Using Chilled Mirror Hygrometers to control moisture in furnaces during Zinc plating

Application Background

Rolled steel sheet produced for the automotive industry needs to be strong and resistant to corrosion.

The raw product is reels of 1mm steel sheet from a roller furnace. As the length of these reels is limited by the length of the roller furnace, they need to be bonded together end to end to produce a reel suitable for efficient processing.

The required strength and corrosion resistance is achieved by annealing followed by hot dip galvanization of the steel. This process involves passing the sheet through a number of stages of surface preparation before the actual galvanization takes place, in order to ensure the final stage coating is of satisfactory quality.

Initially, the steel is washed with a basic solution to clean away dirt and grease, then rinsed. It is then immersed in an acid solution to remove any oxidation, and rinsed again. The sheet is then passed into a drying oven, maintained at 60-70°C and purged with dry nitrogen, to evaporate and purge away moisture to prevent re-oxidation.

The steel then enters the annealing furnace, which is configured at a temperature of 600°C or greater, while maintaining a dew point of -40°C or lower. These conditions prevent the surface layer from oxidising, allowing the surface of the steel to maintain its content of silicon and manganese – a characteristic which ensures that the steel sheet will be very strong. This is typically achieved by feeding forming gas (H_2/N_2 mix) of a very low moisture content into the furnace, in order to purge the moisture out to below the required dew point.

Once the surface has been annealed, a flux of zinc ammonium chloride is applied. This flux has two effects:

1. It prevents the raw steel from re-oxidising when exposed to the air
2. It facilitates the bond between the steel and the liquid zinc

The flux coated steel is then loaded into the galvanizing furnace, which preheats the steel to 450°C, then passes it through a bath of molten zinc maintained at the same temperature. Thickness of the plated layer is critical for the end users of the product, so immediately after exiting the zinc bath, a pair of air knives are used to blow molten zinc away from the surface and precisely control the thickness of the overall sheet.

The sheet is then reintroduced to the furnace to be cooled to solidify the zinc and prevent any further reactions which could be triggered by atmospheric exposure. The atmosphere in this environment is also controlled to prevent oxidation occurring before the product has fully cooled.

Humidity measurements

Measurement 1 = Drying oven

Measurement 2 = Annealing furnace

Measurement 3 = Galvanizing furnace

Each of these areas of the process actually encompass a very large internal volume, so in order to ensure that a representative condition within the furnace is measured it is advisable to make measurements from multiple sample points across each furnace.

Due to the temperatures involved, the sample should be extracted from the furnace, and fed to the instrument through stainless steel sample line of sufficient length to ensure the temperature has equalised with ambient. A particulate filter is also advisable to protect against any fine metal particles which may be present.

The S8000 Integrale is an ideal choice for this application because it uses the fundamental chilled mirror technique to measure moisture. It is accurate to ±0.1°C dew point and offers a range of -60 to +40°C dp.

The temperature in the ambient environment of the furnace room will likely be rather high, so the best position for hygrometers is in air conditioned instrumentation cabinets.

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