Metallurgy

Heat Treatment
Protective Atmospheres
Protective and control atmospheres are the most important factors in metals and material processing operation.

As supplier of gases for protective atmospheres - nitrogen, argon, helium, hydrogen, ammonia - as well as other types of protective atmosphere systems, SIAD can provide practical solutions for:

- ferrous and non ferrous annealing;
- carburizing, neutral hardening and carbonitriding;
- sintering;
- brazing;
- sub-zero treatment of steels;
- back-filling vacuum furnaces;
- autoclave operations;
- metals powder production;
- precious metals annealing.

SIAD has worked in the metals and material processing industry, and has installed nitrogen- and hydrogen-based systems. These systems contribute to improve the quality of the products and to reduce the production costs.

Our specialized team can evaluate, design, install and start-up systems that meet customer’s requirements. Each project is customized to improve quality, flexibility and cost savings. We design process as reliable alternative to conventional exo-, endo-, and dissociated ammonia generators.

SIAD research and development centre, sited in Bergamo, has followed the metallurgical industry with attention at metals heat treatments applications.

SIAD supplies technology, experience, innovation, reliability and technical support.

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Synthetic protective atmospheres produced by mixing nitrogen with hydrogen, methanol, methane and propane are a valid alternative to the exo-endo generators. The main benefits using synthetic atmospheres are listed below.

- **Reliability and Simplicity:**
  - no need for generator monitoring or maintenance;
  - gases are available at a turn of a valve, all the time.

- **Quality:**
  - constant purity of the gases constituents the protective atmosphere;
  - selection of optimum blend composition for each application.

- **Flexibility:**
  - the gaseous mixture composition can range from pure Nitrogen to 100% Hydrogen;
  - different blends can be set for each furnace application where different metals are treated in the workshop;
  - furnace capacity can be added without the requirement of new exo-endo generators;
  - quick shut down and start up of the gas mixer.

- **Increased productivity:**
  - synthetic atmospheres eliminate lost productivity caused by generator downtime;
  - no start up delays.

- **Improved control:**
  - control panels are suited or easily adaptable for PLC and data gathering technology;
  - preset compositions and flow can set to avoid mistakes.

- **Safety:**
  - emergency Nitrogen purge capabilities enhance safety and protect parts during power outages and furnace shutdowns.

- **Low capital investment.**

These gas mixtures allow to have a gaseous protective atmosphere inside the furnaces, having dew point between -70 and -8°C. Checking dew point level or CO₂ concentration inside the heat treatment furnace allows to calculate how much reducing gas has to be used to obtain the desired results. Reducing gases have the benefit to improve the removal of the lubricants used in cold forming operations before metal heat treatment.
The SIAD alternative to exo-gas generator and nitrogen/methanol endoatmosphere is DICPC - Direct Injection carbon potential control.

This system produces a consistent furnace atmosphere. Air and natural gas are mixed together before to be introduced into a catalytic reactor placed near to the furnace. As this blend flows through the catalyst bed, hydrogen, carbon monoxide and nitrogen are produced. After dilution with nitrogen, the synthetic produced atmosphere is injected into the furnace. Additional nitrogen allows to maintain a positive furnace pressure. The nitrogen flow and injection location are optimized to prevent air infiltration and following product oxidation.

Applications like decarb-free annealing of steel pipes, rod and wire, and bright annealing of ferrous metal products can be treated using our DICPC atmosphere. SIAD system provides a highly reliable atmosphere resulting in uniform product quality and minimal rework. Flexibility and safety are the main benefits of this system. Atmosphere flow rates and composition are easily changed and nitrogen is always available to purge the furnace in case of power failure or other shutdown occur.

The main parts of the unit are:
- endogas generator;
- electrical control panel with a PLC to control, regulate and supervise the unit;
- analysis control panel for measuring CO, CO$_2$, and CH$_4$ content in the generated gas mixture and in the heat treatment furnace atmosphere;
- gas flow control and regulation unit of generated endogas, natural gas and nitrogen.

To have a flexible, continuous, simple and safe production of the desired atmosphere, a control supervision unit will check the equipment during operation phase. The main operations performed by this unit are:
- automatic measurement and regulation of the blend resulting from nitrogen dilution of the generated endogas before injecting the blend into the furnace;
- set up of the receipt, performed by the furnace operator, suitable for each thermal treatment process;
- actual cycle modification in order to obtain the protective atmosphere needed for the thermal treatment process;
- supervision of all the process parameters (pressure, flow rate, temperature) related to generated blend, safety measures and alarms control;
- possibility of natural gas injection inside the furnace to adjust CO$_2$ grade measured inside the furnace.

The receipt used for a heat treatment depends on the desired carbon monoxide content.

This value is reached regulating the nitrogen for dilution of the generated endogas. Nitrogen gas is not used only for dilution but also for furnace purging both during the first phase of the process before blend injection into the furnace and in case of non safe conditions (safety parameters out of range) or because of unexpected voltage failure.
Applications

Annealing
SIAD applied synthetic protective atmospheres in all type of furnaces - from continuous to batch furnaces. From bright annealing and normalizing, stress relieving and more, we can supply a system able to meet customer specifications. With our system it is possible to regulate each component precisely. Surfaces stay consistently clean, with no soot, decarburization or oxidation.

Carburizing, neutral hardening and carbonitriding
SIAD synthetic atmospheres provide the needed carbon and nitrogen to have the desired surface carbon content and surface nitrogen content in carburized (or Carbonitriding) parts.

Sintering
Nitrogen and hydrogen based atmospheres results in low operation costs and a reliable sintering process. Synthetic atmospheres drive off lubricants protecting sintered pieces from oxidation. Soot formation is eliminated and finished parts are brighter and cleaner.

Brazing
Protective atmospheres generated with SIAD systems help joints to be better and more uniformly weld, improve reproducibility and require less filler metal. Parts and joints look better and brighter.

Back-Filling Vacuum Furnaces
Nitrogen and argon are used for back-filling vacuum furnaces. Argon is used only with nitrogen-sensitive materials like titanium.

Carbon steel sub-zero treatment
Liquid nitrogen allows to complete the austenite phase transformation in stronger and harder martensite. Not only improved hardness but also dimensional stability is reached with the cryotreatment. Liquid nitrogen is also used in shrink fitting to assemble parts when the tolerances between pieces are very close.

Autoclave operation
Most autoclaves use either gaseous nitrogen or compressed air or a mix of nitrogen and air for a pressurization media. Though the use of compressed air is generally less expensive than nitrogen, it also promotes combustion and can support an internal fire in the autoclave, especially when operating at higher temperatures and/or with solvent-based materials.

Valve Fugitive Emission Tests
Gases blends of nitrogen and helium are used in Fugitive Emission Test. These test can also be performed at cryogenic temperatures in special dedicated equipment.

Safety precautions

Any gaseous atmosphere that is vented from furnaces must be dispersed by adequate exhaust system and be neutralized by combustion. Operators should be instructed in:

- the difference between inert (non flammable) and flammable gases;
- the fact that flammable gases can be introduced safely into any chamber in which the temperature is above the ignition point (750 °C or higher);
- the fact that introduction of a flammable gas into a chamber in which the air temperature is below the ignition point (750 °C) can be hazardous;
- the approved methods and rules for purging various types of chambers;
- the variety of possible effects in purging resulting from the difference in density of various gases.

Furnace atmospheres containing a total of 5% or more of combustibles gases (H₂, CO and CH₄) constitute a potential fire and explosion hazard.

Under no circumstances should these atmospheres be admitted to, or allow to remain in furnaces at temperatures below 750 °C. For complete safety during a furnace cooling cycle, these atmosphere should be completely purged for the furnace with noncombustible oxygen-free gases, nitrogen normally, before the furnace temperature falls below 750 °C. Production and use of flammable and explosive exogas, endogas and dissociated ammonia atmospheres request particular attentions.

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