

Pusher Type Gas Carburizing Furnaces



For high capacity heat treatment

AICHELIN Pusher Type Furnaces for Gas Carburizing

1. Introduction

Pusher type furnaces for gas carburizing are very economical due to their continuous operation and their high performance.

Further important advantages of these plants are the extraordinarily high reproductibility of the thermal treatment results, the small personnel employment as well as easily possible automation.

In the last two decades more than hundred gas carburizing pusher type plants were manufactured and put into operation by AICHELIN.

These figures impressively prove the continuous high quality, reliability and economy of these plants.

By constant advancement, AICHELIN can continuously develop their position as market leader with this type of plant.

The technicians of AICHELIN developed a product series, which covers a huge field of application.

Of course AICHELIN, however, wants to meet customer specific developments at any time. Based on established components, AICHELIN deals with these customers' requests and so develops solutions, adapted to production requirements.

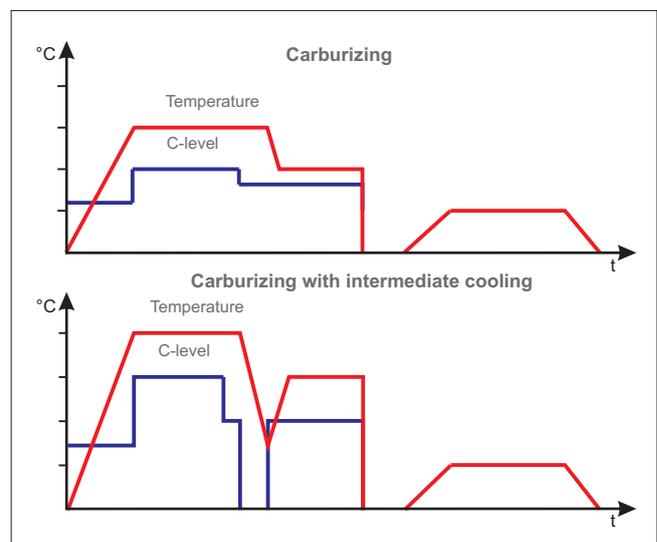
At AICHELIN site, all components are assembled and submitted to a functional test. Before dispatch of the plants, the customer can convince himself with pre-acceptance at AICHELIN site of the scope of supply and the execution of the components.

2. Application of pusher type furnace plants for gas carburizing

Gas carburizing pusher type plants find use everywhere, where work pieces have to be submitted to a thermal treatment in large production outputs, as this is the case for example in the automobile industry, the gear construction or the land- and construction machine industry. It can be assumed that with the question, starting from when a gas carburizing pusher type plant has to be used, already starting from a performance of about 200 kg/hour and a case hardening depth from 0,6 to 0.8 mm, the application becomes economical and thus recommendable.

For particularly high performances, multi-lined executions are available, with which capacities up to more than 2.000 kg/hour are reached.

Gas carburizing pusher type plants are suitable for gas carburizing or carbonitriding with following direct hardening in oil, high pressure gas quenching or in combination with a press hardening.



For distortion-sensitive press hardening pieces there is also the possibility of cooling them down slowly after gas carburizing in a gas cooling sluice.

3. Innovations and advantages of the AICHELIN pusher type plants

- By constant advancement of their pusher type plants, AICHELIN is able to supply their customers plants with highest customer use.
- Efficient utilization of energy
 - High efficiency by recuperative NOXMAT burners
 - Low protective gas consumption
 - Robust and easy to maintain electro-motorical drives
 - Low thermal radiation by well considered wall construction
- Special transferring and removing technology
 - reduced protective gas consumption
 - decreased border oxidation
- Cooling of the circulators and pushers over self cooling equipments with thermal oil
- No cooling water required at the plant
- Submerging oil bath with safe charge guiding
- High pressure - gas quenching as alternative to oil quenching
- Additional limit switch devices with gastight drives (transversal pusher, oil bath descending platform) for end position monitoring
- Integration of an empty tray manipulator for automatic emptying and refilling of empty trays with weekend operation

- **Highest customer use by efficient utilization of energy and low operating cost over the entire life cycle of the plant.**

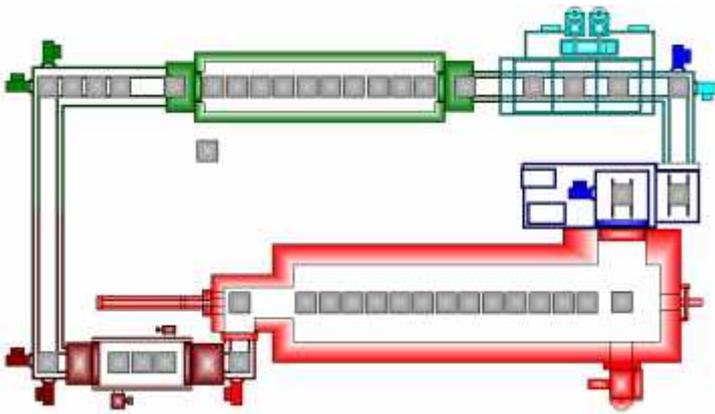
4. Types of execution

According to standard, complete gas carburizing pusher type plants consist of following single aggregates:

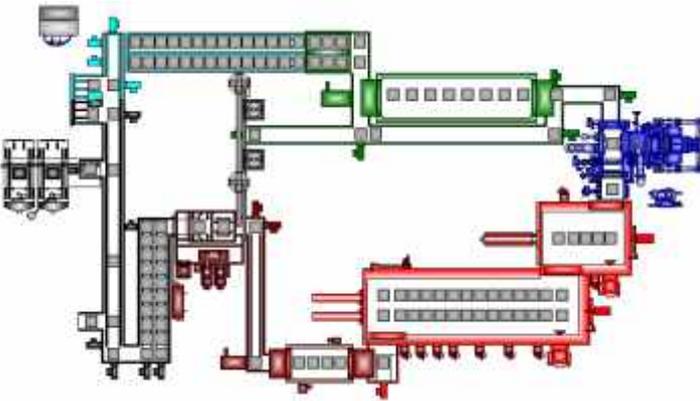
- Pre-washing machine (if necessary)
- Pre-heating furnace
- Charging or inlet sluice
- Gas carburizing furnace, divided in heating up zone, carburizing and diffusion zone (and, if necessary intermediate cooling zone)
- Quenching device for oil or gas (N₂, He)
- Cooling chamber for slow cooling under inert gas
- Washing machine, that is normally divided in degreasing, rinsing and drying zone
- Tempering furnace, divided in heating up and holding zone
- Protective gas generator resp. protective gas supply
- Measuring-, switch and regulating device with C-level regulation
- Subordinated aggregates such as charging and discharging lines, empty tray manipulator etc.

For differently high performances, gas carburizing pusher type plants are offered by AICHELIN in one, two and in three-lined execution.

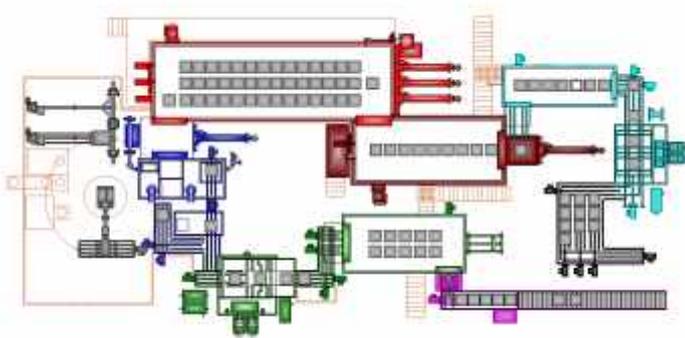
Multi-lined pusher type plants make higher performances possible and have,, besides, the advantage that on the different courses, due to different cycle times, different case hardening depths can be run.



4.1 Single-lined pusher type furnace plant for carbonitriding



4.2 Two-lined pusher type plant with separate diffusion chamber and high pressure gas quenching

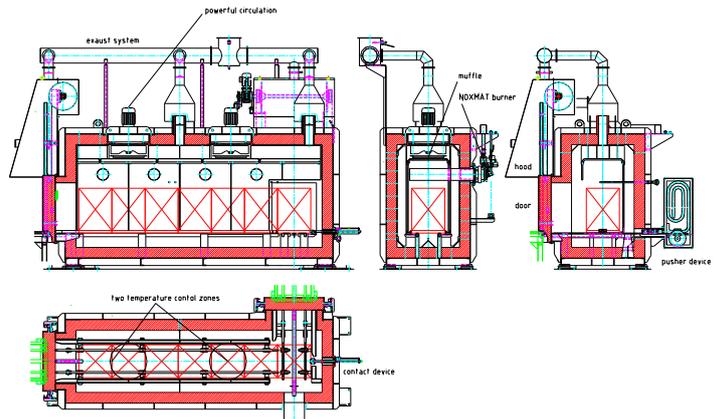


4.3 Three-lined pusher type plant with possibility for the parts withdrawal for press hardening

5. Characteristics of AICHELIN pusher type furnace plants

5.1 Preheating furnace

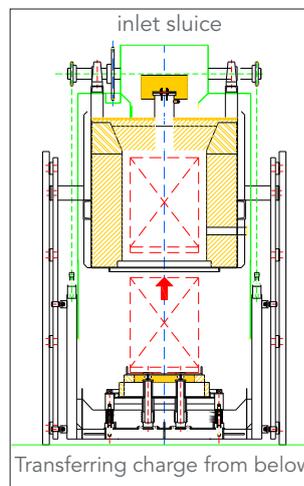
Often, preheating furnaces are used for the heating up of the charges, in order to reduce on one hand the length of the gas carburizing furnace (heating zone) or to



minimize the components distortion and/or to activate the component surface for optimal carburizing results. The working temperature amounts to 400 - 480 °C (in special cases up to 600°C). Heating mostly is done by open heated gas burners, which ensure a uniform heating up of the charge, together with strengthened circulation aggregates and air guiding muffles.

5.2 Gas carburizing furnace

5.2.1 Transferring & removing technology



In order to protect the furnace chamber against unwanted penetration of atmospheric oxygen during the charging processes, the charge is transferred at the furnace inlet from below.

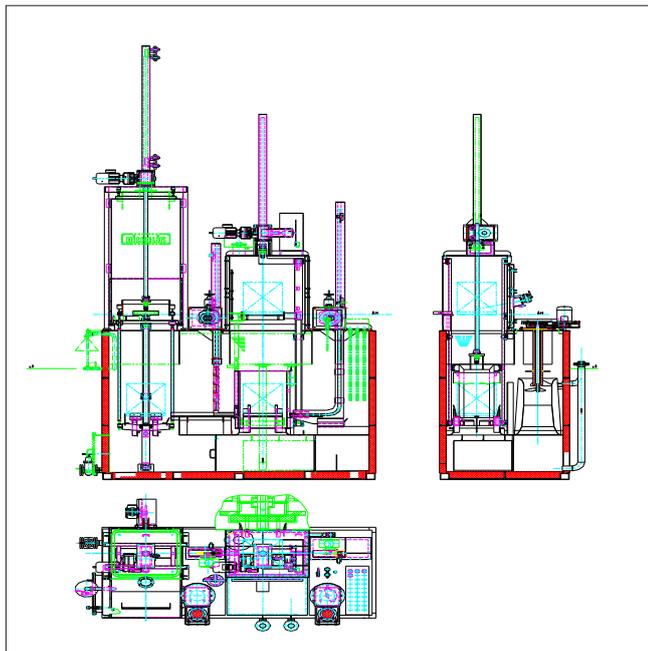
With the furnace exit, the entrance of the atmospheric oxygen is prevented by a diving of the charge in the oil bath.

Advantages of this transferring and removing technology are:

- Less consumption of protective gas (up to -60%)
- Reduced border oxidation because of reduced air oxygen entry
- No flame curtain necessary, only an ignition burner at furnace inlet

Advantages of hardening oil bath:

- Uniform flow rates by deep oil bath flow pit system
- Variable control of rotation numbers of bath circulation aggregates for an adaption of the quenching- resp. hardening results and the distortion behaviour
- Oscillating of the oil bath lowering



platform

The oil bath consists of 2 lowering platforms, the lateral drive of the first to the second platform, the separating sliders between the platform, a tight cover construction with the second platform as well as of one or two circulation aggregates.

After lowering the charge into the oil bath and after a retention time, which can be specified

variably, the charge is carried on by means of chain drive in the oil bath on the second lowering platform. The two lowering platforms and/or flow pits are divided by an electric-motor driven separation sword, in order to make possible an optimal flow situation for each quenching position.

One or two circulation aggregates press the hardening oil through a pressure cabinet with flow optimized form through the lowered charge (stepless speed adjustment of the circulation aggregate).

After the ascending of the second platform and after dripping off the charge, the oil reservoir is closed with a cover, which is on the lowering platform construction. Thus a contact of the hardening oil with air is prevented, in order to work against premature aging of the oil. Further, the liberate area between oil bath surface and dense cover is rinsed with nitrogen (approx. 1 m³/h).

In order to keep the hardening oil on the requested temperature, it is cooled with an externally set up oil/air cooling and/or heated when starting the plant by electrical heating elements in the oil bath.

Cleaning of the hardening oil is made by a double filter system.

The oil bath temperature control is made by inserted thermocouples and automatic controllers, which process the appropriate signal in the switchgear cabinet and thus regulate the oil-cooled system/heating automatically.

By tilting of the charge around a programmable angle, less oil is put in the following washing machine with scooping charging parts.

5.2.2 Gas conversion

At the furnace cover, there are several circulation aggregates, which provide a uniform distribution and mixing of the protective gas.

The circulation aggregates are equipped with a self cooling equipment, which provide the necessary cooling by free convection. The self cooling system by means of thermal oil coolers is inserted also with the pushers, so that no cooling water at the entire furnace plant is necessary.



5.2.3 Heating

Pusher type plants can be implemented electrically or gas-heated. With gas heating, the energy-efficient and low-maintenance NOXMAT burners (see separate brochures) with small NOx value and high efficiency are used.

The heat is transferred over jackets tubes made from heat resistant cast steel or from ceramic (SiSiC).

5.2.4 Pusher

The main pusher consists of a spindle drive, gas-tight execution with self cooling system for sealing, pusher head and simply adjustable limit switch execution with sight hole.



5.2.5 Transversal pusher



The transversal pusher is designed according to the lantern pinion principle, whereby a safe operability is ensured also with thermal expansions of the pusher chain.

The execution permits a clear and user-friendly attitude of the transversal pusher lifting. With power failure, the position of the transversal pusher can be controlled and turned, if necessary, into the basic position.

This construction is also used for the movement redirection of the oil bath lowering platform and the furnace inward pusher.



Therefore no transmission cam-type limit switches are necessary at the entire plant.

5.2.6 Contact device

Contact rods, which are applied for



redirection of the trays with pusher and transversal pusher, are implemented in turnable way and can be adjusted in the setting operation with opened assembly door. This permits a precise and fast identification of the final position of the trays during assembling and putting into operation phase.



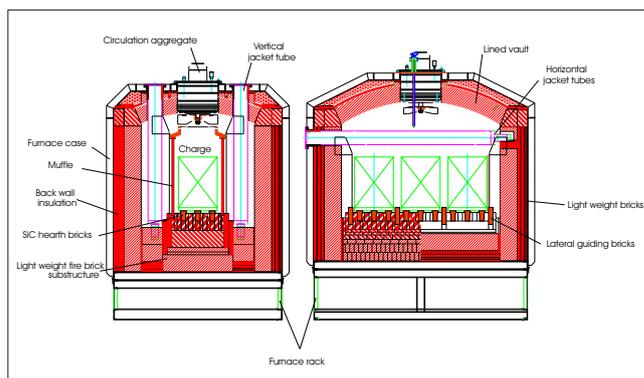
5.2.7 Gasification

Over a gasification rack, which can be positioned depending on available space in furnace proximity, the pusher type plant is gasified. There, the execution goes beyond the safety requirements of the standard EN

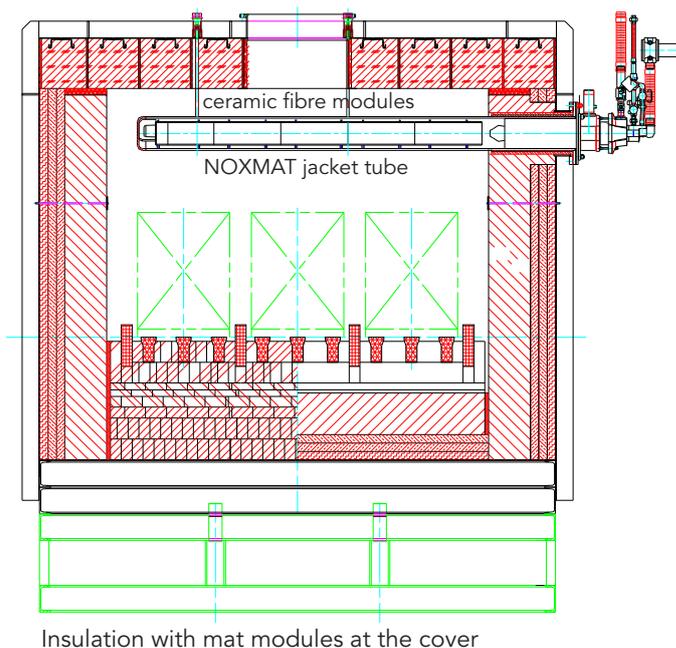
746 valid for the building of furnaces.

As carrier gas, mostly endogas of the AICHELIN protective gas generator or nitrogen-methanol is usually used, as carburizing gas methane or propane is used as well as additional gas, mostly ammonia.

5.2.8 Thermal isolation of the furnace



The thermal insulation consists of light-weight refractory bricks with the hearth substructure and at the side panels. The furnace cover is implemented with ceramic fibre isolation, alternatively a vault lining is also possible. In the range of charge transport SiC rails, resistant to friction, are used.



5.3 Cleaning device

In the cases, where the thermal treatment good is not delivered free from oils, dirt etc., a washing machine has to be pre-connected to the thermal treatment process. After hardening oil quenching a degreasing washing machine is necessary, in order to avoid oil steam formation in the tempering furnace and arrears on the thermal treatment good. The therefore necessary cleaning equipment can be supplied as multi-zone running machines with dipping and spraying zone as well as rinsing and drying zone.



A rotary spraying nozzle system provides better cleaning quality.

Mixing of washing liquids is excluded by separate charge driving system.

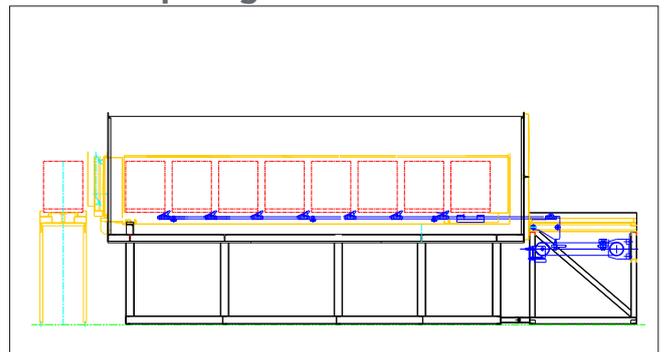
The drying process of the charge takes place by means of vent condensor and electrical heating.

The washing plants are implemented with a special oil separating system, which permits a longer service life of the washing agents.



The separator works according to the physical principles of the gravitation (the force of gravity) and the coalescence (flowing together of droplets). Particles with small density ascend, heavy particles sink downward. Small droplets store themselves together to larger droplets by the coalescence principle and can be separated afterwards.

5.4 Tempering furnace



The thermal treatment of carburized and hardened work pieces is finished with tempering.

An accurate electrical heating in several temperature zones, several circulation aggregates and guiding muffles provide good temperature uniformity.

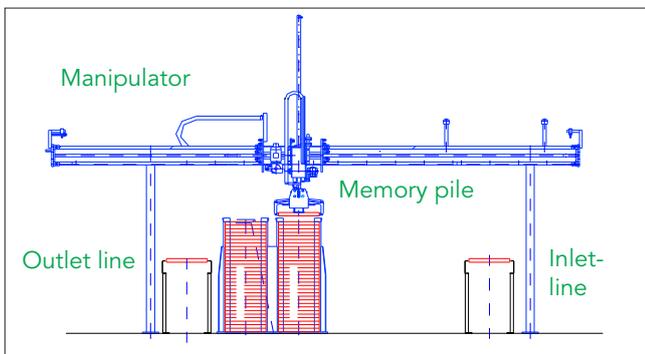
By a clinch conveying system dry-running of the tempering furnace is given.

Depending upon performance, the tempering furnace is manufactured in one- or two-lined execution.

A topped cooling tunnel cools the parts down so far that they are manipulatable at discharging.

5.5 Manipulator for empty trays

This component serves for filling up the plant at the weekend with empty trays and/or emptying of empty trays beginning of the week. Further, empty trays can be slid into the plant with intermediate capacity fluctuations or on changes of the thermal treatment program. For storing of the trays, one or several empty tray magazines are intended depending upon storage volumes. Storing piles can be turned manually by 90 degrees, in order to be able to adjust changes of measure of the tray, caused by grain growth as well as by mechanical and thermal stress.



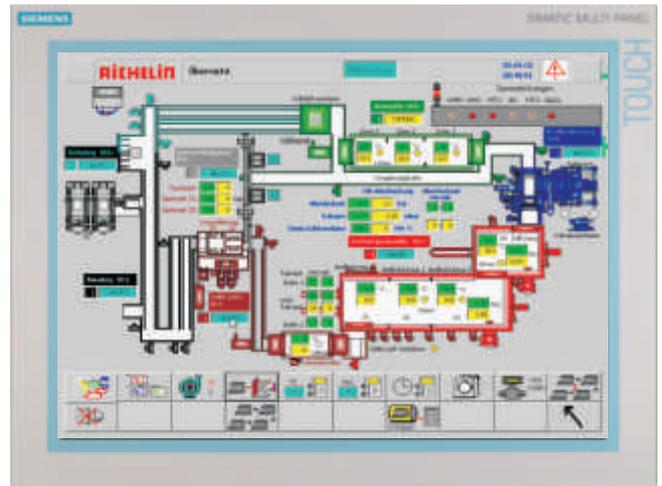
The system is controlled completely automatically via the PLC of the plant.

5.6 Control and process monitoring

All devices, necessary for the automatic operational sequence and for the automatic temperature control are clearly summarized in functional modules in the measuring, switch- and regulation device. Temperature control for the high and low-temperature furnace takes place in several heating zones. As bake UP protection PID hardware temperature regulators are intended. The gasification temperature (safety temperature) is merged in accordance with the safety regulations into the plant protection concept.

The control of the plant is made by a programmable controller (type SIMATIC) with digital input components, digital output components inclusive software for the automatic control and regulation of the furnace plant.

Via the operator panel the plant can be controlled and supervised. Optionally, newest



technologies can be merged, such as bar code readers, connection with tele-service as well as dispatch of failure messages via SMS.

For the measurement and regulation of the carbon atmosphere in the carburizing furnace an AICHELIN Carbomat with one or several measuring points is intended. The measuring and regulation functions are integrated in the SPS the measuring -, switching and controlling device.

For the process documentation and providing of thermal treatment proofs in the context of the quality assurance the FOCOS II system is at disposition. This process control system consists of a PC with colour screen as well as a colour laser printer for the failure protocol and for purposeful printouts of operators. The hardware can be set up in a separate office.

The following functions are realized with FOCOS process control system:

- Input and memory of part and recipe data
- Indication and memory of trend curves for standard and actual values
- Indication and memory of failure messages
- Indication and memory of thermal treatment data

- Printout of thermal treatment proofs, consisting of charge number, part data, recipe data as well as production times beginning and end of each plant zone.

The hierarchical layout of the control brings the advantage that the complete thermal treatment can be continued also in case of a partial or complete loss of the control system.



References



Pusher Type Gas Carburizing Furnaces



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AICHELIN Ges.m.b.H.

P.O.Box 210
A-2340 Mödling
Phone (+43) (2236) 236 46 - 0
Telefax (+43) (2236) 22 22 9
info@aichelin.at

NOXMAT GmbH

Ringstrasse 7
D-09569 Oederan
Phone (+49) (37292) 65 03-0
Telefax (+49) (37292) 65 03-29
info@noxmat.de

SAFED Suisse SA

36, rue Emile-Boéchat
CH - 2800 Delémont
Phone (+41) (32) 421 44 60
Telefax (+41) (32) 421 44 64
contact@safed.ch

EMA Indutec GmbH

Petersbergstrasse 9
D-74909 Meckesheim
Phone (+49) (6226) 788 - 0
Telefax (+49) (6226) 788 - 100
info@ema-indutec.de

**AICHELIN Heat Treatment
Systems Inc.**

Plymouth, MI 48 170 USA
Phone (+1) (734) 459 9850
Telefax (+1) (734) 459 9851
sales@aichelinusa.com

SAFED Industrieöfen GmbH

Robert-Bosch-Strasse 4
D-73463 Westhausen
Phone (+49) (7363) 5071
Telefax (+49) (7363) 5073
contact@safed.de

<http://www.aichelin.com>