of finned tube and unbaffle shell and tube heat exchangers", International Journal ofThermal Sciences, 46: 1311 – 1317 "Process heat Transfer" by D.Q.Kern, Edn. 1965.

[8] "Modern Power Station Practice" – British Electricity International – Volume –G: International Journal of Mechanical Engineering andTechnology (IJMET), ISSN 0976 – 6340(Print), ISSN 0976 – 6359(Online), Volume 6, Issue 2, February (2015), pp. 37-46© IAEME46

[9] Manjinder Bajwa and Piyush Gulati, "Comparing The Thermal Power Plant Performance At Various Output Loads by Energy Auditing (A Statistical Analyzing Tool)" International Journal of Mechanical Engineering & Technology (IJMET), Volume 2, Issue 2, 2011, pp. 111 - 126, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.

[10] S. Paliwala, H.Chandra and A. Tripathi, "Investigation and Analysis of Air Pollution Emitted From Thermal Power Plants: A Critical Review" International Journal of Mechanical Engineering & Technology (IJMET), Volume 4, Issue 4, 2013, pp. 32 - 37, ISSN Print: 0976 – 6340, ISSN Online: 0976 – 6359.