

Advances in Thermo-Chemical Diffusion Processes

Thermo-chemical diffusion processes like carburizing, nitriding and boronizing play an important part in modern manufacturing technologies. They exist in many varieties depending on the type of diffusing element used and the respective process procedure. The most important industrial heat treatment process is case-hardening, which consists of the thermo-chemical diffusion process carburizing or its variation carbonitriding, followed by a subsequent quench. The latest developments of using different gaseous carburizing agents and increasing the carburizing temperature are one main area of this paper. The other area is the evolvement of nitriding and especially the ferritic nitrocarburizing process by improved process control and newly developed process variations using carbon, nitrogen and oxygen as diffusing elements in various process steps. Also boronizing and special thermochemical processes for stainless steels are discussed.

In the Thermo-chemical Diffusion processes elements like carbon, nitrogen or boron are diffused into metal surfaces in order to enhance the surface properties and the strength of metallic components.

In modern heat treatment furnaces, the diffused elements usually originate from gases reacting at high temperatures with the metallic surfaces. This can be a pure thermal and chemical reaction as a consequence of the thermal dissociation of the gases. An increase of the reaction velocity can be achieved in utilizing an electric field in order to ionize the reaction gas (plasma) resulting in largely increased mass transfer.

The industrial thermo-chemical diffusion processes existing today are known under the names carburizing, nitriding and boronizing. They exist since many decades and have evolved with time to precisely controlled and reliable processes as part of the total manufacturing process of metal, especially steel components.

Carburizing

The dominating carburizing technology today is the gaseous carburizing process using endothermic gas carrier gas and a hydrocarbon gas, like natural gas, propane, lpg or others, as enrichment gas for achieving high carbon potentials. Also methanol diluted with nitrogen can be fed into the furnace, creating at elevated temperatures a carrier gas inside the furnace similar to endothermic gas.

The most economical gassing process is the direct-feed of a fuel (hydrocarbon gas) plus an oxidizing gas (air, carbon-dioxide or water) into the furnace and creating a CO- and H₂ – containing carburizing atmosphere inside the furnace [1]. Certain requirements like sufficiently high furnace temperature, strong gas circulation, furnace muffle, etc. need to exist in the furnace for a successful utilization of this in-situ gassing technique called Supercarb[®] [2].

Therefore, years ago, this process was limited to batch furnaces like pit furnaces and sealed quench furnaces. In the meantime, the Supercarb[®] process is used also in all types of continuous furnaces like mesh-belt furnaces, rotary hearth furnaces and in the last four years also in specially adapted pusher furnaces [3]. The savings in gas consumption using Supercarb[®] can be very high, as the example of a pusher furnace in figure 1 shows.

The article in its entirety is available by logging onto www.ipsen-intl.com, click onto Ipsen On Top magazine, and reference page 3. For more information or to speak with a technical person, contact Patrick Weymer at 815-332-4941, ext. 239.

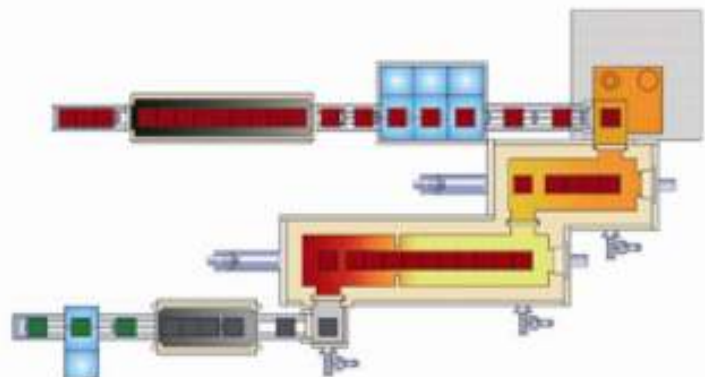


Figure 1: Comparison of gas consumption values for a pusher