The majority of tubes used today in gas heated heat treatment furnaces are of the SER (single ended recuperative) design. The limiting factor for the lifetime in this system is normally the inner tube, which is exposed to a significantly higher temperature than the outer tube. A common material for inner tubes is nickel-chromium.

In a number of gas heated furnaces, the nickel-chromium tubes have been replaced by Kanthal APM™ tubes, a material with much higher loading potential and 100°C (210°F) higher operating temperature. Another feature is that Kanthal APM™ forms no scale that contaminates the tubes and the furnace interior.

**THE CHALLENGE**

Koyo Heat Treatment in Osaka is mainly using natural gas for their batch and continuous furnaces. They work as an independent heat treatment company servicing the local automotive and engineering industry.

Ten of their furnaces are of batch universal type about 200 kW each, used for various heat treatment processes, mainly carburizing at 800–900°C (1470–1650°F) in endogas. Originally, these furnaces were equipped with outer tubes of SHC 22 or HK 40 and inner tubes of Inconel 601. The burners are Osaka Gas 4”, type RT-BDT-100A. A severe problem with the nickel-chromium system was that the oxide flakes filled the outer tube to such an extent that the gas circulation was stopped and the lower part of the tubes were overheated.
THE SOLUTION
In order to solve this problem, to increase the furnace power and to improve the lifetime of the tubes, it was decided to change all tubes to Kanthal APM™ in all 10 furnaces.

The inner tubes are now loaded at 48 kW/m² (4.5 kW/ft²), compared to 25 for the Inconel tubes. The recovery time after charging is much shorter, resulting in faster furnaces and higher production. The life of the Kanthal APM™ system is about 2.5 years compared to 0.5–1 for the elder system. A primary advantage of the Kanthal APM™ tube system is the formation of a cohesive aluminium oxide film on both the inner and outer surface of the tubes, thus the tubes remain free from contamination by internal scaling of the tube. The adherent alumina film formed on the outside of the tube is an extremely effective barrier against carbon activity and makes the tubes highly resistant to carburization even in cases where free carbon is allowed to accumulate on the tubes. The system is thus ideal for use in heat treatment atmosphere furnaces.

THE RESULT
After the positive experiences with Kanthal APM™ in the batch furnaces, it was decided to change over to Kanthal APM™ in the inner tubes when the Inconel tubes failed. So far two furnaces are converted and the experiences are basically the same; the lifetime has more than doubled from 0.5–1 year to about 2.5 years for the Kanthal APM™ tubes.

For the moment, a total of 250 Kanthal APM™ tubes are in operation at Koyo Heat Treatment in Osaka and more are added as other types are replaced.

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