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TATA STEEL

M2A MATERIALS AND MANUFACTURING ACADEMY

Development of Novel Coating Solutions to Improve Pre & Post Heat-Treatment Performance Properties of Carbon Steel Conveyance Tubes

Project Background

- Carbon Steel Conveyance Tubes have been successfully utilised within the building and industrial services industry for many years.
- Tata Steel produce premium hot-finished tubes that deliver consistent mechanical properties and service life benefits, compared to imported, commodity, cold-formed alternatives.
- The hot-finished product refers to a normalising heat treatment; in which the tube is heated to 900°C to remove the Heat Affect Zone (HAZ) and relieve the internal stresses within the microstructure as a result of the tube production.
- The normalising process results in surface oxide formation, which is both advantageous and detrimental. The oxide instigates a yield loss in quality grade steel and causes defects on the surface (see figure 2a/2b)
- The project is designed to develop a novel coating solution to be applied prior to the normalising stage. Coating characteristics include; oxidation protection, descalability, low VOC emission, economic viability, cosmetic improvement, thermal conductivity and sustainability

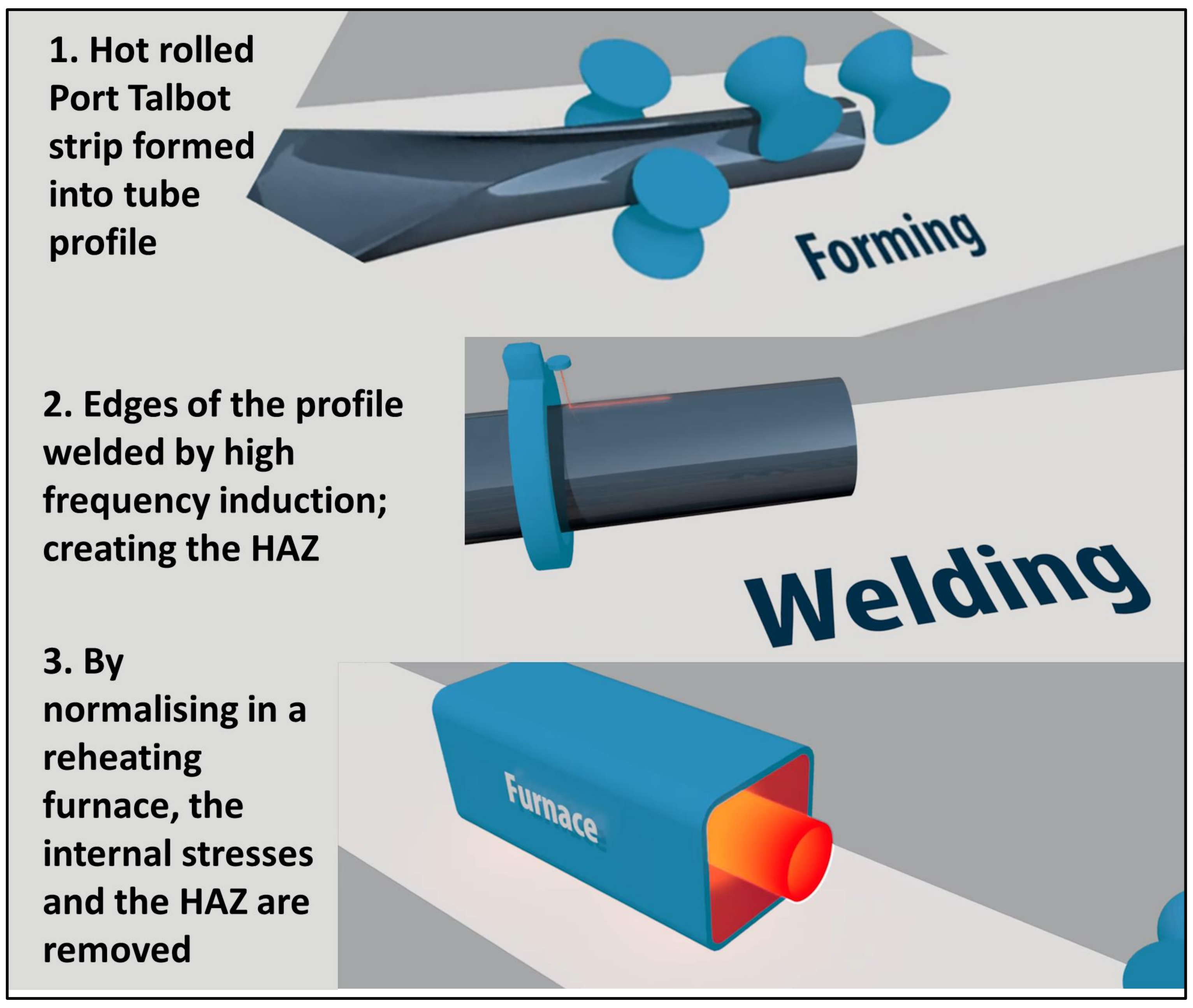


Figure 1- Process route for conveyance tubes at TATA Corby mills

Figure 2a - Oxide waste containing quality grade steel (yield loss)
Figure 2b - Surface cosmetic issues due to the normalisation scale
Figure 2c – SEM Image cross sectional view of scale taken from process mill

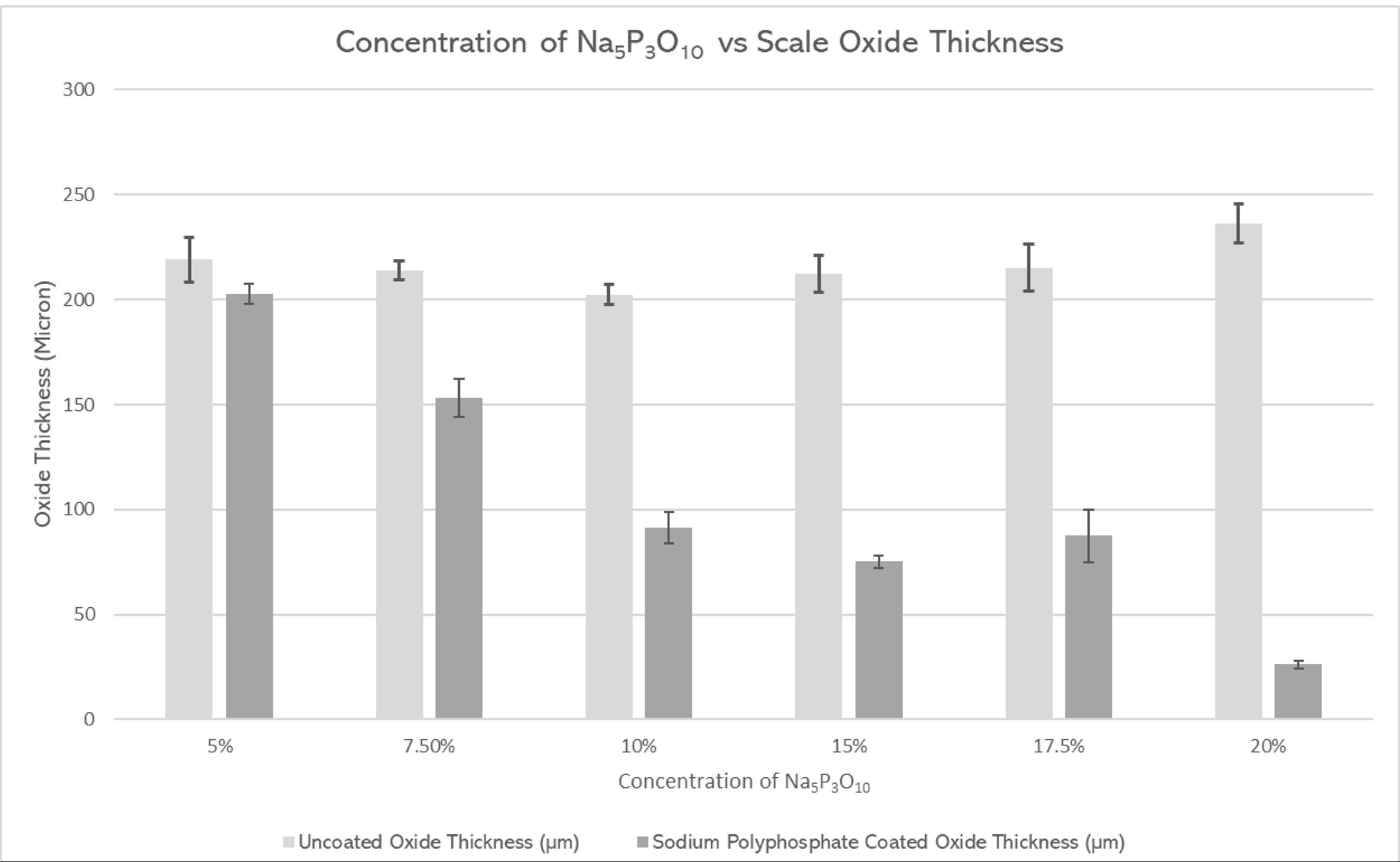
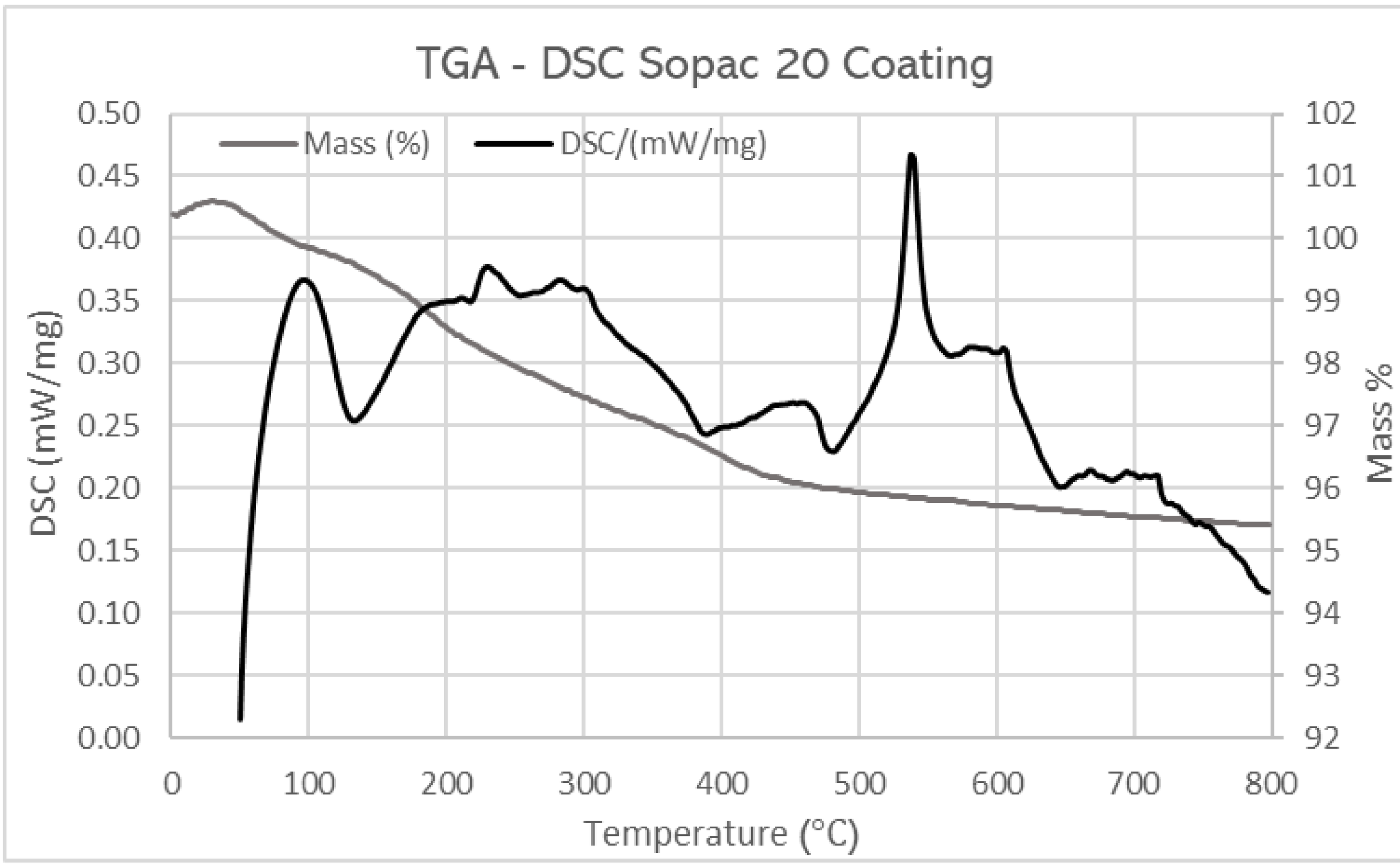


Figure 4 – Effect of Sodium Polyphosphate concentration on Oxide Reduction

Methodology

Phosphate coating solutions

Steel Sample coupons were coated (half side) with a novel coating utilising the 'glassy state' nature of a phosphate (Sodium tripolyphosphate) when taken above transition temperature. The coupons were normalised in an induction furnace with a 900°c thermal cycle and an oxide grown. By cross sectioning, mounting and performing microscopy analysis; the coating's performance could be determined by observing the difference in oxide growth between the uncoated and coated sides at the steel surface.



$Na_5P_3O_{10}$+Recycled Glass Composite

Figure 3 – STA analysis of Sopac 20 coating before application to the steel substrate

- DSC analysis indicates the sintering temperature for the novel coating is below the known dominant phase of wüstite growth – transition temperature occuring >600°C.
- Figure 5 show the effectiveness of Sopac 20 at preventing oxide formation. Further research will focus on coating adherence during reheating as well as reducing coating porosity. LFA analysis has been utilised to determine thermal conductivity.

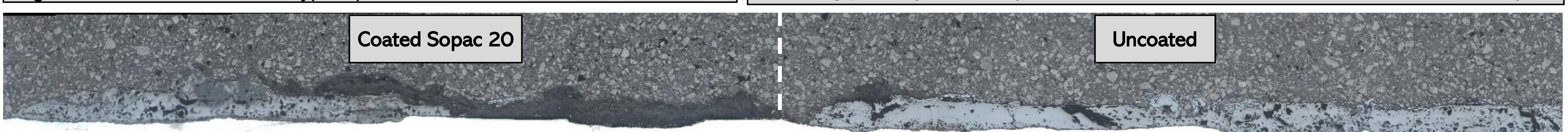


Figure 5 – Cross-Sectional stitch of surface post heat treatment

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