International Journal of Research
Available at https://edupediapublications.org/journals
Special Issue on Conference Papers
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 06
March 2018

# Determination Thermal Performance of a New Integrated Exhaust Manifold Cylinder Head in Diesel Engine

*Musukula Sunitha*

*M.Tech student, Dept. Mechanical engineering, sree chaitanya college of engineering, karimnagar , india*
*E-Mail: sunitha.16musukula@gmail.com*

## Abstract

In this thesis, the heat transfer performance of an integrated exhaust manifold cylinder head in diesel engine is investigated by varying the inlet mass flow rates 0.042Kg/s, 0.044Kg/s, 0.046Kg/s and properties of air at different temperatures 314.5$^0$C, 345.75$^0$C, 361.75$^0$C.The model of the integrated exhaust manifold cylinder head is done in Creo 2.0. CFD and Thermal analysis are performed on the design to determine heat transfer characteristics.

## I. Introduction

The cylinder head of an engine integrating with that of the exhaust has received extended attention in recent years for automotive gasoline engines, attributable to the established advantages in: reduction in engine weight, price saving, power increment reduction, faster engine and warm up after treatment, improved packaging and installation of turbocharger simplification.This design remains for the most part unknown in diesel engines owing to the bigger difficulties, caused by the a lot of complex layout of cylinder head, and therefore the expected lesser advantages, attributable to the absence of enrichment of high load. However, the necessity for engine thermo management improvement and a faster catalytic converter in efficientEuro 6 diesel engines is giving new challenges that an integrated manifold design might effectively address.In 1.6L Euro 6 diesel engine developed recently by General Motors, the engine is modified such that the intake manifold and exhaust manifold are in integration with the cylinder head.

## II. Literature Survey

In this paper by Stefano d'Ambrosio [1]In 1.6L Euro 6 diesel engine developed recently by General Motors, the engine is modified such that the intake manifold and exhaust manifold are in integration with the cylinder head.Utilization of extensive CAD/CAE/CAM analyses to guide in the design of the overall surface and also the jacket of water cooling that surround the exhaust manifold of the newer version of engine, and therefore to be able to increase the cylinder head low-frequency thermal fatigue resistance. In This Paper ByM.A. Neshan, A. Keshavarz, K. Khosrav[3]at first a new exhaust manifold and its cooling jackets is designed for the integrated exhaust manifold into cylinder head (IEMCH) for a turbocharged engine. Then, the gas exchange and flow analysis is done numerically to determine the proper conditions for the exhaust gas and also the coolant stream resp. Finally, the whole engine components are thermally analyzed to assure their acceptable temperature. The obtained results are compared to the base engine conditions, indicating that the new engine with IEMCH may perhaps satisfy all its thermal limitations.

## III. 3D Modeling And CFD Analysis of Integrated Exhaust Manifold Cylinder Head In Diesel Engine

Fig.1. 3D model of IEMCH

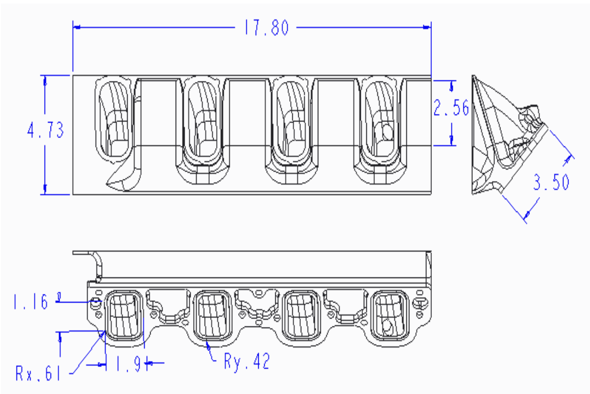



Fig.2. 2D Drafting of IEMCH

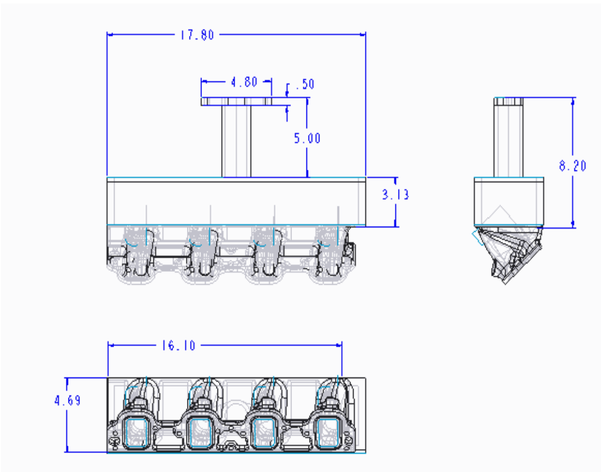



Fig.3. 2D Drafting of complete assembly with fluid region

# IV. CFD ANALYSIS

## AIR AT 587.5K

### The mass flow rates are taken from below journal

Nikhil Kanawade, Omkar Siras, Design, Analysis and Development of 4-Cylinder IC Engine Exhaust Manifold, International Engineering Research Journal, Page No 472-478, specified as [1] in References chapter.

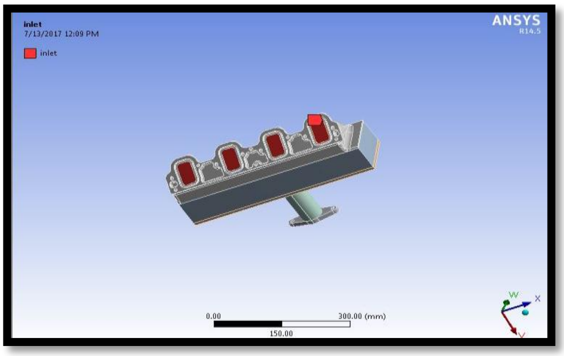



Fig.4. Fluid Inlet

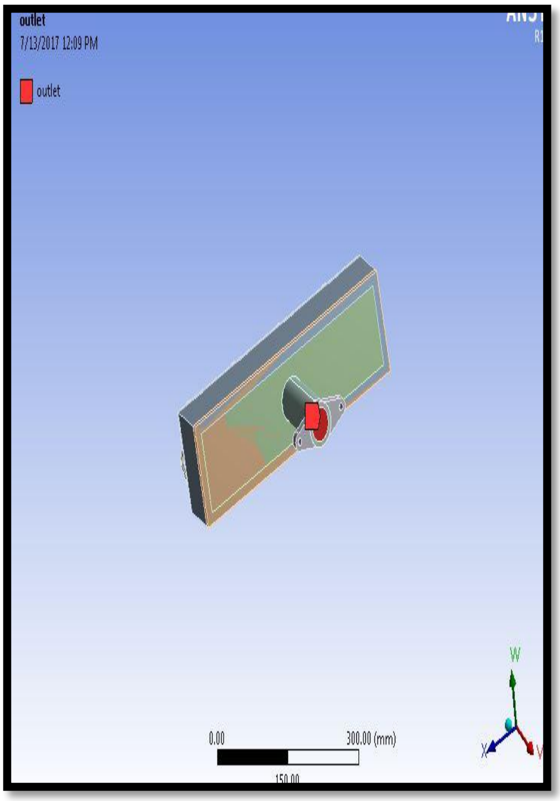



Fig.5. Fluid outlet

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 06
March 2018

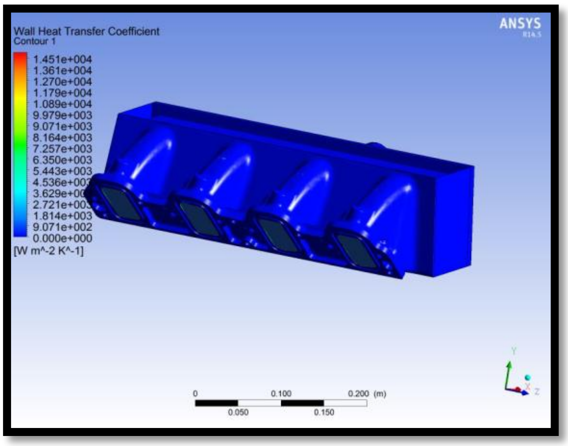



Fig.6. Heat transfer coefficient for inlet mass flow rate 0.042 kg/s for air at 587.5K

**Total heat rate for inlet mass flow rate 0.042 kg/sfor air at 587.5K**

| Total Heat Transfer Rate | (w) |
|---|---|
| inlet | 91.023186 |
| outlet | -213.99341 |
| wall-32 | -5.9972394e-05 |
| wall-32-shadow | 0.00031458362 |
| wall-34 | -1.0985344e-05 |
| wall-34-shadow | 8.1773105e-06 |
| wall-39 | 0.00076441327 |
| wall-39-shadow | -0.00013356203 |
| wall-42 | 3.5293982e-05 |
| wall-42-shadow | 1.01346e-06 |
| wall-45 | -0.001006533 |
| wall-45-shadow | -0.0002464659 |
| wall-48 | -0.00012277858 |
| wall-48-shadow | -0.00010408376 |
| wall-51 | 0.0016791871 |
| wall-51-shadow | -0.00016698903 |
| wall-54 | -0.0041949647 |
| wall-54-shadow | -0.00017632527 |
| wall-57 | 0.013966621 |
| wall-57-shadow | -0.00024394473 |
| wall-60 | 0.0033223927 |
| wall-60-shadow | -1.4026078e-05 |
| wall-61 | 0.17352006 |
| wall-61-shadow | -0.018399442 |
| wall-8 | -6.6443536e-05 |
| wall-8-shadow | -1.7949909e-05 |
| ---------------- | -------------------- |
| Net | 122.80158 |

## Thermal analysis

**Material – copper alloy**
**Temperature – 314.5$^0$C**

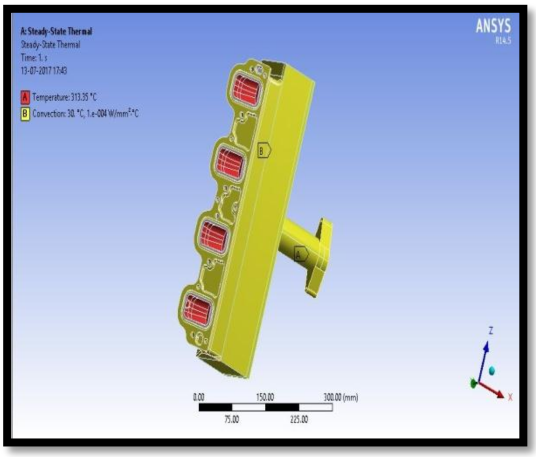



Fig.7. temperature& convection

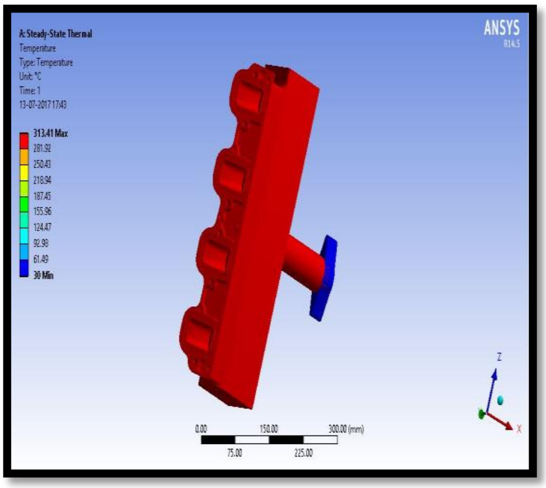


Fig.8. Temperature distribution at 314.5$^0$C

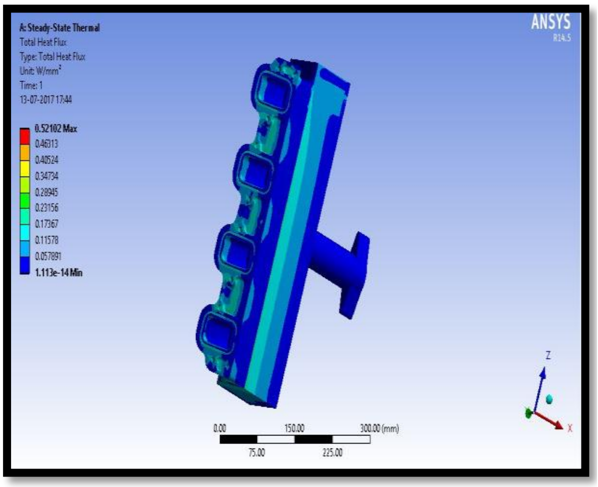
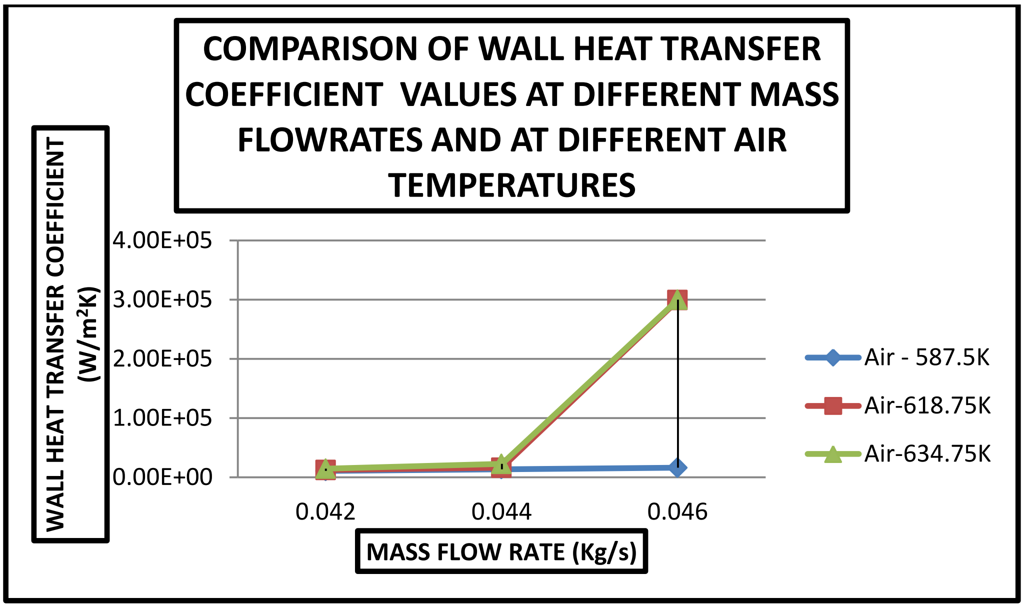


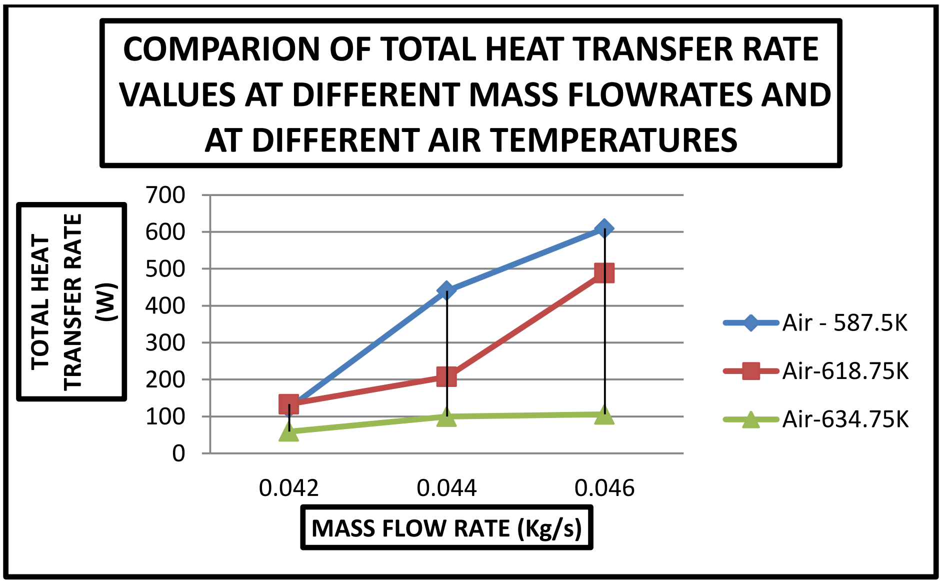
Fig.9. Total heat flux at 314.5$^0$C

## V. Results & Discussions

**CFD ANALYSIS TABLES**

| Fluid at K | In let mass flow rate (Kg/s) | Pressure (Pa) | Velocity (m/s) | Wall heat Transfer Coefficient (W/m$^2$K) | Total heat Transfer rate (W) | Mass flow rate (Kg/s) |
|---|---|---|---|---|---|---|
| Air-587.5 | 0.042 | 7.69e+009 | 1.795e+004 | 1.082e+004 | 122.80158 | 0.066299 |
| | 0.044 | 8.14e+009 | 3.8222e+004 | 1.384e+004 | 440.72895 | 0.229232240 |
| | 0.046 | 9.185e+009 | 6.428e+004 | 1.598e+004 | 609.202041 | 0.30811072 |
| Air-618.75 | 0.042 | 5.377e+009 | 3.667e+004 | 1.227e+004 | 133.324124 | 0.06154380 |
| | 0.044 | 1.493e+010 | 5.349e+004 | 1.59e+004 | 207.35644 | 0.10064146 |
| | 0.046 | 2.274e+010 | 1.340e+005 | 2.95e+005 | 488.41208 | 0.24280566 |
| Air-638.375 | 0.042 | 6.37e+009 | 4.003e+004 | 1.451e+004 | 59.116838 | 0.022736466 |
| | 0.044 | 1.863e+010 | 1.197e+005 | 2.26e+004 | 99.742091 | 0.04534864 |
| | 0.046 | 6.331e+010 | 2.633e+005 | 2.998e+004 | 105.577701 | 0.052658997 |




## THERMAL ANALYSIS TABLE

| TEMPERATURE (°C) | ALUMINIUM ALLOY | | ALUMINIUM ALLOY 6061 | | COPPER ALLOY | |
|---|---|---|---|---|---|---|
| | TEMPERATURE ($^0$C) | HEAT FLUX (W/mm$^2$) | TEMPERATURE ($^0$C) | HEAT FLUX (W/mm$^2$) | TEMPERATURE ($^0$C) | HEAT FLUX (W/mm$^2$) |
| 314.5 | 313.48 | 0.51284 | 313.12 | 0.51411 | 313.41 | 0.52102 |

International Journal of Research
Available at https://edupediapublications.org/journals
Special Issue on Conference Papers
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 06
March 2018

| | | | | | | |
|---|---|---|---|---|---|---|
| 345.75 | 344.75 | 0.5694 | 344.73 | 0.57152 | 344.67 | 0.57848 |
| 361.75 | 359.16 | 0.59546 | 359.14 | 0.59768 | 359.07 | 0.60496 |

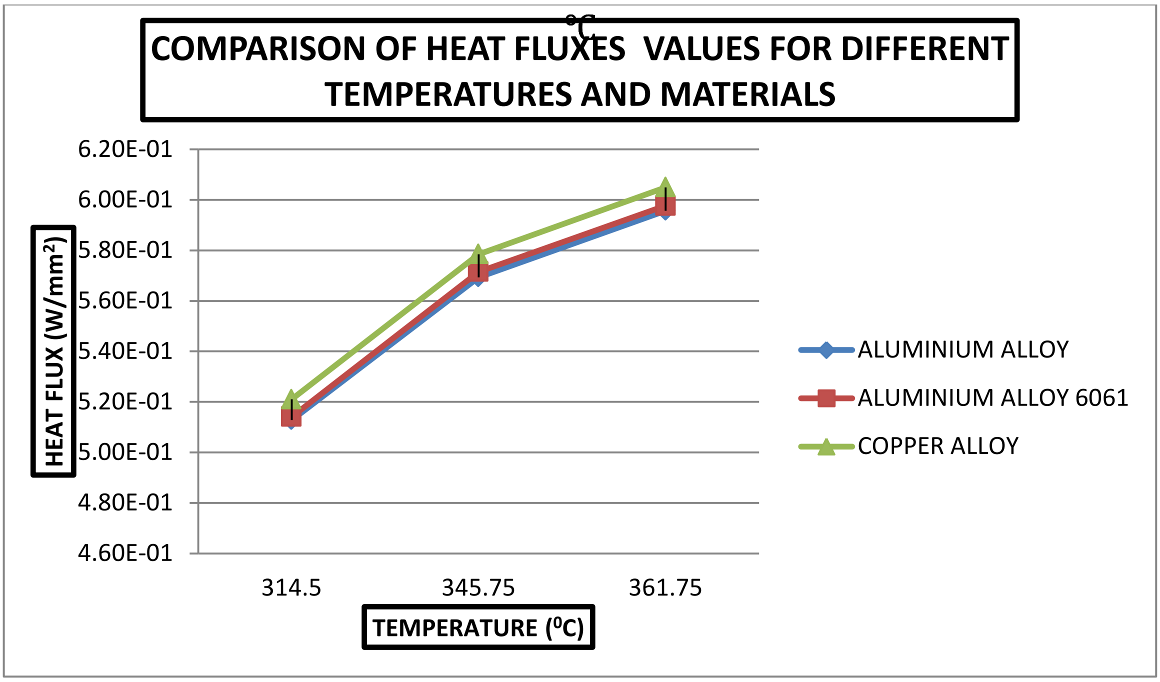



Fig.10. Comparison of heat fluxes for different temperatures &materials

## VI. Conclusion

By observing CFD analysis results, the heat transfer coefficient is increasing by increasing the mass flow rate. The heat transfer coefficient is increasing for 0.046Kg/s by about 46% when compared with 0.042Kg/s, by about 1.6% when compared with 0.044Kg/s. the heat transfer rate is decreasing by increasing the mass flow rate. The heat transfer rate is increasing for 0.042Kg/s by about 19% when compared with 0.044Kg/s, by about 82% when compared with 0.046Kg/s.By observing thermal analysis results, the heat flux (i.e) heat transfer rate is increasing by increasing the air inlet temperature. Heat flux value is more when Copper is used. But the main disadvantage of Copper is its more weight. The heat flux values are decreasing by about 1.5% for Aluminum alloys than Copper, it is better to use Aluminum alloys since their weight is less when compared with that of Copper.

## References

[1]Stefano d'Ambrosio, Alessandro Ferrari, Ezio Spessa, Impact on Performance, Emissions and Thermal Behavior of a New Integrated Exhaust Manifold Cylinder Head Euro 6 Diesel Engine.

[2]D'Ambrosio, S., Ferrari, A., Spessa, E., Magro, L. et al., "Impact on Performance, Emissions and Thermal Behavior of a New Integrated Exhaust Manifold Cylinder Head Euro 6 Diesel Engine.

[3]M.A. Neshan, A. Keshavarz, K. Khosravi,Integration of exhaust manifold with engine cylinder head towards size and weight reduction.

[4]Mohammad Amin Neshan, Ali Keshavarz, Ali Jazayeri,Thermo-Fluid Analysis of the Exhaust Manifold Integrated With Cylinder Head.

[5]Nikhil Kanawade, Omkar Siras,Design, Analysis and Development of 4- Cylinder IC Engine Exhaust Manifold.

[6]Banglin Deng,The Fluid Induced Vibration Analysis on an Integrated Exhaust Manifold.

[7] Jafar M Hasan, Wahid S Mohammad, Thamer A Mohamed, Wissam H Alawee, "CFD Simulation for Manifold with Tapered Longitudinal Section" International Journal of Emerging Technology and Advanced Engineering, Volume 4, Issue 2, February 2014

[8] M. Usan, O. de Weck, D. Whitney, "Exhaust System Manifold Development Enhancement through Multi-Attribute System Design Optimization", American Institute of Aeronautics and Astronautics;

[9] HessamedinNaeimi, DavoodDomiryGanji, MofidGorji, GhasenJavadirad and MojtabaKeshavarz, "A Parametric Design of Compact Exhaust Manifold Junction in Heavy Duty Diesel Engine Using Computational Fluid Dynamics Codes" Thermal Science, Volume-15, No. 4, 2011;

[10] Kyuang-Sang Cho, Kyung-Bin Son, Ue-Kan Kim, "Design of Exhaust Manifold for Pulse Converters Considering Fatigue Strength due to Vibration", Journal of the Korean Society of Marine Engineering, vol-37, No.7, 2013;