aichelin unitherm
industrial furnace solutions

MULTI-PURPOSE CHAMBER SEALED QUENCH FURNACE

Reliability at Work

Safety Always

Customised Solutions

AICHELIN Multi-Purpose Chamber Furnace Unit

1. Introduction

During the last decades, AICHELIN Group has built far more than 3000 protective gas chamber furnaces and put them into operation. These plants have been in operation with high efficiency and reliability thereby delivering quality products for our customers. Due to rugged furnace design and continuous development along with the customer feedback has helped us to gain their confidence and trust. This has resulted in the creation of different models of chamber furnace based on production capacity where each of them is optimally aligned to meet customer needs.

Standard - Line

The standard line constitutes of most common models supplied to our customers for various parts heat treatment.

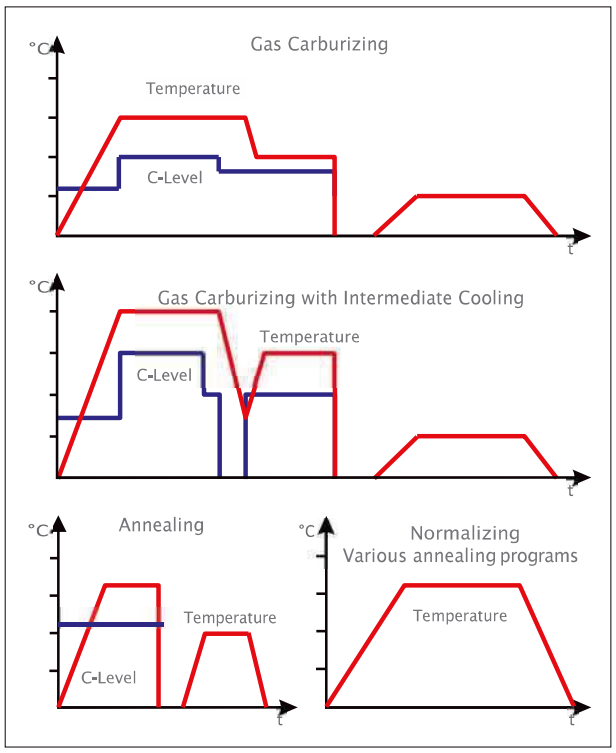
Special - Line

The special line is developed to meet customer special requirements.

2. Application range of the Multi-Purpose Chamber Furnace

Possible heat treatment processes:
For example:

- gas carburizing
  - with direct quenching (Oil or Salt)
  - with intermediate cooling
  - with charge cooling under protective gas
- re-carburizing
- carbonitriding
- hardening in oil or salt
- normalizing
- annealing
- tempering



When are Chamber Furnaces preferentially used?

- for small and moderate batch capacities
- for different heat treatment processes
- for different kind of parts and high diversity of parts
- the gross batch weights of approx. 350 - 2500 kg / batch.
- if flexibility is required
- for different production requirements
- if quality with economy is required

3. Design of a Multi-Purpose Chamber Furnace Units

3.1 Quality features of the Multi-Purpose Chamber Furnace of AICHELIN Design

- Heat treatment with high quality with economy.
- Extremely good temperature uniformity (+/- 5 °C) and accuracy, simple operation.
- Carbon Potential control (+/- 0.03%) through motorised valve in enriching line.
- Quench Oil tank volume ratio as per the customer requirements (Minimum - 1:8)
- Short charge transfer time from heating chamber to oil bath.
- Air cooled quench oil cooling system.
- Computerised Process monitoring with Data Logging Systems.
- High reliability of the production process with long life cycle
- Low energy and media consumption.

3.2 Sizes of the AICHELIN Chamber Furnace

Standard-Line

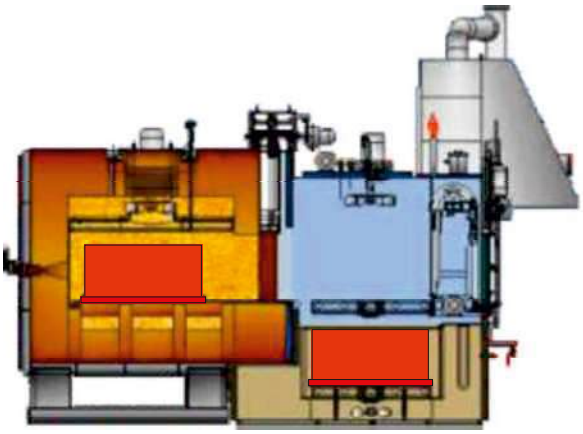
Type*	Gross charge Max. (Kg)	Size of the charge W x H x L (mm)
2	350	500 x 650 x 900
3	650	600 x 650 x 1200
4/2	1000	700 x 850 x 1300
5/2(M)	1200	900 x 850 x 1300
5/2(M)	1500	900 x 900 x 1300
5/2	1500	900 x 850 x 1500
5/2(M)	1800	900 x 900 x 1500
5/3	2000/2500	900 x 1300 x 1500
6/3	2000/2500	1200 x 900 x 1500

Special-Line

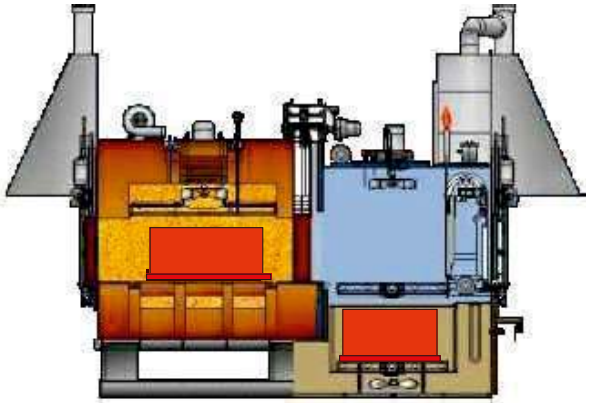
Type*	Gross charge Max. (Kg)	Size of the charge W x H x L (mm)
5/4	1800	900 x 850 x 1800
5/5	2500	900 x 850 x 2250

*Further dimensions and charge weights on request

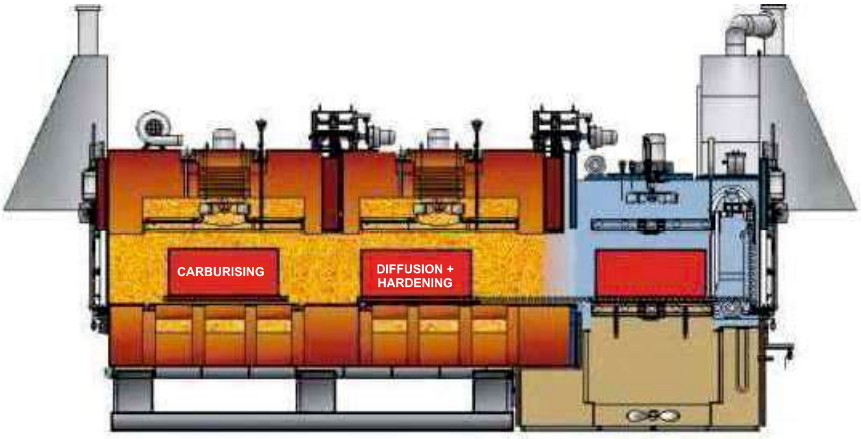
3.3 Possible designs of the Multi-Purpose Chamber Furnace



In-Out Design Chamber Furnace



Straight Through Design Chamber Furnace



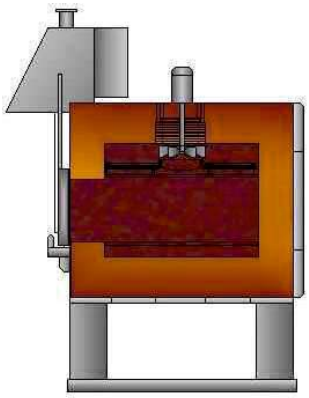
Straight Through Design Double-Chamber Furnace

3.4 Constructive characteristics of the AICHELIN Design Chamber Furnace

- Electrically Heated / Gas Heated options available.
- No moving metallic parts in the Heating Chamber except Re-circulation Fan.
- High thickness insulation for minimizing heat losses and skin temperature.
- Electro-mechanical drive for movement, tray transport device in cold vestibule for long life.
- NO COOLING WATER or COMPRESSED AIR required in the furnace.
- Re-circulation fan housing is oil cooled closed circuit Thermosiphon Design.
- Silicon Carbide skids and Muffle in heating chamber for uniform atmosphere and temperature distribution.
- Furnace Atmosphere : Endo Gas / Methanol + Nitrogen
- Enriching Gas: LPG / Propane / Natural Gas.
- Fully Automatic operation through PLC, HMI, programmer & latest process control system.

4. Accessory equipments for Multi-Purpose Chamber Furnaces

4.1 Pre-Heating / Tempering without N2 Atmosphere.



Furnace temperature max. 500 °C

- VKHLE electrically heated
- VKHLG gas heated

4.2 Pre-Heating / Tempering / Stress relieving without N2 Atmosphere.

Furnace temperature max. 750 °C

- UHAFe electrically heated
- UHAFg gas heated

4.3 Pre-Heating / Tempering / Stress relieving with N2 Atmosphere.

Furnace temperature max. 750 °C

- UHGFe electrically heated
- UHGFg gas heated

Optional: With charge cooling device

4.4 Chamber Retort Nitriding Furnace

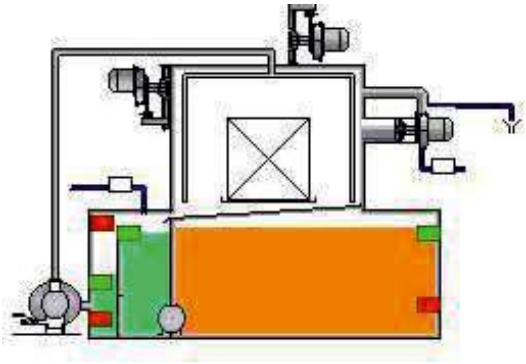
Furnace temperature approx. 700 °C

- KREs electrically heated

With forced charge cooling device (cooling with nitrogen) for

- nitro carburizing
- gas nitriding
- water/steam oxidation
- annealing and tempering under nitrogen
- bright annealing

4.5 Chamber Immersion-Spraying-Drying Washing Machine

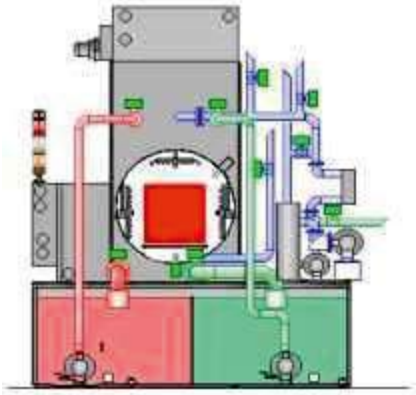


- KEKTE/UHWT(ISDe) electrically heated
- KEKTG/UHWT(ISDg) gas heated

for high-quality washing processes in water based alkaline solutions

- with dipping and spraying system
- Option of one / two washing liquid containers
- drying device by hot air (optional)

4.6 FLEXICLEAN® - Chamber Washing Machine



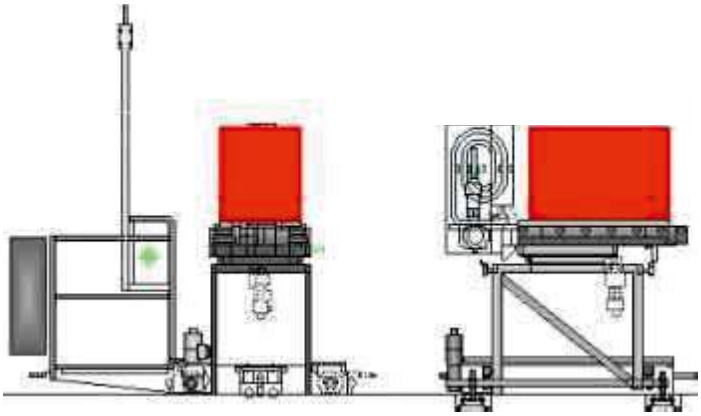
- EKFE electrically heated
- EKFG gas heated

For high-quality washing processes in alkaline solutions (especially with neutral cleaners) with two washing liquid containers (option: third container)

with vacuum boiling “Vacupearl”, spraying and flotation system and vacuum drying device

4.7 Charging and Discharging Wagon

For one-sided or both side operations.

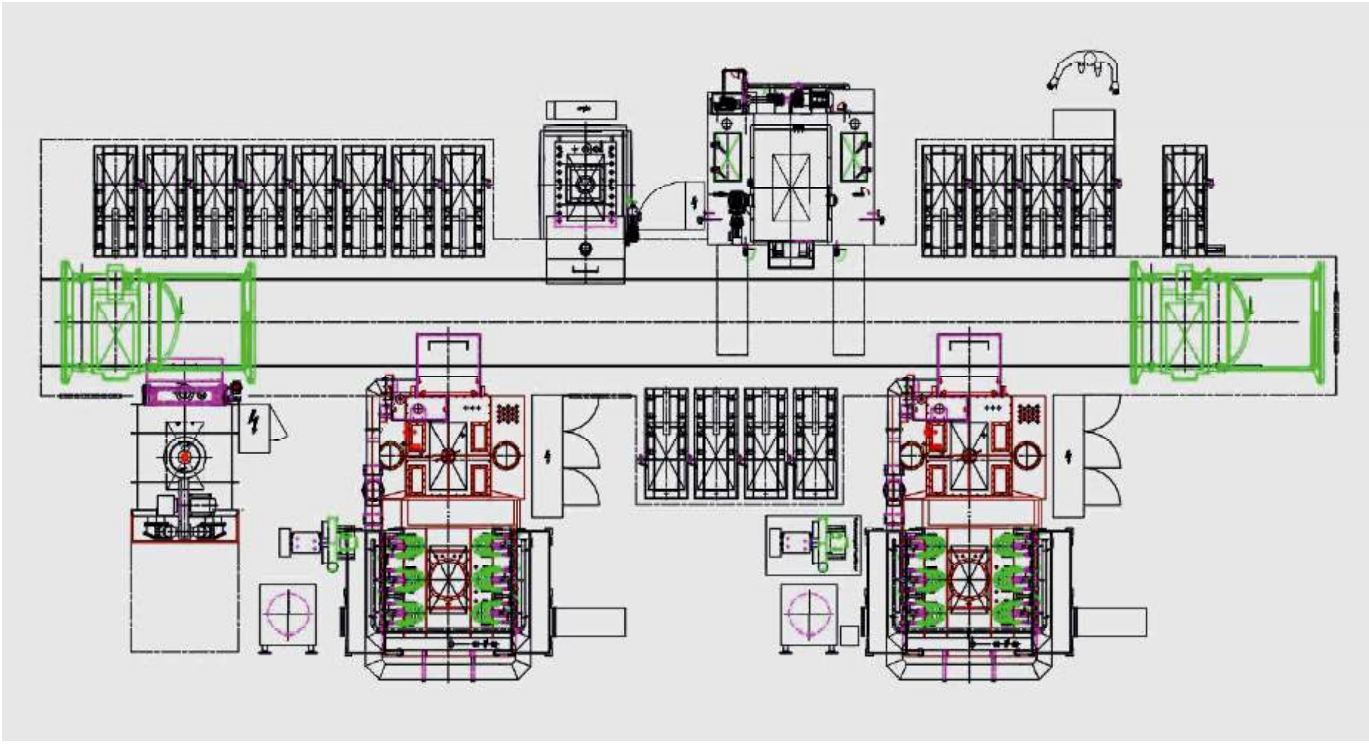


Optional: lifting function for two-layer charge storages

5. Examples of Installations for Multi-Purpose Chamber Furnaces

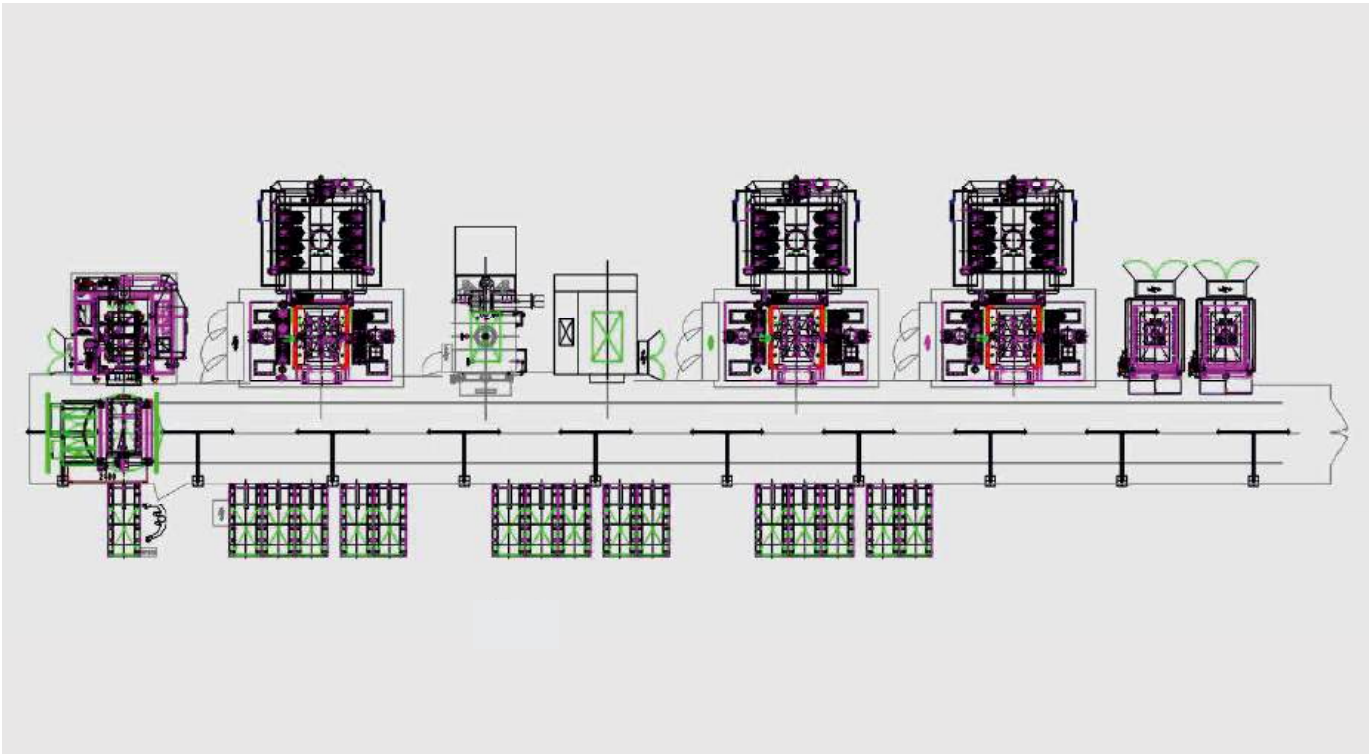
5.1 Single Chamber Furnace Line: (Fully Automatic No Man Operation)

In-Out Design with both side operation through one charge wagon.



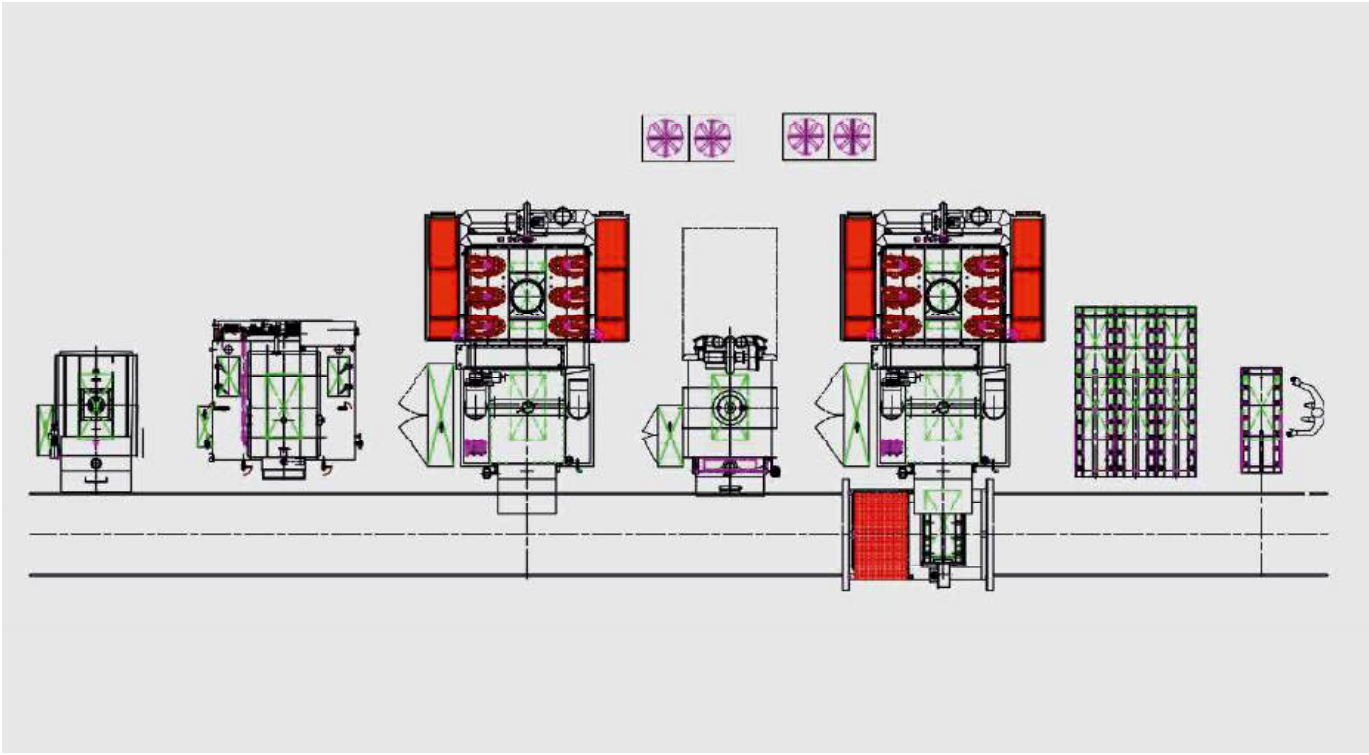
5.2 Single Chamber Furnace Line: (Semi-Automatic Operation)

In-Out Design with both side operation through one charge wagon.



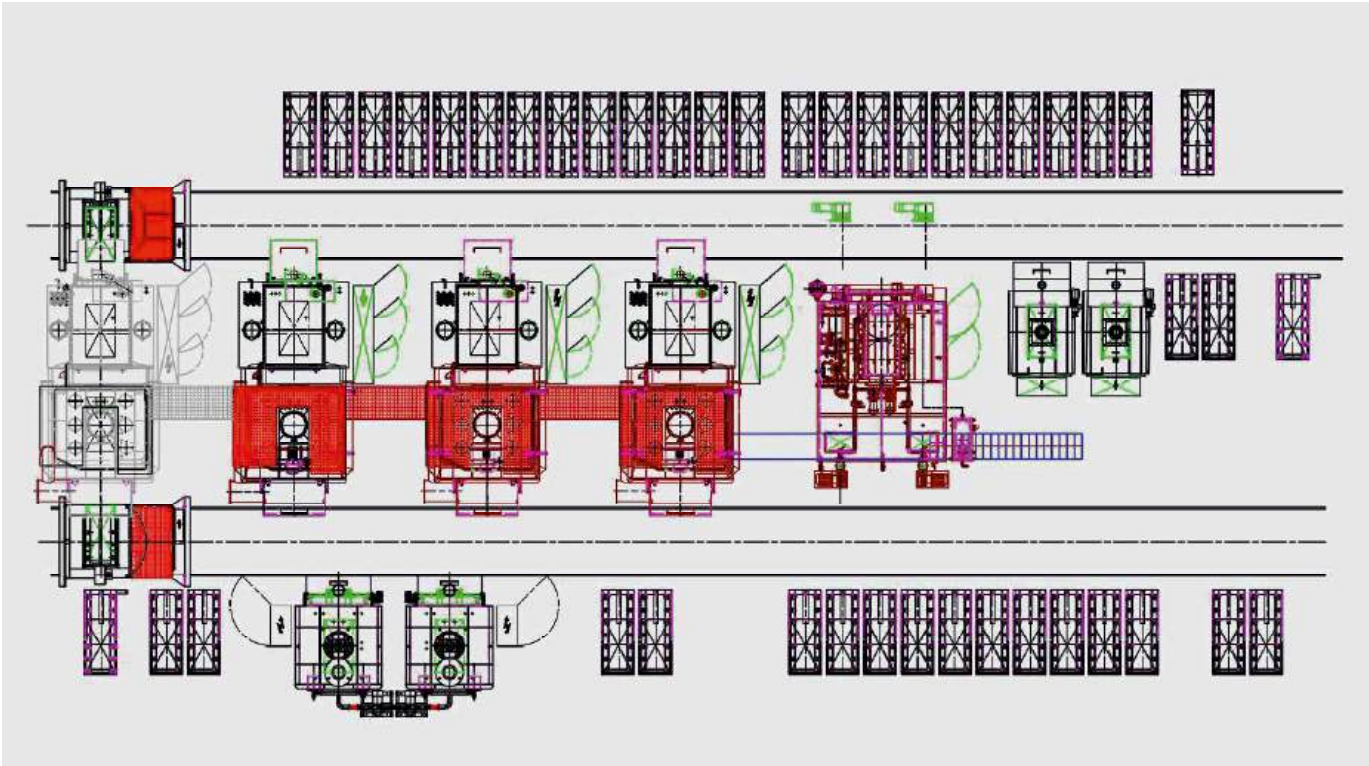
5.3 Single Chamber Furnace Line: (Semi-Automatic Operation)

In-Out Design with one side operation through one charge wagon.



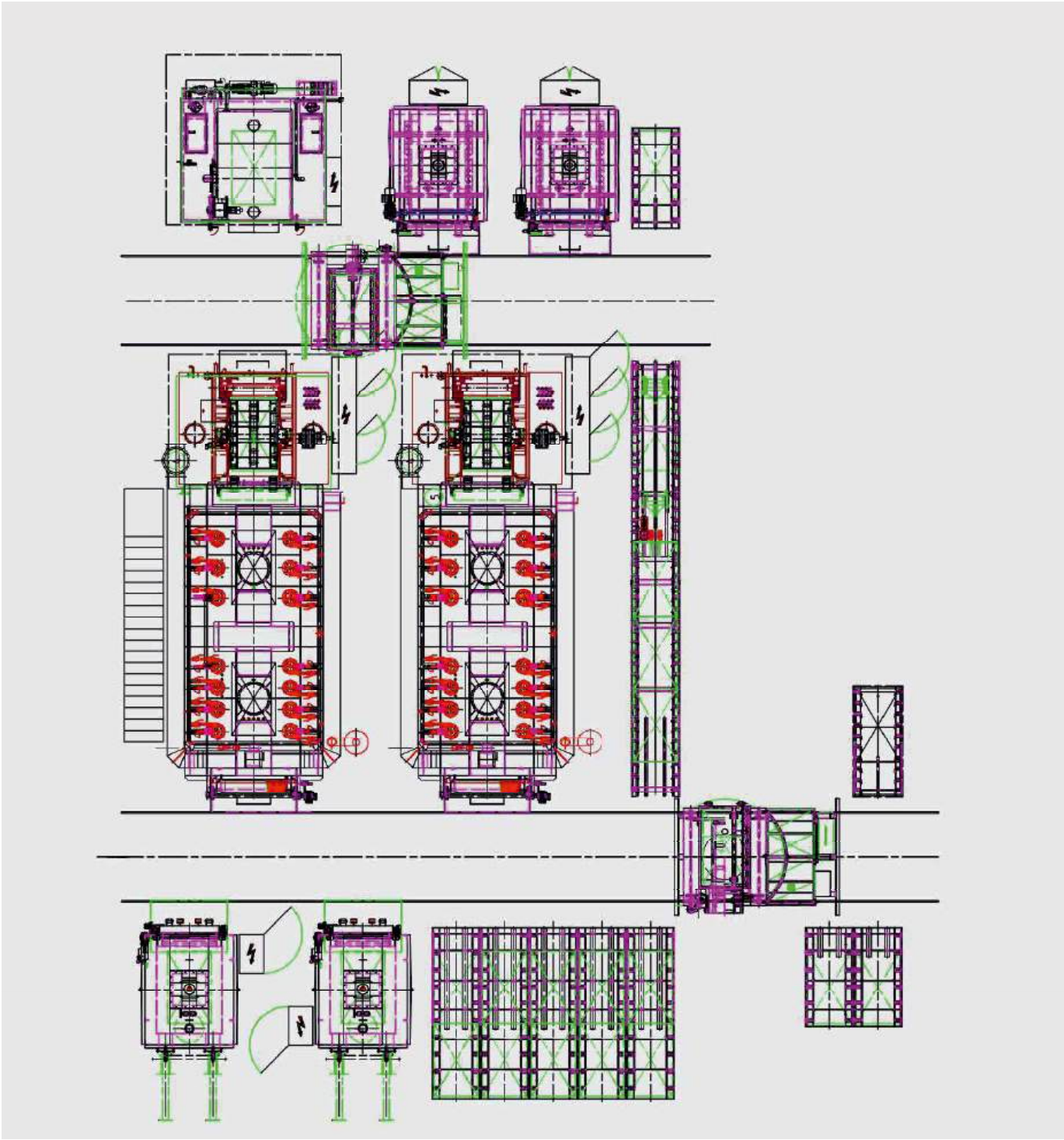
5.4 Single Chamber Furnace Line: (Fully Automatic No Man Operation)

Straight Through Design operation with two charge wagons.



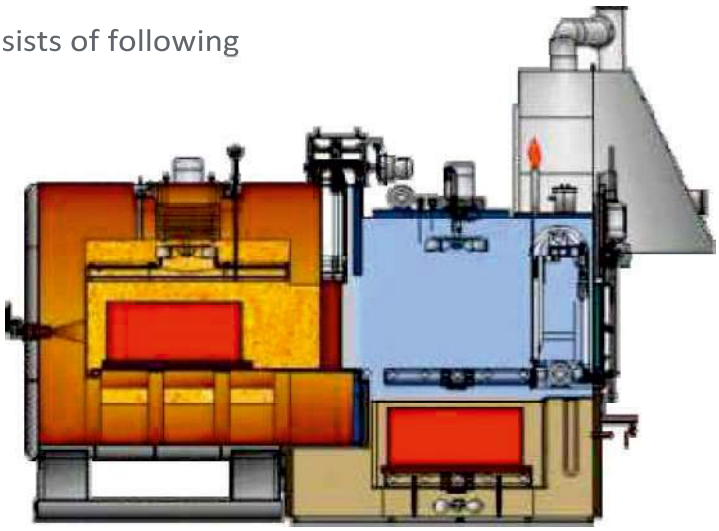
5.5 Double Chamber Furnace Line: (Fully Automatic No Man Operation)

Straight Through Design operation with two charge wagons.



6. Technical description of the Sealed Quench Chamber furnace

The Multi Purpose Chamber Furnace consists of following components:-



6.1 Furnace Chamber:

The furnace chamber consists of a gas tight furnace housing and lining of high-quality insulating material. The ceramic hearth made of silicon-carbide skids, possesses a large open space for the gas flow. The optional silicon carbide gas conduction muffle and the intensively working gas circulation aggregate ensure a continuous flow on the charge and outstanding temperature uniformity. The gas circulation fan is user friendly and easy to maintain due to bearing housing design & coupled motor. By this closed oil cooling circuit with thermosiphon effect cooling of the fan assembly is without current supply. The intermediate door is closely fit to the furnace chamber.

6.2 Heating:

Heating is done by vertically installed radiant tubes, optionally electrically or with gas. For gas heating, automatic gas burners (type Aichelin NOXMAT®) with recuperative preliminary heating are used. These do have a high firing-technical efficiency. A variable switching cycle ensures highest temperature uniformity. With gas heating, the radiant tubes can be used as cooling tube for the rapid lowering of temperature from carburizing to hardening. Thus, it results in shortening of the total heat treatment time. For excess temperature control, there is a separate over-temperature safety thermocouple and controller, which protects the furnace and radiant tubes against overheating.

6.3 Vestibule Chamber - Quenching Tank:

At the furnace chamber, the vestibule chamber with oil bath is attached gas tight. The vestibule chamber can be used additionally for charge cooling down to discharging temperature or for intermediate cooling (isothermal annealing). Therefore, a separate cooling equipment with own heat carrier oil-cooling circuit via finned pipe heat exchangers is provided. For the support of the charge cooling procedure, a gas circulation aggregate with guiding muffle is installed. Optionally, the oil bath and vestibule cooling can be equipped with oil/air heat exchangers.
Thus, no cooling water and cooling tower is required at the plant.

The vestibule door is pressed via cranks by control shafts through a gear motor with spring pressing device into the door seal.

Underneath the vestibule door, a supervised flame curtain device, automatically firing by piezo ignition is implemented. The flame curtain must be ignited, only then the outer door can open. The oil bath volume of the hardening container is optimally adapted to the charges. The double-walled housing execution with oil detector safely avoids environmental - damaging oil leakages can be offered optionally.

The oil level in the hardening container can be supervised by a minimum-maximum level indication for safety. Oil cooling is done by means of heat exchangers (oil / air). The oil bath heating is carried out electrically by immersion heaters. The oil circulation is reached by means of two or four oil circulation aggregates through VFD.

Via oil guidance channels and oil guide plates, attached closely around the charge, uniform flow of oil through the charge takes place. This is particularly important with closely packed charges for a constant hardening result.

Depending upon need, the hardening bath can be equipped additionally with intensified oil bath circulation capacity and with program controlled continuously adjustable circulation capacity of the oil bath circulation aggregates.

6.4 Lowering platform, charge transport:

The lowering platform is carried out in two layers, thus you can load fresh batch in the furnace again, while a charge stays in the oil bath. In the vestibule chamber, the automatically working tray transport equipment is implemented.

The cooperation of the high speeds of lowering platform and intermediate transport results in very short moving times; for example for the multi-purpose chamber furnace size 3: start from the furnace chamber up to complete immersing into the oil bath takes place approx. (30 seconds.)

All drives are electrical geared break motors with safe end positions. Hand wheels are provided for the manual drive movement in case of emergency operation.

6.5 Safety device:

In order to save the charge from de-carb / Oxidation damage during power failures, the multi-purpose chamber furnace is equipped with an automatic N2-safety gas supply device for purging and also helps to maintain the furnace in positive pressure in case of long power failure duration.

Further, all failures of energy supply, drives, heating etc. are signalized in alarm and saved in alarm history for trouble shooting.

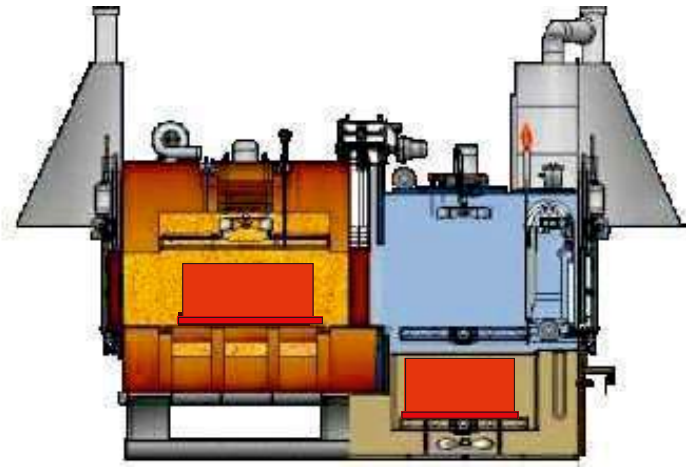
6.6 Gas supply:

The multi-purpose chamber furnace can be designed with different kinds of gas supply. Endogas & N2-methanol as carrier gases.

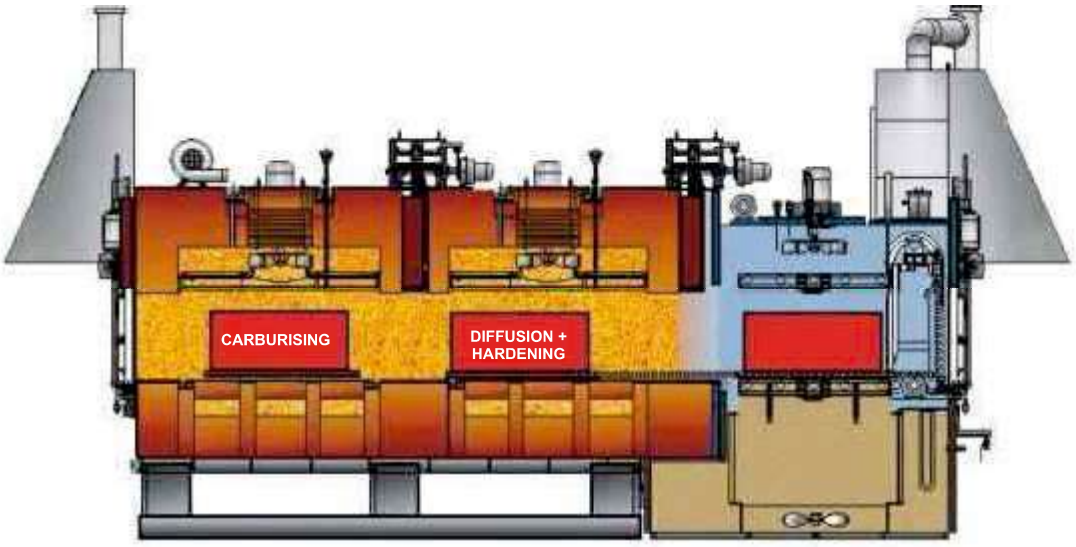
As enriching gases, propane, natural gas, LPG media can be used for carburizing.

The automatic control of the carbon level is done according to standard by oxygen probe.

7. Chamber-Furnace Types (Straight Through Design)



Single Chamber Furnace



Double-Chamber Furnace

The furnace types are chosen as per the requirement of heat treatment process. Charge transport takes place according to the continuous principle. With the continuous chamber furnace, the charge is pushed into the first chamber by the charging wagon. With the double chamber furnace, likewise from the charging wagon into the first chamber and afterwards into second (with slightly opened entry door). Charge transport into the oil bath is done by the transport equipment of the furnace vestibule chamber.

The continuous double chamber furnace has separate temperature and C-level-regulation for each zone. An intermediate door separates both furnace chambers.

8. Control system of a Multi-Purpose Chamber Furnace

8.1 Control:

The control level is divided into 3 operation modes:

- setting mode
- manual mode
- automatic mode

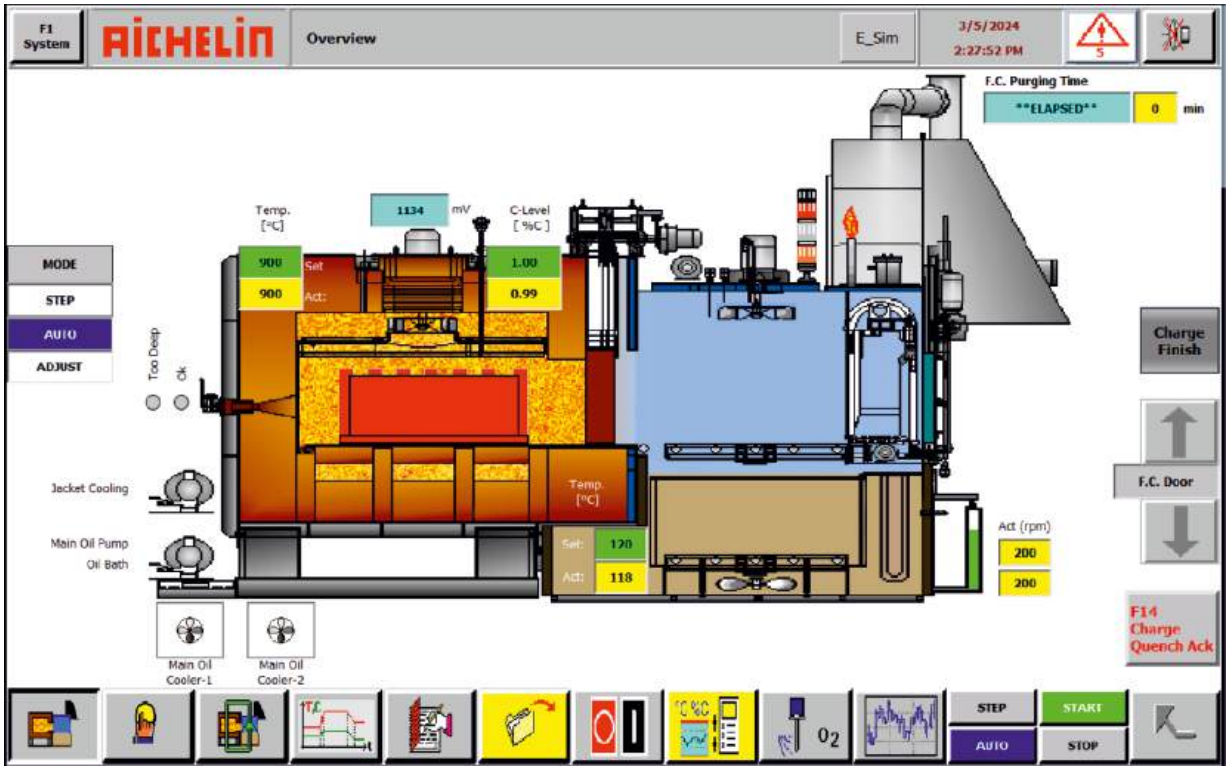
Automatic mode

In this mode, the furnace is operated for normal production. After loading the charge in the front chamber the charge movement inside the furnace is done in automatic mode. i.e. transfer of charge to heating chamber, thereafter quenching the charge from heating chamber to oil bath etc.

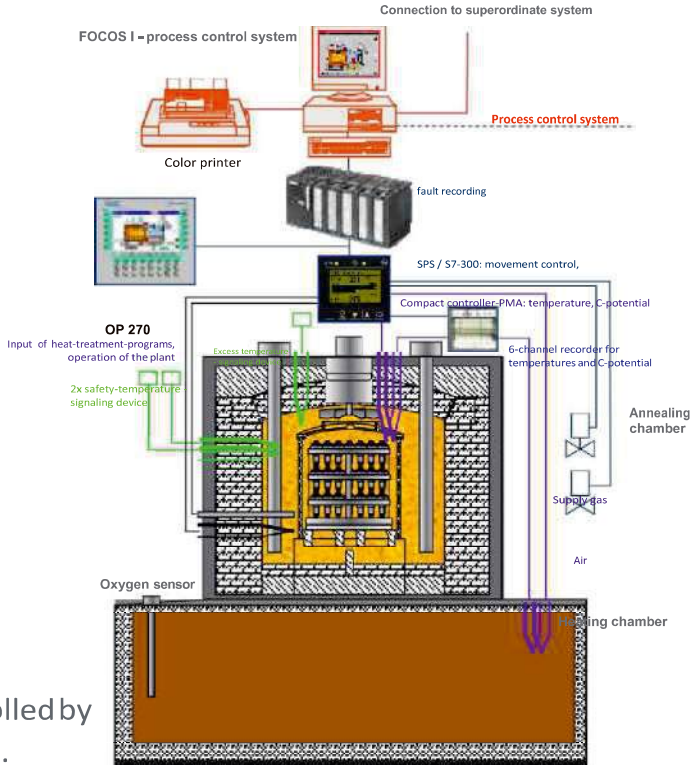
A full graphic operator panel is the central operation element of the furnace. It displays all limit switch conditions and the conditions of the sequencers.
All continuously running devices (fans, pumps, etc.) are also controlled by this operator panel.

On the overview screen (see below), the condition of the plant is shown in form of an animated picture.
Therefore, at any time an overall picture of the plant is visible and secures a simple operation of the furnace.

On these overview pictures, the position of the charge and all actual states of the drives, as well as the actual and standard value indication for C-level and temperature are displayed.



8.2 Controlling:



Temperature control of the heating chamber,
oil bath heating as well as C-level control is done by means of a compact controller.
Communication with the programmable logic control (PLC) by bus system (Profibus DP). With standard operation, the set values are preset by the PLC and the actual values indicated back to the PLC.
These values are displayed at the operator panel.
The protection against exceeding of the allowed maximum temperature of the furnace is controlled by an excess temperature safety device.
Falling below the safety temperature at gasified furnace is supervised by one safety temperature signal devices.
The oil bath is protected against exceed of the allowed maximum temperature by safety temperature controller.
C-level control of the furnace is done by special software in a compact controller.
Regulation and control of the gas feeding is independent from the programmable logic control.
At the operator panel, complete heat treatment programs are menu-driven.
After charging and start of the required heat treatment program, the PLC takes over the function of the programmer.
The set value is preset to the temperature/C-level-controller due to the stored program set values.
The PLC also takes over the control of the quenching processes (oil resp. gas quenching).
Recording of furnace temperature, C-potential, Agitator RPM and temperature of oil bath is done by computerised Data Logging System.

8.3 C-level control:

C-level control and measuring and switch system with Cp controller with extended software for temperature and C-potential. The actual values are transmitted by an oxygen probe (measurement of the gas atmosphere in the furnace via zircon oxide).
Fault signals are intended for sensor loss and as well as for minimum and maximum limit values.
Alternatively, the C-level-regulation can be carried out with software controllers of other selected measuring technology companies.

9. *i*FACE process control system for chamber furnaces

With the *i*FACE, several chamber furnaces can be controlled.
With starting of a heat treatment program, the entire information is sent to the programmable controller (PLC) of the furnace plant. Afterwards, the *i*FACE system controls the program sequence and sends the standard values to the PLC. This passes the standard values on to the compact controller. The current actual values of temperature and C-level are recorded to the *i*FACE system. The program sequence can be viewed on-line via operator panel.
If there were a loss of the *i*FACE system during a heat treatment , then the PLC of the furnace plant immediately takes over the programmer function and the program can be continued without interruption.

*i*FACE system contains the following program items in its basic version:

- **OFF-LINE diffusion program (Can be offered optionally)**
  For simulation and optimization of carburizing programs.

- **Program management**
  Input of different heat treatment programs, whereby the program sequence can be divided into up to 10 sections. Option of time and target size control.

- **Part data bank**
  Allocation of the individual heat treatment programs for certain parts.

- **Programmer**
  Standard value of temperature and C-potential are preset according to the heat treatment program data and indicated graphically.

- **ON-LINE diffusion program (Can be offered optionally)**
  During a carburizing program, the current carburizing profile with the carbon process can be indicated and printed at any time.
  At programs with target size control, the carbon process in the heat treatment material is calculated with the recorded actual values and controlled according to the target size.

- **Heat treatment reports**
  Is available for each charge. It is stored on the hard disk and can be shown on the screen and printed at any time. It contains the heat treatment program in tabular form with all relevant part data, the standard and actual values of C-potential and temperatures in graphic form for the entire process duration, as well as the calculated carbon process in the parts in tabular form and graphical trends.

- **Service programs**
  Calculation of the alloy factor from the composition of the material.
  Different conversion functions such as C-levels in probe tension, CO content, etc.

- **Failure handling**

  Indication of failure alarms in clear text with time stamp with starts and end time.

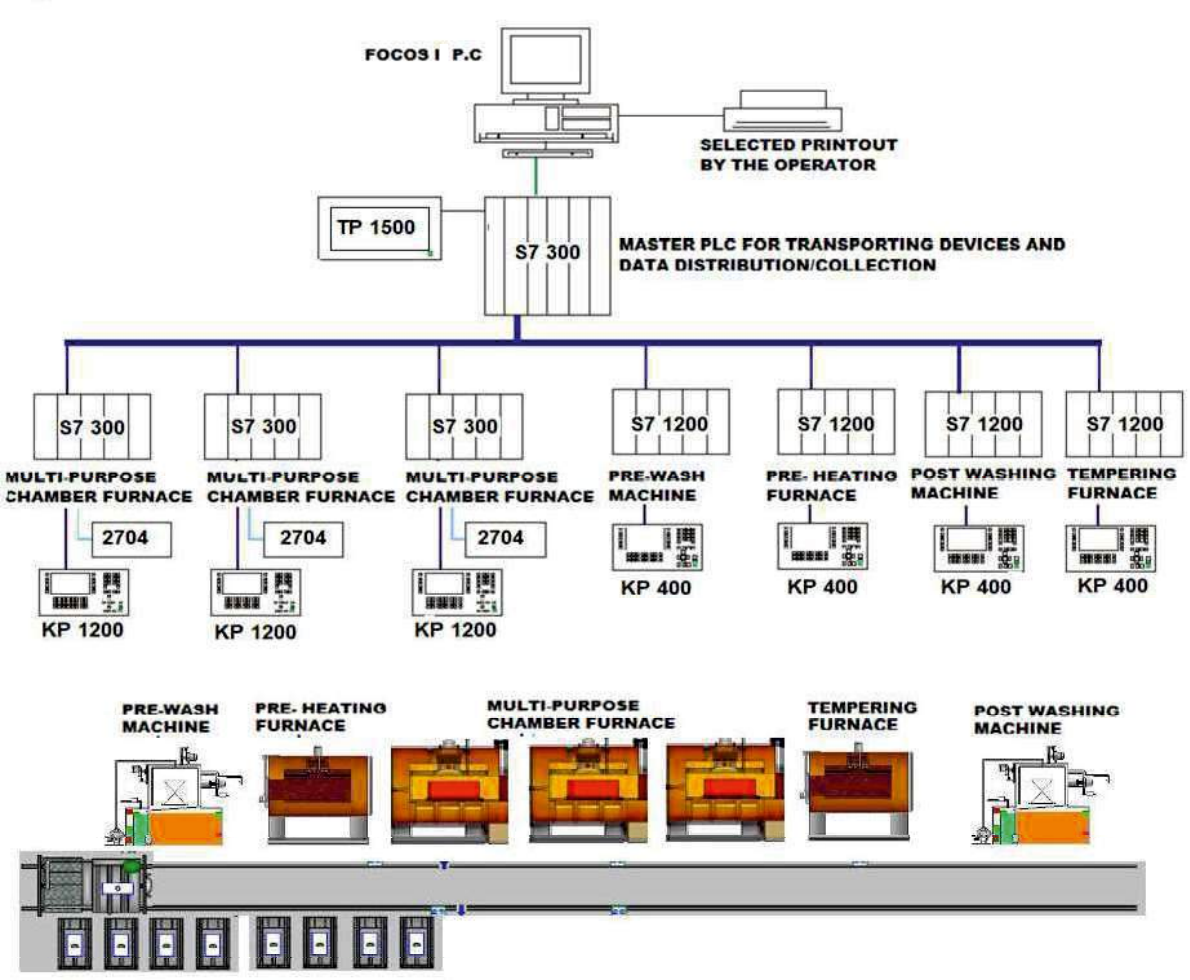
- **Help texts**

  The existing help texts offer valuable support with operation.

  Beyond that, there is however still a multiplicity of development stages of the process control system, which can be extended up to the controlling of a fully automated multi-purpose chamber furnace plant. Then, not only the multi-purpose chamber furnaces are controlled, but all ancillary units get the defaults from the *i*FACE, so that the complete treatment cycle of a charge is accomplished automatically. The operation of the plant is limited to charging/discharging of the storage guide rails. In addition to the already described program items, there is still another multiplicity of software modules such as teleservice, SMS notification (optional) or extended heat treatment proof with laboratory minutes, which can be adapted to the respective customer requirements.

9.1 Fully automatic Chamber Furnace Line:

Data structure and networking



Multi-Purpose Chamber Furnace Line - Single Chamber

Multi-Purpose Chamber Furnace Line - Double Chamber

LOADING SIDE

UNLOADING SIDE

aichelin unitherm
industrial furnace solutions

MULTI-PURPOSE CHAMBER SEALED QUENCH FURNACE

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