Numerical Study of Laminar Forced Convection Cooling of Circuit Board Mounted Heat Source Array

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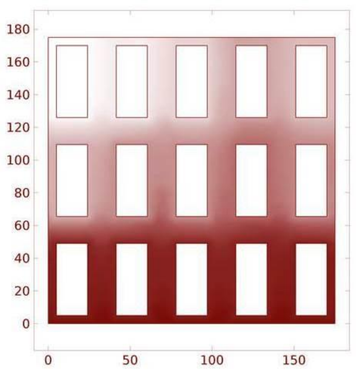
Introduction: Printed circuit board (PCB) is the heart of almost any electronic device. High density PCB comprises of many electronic components requiring high heat dissipation rate. Bakelite substrate board populated with 15 non identical heat sources requires efficient heat dissipation to operate the electronic equipment reliably.



Figures 1 and 2 Substrate

Heat source No.	Size(mm) WxHXD
1,6,11	15x42x5
2,7,12	15x30x5
3,8,13	15x20x5
4,9,14	15x15x5
5,10,15	15x10x5

Table 1. Heat source details

Computational Methods: Stationary laminar forced convection conjugate heat transfer is considered to solve Navier-Stokes equations. Four cases are studied to find the temperature excesses of the components.

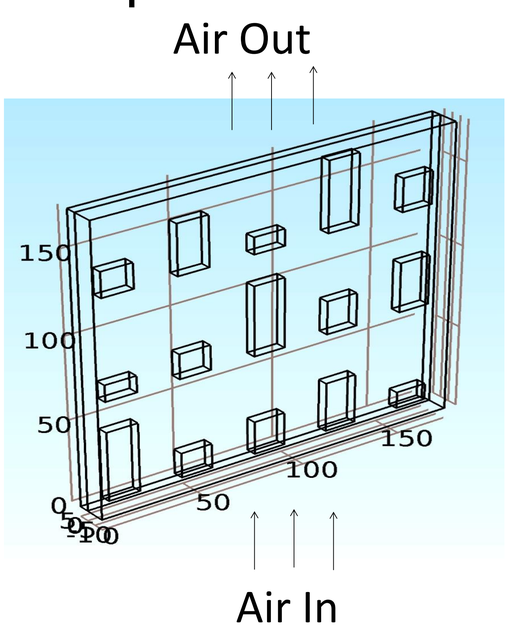


Figure 3. Model

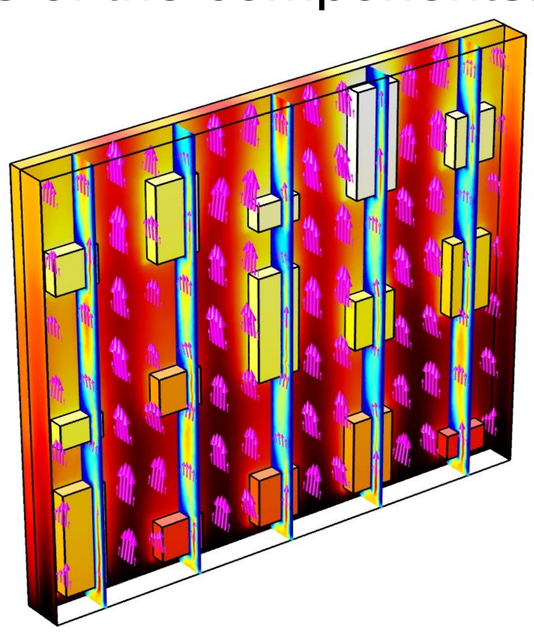


Figure 4. Velocity plot

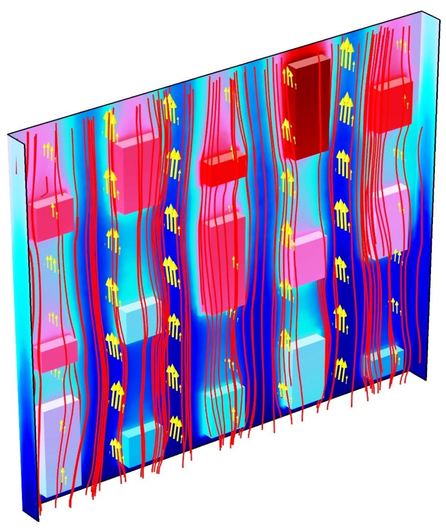


Figure 5. Temperature plot

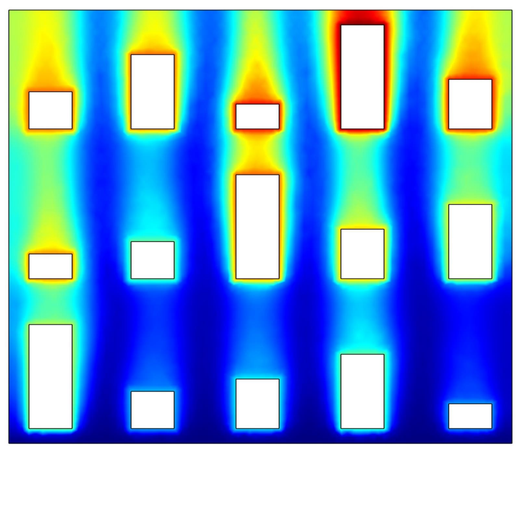


Figure 6. Surface temperature

Results: Simulation results for four cases with heat input of 1500 W/m^2 and air velocity of 1 m/s at ambient temperature of 30^{o}C are shown. Figures 3-10 are the velocity and temperature plots of the optimal configuration. Figure 11 shows the comparison of numerical results of temperature excess at each heat source.

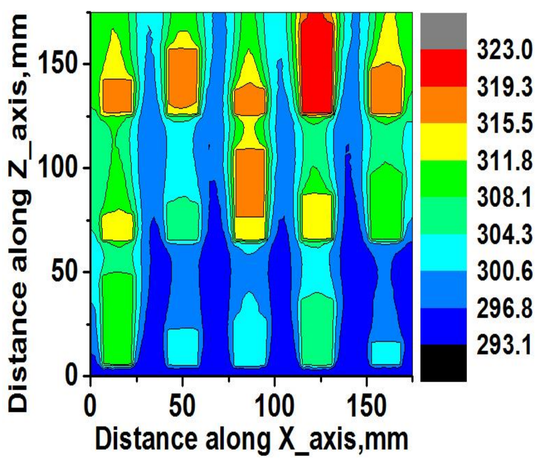


Figure 7. Temperature contours

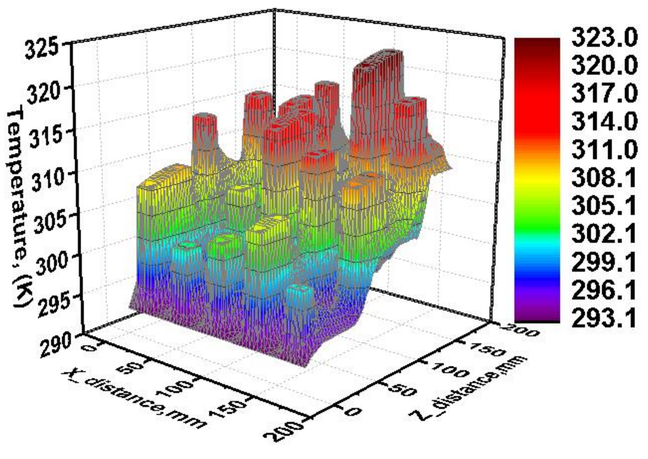


Figure 8. 3d colormap

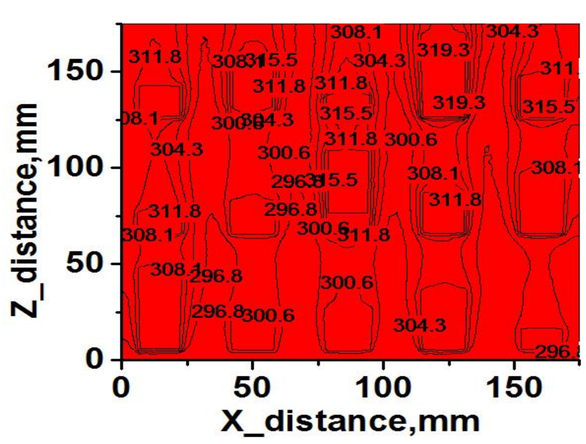


Figure 10. Temperature contour

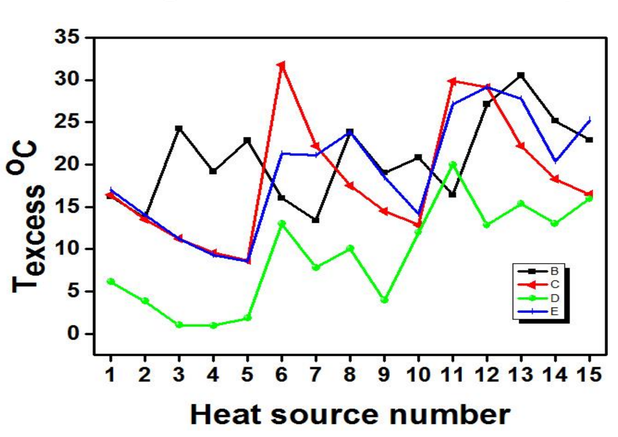


Figure 11. Comparative T_{excess}

Conclusions:

- Study shows that T_{excess} depends on position and size of heat source.
- Optimal configuration has a T_{excess} is 19.77^{o}C.
- Size of heat source are significant for the heat transfer rate.

References:

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[2] Durgam, S. O., Ramanjaneyulu, G., Venkateshan, S. P., and Sundararajan, T., 2015. “A numerical and experimental study of optimal distribution of discrete heat source array cooled by natural and forced convection”,In Proceedings of First TFESC-12696, Begell House, (2015).
[3] Shankar Durgam, S.P.Venkateshan, T.Sundararajan, A Numerical and Experimental Study of Optimal Distribution of Rectangular Discrete Heat Sources Under Laminar Forced Convection ,ihmtc-astfe conference, (2015)