Kobe Steel Solves Roll Steel Blemish Problem

The Kakogawa Works of Kobe Steel, Ltd., operates a continuous annealing line for roll steel at its Kakogawa City, Japan factory. Applications for this high grade steel include automotive, appliance, and other manufacturers, each requiring very high quality, blemish-free material for their products.

According to Isolite Insulating Products representative, Y. Hayashi, Kobe Steel was experiencing problems with roll marks on the steel surface that were created during manufacturing. Isolite Insulating Products is a distributor of engineered insulating systems for high temperature industrial applications in Japan.

The steel manufacturing company implemented a formal study of the surface blemish problem in June of 1984 in cooperation with Chugai Ro Co., Ltd., designer of the annealing line, and Isolite insulating Products Co. The study revealed that these surface defects were caused by contaminating particles within the annealing furnace.

Various countermeasures were considered to eliminate this problem, including more frequent furnace cleaning, increasing the surface hardness of transport rollers, use of improved seals at annealing units inlets and outlets, and masking of refractory insulating material surfaces within the annealing furnace.

Kobe Steel's annealing line raises the temperature of incoming steel to approximately 900°C, and the roll steel follows a serpentine path through the furnace. The annealing line has castable or brick insulation in the radiant tube sections (preheat, heating, soaking and reheating zones), and ceramic fiber bat insulation in the rest of the system (gas jet, roll cooling and quenching zones).

After study, it was determined that the primary cause of surface blemishes on roll steel was alumina silicate particulate matter shed by both the castable brick and ceramic fiber bat refractory surfaces within the annealing furnace. This contaminating refractory particulate was created as a result of thermal shock and surface deterioration after repeated heating and cooling cycles. The Company installed a spray system to coat the moving steel surface to improve its resistance to pickup of contaminants, and began searching for means to control the unwanted release of particulate matter.

A laboratory study of the micro-particle permeability performance of various ceramic fabric furnace liners was conducted by Kobe Steel scientists. A small section of 3M™ Nextel™ Ceramic Fabric was tested in the annealing line, and this material was found to effectively restrict the passage of micro-particles, exhibited high tensile strength at elevated temperatures, and provided good long-term resistance to the effects of thermal cycling.

3M Nextel is made from continuous polycrystalline metal oxide fibers. The ceramic fibers are transparent, non-porous, and can be woven or braided. Nextel consists of alumina/boria/silica fibers (62 percent $A1_2O_3$, 14 percent B_2O_3, and 24 percent SiO_2).

Nextel fibers are made by "sol-gel" process whereby a chemical sol is extruded through a spinneret and fired to form individual continuous ceramic fibers with consistent compositions, diameter and physical properties. The resulting metal oxide fibers are polycrystalline and non-porous, and consequently have good strength, chemical resistance, flexibility, and abrasion resistance properties. Nextel ceramic fibers resist elongation and shrinkage with changes in temperature, allowing for good dimensional stability. Nextel ceramic fabrics are also used for high temperature zone dividers, furnace curtains, and seals and gaskets in the industrial market.

A scaleup test of Nextel fabric lining was implemented by Kobe Steel in October of 1985. Results confirmed the temperature and particle restriction capabilities of the ceramic fabric. According to Mr. Hayashi, Kobe Steel found that Nextel exhibited less reheating shrinkage, superior micro-particle filtration, and better high temperature flexibility than any of the other materials tested.

Based on these results, it was decided to use Nextel as a permanent refractory surface cover component in Kobe Steel annealing furnaces. A Nextel ceramic liner was fabricated for the uniform temperature zone of a continuous annealing line at Kakogawa Works in 1986. Later, the ceramic fiber material was used to line the entire furnace. The material is held in place, around the walls and ceiling of the furnace, by impaling the material on stud pins welded to the furnace frame.

Kobe Steel reports that the Nextel surface lining is capable of totally controlling dust and contaminants generated in the furnace over a long period of time with excellent stability. Sheet steel quality has been substantially improved, and the Company has been able to eliminate periodic furnace cleanings and to speed up routine maintenance activities because contamination is controlled by the fabric lining. As a result, both the quality of annealed steel and annealing productivity have been greatly improved.

The first Nextel refractory liner installed in the Kobe Steel, Ltd. annealing furnace soaking zone, in 1986, continues to serve its intended purpose without deterioration in performance Hayashi reports. Kobe Steel, Ltd., has patented this effective furnace lining application in France and Germany.