

Making our world more productive



# CRYOFLEX<sup>®</sup>

Cryogenic freezer for sub-zero treatment of metal parts and components.

Linde has developed a broad range of specially engineered CRYOFLEX<sup>®</sup> cryogenic cooling solutions to support sub-zero treatments of metal parts and components. Designed to achieve the structural stability requirements mandated by demanding aviation, aerospace and automotive standards, CRYOFLEX brings a new level of control and precision to steel fabrication.

## Benefits of CRYOFLEX<sup>®</sup> at a glance

- Enhanced process control for improved hardness, wear resistance and dimensional stability
- Sophisticated tracking and reporting features for compliance with standards such as AMS 2750 F, NADCAP and CQI-9
- Deployment flexibility with box, cabinet, tunnel and metal strip contact cooling models
- Ease of operation
- Smooth integration into fully automated heat treatment systems
- Cost-efficient operation
- Highest standards of quality and safety
- Customized models and sizes available on request



## Challenge in sub-zero treatments of metal parts

Manufacturers in the automotive, aerospace and machine tooling industries must meet the highest possible standards when it comes to the strength, wear resistance and lifetime of the components they produce. To achieve this, metals are generally subjected to various heat treatment steps such as hardening and case hardening. Depending on the carbon content of the steel and the alloying factor, the transformation from austenite to martensite may not be fully achieved after quenching the parts to ambient temperature. Incomplete transformation during quenching leads to a crystal structure containing retained austenite. Consequently, the steel will not achieve its full strength and hardness. In addition, since the retained austenite is unstable and able to transform over time, dimensional changes might occur in the future.

Components that require a high degree of dimensional precision must thus be engineered to avoid this transformation process over time. Sub-zero treatments are an effective way of achieving the required level of structural stability. However, manufacturers must be able to prove that any heat or sub-zero treatments they apply comply with the process and documentation requirements mandated by international standards. In addition, sub-zero steps should ideally support ease of integration with existing heat treatment processes.



The CRYOFLEX® C1400 freezer

## Controlled processes for enhanced product performance

Linde offers a range of specially engineered CRYOFLEX® cryogenic cooling solutions to support sub-zero treatments. Sub-zero treatment helps to transform retained austenite to martensite. It thus improves the properties of steel parts with respect to hardness, wear resistance and dimensional stability. It also precipitates fine carbides in the steel microstructure to particularly improve the wear resistance and lifetime of the parts. Linde's freezers come with sophisticated features such as fully automatic temperature tracking and reporting capabilities, making them the ideal fit for the compliance demands of aviation, aerospace and automotive standards such as AMS 2750 F, NADCAP and CQI-9.

As an isolated cryogenic step, these freezers can be easily integrated into manufacturers' existing heat treatment processes. Typically working at temperatures ranging from  $-60\text{ }^{\circ}\text{C}$  to  $-180\text{ }^{\circ}\text{C}$ , these treatments take between 4 and 72 hours, depending on the goal of the process. The transformation of retained austenite to martensite can be achieved at a range between  $-60\text{ }^{\circ}\text{C}$  and  $-120\text{ }^{\circ}\text{C}$ , with a dwell time of 1 to 4 hours, depending on the cross section of the materials. Applying colder temperatures between  $-120\text{ }^{\circ}\text{C}$  and  $-180\text{ }^{\circ}\text{C}$  with longer dwell times will support the precipitation of fine carbides, which improves the wear resistance of metallic parts in particular.



The CRYOFLEX Box freezer

Talk to our CRYOFLEX® experts today to see how we can enhance the accuracy and compliance of your sub-zero treatments. Email us at [heat-treatment@linde.com](mailto:heat-treatment@linde.com) or visit [www.linde-gas.com/heat-treatment](http://www.linde-gas.com/heat-treatment).

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