(Eq. 4.4)

Study on Air Tubes Failure in Sponge Iron Rotary Kiln

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Introduction: The rotary kiln process is a commonly practiced method in India for producing coal based sponge iron. In the industry, there have been many recent reports of premature failures of certain air tubes in rotary kilns. This work aims at developing a temperature profile by modelling the heat transfer phenomena happening inside the kiln.

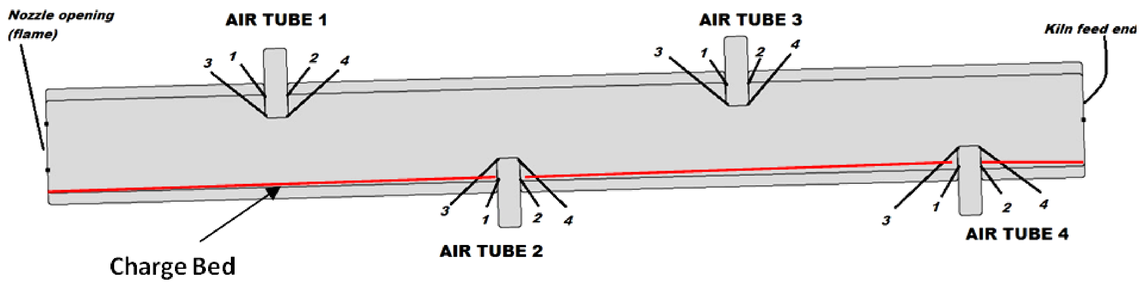

Figure 1. Geometry of the cross-sectional model

Computational Methods: Conjugate Heat Transfer Module interface in COMSOL was used for the study. The following set of equations were used:

$$\rho C_p\left(\frac{\partial T}{\partial t}+(\mathbf{u}.\nabla)T\right)=\nabla.(K\nabla T)+Q$$

$$-\mathbf{n}.(K\nabla T)=h.(T_{ext}-T)$$

$$-\mathbf{n}.(K\nabla T)=\varepsilon(G-\sigma T^4)$$

The heat source was taken as constant ; surface to ambient radiation was also considered and study was in transient mode.

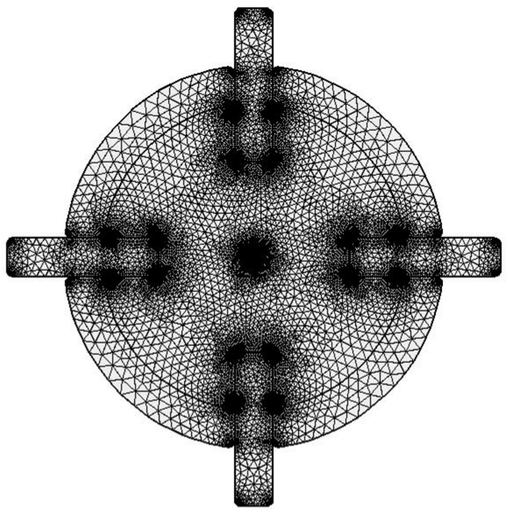

Figure 2. front view of the model with meshing

Results: The temperature profile showed that certain parts are susceptible to thermal shocks and thermal failure and middle portion of the kiln is the most vulnerable location.

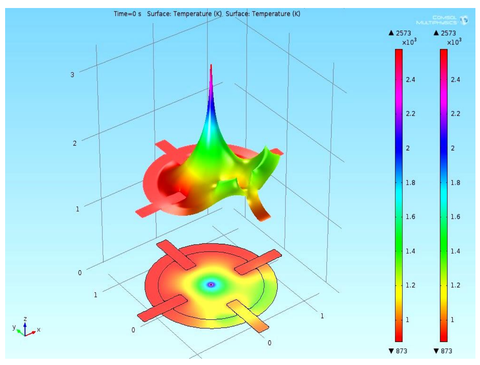

Figure 3. Temperature profile of cross-section(front view) of the kiln

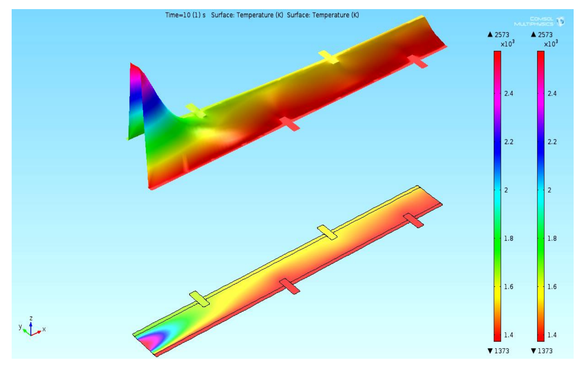

Figure 4. Temperature Profile of the kiln cross-section(side view)

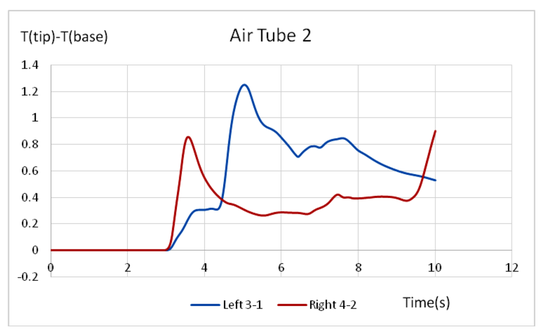

Figure 5. Temperature Evolution Curve for Air Tube no. 2

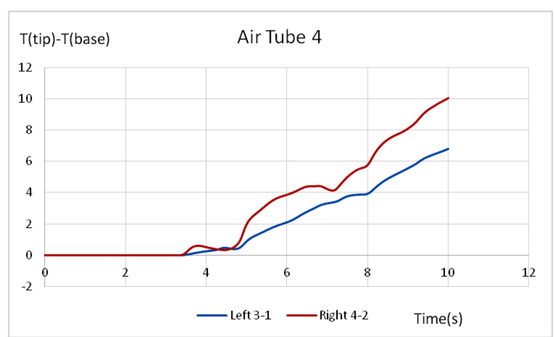

Figure 5. Temperature Evolution Curve for Air Tube no. 4

Conclusions: The central portion air tubes are more susceptible to failure than other air tubes in the present design of the kiln. Thus knowing that thermal action is most probably behind the premature failure , the design flaw was identified in this study and corrective actions are under research.

References:

1. F.P. Incropera, et al, Fundamentals of Heat and Mass Transfer, John Wiley & Sons, Sixth edition, 2006
2. S.Q. Li, L.B. Ma et. al., A Mathematical Model of Heat Transfer in a Rotary Kiln Thermo- Reactor, Chem. Eng. Technol, Vol. 12, 2005,