iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** VIII **Month of publication:** August 2020

DOI: https://doi.org/10.22214/ijraset.2020.30824

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Radiation Heat Transfer between Two Concentric Cylinders using Surface to Surface Radiation Model

Tammineni Ravi Kumar[1], Dr. V Sridhar Patnaik[2], K. Ravindra[3], U. S. Ramakanth[4]
[1, 2, 3]M. Tech Student, Department of Mechanical Engineering, Visakha Technical Campus, Vizag, AP
[4]Associate Professor, Lendi Institute of Engineering and Technology, Vizianagaram, AP

Abstract: Energy consumption and efficient use are important factors of thermal systems. This work indicates numerical studies on surface radiation and the effects of natural convection on the heat transfer and flow field between two united cylinders united, using a radiation shield between them. This study reveals the physical and engineering effects of the radiation shield on the internal radiation of two concentric cylinders closed at a certain temperature. It consists of two concentric cylinders with a hotter inner cylinder and a cooler outer cylinder. A 2 mm thick radiation shield (made of aluminum oxide plate) is inserted between the cylinders. Radiation protection has been found to reduce radiation from the inner surface of the outer cylinder to the outer surface of the inner cylinder. Almost 28% of the hypothermia is observed due to decreased radiation by the radiation shield.
Keywords: Radiation, Heat transfer, Temperature, Radiation shield

I. INTRODUCTION

Heat transfer is a thermometry discipline that refers to the generation, use, transformation, and exchange of heat energy (heat) between physical systems. Heat transfer is classified into several mechanisms, such as thermal conductivity, convection, heat radiation, and energy transfer by phase changes. Engineers also consider the mass transfer of different chemical types, both hot and cold, to achieve heat transfer. Although these mechanisms have different properties, they often occur simultaneously in the same system. Thermal conductivity, also called diffusion, is the direct microscopic exchange of the kinetic energy of a particle across the boundary between two systems. When the body is at a temperature different from or around another body, the heat flows so that the body and the surrounding areas reach the same temperature, and then they are in a state of thermal equilibrium. This automatic thermal transfer always occurs from one high temperature zone to another low temperature region, as defined in the second law of thermodynamics. Thermal radiation is the electromagnetic radiation resulting from the thermal movement of particles in the material. All matter whose temperature is above absolute zero emits heat radiation. The movement of the particles produces acceleration of the charge or the dipole fluctuation that produces electromagnetic radiation. Infrared radiation from animals (can be detected using an infrared camera) and microwave cosmic background radiation are examples of heat radiation. If the radiation body meets the physical properties of the black body in thermodynamic equilibrium, then radiation is called black body radiation. [1] Planck's law describes the black-body radiation spectrum, which depends only on body temperature. Fein's displacement law determines the most likely repetition of emitted radiation, and Stefan Boltzmann's law gives radioactive density. Thermal radiation is also one of the primary mechanisms of heat transfer.

One way to reduce the radiant heat transfer between two specific surfaces is to use highly reflective materials. An alternative method is to use radiation shields between heat exchange surfaces (Holman, 2009). These shields do not transfer or remove heat from the general system; They only put another resistor in the heat flow path so that the total heat transfer is delayed. Additionally, radiation shielding is recommended and patient cloning is allowed for daily treatments (Mantri and Bhasin, 2010; Zemnick et al., 2007; Brosky et al., 2000). Radiant shields made of low-emission (high reflectivity) materials can be used to reduce the net transfer of radiation between two surfaces. Note that emission associated with one side (shn ε +) may differ from the side associated with the opposite side (shn ε -) of the shield (Incropera et al., 2007). Our goal is to demonstrate how seemingly intractable problems in radiating heat transfer can be easily solved using the concept of net radiation transfer. Many researchers have used this method for the three modes of heat transfer (Afonso and Castro, 2010; Jamalud-Din et al., 2010; Zueco and Campo, 2006; Zueco. Et al., 2004). Although this method is simple, it provides a useful tool for visualizing the radiation exchange between plates in the can and can be used as a basis for predicting this exchange.

Moreover, Micco and Aldao (2003) generalized the net transmission method to the spherical and cylindrical symmetry. But they only used a radiation shield between two main surfaces. We do not claim it to be original because the pure radiation method can be found in the literature (Howell et al., 2010). A careful evaluation of previous literature shows that most radiological shield studies assume that the surfaces are gray. Indeed, surfaces are limited, and shield emissions are temperature or direction functions. In this work, the general formula for calculating net heat transfer between two long concentric and long cylinders was investigated, which is more difficult compared to our previous studies (Saedodin et al., 2010; Saedodin et al., 2010). Then reduce the heat transfer by one and Two calculated diffuse radiation shields. Thus, by applying two radiation shields with different materials, the improvement was made. The image is processed suck the sample is guided by "Adobe Photoshop CS2" and "Image J" is applied to estimate the average grain size. The annoying process was simulated with the finite element action code, ANSYS ver11.0. Al-Zinc / fly ash /SiC-supported compounds are manufactured by the vortex method using a casting path. The incorporation of fly ash the tensile properties, such as tensile and yield strength are improved. Reinforcement mechanisms to improve the properties of wear and corrosions are discussed (Ramakanth et.al 2019).

II.RADIATION HEAT TRANSFER BETWEEN TWO CONCENTRIC CYLINDERS USING FEM

One of the primary methods of heat transfer is radiative heat transfer. Consider two long concentric cylinders and meshed structure as shown in Figure 1.1. This study reveals the physical and engineering effects of the radiation shield on the internal radiation of two concentric cylinders closed at a certain temperature. It consists of two concentric cylinders with a hotter inner cylinder and a cooler outer cylinder. This analysis briefly summarizes the main heat transfer mechanisms and focuses on the heat transfer exchange by heat radiation between surfaces. In high performance insulating materials, it is common to prevent conduction and heat transfer by convection by freeing the space between two surfaces. This leaves heat radiation as the predominant method of heat loss, even for low-temperature applications such as insulation in refrigerated storage tanks. One way to reduce the radiant heat transfer between two specific surfaces is to use highly reflective materials.

Thermal radiation is spread in a vacuum, which makes the radiative heat transfer a long-term phenomenon. Therefore, the energy balance of the observed surface is affected by emissions from the remote surface. To calculate the total radiant energy, the entire room must be taken into account. The radiation exchange between surfaces, as well as their radiating properties and temperatures, is largely dependent on the geometrical shapes, orientations, and separation distances from the surface. The material properties of the cylinders chosen as a structural steel. Here first select the two faces and using face meshing technique meshing was completed for the total body of the structure as shown. Total nodes and elements are 75564 &15808

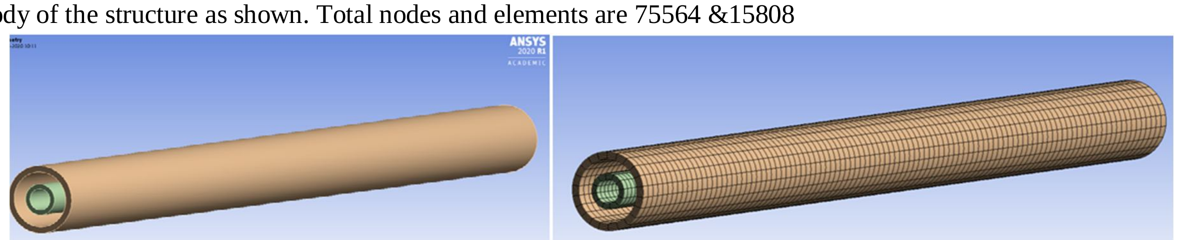


Fig 1.1 Design of two long concentric cylinders and meshed structure

At the temperature of inner cylinder was maintained as 50^0C and heat flux is 4000W/m^2 and outer surface of the external cylinder convention takes place, and radiation was applied on the cylinders as shown in Fig 1.2. The applied heart on the structure is 658.88W.

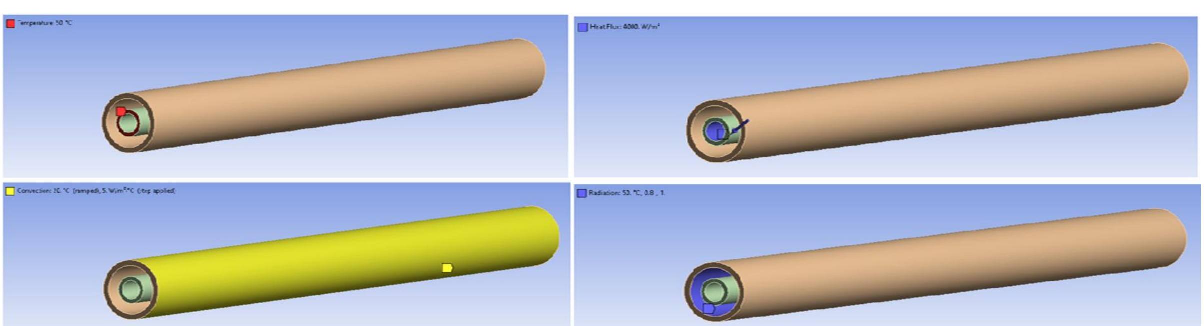


Fig 1.2 Boundary Condition-Radiation and convection

In this two-cylinder concentric model the problem was converged. due to the radiation effect the outer surface of the inner tube was affected, the reduction of temp is important. In this analysis the temp we got 342.28^{0}C, it was shown in the Fig 1.3.

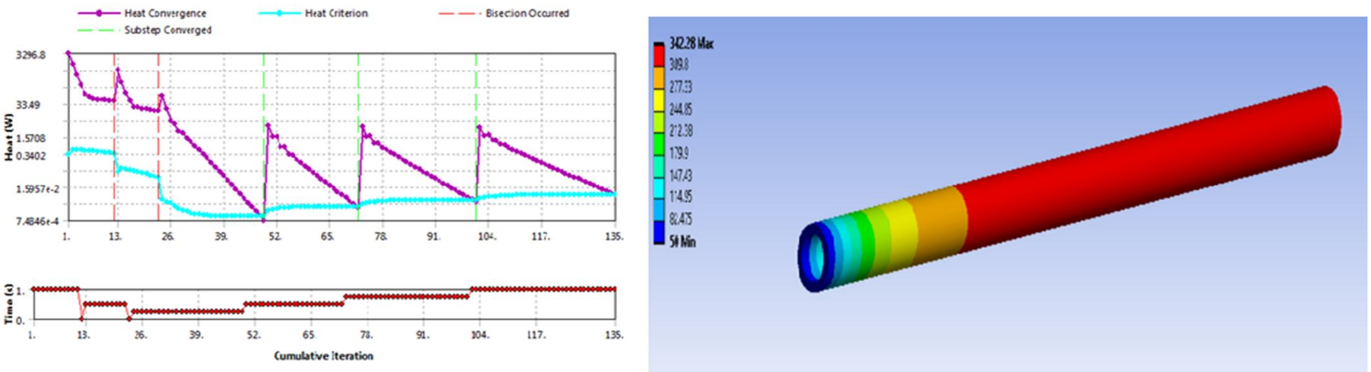


Fig 1.3 Convergency and max temp obtained due to radiation

III. RADIATION HEAT TRANSFER BETWEEN TWO CONCENTRIC CYLINDERS WITH RADIATION SHIELD

This study reveals the physical and engineering effects of radiation shield on the thermal loss of two concentric cylinders closed at different temperatures and pressures. The box consists of two concentric cylinders with a hotter inner cylinder and a cooler outer cylinder. The radiation shield is inserted with three different materials (aluminum, copper, and steel) between the cylinders in two different radial positions. External cylinder temperature test is used for reference numerical simulation. The results showed that both the container pressure and the radiation shield emission are responsible for reducing the overall heat loss of the inner cylinder. The radiation shield with 2 mm thickness (of aluminum oxide plate) is inserted between the cylinders and meshed structure as shown in Fig1.4.

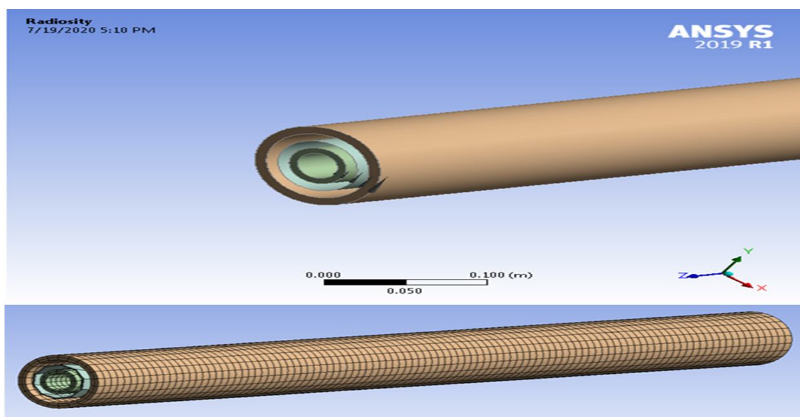


Fig1.4 radiation shield Model and face Meshing

At the temperature of inner cylinder was maintained as 50^{0}C and heat flux is 4000W/m^2 and outer surface of the external cylinder convention takes place, and radiation was applied on the cylinders as shown in Fig 1.5. The applied heart on the structure is 658.88W.

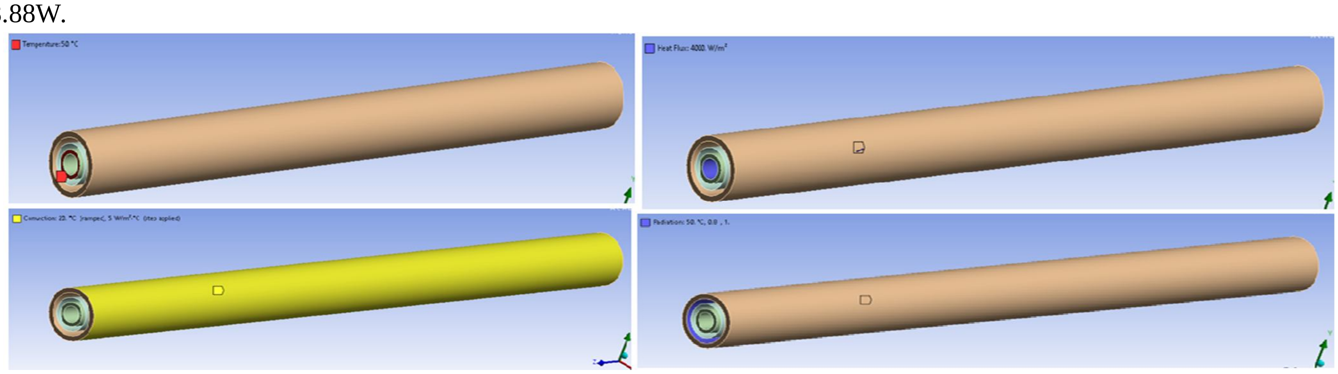


Fig 1.5 Boundary Condition-Radiation and convection

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VIII Aug 2020- Available at www.ijraset.com

Simulated the effects of radiation between concentric cylinders with or without radiation protection using a surface-to-surface radiation approach. From the heat balance, it clearly proves that the results are acceptable, which represents a 0.6% difference in the energy balance. The decrease in total internal radiation was observed by adding radiation protection between the concentric cylinders and increasing the temperature in the inner cylinder with approximately 28% less radiative forcing, as shown in Figure 1.6. Therefore, adding radiation protection reduces the effects of incident radiation.

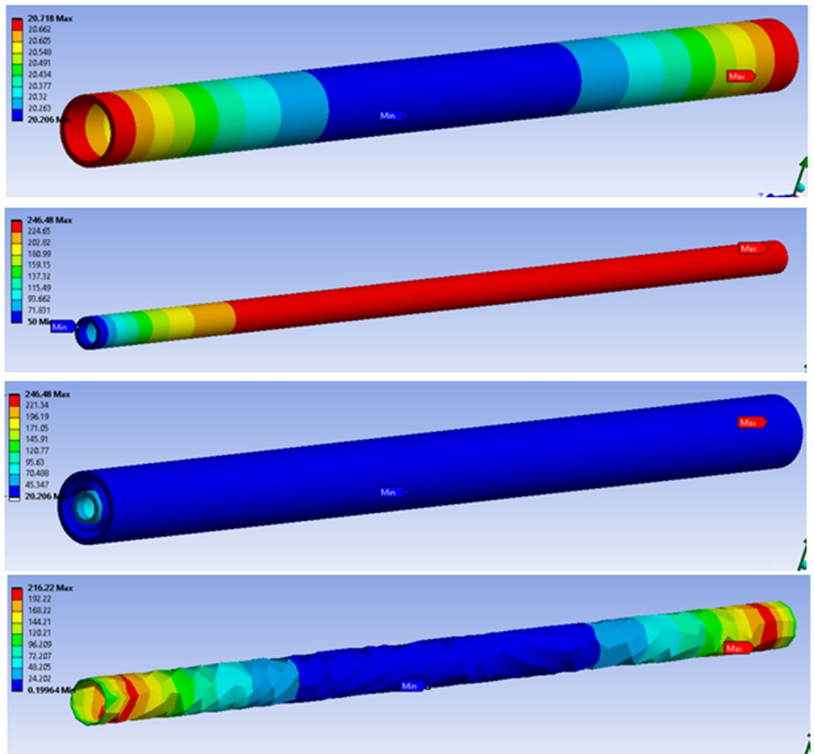


Fig 1.6 28% less radiative forcing

This work examined a numerical study on the effect of cylindrical radiation protection with temperature-dependent emissivity within cylindrical packages to reduce heat loss.

Various effects of parameters, such as different materials for radiation shields, the location of the radiation shield and casing pressure, are found in the field of heat transfer and flow between two inner and outer cylinders.

According to the results, radiant heat losses increase with increasing emissivity, and do not depend much on the pressure of the can. However, the total heat loss for each condition decreases while the compression of the can is reduced, due to poor load effects. The results obtained from copper showed that copper is the most suitable option for use as a radiation shield compared to aluminum and steel, which results from a lower emission.

IV. RESULTS AND DISCUSSIONS

This work indicates numerical studies of surface irradiance and the effects of natural convection on the heat transfer and flow field between two connected cylinders, using a radiation shield between them. This study reveals the physical and engineering effects of radiation shield on the internal radiation of two concentric cylinders closed at a certain temperature. It consists of two united cylinders with a hotter inner cylinder and a cooler outer cylinder. 2 mm thickness shield (made from aluminum oxide plate) is inserted between the cylinders.

Because of the radiation effect, the outer surface of the inner tube is affected, temperature drop is important. In this analysis, the temperature obtained was 342,280 ° C, was illustrated in Figure 1.7 and the radiation shield model was shown in Figure 1.8, 246,480 ° C. The new model given the good results is that the temperature has decreased. The total applied temperature is 658.88 watts and has not changed the thermometer for the old and new models shown in the thermometer table below. Table I showed the heat balance sheet of the both the models, observed that the net balance of the heat is almost same for the two models is 4.02 and 4.295W.

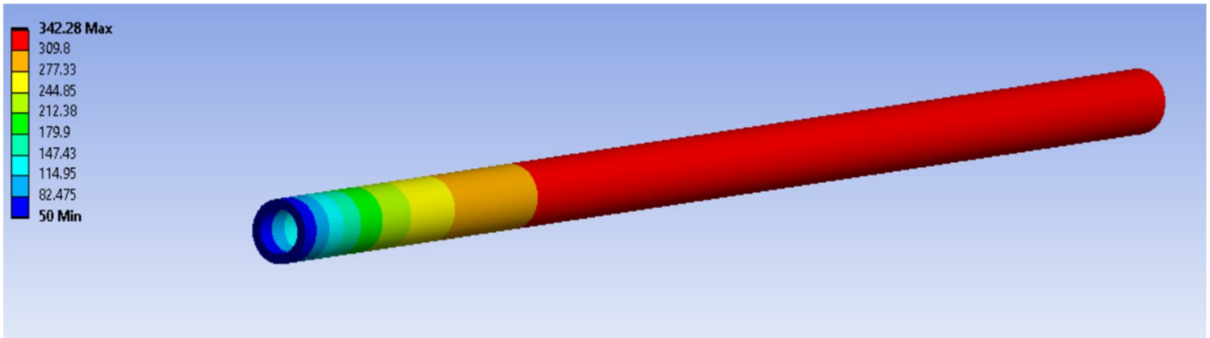


Fig 1.7 Max temperature of the inner cylinder due to radiation

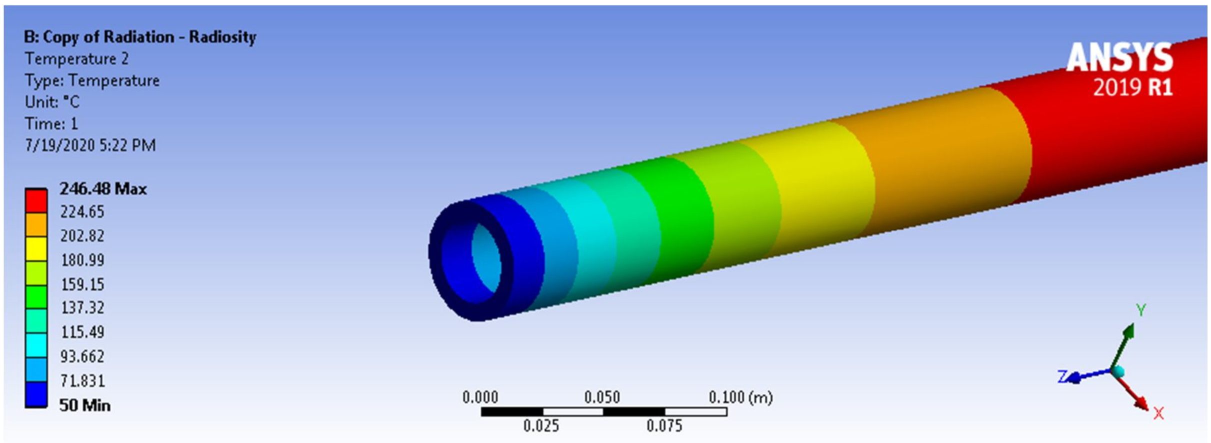


Fig 1.8 Max temperature of the inner cylinder due to radiation

Table I
Heat Balance sheet

Total Applied Heat on both the models 658.88W		
Parameter	Energy(W)- Old Model	Energy(W)- Radiation Shield Model
Temperature probe	-104.99	-79.968
Convection heat	-525.96	-0.95345
Radiation Heat	-23.91	-573.663
Total Balance	4.02	4.295855

V. CONCLUSION

The two concentric cylinders and with radiation shield model was developed in ANSYS WORKBENCH software successfully. The radiation heat transfer enhancement was investigated successfully for the old model and newly developed model in ANSYS. The thermo analysis clearly indicates that the results are acceptable, making a 0.6% difference in the energy balance. A decrease in the total internal radiation was observed by adding radiation protection between the concentric cylinders and an increase in temperature was observed in the inner cylinder with less radiative effects of about 28%.

REFERENCES

[1] Bejan, Convection Heat Transfer, Fourth ed. John Wiley & Sons, Inc., 2013
[2] T.L. Bergman, A.S. Lavine, F.P. Incropera, D.P. DeWitt, Introduction to Heat Transfer, Sixth ed. John Wiley and Sons, Inc., 2011
[3] E.M. Sparrow, J.L. Gregg, Laminar free convection heat transfer from the outer surface of a vertical circular cylinder, Trans. ASME 78 (1956) 183–189.
[4] S.W. Churchill, H.H.S. Chu, Correlating equations for laminar and turbulent free convection from a horizontal cylinder, Int. J. Heat Mass Transf. 18 (1975) 1049–1053.
[5] Mohammad Sadegh Motaghedi Barforoush ⁎, Seyfolah Saedodin, "Heat transfer reduction between two finite concentric cylinders using radiation shields; Experimental and numerical studies", International Communications in Heat and Mass Transfer, International Communications in Heat and Mass Transfer 65 (2015) 94–102

[6] Afonso, C., and Matos, J., 2006, "The effect of radiation shields around the air condenser and compressor of a refrigerator on the temperature distribution inside it," International Journal of Refrigeration, 29, 1144- 1151. http://dx.doi.org/10.1016/j.ijrefrig.2006.01.006

[7] Afonso, C., and Castro, M., 2010, "Air infiltration in domestic refrigerators: The influence of the magnetic seals conservation," International Journal of Refrigeration 33, 856-867. http://dx.doi.org/10.1016/j.ijrefrig.2009.12.007

[8] Brosky, M.E., Lee, C., Bartlett, T.S., and Lo, S., 2000, "Fabrication of a radiation bolus prosthesis for the maxillectomy patient," Journal of Prosthetic Dentistry, 83, 119-121.

[9] http://dx.doi.org/10.1016/S0022-3913(00)70097-7

[10] Holman, J.P., 2009, Heat Transfer, 10th Edn., McGraw-Hill, New York. Howell, J.R., Siegel, R., and Menguc, M.P., 2010, Thermal Radiation Heat Transfer, 5rd Edn., CRC Press, New York. Incropera, F.P., DeWitt, D.P., Bergman, T.L., and Lavine, A.S., 2007, Fundamentals of Heat and Mass Transfer, 6th ed., John Wiley & Sons, Hoboken, NJ. Jamalud-Din, S.D., Rees, D.A.S., Reddy B.V.K., and Narasimhan, A., 2010, "Prediction of natural convection flow using network model and numerical simulations inside enclosure with distributed solid blocks," Heat Mass Transfer, 46, 333–343. http://dx.doi.org/10.1007/s00231-009-0567-9

[11] Mantri, S.S., and Bhasin, A.S., 2010, "Preventive prosthodontics for head and neck radiotherapy," Journal of Clinical and Diagnostic Research, 4, 2958-2962. Micco, C.D. and Aldao, C.M., 2003, "On the net radiation method for heat transfer," European Journal of Physics, 24, 81–89. http://dx.doi.org/10.1088/0143-0807/24/1/309

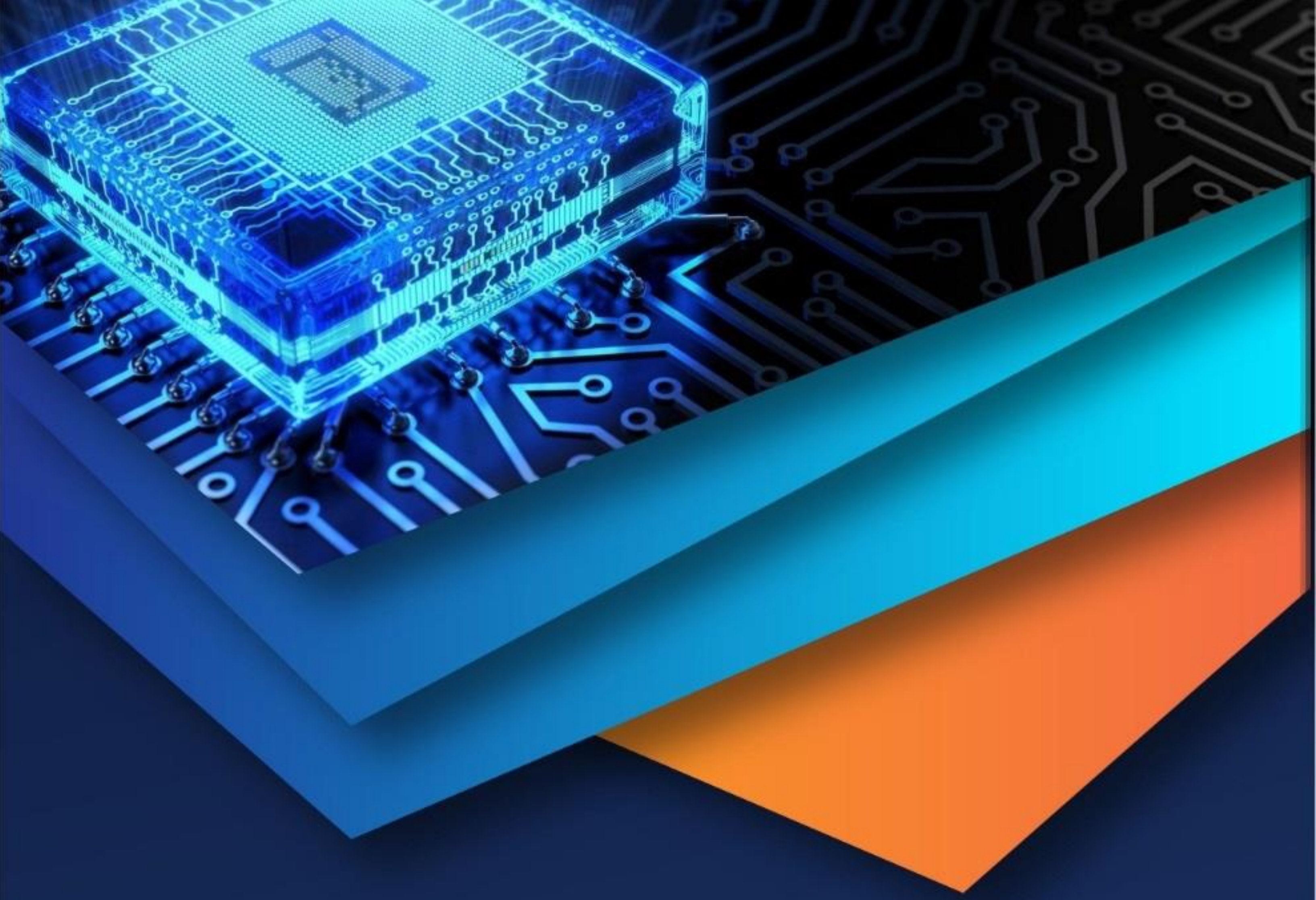
[12] Modest, M.F., 2003, Radiative Heat Transfer, 2nd Edn., Academic Press, New York.

[13] Zemnick, C., Woodhouse, S.A., Gewanter, R.M., Raphael M., and Piro, J.D., 2007, "Rapid prototyping technique for creating a radiation shield," J. Prosthetic Dentistry, 97, 236-241. http://dx.doi.org/10.1016/j.prosdent.2007.02.005

[14] Uppada Rama Kanth, Putti Srinivasa Rao, Mallarapu Gopi Krishna, "Mechanical behaviour of fly ash/SiC particles reinforced Al-Zn alloy-based metal matrix composites fabricated by stir casting method", Journal of Materials Research and Technology Volume 8, Issue 1, January–March 2019, Pages 737-744.

[15] U. S. Ramakanth & Putti. Srinivasa Rao, "Wear Behavior of Al 7075/Fa/Sic Hybrid Composites", International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) ISSN(P): 2249-6890; ISSN(E): 2249-8001 Vol. 9, Issue 2, Apr 2019, 331-338.

[16] U. Ramakanth & Putti. Srinivasa Rao, "Corrosion Studies on Ceramic Particulates Reinforced Hybrid Metal Matrix Composites", International Journal of Mechanical Engineering and Technology (IJMET) Volume 10, Issue 01, January 2019, pp. 661–666.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY