Controlled-Atmosphere Technologies for Sintering High-Quality Components with Proper Delubrication and Lean Sintering Atmospheres

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ABSTRACT

Atmosphere control of the sintering process is becoming a more common practice with use of equipment that controls the supply of gases to the furnace. However, there is often little consideration of the thermochemistry within the sintering atmosphere. Analytical methods that simply rely on raw input from analyzers allow some general control of the gas-atmosphere composition. But dynamic analysis and control is the most efficient way to adjust furnace parameters and fine tune the thermodynamics of the sintering atmosphere. The paper explains some of these technologies as well as the current practice and theory of controlling delubrication. It also gives troubleshooting examples to help manufacturers and heat treaters improve their sintering processes.

FURNACE ATMOSPHERE BASICS

In order to achieve specific mechanical and metallurgical properties and the desired surface quality after sintering of a steel object, numerous process parameters need to be controlled. The most critical parameters are the composition, function and control of the furnace atmosphere. In sintering processes, the function of the atmosphere is to ensure proper bonding between powder particles during sintering with no defects such as oxides or decarburized areas. Therefore, it is important to not only ensure a reliable supply of the required gases and process-gas blends, but also to integrate leading application technologies that enable precision control of furnace atmospheres to achieve desired product specifications of steels.(1)

1. GAS SPECIES IN FURNACE ATMOSPHERES

   The gases used in furnace atmospheres during all heat treatment processes are listed in Table 1 below. Most of these gases are not directly supplied to the furnace during the powder-metal sintering process. Many are products of thermochemical reactions, so they should be investigated in a troubleshooting study. A typical sintering atmosphere is formed by blending nitrogen (N_2) and hydrogen (H) gases with small amounts of a hydrocarbon such as natural gas. Or in other cases when endothermic gas generators are used, mixtures of the incomplete combustion products comprising carbon monoxide (CO), H_2, and N_2, as well as low levels of H_2O, carbon dioxide (CO_2) and trace amounts of other combustion products.

Table 1: Industrial gases used in heat treatment and their functions.

Neutral Gases	Active Gases				
	Reducing	Oxidizing	Decarborizing	Carburizing	Nitriding
Ar	H_2	H_2O	H_2O	CO	NH_3
N_2	CO	CO_2	CO_2	C_xH_y	
He		O_2	O_2		