HOTSEAT

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IF I'VE TOLD YOU ONCE I'VE TOLD YOU A THOUSAND TIMES: Close the door — and don't slam it! That command, albeit in a different context, has been recited millions of times around the world by frustrated fathers and mothers...and by furnace engineers.

As manufactures of furnaces that operate with combustible gases for heating and hydrogen containing carburizing atmospheres, we are obligated to make sure that when a system is installed and commissioned all interested parties are trained in the proper operation. However, as a customer's production resource requirements change, individuals come and go through the heat treat department, and more often than not the knowledge base is slowly diluted and inexperienced staffing results.

Then we get a call from a conference room populated with the plant manager, maintenance manager, maintenance supervisor, shift supervisor, safety director, heat treat supervisor, and finally the furnace operator. Through the mumbling in the background we would likely hear someone saying, "and that's when the door came off," or "that's when we discovered the soft gears."

Operating instructions for any device, whether it's a household blender, dishwasher, or even a three-row carburizing furnace must comply with industry specific terminology, even though they are expected to be operated by people skilled in the art; but skill levels vary.

We've all learned at an early age not to stick our fingers into a light socket or run with scissors; what many may not have learned are the dangers of premixed natural gas and air and their undesirable potential to rapidly burn or, in some cases, explode. Our grandmothers faced similar problems with the old pilot ignited gas fired ovens and will attest to the trepidation of checking the condition of such pilots.

As furnaces go, when using combustible atmospheres any temperature above 1400°F [760°C] is a good thing, as that temperature is the auto-ignition point of the 10/1 air/gas ratio we use when firing into an alloy radiant tube. The same goes for the endothermic atmosphere. If, for example, a furnace with endo gas operating above 1400°F [760°C] and a pipe connected to the furnace was suddenly opened and air was introduced, you would see what I call a reverse flame: A flame created by the air instantly igniting the endo gas (hydrogen). The length of the flame would be proportional to the velocity of the air.

Problems can occur when combustible or fuel gas is used at temperatures below 1400°F [760°C]. This condition exists in many heat treating processes, gas nitriding being a very common one. It's especially sensitive in integral quench batch furnaces (IQ) where many FNC [ferritic-nitrocarburizing] processes are performed. In these applications the hot zone connected to the quench vestibule is operating at approximately 1075° (579°C) with a 50/50 endo/ammonia mix while the vestibule and quench tank with oil are cold. One of the mechanisms to prevent a premix from forming in either the hot zone or the vestibule a flame screen is incorporated at the bottom of the vestibule door. Upon charging a tray into the vestibule, the flame screen fills the vestibule with flue products and heat. When the door closes, one of two conditions take place: (1) adequate or excess fuel gas assures that 98% + of the oxygen within the vestibule has been consumed, or (2) inadequate fuel allows residual oxygen to remain possibly creating a situation that can cause a premix and ignition causing an impulse combustion (a burp) quickly pushing the door open. If we could see inside the vestibule after the door closes we would observe remnants of the fuel (flame) consuming the oxygen until the flame is gone; or without enough fuel the flame would extinguish quickly, leaving excess oxygen.

Getting back to the doors: Opening the doors of a furnace doesn't present a problem – the closing speed does. In any furnace where endo gas is used, the internal pressure dictates how well the atmosphere will respond to control loop corrections. Pushers or IQ furnaces are designed to operate in a steady-state condition at approximately 0.1 to 0.3 inches of water column [WC] (0.25 mbar to 0.75 mbar) to function properly. When the inner door of an IQ furnace opens, the vestibule atmosphere is heated, rapidly increasing the pressure — the longer the door is open, the higher the pressure. Then when the inner door closes, the vestibule atmosphere rapidly cools and contracts, reducing the pressure in the entire system even the hot zone. Most maintenance problems in IQ furnaces are created when the inner door closes too fast, damaging the door and sucking in air to create an air/gas premix. When the inner door closing speed is reduced, the pressure reduction occurs gradually and to a lesser degree.

The flame screen and door concept can be observed at home: Place a lighted candle in a cereal bowl partially filled with water and place a glass over the candle. Sit back with the kids and watch!

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