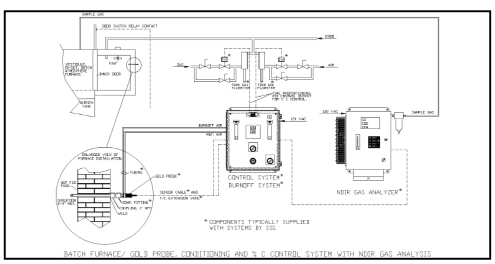
How to maximize process efficiency using atmosphere probe results?

One solution to the puzzle contains four pieces and can be identified by; In-situ monitoring of the furnace atmosphere, content of the prepared atmosphere, real-time effects on the part and assurance that control is acheivable.

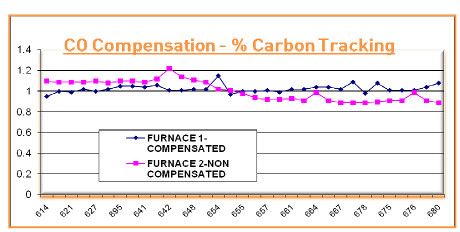
In-situ monitoring is performed by a carbon/oxygen probe. The probe is inserted in a heat treat furnace and measures the “lack” of oxygen in the atmosphere. Using this measurement along with the temperature of the probe, the % carbon is calculated. This calculation uses the partial pressure of oxygen divided by the partial pressure of carbon monoxide (CO) along with temperature to calculate percent carbon available to the surface of the work pieces.

A prepared atmosphere is used to ensure that a non-oxidizing atmosphere is present in the furnace at temperature to prevent / minimize oxides that might be introduced into the furnace. In most cases, the prepared atmosphere is produced using an endothermic generator while some furnace atmospheres are generated using a nitrogen/methanol mixing system. Typically, the oxygen probe used in a furnace application is connected to a control instrument that calculates % carbon using the assumption that the prepared atmosphere has a composition of 40% H_2, 40% N_2 and 20% CO. Control technology today allows for a correction factor (COF or PF) correlated to the % carbon calculation. This correction factor is set to ensure that the probe is calculating the carbon potential accurately. There is much debate regarding COF/PF adjustments in industry today. The most important factor regarding these settings is the precision, repeatability and accuracy of the process to produce quality results.



Atmosphere composition, independent of the probe reading, can be monitored and used to improve the accuracy of the carbon caluculation using the probe only input. This is performed by adjusting the correction factor (COF/PF) configured in the atmosphere control instrumentation. The adjustment process is implemented using a dedicated, continuous gas monitoring system focusing on three gases that are the largest components of the furnace atmosphere. Using non-dispersive infrared cell technology, the relavent components of the atmosphere (CO, CO_2 and CH_4) are monitored to provide an alternate carbon potential reading which is independent of the calculation provided by the probe. This data is utilized to provide real-time feedback to the control instrument. The COF/PF is adjusted based on the 3 gas reading. This control feedback loop utilizes multiple technologies to create the most precise atmoshpere control available today.

Metallurgical results on comparative furnaces have shown tighter % carbon tracking and less case depth deviation when probe and 3-gas analysis are used together versus using only one of these technologies. In the study that was performed, the 3-gas analyzer automatically made adjustments to the correction factor on the carbon controller during the carburizing process.



Years of engineering innovation have led the heat treat industry to several advanced techniques that use the oxygen probe in the most efficient manner. These techniques ensure the proper molecular structure required by the work specification. One method uses the basic principles of redundancy where the use of redunant oxygen probes further guarantees load completeness with a high level of confidence. Redundancy provides process efficiencies through rework elimination and improved performance of in-situ carbon monitoring.

Mathematical models and computer processes will take sensors and control parameters to the next level and provide the next improvement in precision and accuracy. A simulation tool provides you with the ability to define a “blueprint”. The blueprint defines the carbon profile required to produce the desired results in a part. From there, the system will monitor the atmosphere parameters provided by controllers and analyzers and generate a real time carbon profile using diffusion priciples which are based on alloy, temperature and carbon potential. Process efficiencies will be gained based upon process optimization and enhanced precision of the controls. Studies have shown that a boost/diffuse process delivers case depth in a shorter period. Using a boost/diffuse automated program, the system will evaluate the carbon profile during each phase and adjust the process, time, based upon carbon levels achieved against the carbon levels desired. Soak times will be adjusted based upon the actual carbon available to the work piece to ensure proper case depth. This approach acheives the best possible outcome in the optimal amount of time.