

Gas Analysis in Heat Treatment Furnace Atmospheres

Why is Heat Treatment of metals so important?

Heat treatment is the process of heating metal without letting it reach its molten (or melting) stage and then cooling it in a controlled way to select desired mechanical properties; these include increased strength, greater malleability, increased ductility or more resistance to abrasion.

The furnaces used for heat treatment require a highly controlled atmosphere to achieve this and they often involve inert gases (argon, helium, nitrogen) and hydrogen for successful annealing (for example, brazing), carbonitriding (for example, sintering) and tempering (for example, hot isostatic pressing) processes.

An inert atmosphere ensures clean parts and can produce either desired (such as hardening) or prevent unwanted (such as oxidation) chemical reactions on the surface. For example, forming gas - a mixture of nitrogen and hydrogen (typically 5%) - is used as an atmosphere in furnaces during annealing of steel because it reduces the formation of oxides on the metal surface; hydrogen helps reduce the oxygen content due to reaction.

Other techniques used in heat treatment include vacuum processes and endothermic atmospheres.

Gas Analysis in Heat Treatment

As well as adding gases to an inert atmosphere to optimise a particular heat treatment process, traces of others can be formed because of it; the gamut of gases to analyse therefore includes one, or a selection from – oxygen, dewpoint, hydrogen, carbon monoxide, carbon dioxide, propane, methane, butane, and ammonia.

The most important parameter to measure is the lack of oxygen; this is usually achieved with a suitable high sensitivity oxygen sensor connected to a gas analyser. Another important parameter to measure is dewpoint (water); this is because oxygen is depleted due to reaction with hydrogen in forming gas at the hot zirconia sensor to form water, thereby giving falsely low readings for oxygen - suitable calculations then enable true values to be displayed. The other gases can all be measured as well - sometimes with a mobile gas analyser moved to a suitable connection point on the furnace.

Why should Heat Treatment customer sites and furnace manufacturers work with Cambridge Sensotec?

Cambridge Sensotec has a long and established history of manufacturing high precision gas analysers. The company's technical team has collaborated with several heat treatment users to fine-tune the form and function of their analysers to suit their requirements and we continue to develop our products for the industry.

The Rapidox 2100 is a high-performance oxygen analyser fitted with a rugged long-life zirconia sensor on a remote cable and, together with the type K thermocouple sensor supplied with it, allows direct in-process measurement of oxygen and temperature in the sample gas. The oxygen sensor provides fast and accurate analysis over a 10E-20ppm to 30% oxygen range in harsh environments up to 650°C (or higher with slightly reduced accuracy) and is supplied at the end of a cable that can be customised to any length up to 25m.

The Rapidox 2100-FGA Forming Gas Analyser has been optimised for forming gas applications. The oxygen sensor measurement range is extended down to 10E-30ppm oxygen to cover the ultra-low oxygen partial pressures in forming gas mixtures and is designed for high-temperature operation which can be extended up to 1000°C when using one of the available insertion sample tubes. In addition to this, the analyser

performs complex thermodynamic equations to calculate the dewpoint of the forming gas; these calculations have been verified by a resident thermodynamics expert at Cambridge University - the operator simply dials in the hydrogen content of the forming gas and the analyser does the rest so that dewpoint is then displayed simultaneously on-screen in either °Cdp or ppmV.

The Rapidox 2100-OEM-RSB range are special miniaturised 24V OEM versions of the bench-top Rapidox 2100 oxygen analyser; the compact design allows integration into the tightest of spaces. The analyser is supplied in four packages to meet the demands of any customer: a basic circuit board, a custom DIN rail version and a full metal DIN rail enclosure, either with or without local display and keypad. A multi-channel version, boxed with a stack of three separate PCBs and three remote sensors, is also available if several points are to be monitored at the same time.

The Rapidox 1100 is a versatile and cost-effective analyser that measures oxygen in ppm and has gas sample connections at either the front or rear; it can also be panel mounted.

The Rapidox 5100 is a mobile analyser with full laboratory functionality; the modular design allows for bespoke sensor combination upon request, and measurable relevant gases include - amongst others - carbon dioxide, carbon monoxide, hydrogen, oxygen, hydrocarbons, and methane.



Rapidox 2100 Forming Gas analyser



Rapidox 2100 OEM, Aluminium encased version and DIN rail mountable – with display and keypad



Rapidox 1100



Rapidox 5100

As a privately-owned company, staffed by highly skilled technologists, Cambridge Sensotec is perfectly placed to react to its customers specialised gas analysis requirements. Dynamic and flexible, the company can design and supply solutions to suit a variety of gas analysis applications.

If you would like to learn more about how Cambridge Sensotec can help improve your Heat Treatment process, please contact us at info@cambridge-sensotec.co.uk or call us on (+44) 1480 466142.