Study on Air Tubes Failure in Sponge Iron Rotary Kiln

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Abstract

INTRODUCTION: The rotary kiln process is a commonly practiced method in India for producing coal based sponge iron. The iron ore along with coal is charged into the kiln and air tubes located along the length supply the air for combustion. In the industry, there have been many recent reports of premature failures of certain air tubes in a rotary kiln. Most of those cases have concentrated on those air tubes which run into the kiln around the middle portion of the kiln. This work aims at developing a temperature profile by modeling the heat transfer phenomena happening inside the kiln. This study helps in detecting early identification of crack prone air tubes and facilitates timely replacements and repair.

USE OF COMSOL MULTIPHYSICS: Conjugate heat transfer Interface was used in the study. Two different types of kiln models (Front view and Side view 2-D models) were constructed and a temperature profile and an air-flow velocity profile were obtained. There were three domains; the innermost was the air which contained the heat source, the second was the refractory layer and the third was the steel shell. The heat source was defined based on the heat of reactions in the kiln. The boundary conditions were defined as the outside temperature of the kiln.

RESULTS: In the detailed study of the temperature profile of the side view model, it was found out that the susceptibility to thermal shocks and thermal failure is high for the air tubes around the middle portion of the kiln due to steep changes in internal thermal gradient within the tubes. This in combination with the rotation of the kiln might lead to thermal fatigue in the longer run. In the front view model, it was found out that the thermal shocks due to frequent change of internal gradients were present in all the air tubes. Also inferred was that the surface of the air tube that is in the middle of the charge bed has a huge gradient and is most vulnerable to thermal shock.

CONCLUSION: The surface of the central portion air tubes is the most susceptible to failure than other air tubes in the present design of the kiln. It is consistent with the failure reports from the industrial plant which stated that the air tubes around the central portion have cracked originating from the surface very prematurely. Thus knowing that thermal action is most probably behind the premature failure of these central air tubes and thus further analysis is direct in this area. The design flaw was identified in this study and corrective actions are under research.