CONTINUOUS DEW POINT MONITORING SYSTEM FOR A SINTERING FURNACE

Accurate dew point measurement is key to maintaining the atmosphere composition required to achieve high quality and consistency of sintered products.

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Common powder metallurgy (PM) techniques involve compacting a blend of metal powder with lubricant and graphite (for ferrous parts) into a green part in a press, and sintering the part in a batch or continuous furnace. Continuous mesh-belt furnaces are widely used for mass production of PM parts[1]. They typically have at least three zones—a preheating (or de-lubrication) zone, a hot (or sintering) zone, and a cooling zone. In addition, some continuous sintering furnaces have a specially designed rapid-cooling zone between the hot and cooling zones for sinter hardening steel parts. Figure 1 shows a typical continuous sintering furnace design.

WHY DEW POINT IS IMPORTANT

Atmosphere quality plays a key role in the final properties of a sintered part. Dimensional accuracy as well as characteristics such as hardness, ductility, carbon content, microstructure, and magnetic properties are influenced not only by time and temperature, but also by furnace atmosphere composition, flow rate, and stability. Different furnace zones require varying degrees of oxidizing or reducing power to develop optimum final sintered part properties[2]. Generally, a reducing and carbon-neutral atmosphere is desired in the hot zone for ferrous parts.

The *reducing potential* determines the rate at which powder particle surface oxides are reduced, which directly influences sintering bonding between particles in the compact. A dry or slightly humidified[1] nitrogen-hydrogen blend is used for steel PM operations. The hydrogen-to-moisture ratio in the hot zone determines reducing capability. Moisture is simply a product of powder oxides reduced by hydrogen introduced into the furnace, as well as belt reduction and air ingression. Properties of sintered parts, such as surface hardness and strength, are affected if uncontrolled carburization or decarburization occurs. In a carbon-neutral atmosphere based on nitrogen with hydrogen addition, the actual hydrogen-to-moisture ratio in the sintering zone can be used as the control parameter. For example, in nitrogen and hydrogen sintering atmospheres, maintaining an atmosphere dew point (DP) below −30°F ensures a reducing and carbon-neutral hot zone for common steel grades used in gear manufacturing[3].

Thus, monitoring and controlling hot-zone atmosphere DP is necessary for better sintering process control and production cost control[4]. Continuously measuring DP enables real-time monitoring of the furnace condition. For example, a sudden, extremely high (wet) DP reading may indicate a leak in the muffle or cooling zone inside the furnace.

SELECTING THE CORRECT DP SENSOR

Ceramic and polymer-based capacitance DP sensors are popular in the heat treating industry due to their low cost, fast response, and long service life. Alumina (Al_2O_3) is a preferred ceramic sensing material for DP sensors, and current Al_2O_3 DP sensors are fabricated by an anodization process. One limitation of these sensors is that significant degradation in sensitivity and drift in capacitance characteristics occur after long exposure to high humidity. This is attributed to the gradual decrease of effective surface area and porosity caused by water absorption[5].

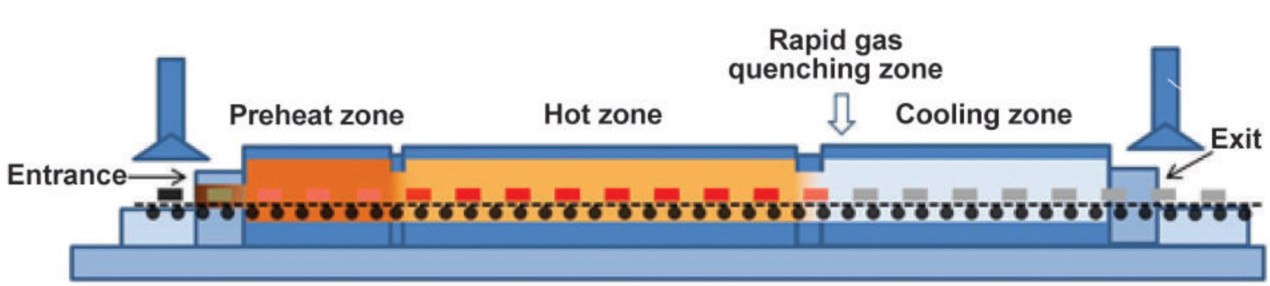

Fig. 1 — Typical design of a continuous sintering furnace.

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