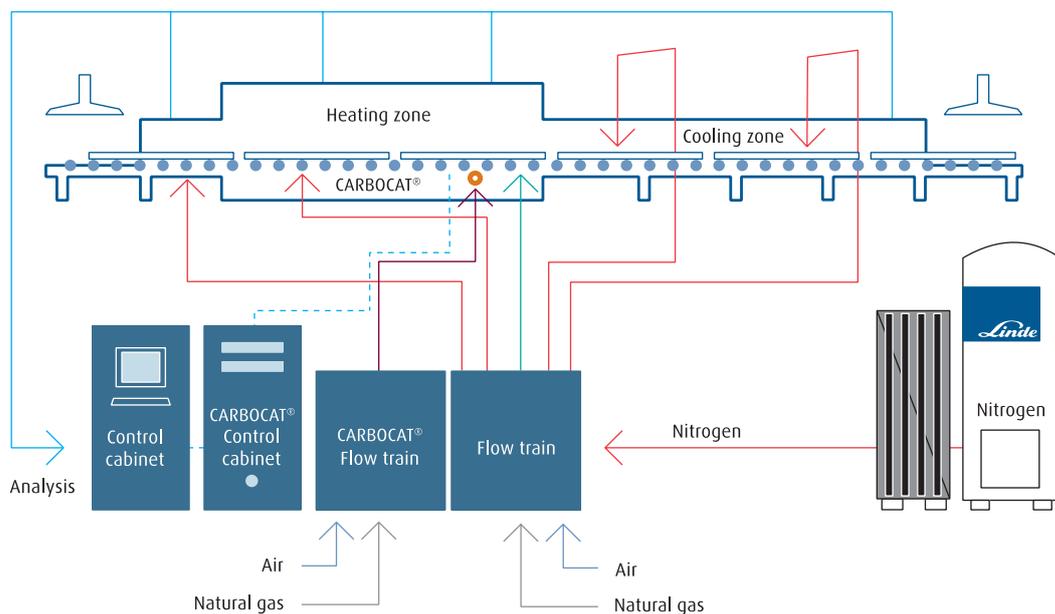


## CARBOFLEX® Nitrogen-Endogas. Nitrogen based atmosphere system with endogas generator.



System overview of CARBOCAT® solution

**General** Nitrogen based atmosphere systems and atmosphere generators used to be regarded as separate alternatives, each with its pros and cons. The current trend is to combine the two systems – taking the best out of each system and bringing them together for optimal results.

The CARBOFLEX® Nitrogen-Endogas solution offers a nitrogen based atmosphere system in combination with either an external or in-situ endogas generator (CARBOCAT®). With such a combination, it is possible to create varying atmosphere compositions with respect to the position inside the furnace and to the alloy being treated.

**Benefits** Linde Gas has installed several CARBOFLEX® Nitrogen-Endogas systems in Western and Eastern Europe. All have satisfied our customers with the following benefits:

- Carbon-neutral atmosphere avoiding decarburisation
- Fulfilment of high surface quality requirements in terms of brightness and freedom from carbon deposits
- High levels of safety by use of a minimum of flammable gases at the cold furnace inlet and exit and by a nitrogen based safety purge function
- Reduced costs due to minimised total gas consumption, reduced reject reworking and lower dependence on operator skills

If the solution with the CARBOCAT® in-situ generator is used, less energy consumption and reduced floor space requirements are further advantages.

### Atmosphere generation

The atmosphere is generated from two sources:

- Nitrogen supply from a liquid nitrogen tank or an on-site nitrogen generator
- Endogas supply from the CARBOCAT® in-situ endogas generator or an external endogas generator

Nitrogen and endogas are mixed inside the furnace to form the furnace atmosphere. With two separate gas sources and several separately controlled gas inlets to the furnace, it is possible to adjust the atmosphere composition to meet varying requirements in the different areas of the furnace. In particular, the concentration of the flammable and reactive constituents CO (carbon monoxide) and H<sub>2</sub> (hydrogen) can be maintained:

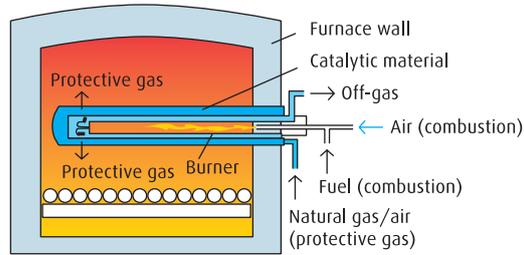
- high in the hot furnace zone, where the reaction rate is high for both decarburisation and carburisation;
- low at the cold furnace inlet and exit to ensure safety.

Air and natural gas (or propane) are used as complementary gases for optimal control of the carbon potential and for lubricant removal.

### CARBOCAT®

The patented CARBOCAT® equipment is an in-situ generator, in which endogas is produced directly inside the furnace chamber. The principle is that air and natural gas (or propane) are mixed and fed into a heated catalyst, where they react to CO and H<sub>2</sub>.

Major benefits of CARBOCAT® include elimination of a cooling device for the gas, energy savings, floor space reduction and the elimination of piping between generator and furnace. Multiple CARBOCAT® generators can be installed in the same furnace.



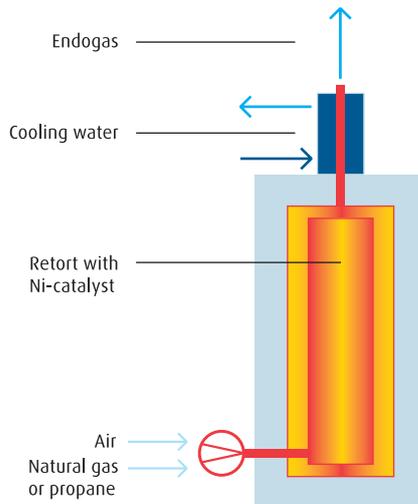
Design of CARBOCAT®



Installation of CARBOCAT® (roller hearth furnace)

### External endogas generators

Different gas compositions in different zones of the furnace can also be achieved with external endogas generators. They bring the advantage that usually no furnace adaptation is required. The output flow rate, however, can be varied only within certain limits.



Design of an external endogas generator



Installation of an external endogas generator (photo courtesy of Ipsen)

### Atmosphere control system

Both versions of the CARBOFLEX® Nitrogen-Endogas system can be easily combined with CARBOFLEX® ACS (Atmosphere Control System) for even more precise control of the heat treatment atmosphere and additional features, such as recipe handling, historical process data storage, alarms, etc.

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