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Transient Analysis of Temperature Distribution in 3D Heat Conduction

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Abstract

In the current analysis the conduction of heat of transient nature has been studied in three dimensions. With the help of computational domain the variation of temperature has been studied. The temperature distribution in x – axis, y -axis and z- axis has been plotted with the help of simulation software. An assembly was made for the four bricks. The concept of internal heat generation was used. Also the temperature graphs in different planes are interpreted.

Keywords: *Transient, Temperature, Bricks, Heat generation, Computational*.

1. Introduction

In case of conduction collision takes place between the molecules. And this results in transfer of energy. In case of steady state conduction temperature does not vary with time. But in case of transient heat conduction the temperature is not constant.

Gao, X .W., 2006.Presented equation in the integral form related to the conduction of heat considering the generation of heat. In the study non homogeneous thermal conductivity was taken into account. Another important thing was that gradients of temperature were not included in the integral domain. And this was because concept of Normalized temperature was used. Method robustness was shown with the help of examples in the numerical form. The use of Green's function In the Laplace equation made the equation which was in the integral form unique for various generations of heat and thermal conductivity values. Ramzan, et al 2017 guided heat generation heat flux in three dimensions for flow of fluid. It was studied using a surface which was stretched in two directions.

The study was done in the vicinity of MHD. The boundary conditions were used for convection and all the effects with boundary conditions which were of the convective nature were considered. The method of analysis was Homotopy. Since the equations were nonlinear the solution was obtained by using the method described above. The concentration of various parameters was exampled with the help of graphs. Also the physical impact was discussed in detail. And the results of distribution of velocity were in the decreasing term of Hartmann number. Also the decrease in the distribution of concentration was observed. Tung, P., 2006 promoted a method with the help of which boundary conditions which were not known were found. This method was named as inverse method. The problem was based on heat conduction which was of the non Fourier type. First of all problem was discretized with the help of finite difference method. Secondly a model was prepared which was inverse linear. And finally boundary conditions were selected. Method of least square was employed to determine the solution of the problem. It was found that the method was pretty good for approximations which were of the numerical type with errors. In the most of the numerical methods initial guess is very important but from here it was analyzed that the no initial guess is required. Also as far as iterations were concerned only single iteration is required. Using some of the known values results can be obtained. Also it was studied the solutions was in the unique form. It was found that the two methods were different one for heat conduction problem which is non Fourier and inverse, second for conduction of heat which is Fourier and inverse. Singh,V.I et.al.2002 validated the results using two methods. First method used was finite element method and the second was using analytical methods. Results were obtained using free Galerkin method in which mesh less element were used. The problem was defined for conduction of heat in steady state in three dimensions. For the approximation of the solution method of least squares was used. A weight function was defined for the approximations. This lead to the formation of equations

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known as governing equations. Variational technique was the basis for the development of governing equations. Another method named as Lagrange method of multiplier was used for the development of boundary conditions which were essential. Also the concept of weight function named as hyperbolic was utilized. Kim,K.J et al**.** investigated the conduction of heat in case of a cantilever which is micro based.

The environment was taken as air. The heated cantilever was analyzed with the help of simulations of finite element continuum. This helped in the investigation of conduction of heat in a detailed view. The magnitude of heat generation for the analysis was taken as 8MW. The two things, first is conduction of heat between air and heater and the second between cantilever with the surrounding air were compared. The interesting thing observed was that the conduction of heat in the later case was higher as compared to the former. And the magnitude was 2 to 6 times. This study will help in the different aspects of micro cantilever heaters. It was found that as the time of pulse heating increases, the time constant for cooling also increases. The magnitude of former and later was 1-1000 micro seconds and 4.6-70 micro seconds respectively. Ferreira, M.S. & Yanagihara, J.I.2001 studied the conduction of heat which was time dependent. The conduction of heat was used in case of cylinder of elliptical shape in three dimensions. This cylinder was converted into a parallelepiped with the help of a transformation which was analytical and not orthogonal. FVM was applied to this transformation. The final equations which were of the algebraic nature were solved with the help of an implicit technique of alternating direction. Khosravifard, A. et.al.2011 provided a method for the solution of conduction of heat problems which are not linear in nature. In this method interpolation was used with radial point and without mesh.

This was used for the conduction of heat problems transient in nature. It was adopted for the materials known as functionally graded with heterogeneous sources of heat or the sources which are dependent on temperature. This particular method was improved one. Global weak formulation was the basis for this method. Also the function associated with function of shape was inbuilt property of delta function. This technique resulted in very accurate and fast results, however in its initial form it is in the requirement of background meshing. The efficiency and the effectiveness of the method was assesses with the help of examples. Yang, R., et.al.2005 studied the conduction of heat in the nano scale heat problems. Due to certain factors the conduction of heat in such type of problems may differ with that of the law known as Fourier law for conduction of heat. The different factors may be like transport nature heat carrier time which is finite relaxation. Scattering at the boundary and interface is also an important factor for this type of deviation. For this conduction of heat equations were drafted which were of the ballistic diffusive nature and dependent on time. It served as an approximate solution to the Boltzmann equations. The results obtained from the simulation were compared with the results obtained from law. The problem also analyzed for multi dimensions. Boundary conditions were also an important consideration for this type of problems.

The two cases were compared one with internal heat generation and other without internal heat generation. For these two cases study was focused on the deviation obtained with that of the Boltzmann equations and ballistic equations. It was observed from the results that the difference was more in Boltzmann equation and Ballistic equation in the case of internal heat generation as compared to that of without internal heat generation. Ferreira, M.S. & Yanagihara, J.I.2001 validated the results with the experimental data. It was found from the results that the results are in good correlation with the experimental work. The main point of focus was to develop thermal systems for human body and to improve this as well. For this the geometry of body was approximated with the help of cylinder which was elliptical. Also the care was provided how to explore the different organs of the body. The implementation of computational domain was also an important factor for this type of work. Transfer of heat was analyzed for the behavior of thermal body of humans.

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2. Results

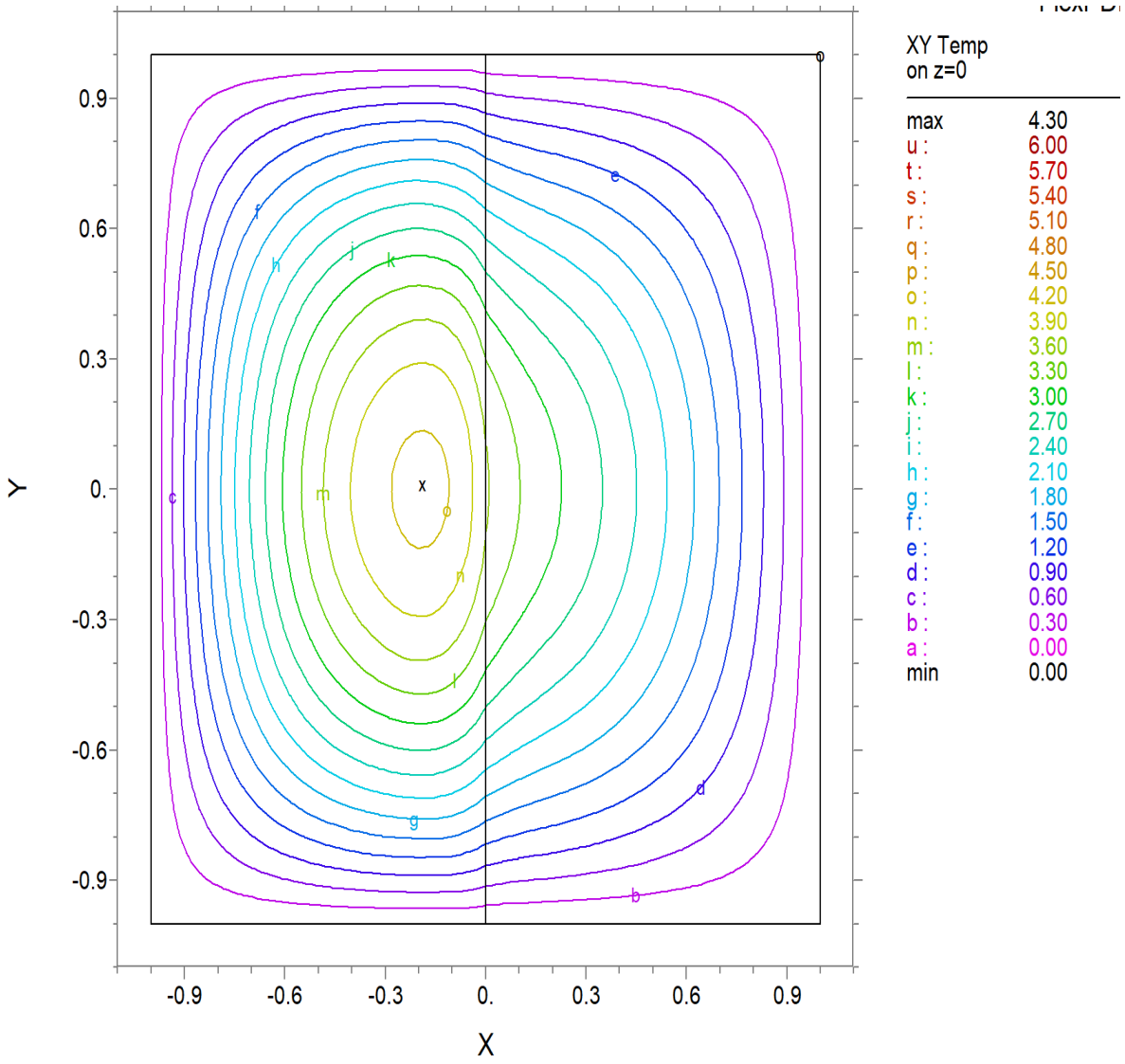

Figure 1: X – Y Temperature

Figure 1 shows the X- Y temperature distribution in case of transient heat conduction. Here Z = 0. The maximum value observed to be 4.3 and the minimum value is zero. Here we can see the X-Y contours as shown in the plot.

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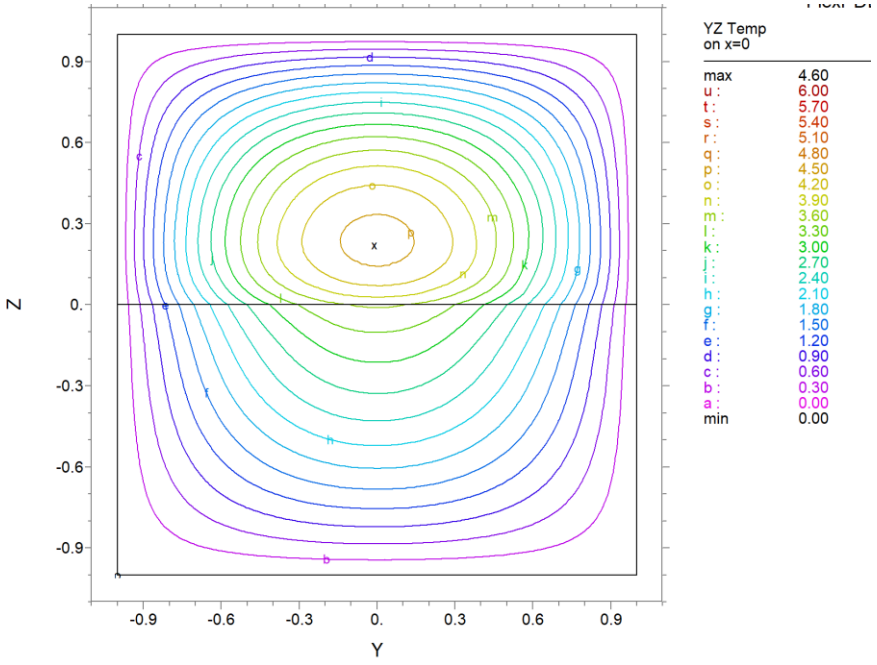

Figure 2: Y – Z Temperature

Figure 2 shows the Y- Z temperature distribution in case of transient heat conduction. Here X = 0. The maximum value observed to be 4.6 and the minimum value is zero. Here we can see the Y-Z contours as shown in the plot.

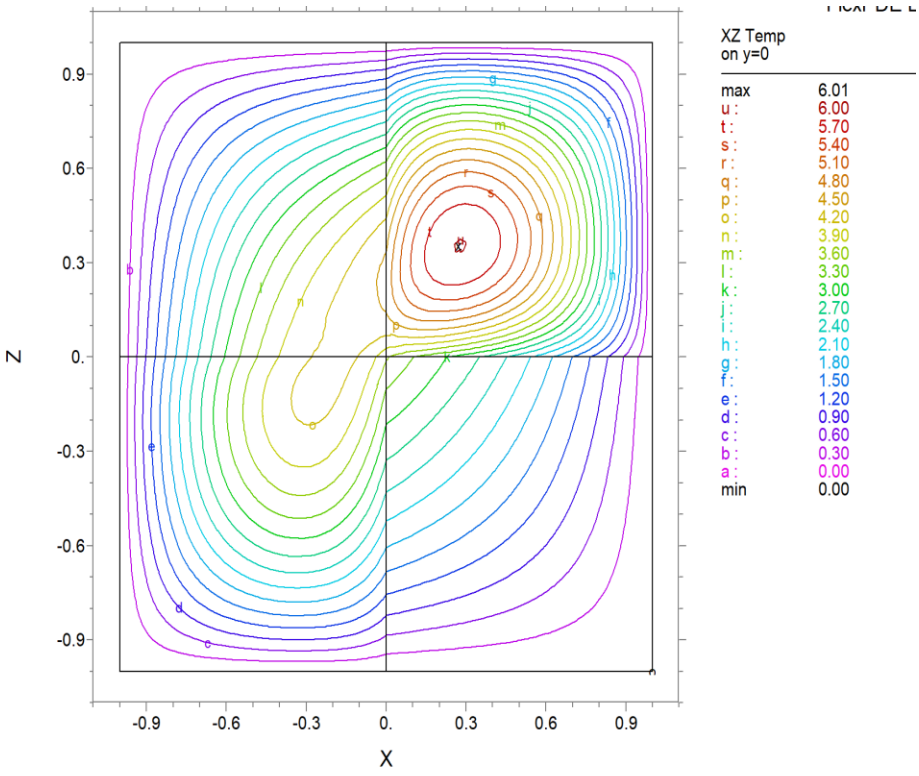

Figure 3: X – Z Temperature

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Figure 3 shows the X- Z temperature distribution in case of transient heat conduction. Here Y = 0. The maximum value observed to be 6.01 and the minimum value is zero. Here we can see the X-Z contours as shown in the plot.

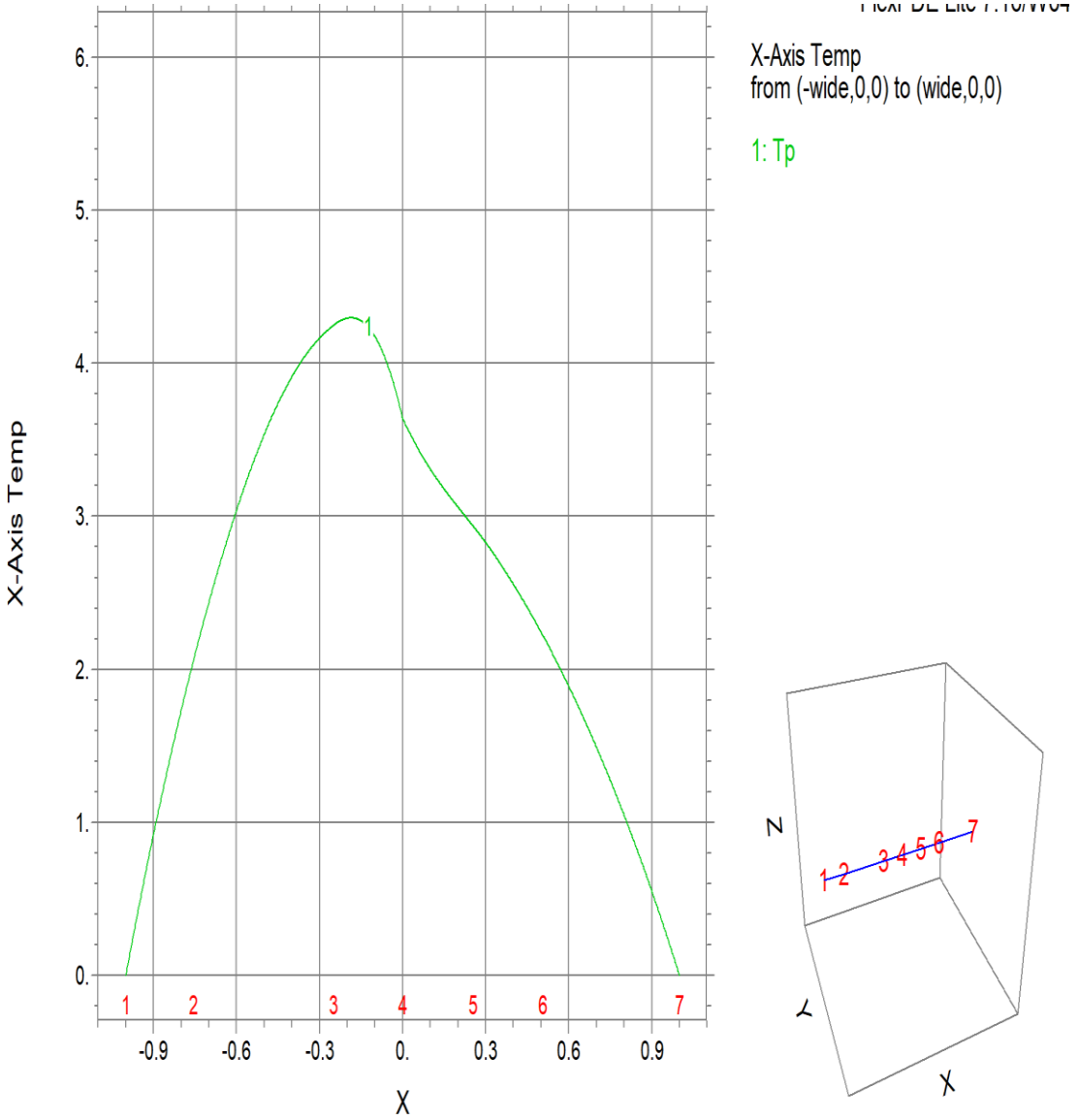

Figure 4: X –Axis Temperature

Figure 4 shows the X-axis temperature scattering in case of time dependent heat conduction.

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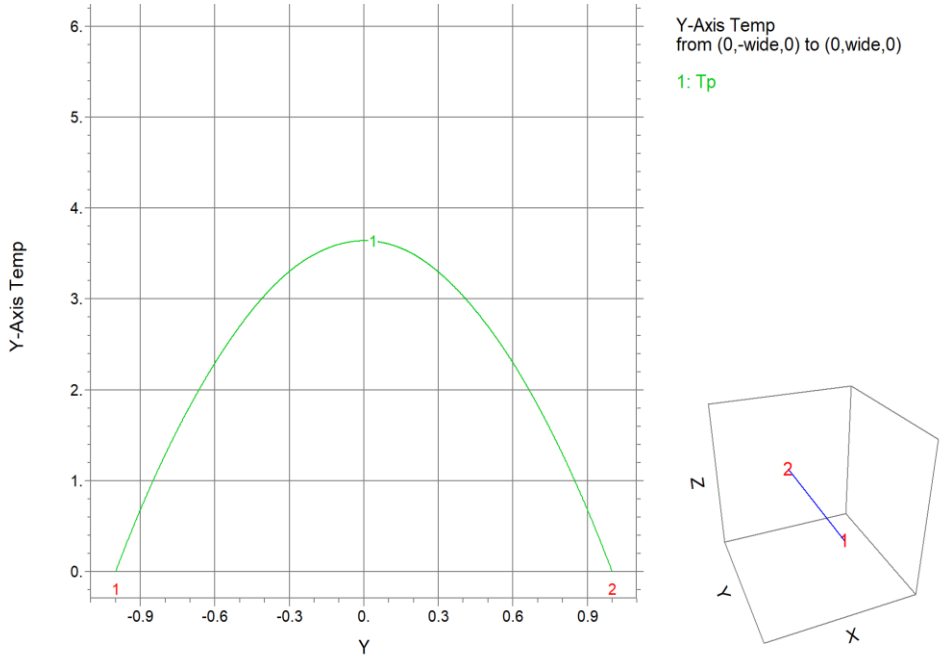

Figure 5: Y –Axis Temperature

Figure 5 shows the Y-axis temperature scattering in case of time dependent heat conduction.

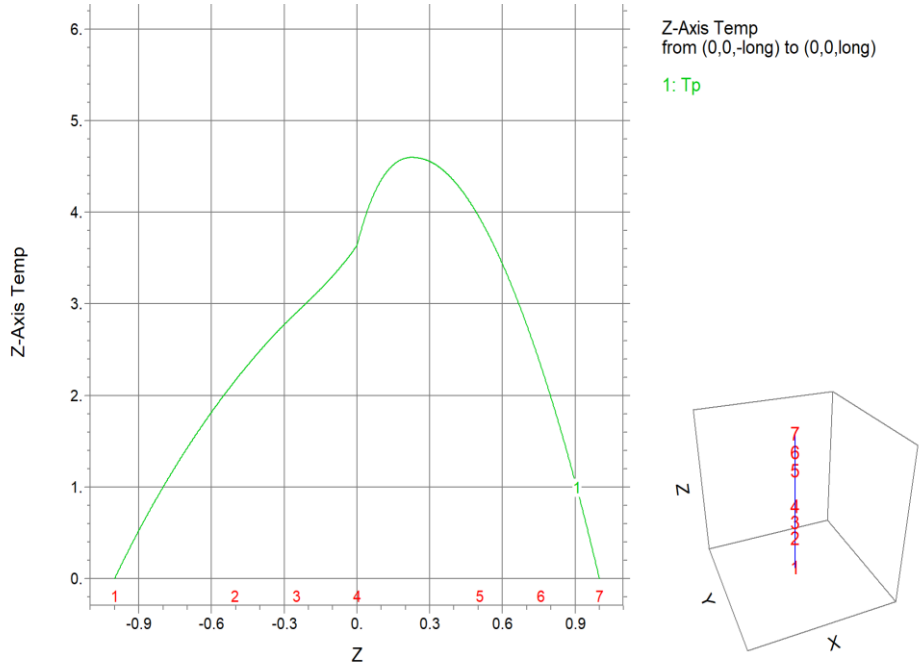

Figure 6: Z –Axis Temperature

Figure 6 shows the Z-axis temperature scattering in case of transient heat conduction.

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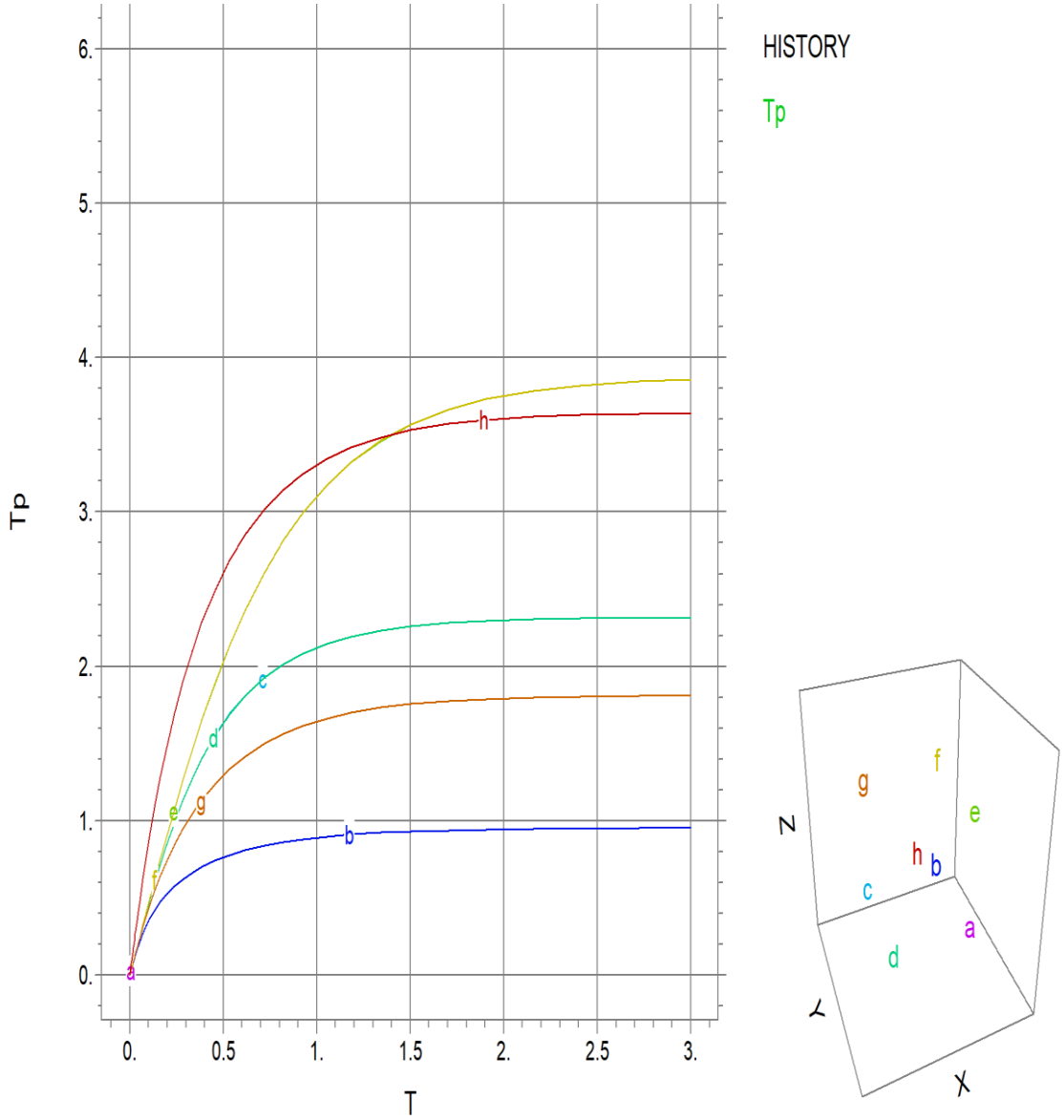

Figure 7: Temperature Variable

Figure 7 shows temperature distribution in case of transient heat conduction

Conclusion

An assembly of the four bricks with internal heat generation has been analyzed for the conduction heat transfer. The temperature distribution has been studied in different planes as x- y plane, y-z plane and x- z plane. The same has been analyzed with the help of simulation software. From the studies it has been found that the temperature reaches to its equilibrium position after a time.

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