

2 Delivery scope for fulfilling the requirements from the requirements

| Item no. | Designation | Pcs. |
|----------|---|------|
| 1 | Loading lifting table as roller conveyors Ø 900 mm with weight control | 1 |
| 2 | HTF infeed as transverse transfer carriage with roller table, rollerways with absolute value encoder Ø 900 mm with height control | 1 |
| 3 | High-temperature roller hearth furnace Type DRGs 90x30 (HTF). Gas heated. Protective gas operation. | 1 |
| 4 | Roller conveyor 1 with lifting table behind HTF Ø 900 mm | 1 |
| 5 | Roller conveyor 1 with lifting table in front of the oil quenching bath Ø 1.200 mm | 1 |
| 6 | Roller conveyor 2 in front of the oil quenching bath Ø 1.200 mm | 1 |
| 7 | Portal manipulator double axles and electric chain hoist | 1 |
| 8 | Oil quenching bath, Type AB 120x50/1 for fixture Ø 1.200 mm – ca. 10 m ³ | 1 |
| 9 | Roller conveyors in front of the oil-washing machine Ø 900 mm, max. 300 kg | 2 |
| 10 | Two-zones (3 treatment steps, 2 tanks) oil washing machine Ø 900 mm: injector flood washing + spray washing & Drying zone (circulation air 130°C) | 1 |
| 11 | Roller conveyor with lifting table downstream of the oil washing machine Ø 900 mm, 1.300 mm to 1.000 mm | 1 |
| 12 | Transverse transport with driven roller conveyor in front of the Low-temperature continuous furnace (LTF) Ø 900 mm | 1 |
| 13 | Roller conveyor downstream of the transverse transport for lock out to measuring Ø 900 mm | 1 |
| 14 | Roller conveyor downstream of the transverse transport for lock in after measuring Ø 900 mm | 1 |
| 15 | Buffer roller conveyors in front of the LTF Ø 900 mm | 1 |
| 16 | LTF Type DAOE 1 – 90x90x40 / 1*12, max. 300 kg | 1 |
| 17 | Buffer roller conveyors downstream of the LTF Ø 900 mm | 1 |
| 18 | Air cooling station with 3*1 bays and driven roller conveyor including 1x cooling air fan Ø 900 mm | 1 |
| 19 | Unloading lifting table with stopper unit Ø 900 mm | 1 |
| 20 | Complete access facilities, platforms, stairs, and access ladders | 1 |
| 21 | Safety equipment such as safety screens | 1 |
| 22 | | |
| 23 | Declaration of CE-Conformity | 1 |
| 24 | Documentation in national language + German | 1 |
| 25 | | |
| 26 | | |
| 27 | | |
| 28 | Submerges pump for the washing machine | 1 |

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| 29 | Double bag filter in the oil washing machine incl. piping, etc. | 1 |
| 30 | Switch off at peak current | 1 |
| 31 | Pressed welded gratings as underlay 900x900x5 mm, additionally welded with inert arc outside | 50 |

4 Description of plant (basic machine, ancillary units, general equipment, technical assemblies and further requirements (specific to the machine))

4.1 General informations

| General | |
|-------------------|--|
| Output | 540 kg/h (net) |
| Operation mode | Martensitic |
| Transport general | Direct on transportation rollers |
| | Direct on pressed welded gratings as underlay 900 x 900 x 5 mm |
| Usable diameter | Only rings: max. Ø 900 mm |
| | Fixture incl. ring: max. Ø 1.200 mm |
| Usable height | Only rings: - one layer: max. 156 mm - two layer: max. 312 mm |
| | Fixture incl. ring: max. 500 mm |
| Batch load | Only rings: - one layer: max. 108,6 kg - two layer: max. 217,2 kg |
| | Fixture incl. ring: max. 1.800 kg |
| Mesh grids | Necessary for washing machine and all further components |
| | |

4.2 Loader / feeding machine

4.2.1 Loading lifting table as roller conveyors

| General | |
|------------------------|-------------------------------------|
| Number | 1 |
| Kind of loading | Manual loading from three sides |
| Effective width | 900 mm |
| working height | 650 mm – height of HTF (1.217,5 mm) |
| Check of the dimension | Maximum weight by scale |
| Documentation | Weight of each batch |

4.2.2 HTF infeed as transverse transfer carriage with roller table

| General | |
|------------------------|----------------------------|
| Number | 1 |
| Effective width | 900 mm |
| Level of height | Height of HTF (1.217,5 mm) |
| Check of the dimension | Maximum height by scale |

4.3 High temperature furnace (HTF)

| Design | |
|---------------------------|---|
| Type | Roller hearth furnace Type DRGs 90 x 30 |
| Number of fans | Min. 2, executed with Harting plugs |
| Insulation | <ul style="list-style-type: none"> - Bottom: Bricks - Side wall: Bricks - Ceiling: Bricks - Resistant: > 5 years - The temperature of the outside furnace wall (HTF: 850 °C): max. 40 K above temperature of the shop floor (exception: design / function-based heat transfers such as door openings, peeping windows, ducts) |
| Peeping window | 4x HTF Reasonable peeping windows are required. Gage-glasses with nitrogen rinsing (without carbon disposal) permit the view onto the hardening good inside the furnace. |
| Sluice | First door of the furnace (entrance) is gas tight, entrance sluice N ₂ flooded. |
| Furnace top | Accessible with stairs and ladder |
| Position of ex-flap | Entrance and outlet sluice |
| Position gas panel | Left side |
| Position operation panel | Right side |
| Number of batch positions | 1x entrance sluice; 4 +1 HTF; 1x outlet sluice |

| Gassing | |
|---------------------------------------|--|
| Gassing positions | <ul style="list-style-type: none"> - Zone 2: 1 lance - Zone 3: 1 lance |
| Gas connections per zone | <ul style="list-style-type: none"> - Zone 2: methanol, nitrogen - Zone 3: methanol, nitrogen, propane, air |
| Methanol inlet | No irritation of temperature |
| Flame curtain | located at furnace entrance and outlet |
| Gas panel | |
| Propane C ₃ H ₈ | Solenoid valve (proportional) |
| Methanol CH ₃ OH | Flow meter for every zone min/max sensors for flow surveillance |
| Nitrogen N ₂ | Flow meter for every zone min/max sensors for flow surveillance |
| Soot burning | Switchable at panel |

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| Carbon-potential regulation | |
| Range of operation | 0,85 % +/- 0,05 % Carbon |
| Measurement system | Lambda probe (redundant) |
| | |
| Number of lambda probes | 2 |
| Lambda probe position | 2 parallel probes in Zone 3 Probes surveil each other (adjustable deviation tolerance), only one probe regulates C-level. |
| Regulation principle | The lambda probe measures online in the furnace atmosphere. The regulation of the carbon potential is done by adding a proper amount of propane in the same zone. |
| Apparatus for shim test | One shim test for zone 2, one shim test for zone 3 (close to regulation probe). Tubes inclusive connection for gas analyzer. All other zones (incl. both sluices) have connections for gas analyzer. |
| Correction factor | Differences between displayed carbon potential and measured carbon potential of the shim test can be compensated in the regulation system. |

| | |
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| Heating / Temperature regulation | |
| Heating zones | 4 |
| Temperature | max. 880 °C, automatic shut down of heating |
| Working temperature | 800 - 850 °C |
| Cooling | Rapid cooling of the furnace with air injection in the jet tube. |
| Burner | Recuperation type, efficiency $\geq 70\%$ |
| Radiant tube | Ceramic (SiC) / max load: 40 kW/m ² |
| Temperature constancy / uniformity | $\pm 5\text{ °C}$ in material during temperature uniformity |
| Temperature regulation | 1 thermocouple (double head) 100 mm over hardening material in each heating zone. |
| Thermocouples | Thermocouples Type K with additional bore for test thermocouple, mounted in a protection tube. |
| Thermocouple online control | The 2 thermocouples control each other. The max. difference between both measured values is 5 °C |

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| Parts transportation system | |
| Parts transportation | Rollers |
| Transportation rollers | Heat resistant steel, dismantable, powertrain control |
| Fast feeding and rewards feeding | Function to fast feeding and rewards feeding the basket for take out parts from front door manual / maintenance. |
| Emergency power transformation | Quickly transfer automatically to emergency power for the rollers running when normal power is cut off. |
| Roller manual turn | Manual handle with measurement to turn the rollers manually for emergency case. |
| Max. deviation of furnace time | $\pm 3\%$ of set point |

4.4 Transport HTF to fixture quenching

4.4.1 *Roller conveyor 1 with lifting table behind HTF*

| | |
|-----------------|---------------------------------------|
| General | |
| Number | 1 |
| Effective width | 900 mm |
| working height | height of HTF (1.217,5 mm) – 1.000 mm |
| Set-up | Table with bracings for free lift |

4.4.2 *Roller conveyor 1 with lifting table in front of the oil quenching bath*

| | |
|-----------------|--|
| General | |
| Number | 1 |
| Effective width | 1.200 mm |
| working height | height of HTF (1.217,5 mm) – 650 mm |
| Maximum weight | max. 1.800 kg |
| Set-up | Dripping tray at the bottom of the table |

4.4.3 *Roller conveyor 2 in front of the oil quenching bath*

| | |
|-----------------|--|
| General | |
| Number | 1 |
| Effective width | 1.200 mm |
| working height | 650 mm |
| Maximum weight | max. 1.800 kg |
| Set-up | Dripping tray at the bottom of the table |

4.4.4 *Portal manipulator double axles and electric chain hoist*

| | |
|------------------|---|
| Design | |
| Number of cranes | 2 |
| Execution | electrical |
| Kind of lifting | Chain hoist or similar |
| Lifting capacity | 1.800 kg |
| Portal | Steel construction |
| Control | Located control station (identical Wuppertal) |

4.5 Oil quenching bath for fixture quenching (martensitic)

| | |
|--------------------------------|--|
| Design | |
| Execution | media-tight, single-walled <input type="text"/> elevator covered with plates (not gas-tight) |
| Heating | electrical |
| Cooling | expandable plate cooler |
| Cooling power | Set point of temperature should be reached again within one cycle time |
| Working temperature | 50 – 90 °C |
| Thermocouples | Double head thermocouples Type K with additional bore for test thermocouple, mounted in a protection tube. |
| Thermocouple online control | The 2 thermocouples control each other. The max. difference between both measured values is 5 °C |
| Temperature uniformity | ± 5 °C |
| Temperature increase | max. 20 °C with maximum batch weight |
| Quenching | Directed by elevator |
| Agitation | Enough homogenic agitation. The volume flow shall prevent local overheating of quenching medium. Agitation frequency-controlled. |
| Sampling point | Accessible during all operational states |
| Level control | Redundant inspection of different levels (min. min., min., max., max. max.). Warning when levels are reached. |
| Elevator (lift-down operation) | frequency controlled, adjustable hub and frequency, bath overlap min. 200 mm |
| Addition of oil | Manual addition |
| Nitrogen purging | Two positions on the top. Each position with two valves (n. o.). Software integration together with CO2 extinguisher <input type="text"/> <input type="text"/> |

4.6 Oil washing process

4.6.1 Roller conveyors in front of the oil washing machine

| | |
|------------------------|--|
| General | |
| Number | 2 |
| Effective width | 900 mm |
| working height | 1.300 mm |
| Maximum weight | max. 300 kg |
| Set-up | Dripping tray at the bottom of the table |
| Check of the dimension | Maximum height by scale |

4.6.2 Oil washing machine

| | |
|---------------------|---|
| Design | |
| Effective width | 900 mm |
| working height | 1.300 mm |
| Maximum weight | max. 300 kg |
| Active zones | <ul style="list-style-type: none"> - Washing and rinse 1 and rinse 2 (chamber 1) - Drying (chamber 2) |
| Carry over | No mix of fluids from washing / rinse 1 tank to rinse 2 tank |
| Process | Washing by spraying, drying by blow off with hot air |
| Washing result | no visible residuals, dry (as technical possible) |
| Reflux screen | In all tanks (mesh size max. 1 mm) |
| Fresh water feeding | <ul style="list-style-type: none"> - Feeding in tank rinse 2 - Cascade to washing / rinse 1 - Time controlled - Water supply tube equipped with electrical pneumatic valve Bypass in water supply tube with manual ball valve |
| Water level control | 2 controlled water levels (min / max) for each tank, overflow tank only max level |
| Nozzles | Adjustable and easy to dismantle |
| Exhaust | No escaping steam at entrance and exit (as small as possible) |
| Materials | All metal parts which get in touch with washing medium must be made of stainless steel or water resistant |
| Accessibility | Pumps, filters and level switches are assembled for easy access, maintenance doors in active zones, motors are plugged |
| Safety base tub | Stainless steel 2,5 mm, leakages are detected |

| | |
|----------------|--|
| Washing | |
| Design | Flood washing with case |
| Pump pressure | 1-2 bar, visible on manometer |
| Mass flow | min. 350 l/min |
| Temperature | Adjustable up to 80 °C |
| Bag filters | In main flow, blocked filter is controlled by pressure switch with adjustable limits |
| Oil separation | <ul style="list-style-type: none"> - Oil separator at washing tank - Filling with floater in balance tank - Filling balance tank via overflow in washing tank |
| Water | Tank 1 |

| | |
|---------------|-------------------------------|
| Rinse 1 | |
| Pump pressure | 1-2 bar, visible on manometer |
| Mass flow | min. 350 l/min |
| Temperature | Adjustable up to 80 °C |
| Water | Tank 1 |

| | |
|---------------|-------------------------------|
| Rinse 2 | |
| Pump pressure | 1-2 bar, visible on manometer |
| Mass flow | min. 350 l/min |
| Temperature | Adjustable up to 80 °C |
| Water | Tank 2 |

| | |
|----------------|--|
| Air blowing | |
| Medium | Compressed air |
| Blowing knives | From top + bottom, air flow adjustable |

| | |
|-----------------------------|--|
| Dry | |
| Medium | Hot air |
| Temperature | Adjustable up to 20 °C |
| Position temperature sensor | As close as possible to the hot air exit |

4.6.3 *Roller conveyor with lifting table downstream of the oil washing machine*

| | |
|-----------------|--|
| General | |
| Number | 1 |
| Effective width | 900 mm |
| working height | 1.300 mm – 1.000 mm |
| Maximum weight | max. 300 kg |
| Set-up | Dripping tray at the bottom of the table |

4.7 Measuring and transport to LTF

4.7.1 *Transverse transport with driven roller conveyor between washing machine, measuring station*

| | |
|-----------------|--|
| General | |
| Number | 1 |
| Effective width | 900 mm |
| working height | 1.000 mm |
| Maximum weight | max. 300 kg |
| Set-up | Dripping tray at the bottom of the table |

4.7.2 *Lock in and lock out roller conveyor to measuring station*

| | |
|-----------------|---|
| General | |
| Number | 1 + 1 |
| Effective width | 900 mm |
| working height | 1.000 mm |
| Maximum weight | max. 300 kg |
| Set-up | Possibility to lock out the batches at the lateral transport before tempering and lock in the batches back to the lateral transport that they can go into the tempering furnace. Conveyors must be implemented in the working safety. |

4.8 Tempering process in LTF

4.8.1 *Buffer roller conveyor in front of the LTF*

| | |
|-----------------|-------------|
| General | |
| Number | 1 |
| Effective width | 900 mm |
| working height | 1.000 mm |
| Maximum weight | max. 300 kg |

4.8.2 *Low temperature continuous furnace (LTF)*

| | |
|---------------------------|---------------------------------------|
| Design | |
| Circulation zones | 4 or more |
| Insulation protection | Insulation must be protected from oil |
| Number of batch positions | 1*12 (one track with 12 positions) |
| Oil outlet | Possible to drain easily |

| | |
|------------------------------------|--|
| Heating / Temperature regulation | |
| Heating | Electrical |
| Temperature | max. 300 °C |
| Temperature constancy / uniformity | ± 5 °C |
| Temperature regulation | 1 double thermocouples in each heating zone |
| Thermocouples | Thermocouples Type K with additional bore for test thermocouple, mounted in a protection tube |
| Heating zones | min. 4 |
| Thermocouple online control | The 2 thermocouples control each other. The max. difference between both measured values is 5K |

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|--------------------------------|--------------------|
| Transporting system | |
| Transportation | chain |
| Through put time | 120 - 360 min |
| Max. deviation of furnace time | ± 3 % of set point |

4.8.3 Buffer roller conveyor downstream of the LTF

| | |
|-----------------|-------------|
| General | |
| Number | 1 |
| Effective width | 900 mm |
| working height | 1.000 mm |
| Maximum weight | max. 300 kg |

4.9 Air cooling station

| | |
|-----------------|---|
| Design | |
| Type | Cooling down by air blowing |
| Requirement | Cool down: < 60 °C |
| Design | - min. 3 active positions - with two fans (operation frequency tested by start-up) |
| Effective width | 900 mm |
| working height | 1.000 mm |
| Maximum weight | max. 300 kg |

4.10 Unloading lifting table with stopper unit

| | |
|-----------------|-----------------------------------|
| General | |
| Number | 1 |
| Kind of loading | Manual unloading from three sides |
| Effective width | 900 mm |
| working height | 1.000 mm – 650 mm |

5 Control, hardware and software

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|---|---|
| | |
| Visualization | Panel: TIA Portal V14; PC: WIN CC |
| Operation panel | Work station + panel |
| Documentation | The process data (temperatures, treatment times, carbon level, and alarms) is saved in a data bank and can be allocated to the respective work order. |
| Receipts | 100 heat treat receipts can be edited and saved in a data bank. The receipts can be called and loaded to the machine automatically. |
| Heat treat certificate | The system must generate a heat treat certificate for every single work order. The certificate includes all heat treat data (temperatures, treatment times, carbon levels, quality effecting alarms). |
| Display of every charge on a screen in a layout of the furnace line | Every charge is green and turns to red when a failure occurs. Red charges will be stated by a red light and an acoustic-alarm when leaving the tempering furnace. |
| Manuel / Automatic | Switchable |
| Production data | Wienstroth focus system and Host computer possible |
| Controller | Local computer |
| Host computer | Connection for data recording , superior |
| Emergency stop | Two ways: Emergency stop (record of alarm), all dangerous moving parts stop, easy restart of system after acknowledgement |
| CP343 | Included |
| SPS | F-SPS |
| Interface | Barcode scanner to be provided |