



Scientific and Manufacturing
Enterprise

**TOMSK
ELECTRONIC
COMPANY, Ltd.**

STEELMAKING INDUSTRY

PRODUCTS AND SOLUTIONS

A large, glowing orange-red cylindrical object, likely a steel ingot or a part of a furnace, dominates the center of the image. It has a rough, textured surface with visible cracks and debris. In the foreground, there are dark, circular mechanical components, possibly rollers or guides, with bright sparks or light reflecting off their surfaces. The overall scene is industrial and high-temperature.

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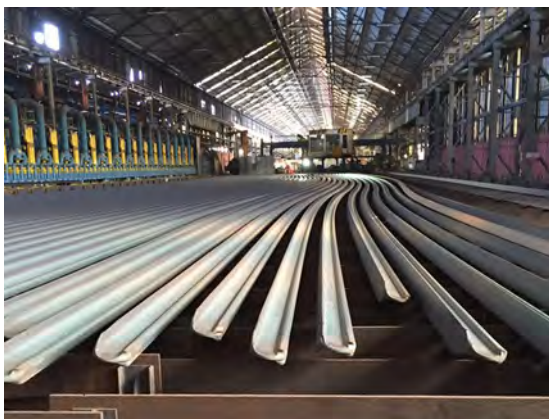


SME «TEC» Ltd. was established in 1999 on the base of Moscow branch of R&DI Technologii Mashinostroyenia. The Company started with the development of intellectual electric drives for oil and gas industry but later decided to add a steelmaking industry into the portfolio. Thus «Tomsk Electronic Company» has been successfully developed and realized big projects including equipment supplying for different steelmaking companies for many years. This catalogue will show you the services we render to steelmaking companies as well as the whole list of the equipment we supply. We believe that the information herein will be useful for you and your business!

A handwritten signature in black ink, appearing to read 'Shestakov' followed by a stylized flourish.

Shestakov Andrey Nikolaevich
General Director of SME «TEC» Ltd.

Engineering



Over 15 years «Tomsk Electronic Company» has been successfully involved into the development and engineering for steelmaking companies all over the world. Currently we see that the technologies are developed at a full throttle. The main special feature of the comprehensive engineering is a careful selection of required technologies and solutions for a certain production.

Working with «Tomsk Electronic Company» the Customers are sure that the development goals and quality improvement will be fully achieved. «TEC» has its own design, engineering and process departments with a rich experience of development and implementation of project with all complexity degrees. We also develop and implement our own technologies and solutions and we have patented certain process solutions and technologies for steelmaking industry.

SME «TEC» is widely experienced in upgrading the current production lines without the main production shutdown.

We highly appreciate the partnership with our Russian and foreign partner companies. Besides that «TEC» own engineering staff is more than 300 employees. We offer the whole range of services from the engineering up to the start-up and commissioning works including civil, installation works and manufacturing and supply of required equipment.

Our main target is a continuous development of our engineering skills. SME «TEC» staff is always at your disposal to answer any questions you have, ready to visit the site to survey and get the initial data to provide you with the best combination of engineering and process solutions.

We shall be delighted to cooperate with you!

**SMS
MEER**
SMS group

ANDRITZ
MAERZ

Continental
CONTITECH

PRIMETALS
TECHNOLOGIES

wheelabrato
shaeslin industries

EVRAZ

АО «ВНИИЖТ»
АО «Научно-исследовательский
институт железнодорожного транспорта»

Fraunhofer

GMH Prüftechnik
GmbH · ND-Testing · Systems · Services

ALPINE METAL TECH

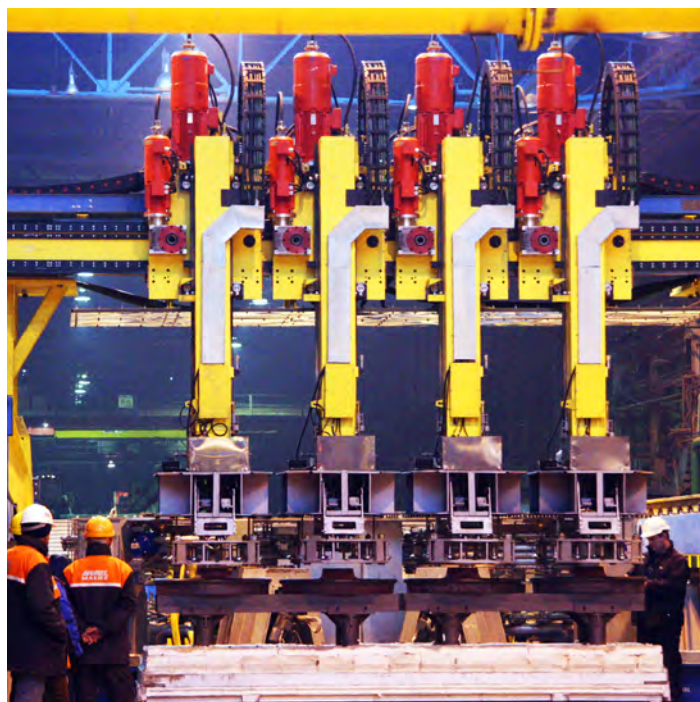
TYHI 太原重工股份有限公司
TAIYUAN HEAVY INDUSTRY CO.,LTD

HHMP
MECM

LOI
THERMPROCESS

MA STEEL

KARDEMİR



Ironmaking

JSC «EVRAZ NTMK» Blast Furnace №7

Customer

JSC «EVRAZ NTMK» (Russia, Nizhniy Tagil)

Performance calculation with reference to scope of work

Calculated performance of the equipment integrated into the charging line of the

Blast furnace №7 in terms of charged raw materials amounts to 2,5 mln t/annum or 7062 t/day considering the total operating time of the plant. The equipment was carefully selected based on a required performance including a performance reserve.

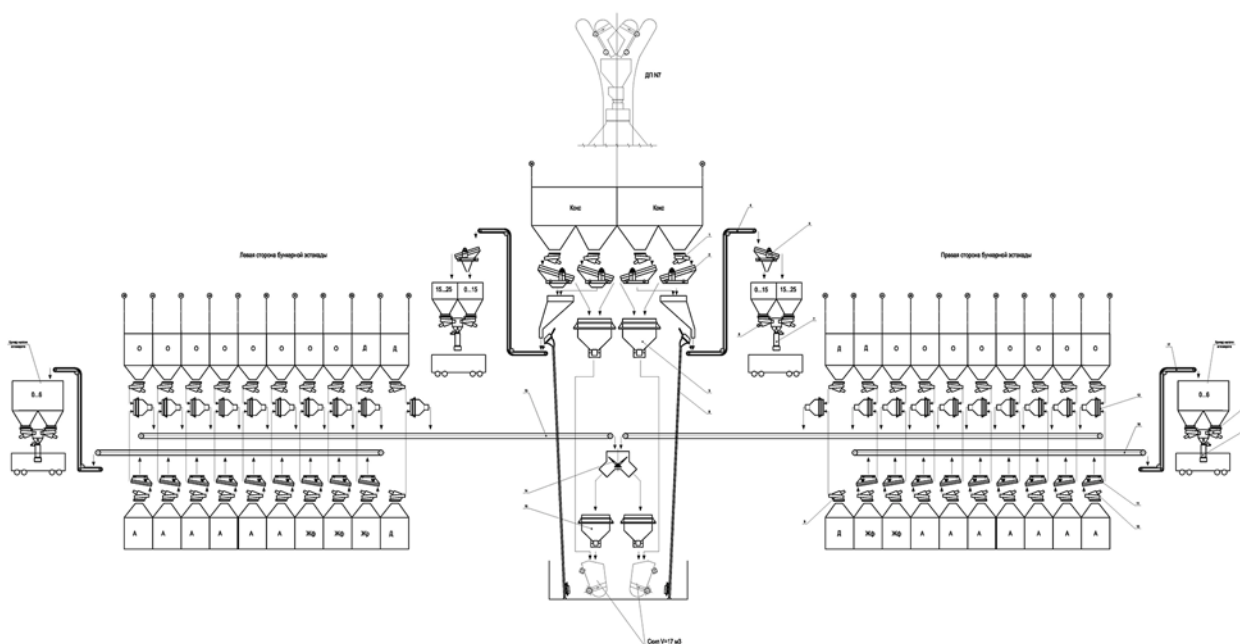
Properties of applied raw materials

| Name | | Grain-size composition, % | | | | |
|------|--------------|---------------------------|-------|-------|-------|------|
| | | > 80 | 80-60 | 60-40 | 40-25 | < 25 |
| Coke | Wet quenched | 26.0 | 42.6 | 23.6 | 2.9 | 1.3 |
| | Dry quenched | 11.6 | 38.7 | 37.1 | 9.7 | 2.9 |

| Name | | Grain-size composition, % | | | | |
|--------|--|---------------------------|-------|-------|-------|-------|
| | | > 40 | 40-20 | 20-15 | 15-10 | 10- 5 |
| Sinter | | 2.1 | 14.7 | 16.4 | 13.0 | 46.0 |

| Name | | Grain-size composition, % | | | | |
|---------|--|---------------------------|-------|-------|------|-----|
| | | > 40 | 40-20 | 20-10 | 10-5 | < 5 |
| Staflux | | 17.1 | 27.8 | 30.2 | 18.6 | 6.3 |

Process flow diagram



Sinter production and mining industry

Revamping of burnt pellets feeding line

Customer

JSC «KGOK «VANADII» (Russia, Kachkanar)

Purpose

Burnt pellets transportation from the pelleting and burning area into the bed separation area.

Scope of works and services

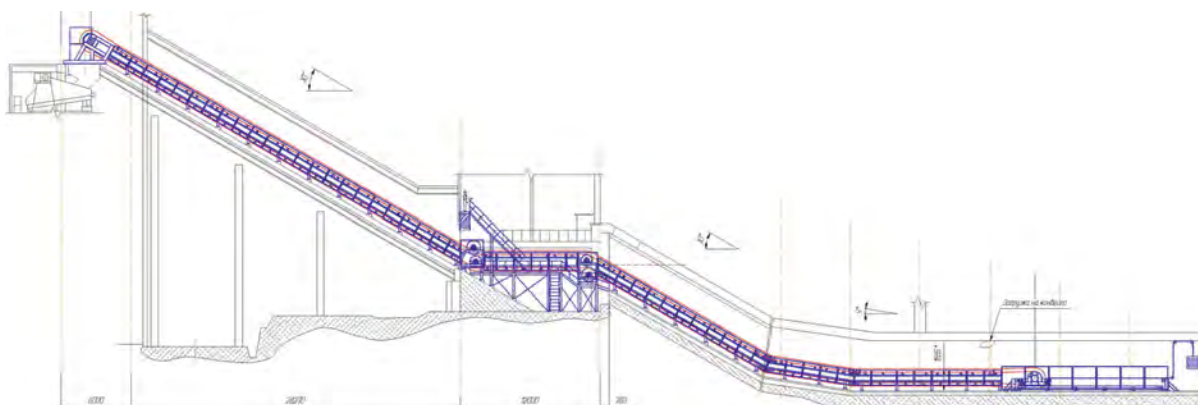
- development of a process project;
- development of engineering documentation;
- design safety review.

Data sheet

- Feeding line performance output amounts to 1400-1500 t/hour (peak performance is up to 1900 t/hour within 10 minutes twice a day maximum);
- Belt travel speed – 2 m/sec;
- Burnt pellets temperature is up to +120 °C within normal operation and up to +300 °C within abnormal situations;
- Conveyor belt length – 91 m;
- Hoisting height – 28 m.

The conveyor was commissioned in 2013.

Process flow diagram



Steelmaking

Revamping of bulk materials and ferroalloys handling system to feeding bins and converters materials handling system in BOS #1

Customer

JSC «Nizhniy Tagil Iron and Steel Works»
(Russia, Nizhniy Tagil)

Purpose

- replacement of worn out and obsolete process and electric equipment of bulk materials and ferroalloys handling system and materials handling systems of converters and ladles.
- enhancement of batching system accuracy. Relative accuracy of materials batching is not exceeding 0,5 % of the total batch weight;
- a level-up of the production process considering the latest operational and environmental requirements;
- materials feeding to the day bins is supported through bypass material handling line with SICON folding belt;
- automated charging of the materials into converters within preset cycles as a part of a fully automated converter steelmaking process (converter tilting drive, lance travel devices, oxygen supply system, heat recovery system and deducting system).

Scope of works and services

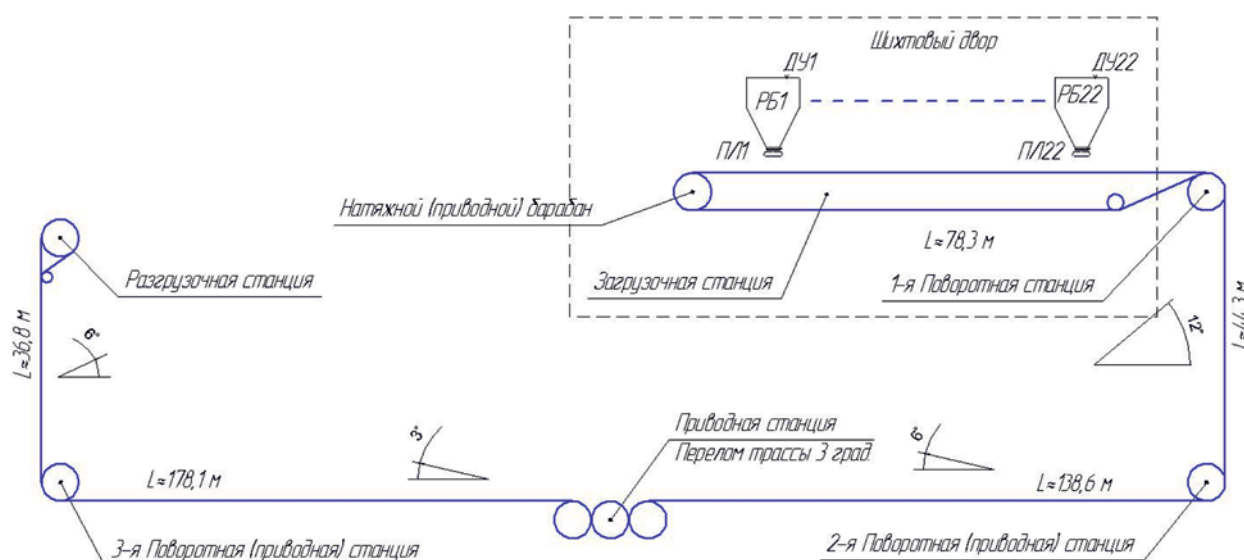
SME «TEC» being a contractor of Siemens VAI has performed the following works under this project:

- pre-engineering including several options of the process line design;
- development of process requirements for the line;
- basic and detailed engineering of the process, civil and automation parts of the project;
- development of project documentation within the scope of SME «TEC» works with its further approval by «Gipromez» LLC;
- installation of bypass handling system and material feeding lines to converters of BOS # 1;
- engineering, manufacturing and supply of process and automation equipment;
- installation supervising and commissioning.



Special features and forecast efficiency

- the revamping was performed step by step and without shutdown of the main production process;
- the SICON conveyor gallery (self-supported pipe) of the bypass material handling system resulted in minimum construction loads onto the existing structures of the workshop. The SICON conveyor ensured a dust-free transportation of the materials in combination of a compact design within the existing buildings of the workshop;
- fully automated charging cycle according to preset priorities was implemented;
- a flexible control of the handling system performance depending on the route (direction) of the materials was implemented;
- the batching system was equipped with a weighing bin as an intermediate one to ensure the automated accuracy control of the belt conveyors during the converters charging and automated calibration of those conveyors;
- a force applying module in combination with force measuring system was implemented to control the accuracy of the belt weighing units;
- an opportunity of simultaneous (any batching device may be started any time as per the set cyclogram) materials batching from all available day bins resulted in on-time material batching and converters charging without any «salvo» charges making the production process smooth, with reduced emissions, less skull on the converter mouth and also making the whole workshop performance higher;
- all the units and devices were united in a network with an opportunity to perform diagnostics of any single unit or device (motor, drive, sensor etc.).



«SICON» Conveyor gallery - bypass handling line

Alloying and additives system for Ladle furnace

Customer

JSC «Nizhniy Tagil Iron and Steel Works»
(Russia, Nizhniy Tagil)

Purpose

The system is used to charge alloying, bulk materials and additives into the ladle furnace to finalize a steel grade chemical composition.

Scope of works and services

- development of a process project;
- manufacturing and supply of process equipment;
- civil, installation and commissioning works.

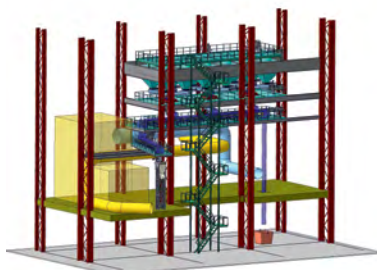
The process line consists

of the following equipment

- discrete action batchers with a weighing control system for bulk materials;
- slide gates;
- belt conveyors;
- vibration feeders.

Data sheet

- the system performance output – 100 m³/hour;
- the batchers accuracy class –0,5 as per the requirements of GOST 8.610-2012;
- maintaining a component rate $\pm 1\%$.



Steel slag sorting line

Customer

CJSC «Stroikompleks» (Russia, Nizhniy Tagil)

Purpose

Sorting of steelmaking slag per fractions, separation of metallic inclusions.

The process line consists of the following equipment

- discrete action batchers for dry bulk materials with weighing system control;
- slide gates;
- belt conveyors;
- vibration feeders.

Scope of works and services

- development of a process project;
- development of engineering documentation;
- design safety review;
- manufacturing and supply of process equipment and steel structures;
- installation supervising and commissioning.

Data sheet

- the system performance output – 160 t/hour;
- initial slag fraction 0...700 mm;
- product:
 - concentrated metal with fraction up to 100 mm with Fe content at least 86%;
 - iron containing concentrate with fraction from 10 up to 100 mm and Fe content at least 40%.



Raw materials

Vanadium slag processing area

Customer

JSC «EVRAZ NTMK» (Russia, Nizhniy Tagil)

Purpose

Processing of vanadium slag and extraction of metallic inclusions. Production output:

- not lower than 135 000 tpa (rated output is 18 t/hour) of incoming slag when producing slag with fractions 0...50 mm;
- not lower than 50 000 tpa (rated output is 7 t/hour) of incoming slag when producing limestone & vanadium mixture.

The process line consists of the following equipment

- receiving and storage bins;
- conveyor transportation system;
- rotary crushers;
- magnetic separators;
- ball crusher;
- air centrifugal dynamic classifier;
- weighing and batching equipment;
- dedusting system.

Location

JSC «EVRAZ NTMK» Foundry shop

Commissioned in November 2016.

Scope of works performed under the project

- development of crushing and griding technologies, as well as those for transportation, acceptance, sampling and samples preparation, big bag packing, storing and shipment of vanadium slag;
- design and survey works including designer's supervision;
- expert opinion on the industrial safety of the project and authorization issued by Rostekhnadzor UrFO;
- manufacturing/selection and supply of the equipment for crushing, grinding, transportation, acceptance, big bag packing and final product storing;
- civil and installation works including new foundations for crushing and grinding equipment, supporting structures manufacturing and installation, piping and cabling works from take-over points within the plant area, installation of the process equipment;
- supplied equipment start-up and commissioning;
- consulting services on the equipment operation rendered to the Customer's staff.



Pilot commercial plant for hydrophilic aluminum powder granulation

Customer

LLC «SUAL-PM» Russia
(Shelekhov, Irkutsk region)

Purpose

The pilot commercial is designated for hydrophilic aluminum powder granulation. The production output is 20 kg/hour (as per the wet product).

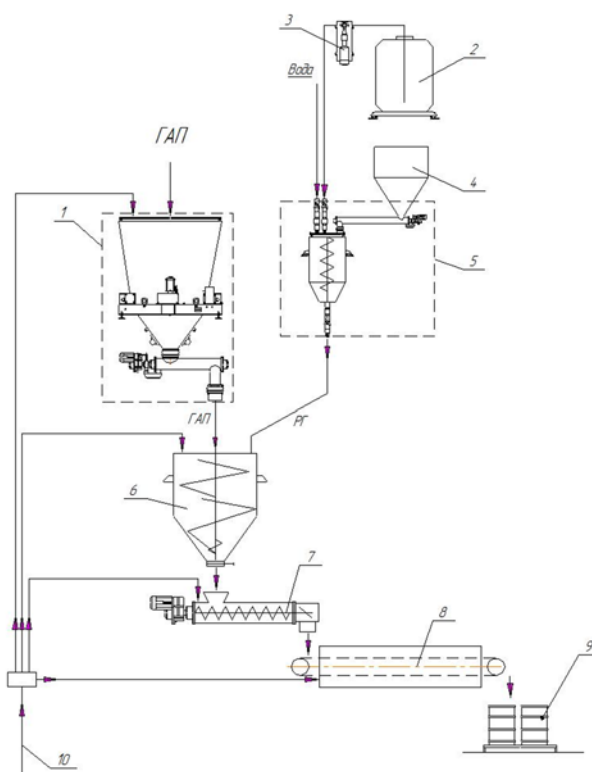
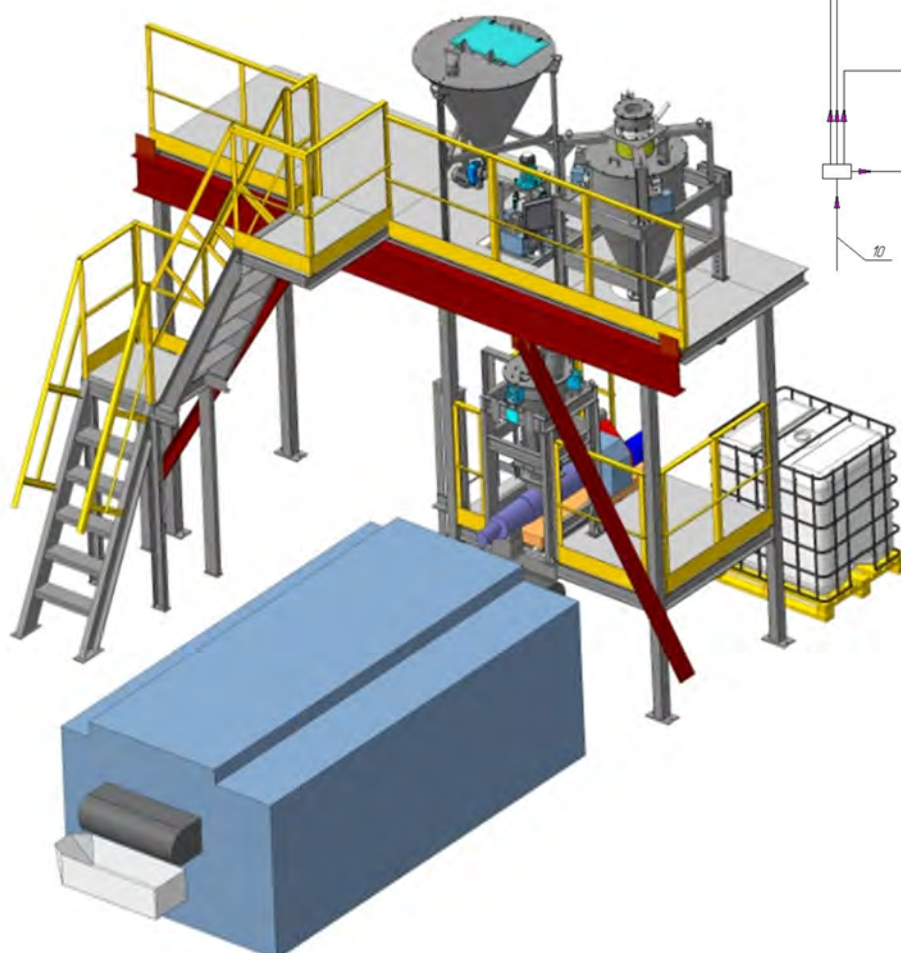
The process line consists of the following equipment

- receiving and storage bins;
- weighing and batching equipment;
- intense action mixer;
- screw type granulating plant;
- drying chamber.

Commissioned in March 2017.

Scope of works performed under the project

- development of granulating process;
- development of technical documentation;
- manufacturing/selection and supply of the granulating equipment;
- supplied equipment start-up and commissioning;
- consulting services on the equipment operation rendered to the Customer's staff.



Process lines for JSC «TNK «Kazhrom»

Customer

Aksuskiy ferroalloys plant of JSC «TNK «Kazhrom»
(the Republic of Kazakhstan, Aksu)
Akubinskiy ferroalloys plant of JSC «TNK
«Kazhrom» (the Republic of Kazakhstan, Aktubinsk)

Purpose

Improvement of ferroalloys furnaces performance
by replacing the obsolete and worn-out process
and electric equipment of the batching units.

- Batching units (BU) of continuous batching area:
 - BU-1, 2 of the workshop № 6; BU-1, 2, 3 of the workshop № 1;
 - BU DPPTU at Aksuskiy ferroalloys plant, Aksu;
 - Sintering plant at Aksuskiy ferroalloys plant, Aksu;
 - BU-2 of the workshop № 1 at Akubinskiy ferroalloys plant, Akubinsk

The total number of continuous action batchers within the process lines exceeds 150 pieces.

- Batching areas of split batching and materials charging into the furnace:
 - BU-1, BU-2, BU-3 of the workshop № 2;
 - BU-1, 2, 3, 4, 5, 6, 7, 8 of the workshop № 4 at Aksuskiy ferroalloys plant, Aksu;
 - Sintering plant at Aksuskiy ferroalloys plant, Aksu;
 - BU-24, BU-27 of the workshop № 2 at Akubinskiy ferroalloys plant, Akubinsk.

The total number of split batchers within the process lines exceeds 100 pieces.

Special features of the process lines

The supplied and commissioned equipment of the process lines of continuous and split batching ensure the following:

- high accuracy of the materials batching:
 - for continuous batchers accuracy is $\pm 0,5\%$ as per the requirements of GOST 30124-94;
 - for split batchers accuracy class is 0.5 according to GOST 10223-97;
- **guaranteed maintaining of the charged materials rate as per preset receipt by means of ASAB (adaptive system of automated batching) system within $\pm 1\%$;**
- minimum influence of «chocking-up and improper descent» of the materials in the storage bins through automated activation/deactivation of the batchers and implementation of «start-stop» mode of each batcher operation;
- automated correction of the receipt upon the values of a reducing agent moisture and the content of the main ore component.



Unshaped materials production line №2 and runner castables

Customer

LLC «Magnezit-torkret-massy» (Russia, Satka)

Purpose

The process line is designated for the production of unshaped materials with an annual output of 15 000 tons. Number of components - 8. Maintaining of components rate with ± 1 % accuracy.

The process line consists of the following equipment

- continuous action batchers for dry components;
- screw type feeders;
- elevators;
- worm type conveyors;
- slide gates.

Scope of works and services

- designing, manufacturing and full scope supply of the process lines;
- installation supervising and commissioning.



Batching and process automation equipment for manufacturing of corundum-graphite products

Customer

JSC «Pervouralskiy dinasoviy zavod» (JSC «DINUR»)
(Russia, Pervouralsk)

Purpose

Process line and automation system of the batching area are designated to prepare a preset receipts of a multicomponent mixture for manufacturing of corundum-graphite products.

Scope of works and services

- designing of a process and automation system projects;
- manufacturing and full scope supply of the line;
- installation supervising and commissioning.

Data sheet

- the production output of the line operating three mixers is 5,85 t/day;
- accuracy of each component batching is 0.2 as per the requirements of GOST 10223-97;
- transport car speed is 0.3 m/sec;
- lifting table:
 - lifting speed is 20 mm/sec;
 - screw full pitch is 200 mm;
 - lifting capacity is 2500 kg.



Revamping of ferromolybdenum production workshop

Customer

CJSC «Kamyshinskiy liteino-ferrosplavniy zavod»
(Russia, Kamyshin)

Purpose

The process and control system of the briquetting area and material to furnace charging area are designated:

- to control the briquetting process and to batch materials to furnace;
- to supervise the batching and furnace charging processes, record the current system status, process the emergency situations, generate interlocks and alarms.

Scope of works and services

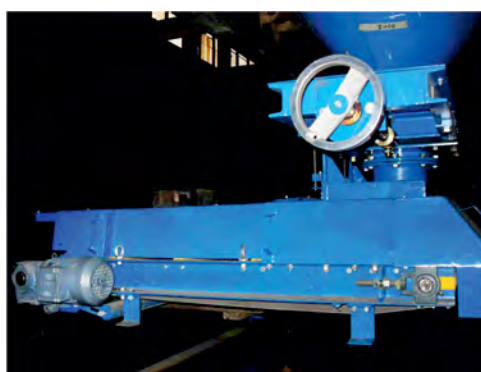
- survey of the existing foundations, steel structures, buildings and rooms, diagnostics of the re-used equipment;
- designing of a process and automation system projects;
- development of civil works and interfacing parts requirements;
- manufacturing and supply of process equipment;
- installation supervising and commissioning.

The process line consists

of the following equipment

The ferromolybdenum workshop is to produce 100 t/month of FeMo grade FMO and is equipped with the following process units:

- preparation area of briquetted charging materials:
 - continuous action weighing batchers for dry components;
 - continuous action weighing batcher for liquid state components;
 - slide gates;
 - screw type feeders;
 - belt type feeders;
 - intensive action mixer;
 - briquetting press;
 - throw screen;
 - drying furnace;
- furnace charging area:
 - continuous action weighing batchers for dry components;
 - slide gates;
 - screw type feeders;
 - rotary-valve feeders;
 - charging manipulator.



Carbon containing briquettes production plant

Customer

LLC «Promyshlennoe pazvitie» (Russia, Barnaul)

Purpose

Processing of coke and stone coal screenings to produce coke-coal fuel briquettes. The project is to solve the issues related to recycling of process wastes and namely coke screenings and coke fines generated at coke-making and chemical plants.

The process line consists of the following equipment

In general there are the following areas within the plant:

- bulk materials acceptance area;
- binding materials acceptance area;
- bulk materials storage area and charging preparation area;
- press area and briquettes drying area;
- finished product storage area;
- plant infrastructure (boilerplant, administrative buildings, laboratory, etc.).

Scope of works and services

- SME «TEC» being a general designer of the project has developed the project and engineering documentation for all sections;
- follow-up of the project documentation State opinion.

Special process lines' features

One of a kind patented process line for production of carbon containing briquettes.

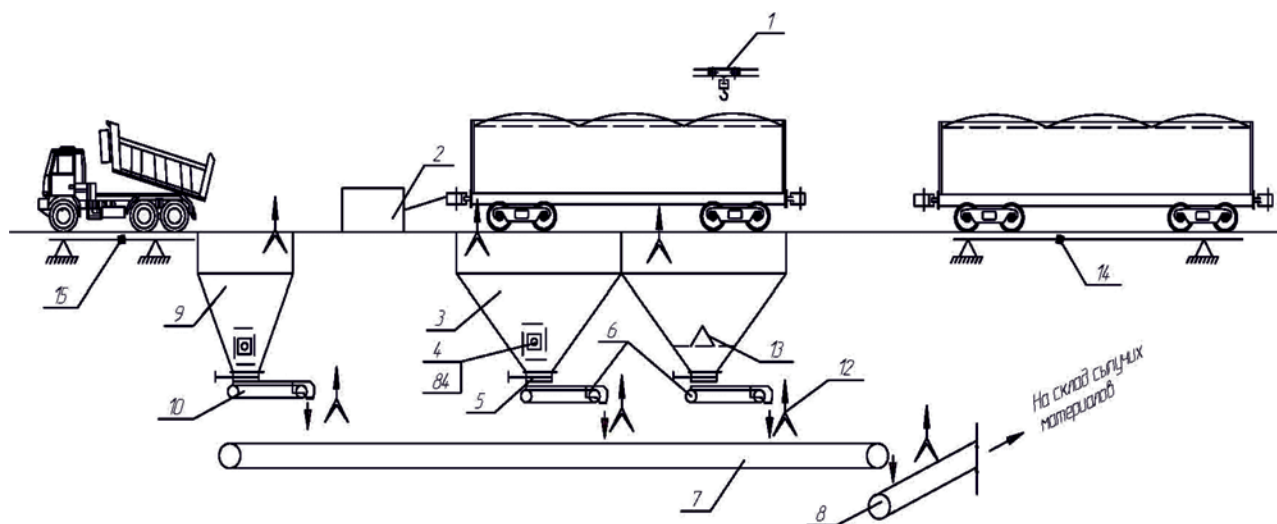
Data sheet

| Materials consumption rate for production of 1 ton of briquettes | | | |
|--|-----------------------|----------|---------------|
| Coke fines (class 0-8 mm) and coke screenings | Stone coal screenings | Molasses | Rape-seed oil |
| 1.074 | 0.05 | 0.103 | 0.015 |

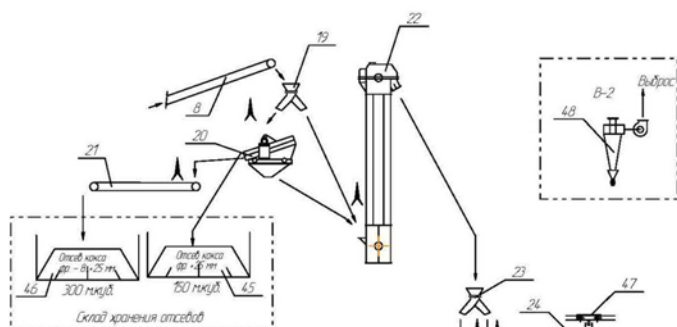
| The plant's products | | | |
|----------------------|--------|--|---------|
| Briquettes, tons | | Screened coke fraction (+8 – 25) mm and +25 mm, tons | |
| month | year | month | year |
| 7 000 | 84 000 | ~1100 | ~13 200 |



Plant units. Structure

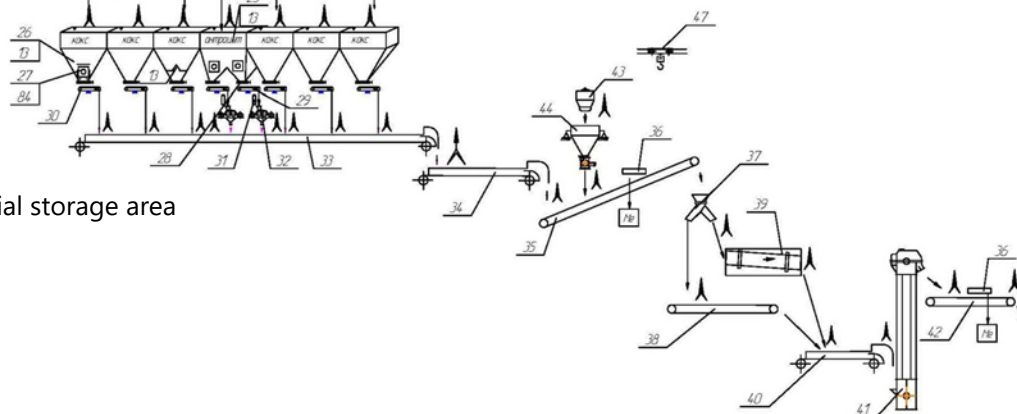


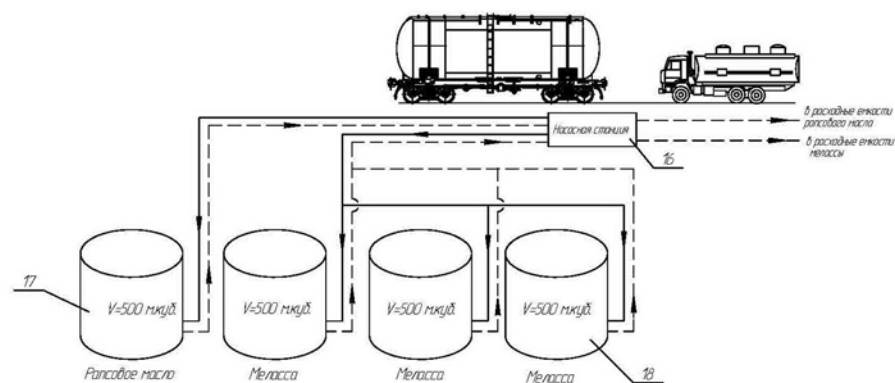
Bulk materials acceptance area



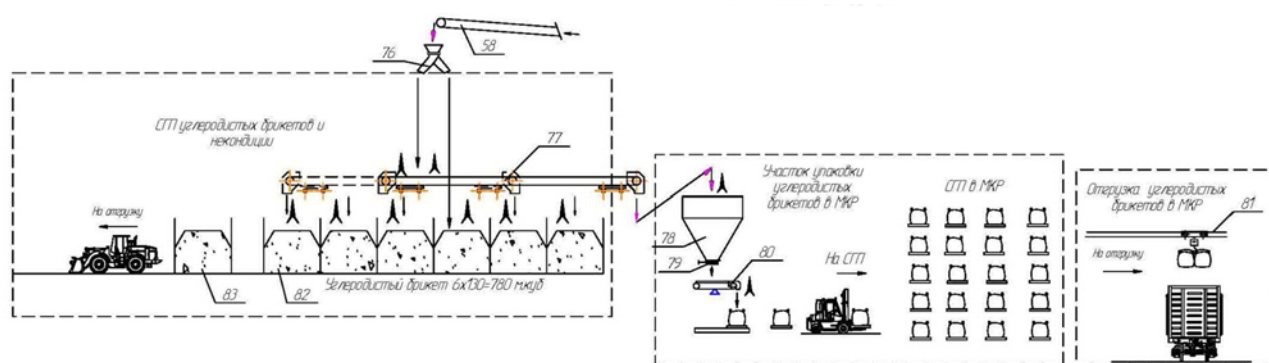
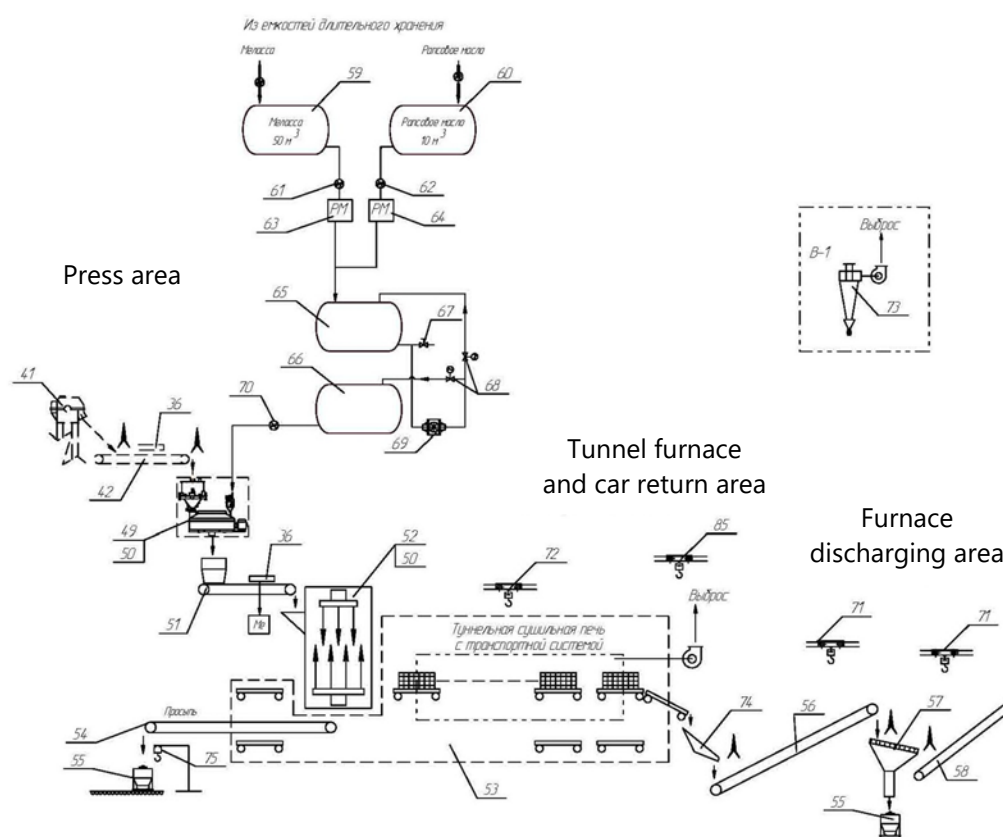
Charge materials heating area

Bulk material storage area

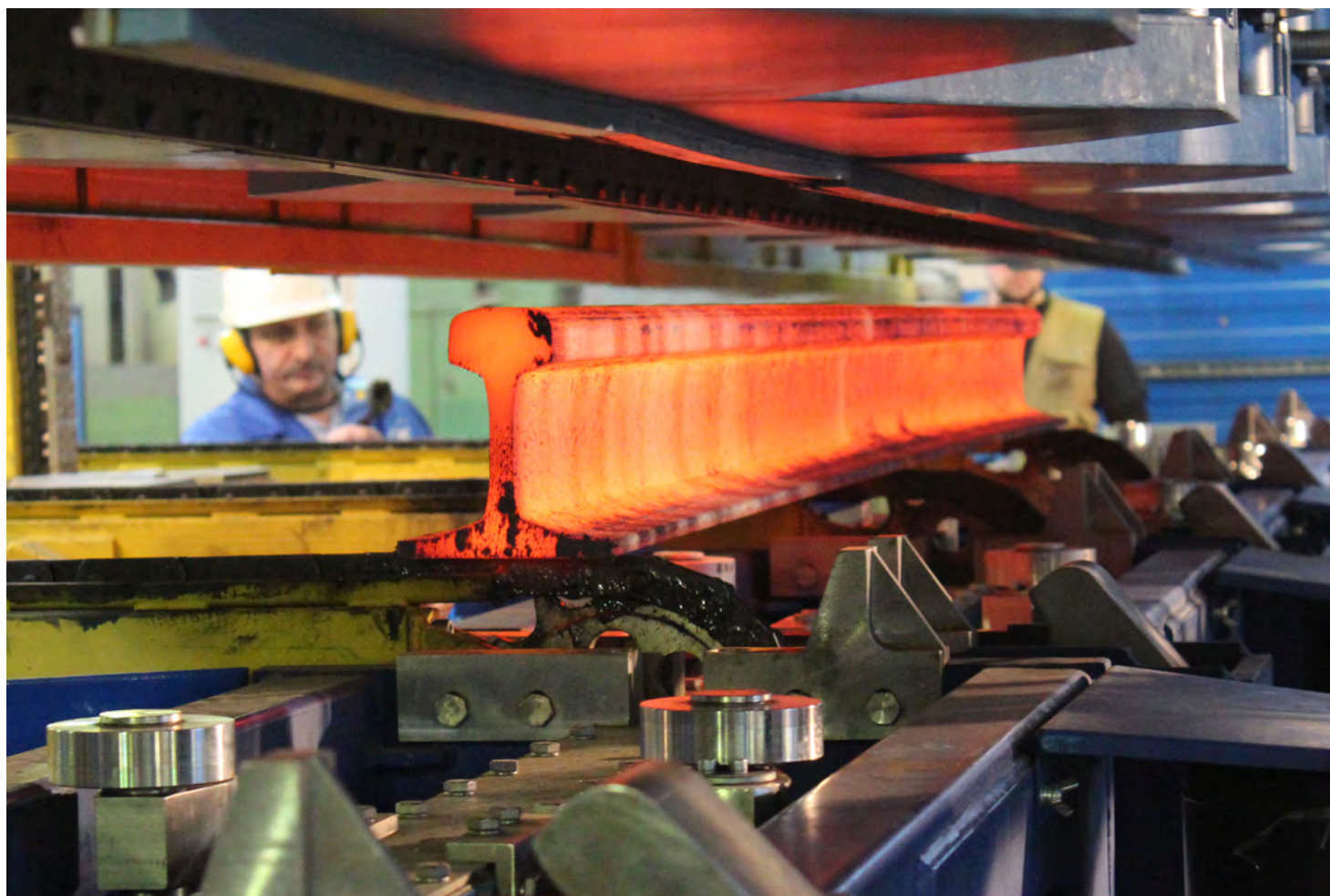




Acceptance and storage area of binding materials



Finished product storage



Package solutions for rolling productions

SME «TEC» offers the following:

- grinding balls production lines;
- process lines for rolling production;
- heat treatment lines and units for railway wheels, bushes, bolsters, pipes and other steel rolled products;
- robotic transportation lines and integrated automation of rolling lines.



Process lines for rolling productions

Under the hard market competition the quality of the products play a significant role in the financial success of any production. Besides the operational reliability and safety of railway infrastructure directly depends on the rolled products quality. Since 2005 SME «TEC» is busy in development of non-destructive control of rolled products for transport building companies within the terms of national and international requirements becoming tougher and tougher.

The final inspection lines 1 and 2 for testing and acceptance of railway wheels in JSC «Nizhniy Tagil Iron and steel works» were the first projects in this field. The cooperation with European companies and institutes was the next development step. Since 2010 the Company is involved into establishment of a Competent center in cooperation with the following companies: RESA (Germany), AREVA (France), IntellegENDT (SIEMENS& AREVA) and Fraunhofer Society institutes IZFP, IPA and IIS. Within the Competent Center the participants are engaged to development of the state-of-the-art process solutions in the field of non-destructive testing for steelmaking, nuclear and oil&gas industries:

- for steelmaking industry - quality control of the products ensuring the required production performance;
- for oil&gas industry – control of valves operation and pipelines state;
- for nuclear industry - control of valves operation and pipelines state including defect inspection when a human presence is not allowed.

Все это позволило нашему предприятию с As a result of this development the solutions have been promoted within the Chinese market and in 2011 SME «TEC» started to realize the project of final inspection line for high speed trains railway wheels for MaSteel corp. Magan (China). The line was successfully commissioned in December 2012.

These are the main requirements for lines and units that assure the quality of the products:

- compliance to national and international standards;
- opportunity to perform the full scale process control operations under different methods (depending upon the type of products);
- keeping the high production output.

All operations are performed at high automated level and some of them are fully automated. The lines and units are equipped with state-of-the-art process automation (built onto the equipment of worldwide controller manufacturers) with a developed hierarchy and integration into the existing systems. Besides the final inspection lines SME «TEC» develop and supply products transportation lines (PTS) to transport the products.



Automated final inspection line
of railway wheels in JSC «NTMK»
Wheel and tire shop

SME «TEC» is experienced in development and implementation of quality equipment in cooperation with different manufacturers:

- internal soundness control at immersion type ultrasonic testing machines – in cooperation with Fraunhofer-Gesellschaft IZFP (Germany);
- surface defect at fluorescent magnetic particle testing machines - in cooperation with SME «INTROTEST»;
- flat products dimensional parameters inspection at SIG units (geometry measurement system) – the in-house developed solution.

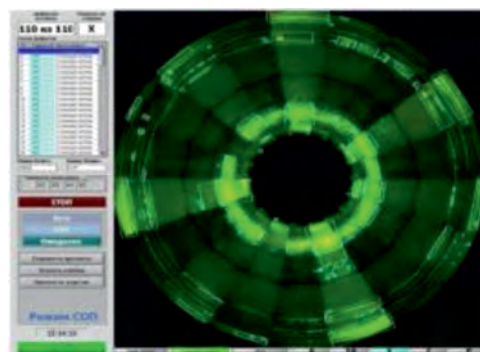


The system of rolled steel sheets dimensional control at JSC «Vyksa steel works»

Non-destructive testing equipment

In cooperation with partners SME «TEC» develop and supply the nob-destructive testing equipment and lines for rolled products that may have the following units:

- surface defects inspection units (magnetic particle testing, thermal image and eddy-current testing);
- internal flaws detection;
- dimensional control.



Surface defects inspection equipment

is developed and manufactured in cooperation with SME «INTROTEST»



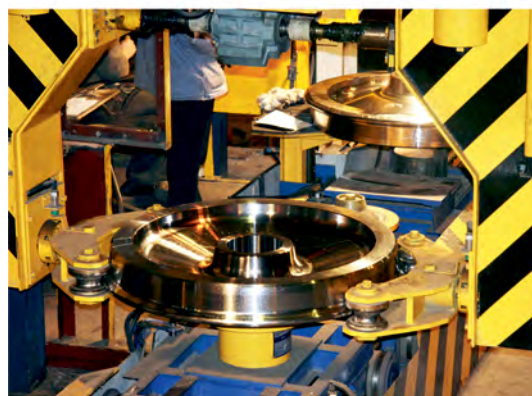
Equipment features

| | |
|---|-------------------------------|
| General data | |
| - testing method | fluorescent magnetic particle |
| - testing practice | applied field process |
| - minimum length of a conditional flaw, mm | 4 |
| - minimum depth of a conditional flaw, mm | 4 |
| - minimum width of a conditional flaw, mm | 25 |
| - power consumption, kW | 120 (380 В, 50 Гц) |
| - accidental reject products output by the equipment (from the number of rejected wheels), %, not exceeding | 0.01 |
| Data of the products to be inspected | |
| - overall dimensions (WxHxL), mm | 500 x 500 x 2000 |
| - weight, kg | 3000 |
| Output capacity | |
| - operation cycle, sec | 120 |

Railway wheels final inspection lines LVK-1 and LVK-2

In 2005 SME «TEC» as a General project contractor started the construction of final inspection line LVK-2 in the Wheel and tire shop of JSC «Nizhniy Tagil Iron and Steel works». The performance guarantees of the line were successfully achieved in August of 2007. The project was executed in partnership with the following companies: Wheelabrator Group (Toronto, Canada), SME «INTROTEST» (Ekaterinburg), NII LKPs OMZ «Viktoria» (Khotkovo), Fraunhofer-Gesellschaft (Germany).

At the same time in September 2005 SME «TEC» started the revamping project of the existing final inspection line # 1 aimed to extend the functions of the line and unify the equipment with the new wheels final inspection line of JSC «Nizhniy Tagil Iron and Steel works». The main targets of the project were to add a shot blasting unit (for railway wheel plate shot peening) and an anti-corrosion coating unit with no shutdown of the line operation. The revamping works were successfully completed and the LVK-1 was commissioned in the late 2007.



Functions performed at LVK-1 equipment

The process operations that are performed at LVK-1 equipment:

- transportation of the railway wheels through the final inspection line and namely:
 - wheels' handling;
 - wheels loading/unloading into and out of process plants;
 - wheels preparation for overhead crane handling (pile or cassette stacking);
 - pile staking of rejected wheels by flaw type.
- wheel surface chemical cleaning;
- shot peening of wheel plate;
- anti-corrosion coating of wheel plate;
- process informational support.



Functions performed at LVK-2 equipment

The process operations that are performed at LVK-2 equipment:

- transportation of the railway wheels through the final inspection line and namely:
 - de-piling of the wheels onto the transportation line;
 - wheels' handling;
 - wheels loading/unloading into and out of process plants;
 - wheels preparation for overhead crane handling (pile or cassette stacking);
 - pile staking of rejected wheels by flaw type;
- wheel surface chemical cleaning; Wheel marking identification;
- visual surface flaw inspection and dimensional inspection of the wheels;
- ultrasonic testing of the wheel internal soundness;
- surface flaw inspection by magnetic particles;
- wheel rim hardness inspection;
- shot peening of wheel plate;
- anti-corrosion coating of wheel plate;
- process informational support.

Upgrading of railway wheels final inspection lines LVK-1 and LVK-2

The upgrading of railway wheels final inspection lines LVK-1 and LVK-2 included the installation of additional equipment to perform magnetic particles inspection of 100 % wheels. This was a «turn-key» project.

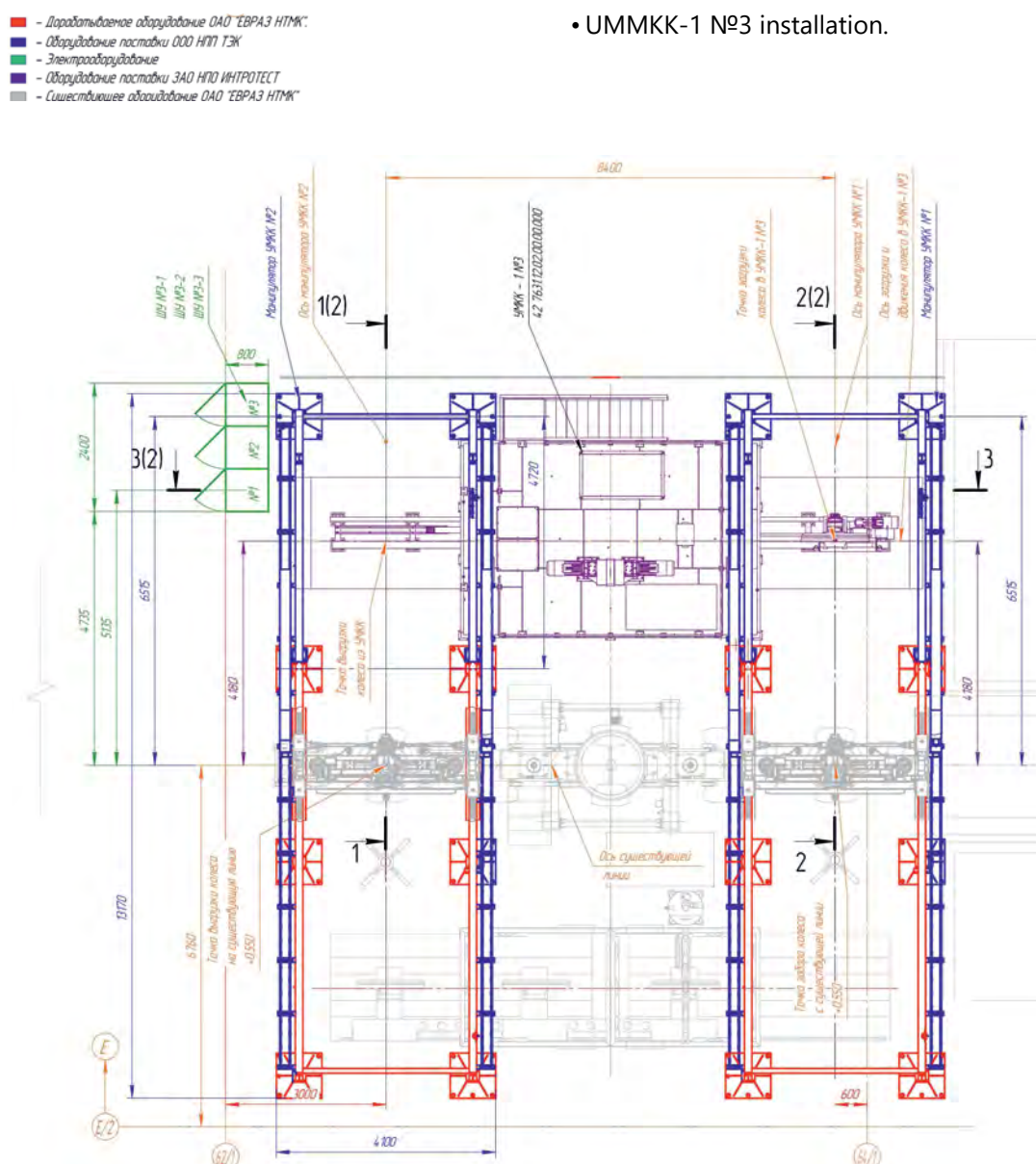
The project was executed in partnership with SME «INTROTEST» (Ekaterinburg). The project was implemented onto the operating loiles LVK-1 and LVK-2 without production shutdown.

Within this project SME «TEC» performed the following works:

- development of project and design documentation;
- equipment manufacturing;
- equipment supply;
- upgrading of the existing software of LVK №1 and 2;
- installation works;
- commissioning works.

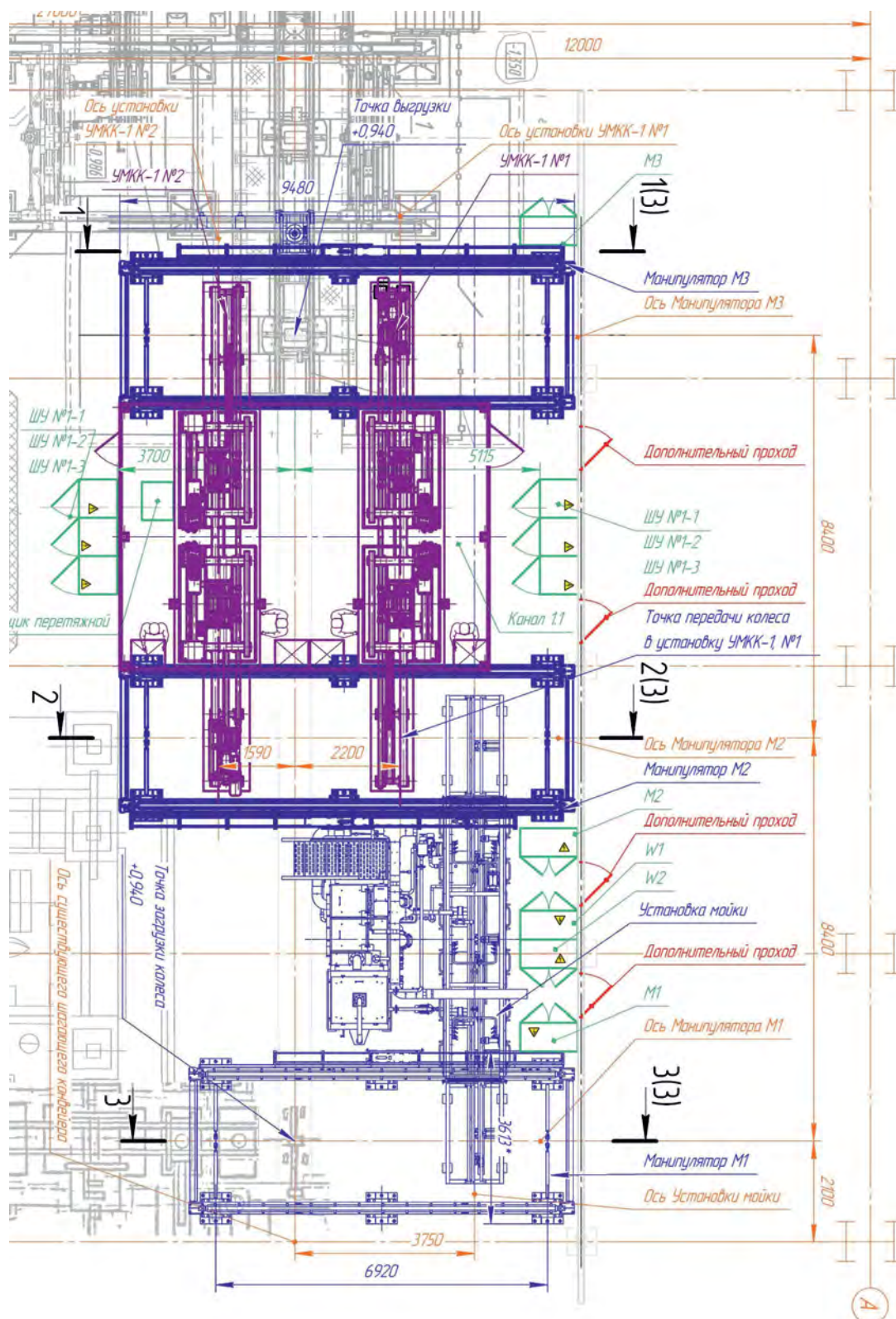
Equipment supplied to LVK №2

- UMMKK-1 №3 installation.



Equipment supplied to LVK №1

- Manipulators M1 / M2 / M3;
- Railway wheels washing plant;
- Plants UMMK-1 №1 / №2.



LVK №1 Layout

Inspection line of railway wheels for high speed trains MAANSHAN IRON & STEEL COMPANY LIMITED

Since May 2011 till February 2012 SME «TEC» was involved into the execution of high speed railway wheels process and inspection line project for the company Maanshan Iron & Steel Company Limited (Maanshan, China).



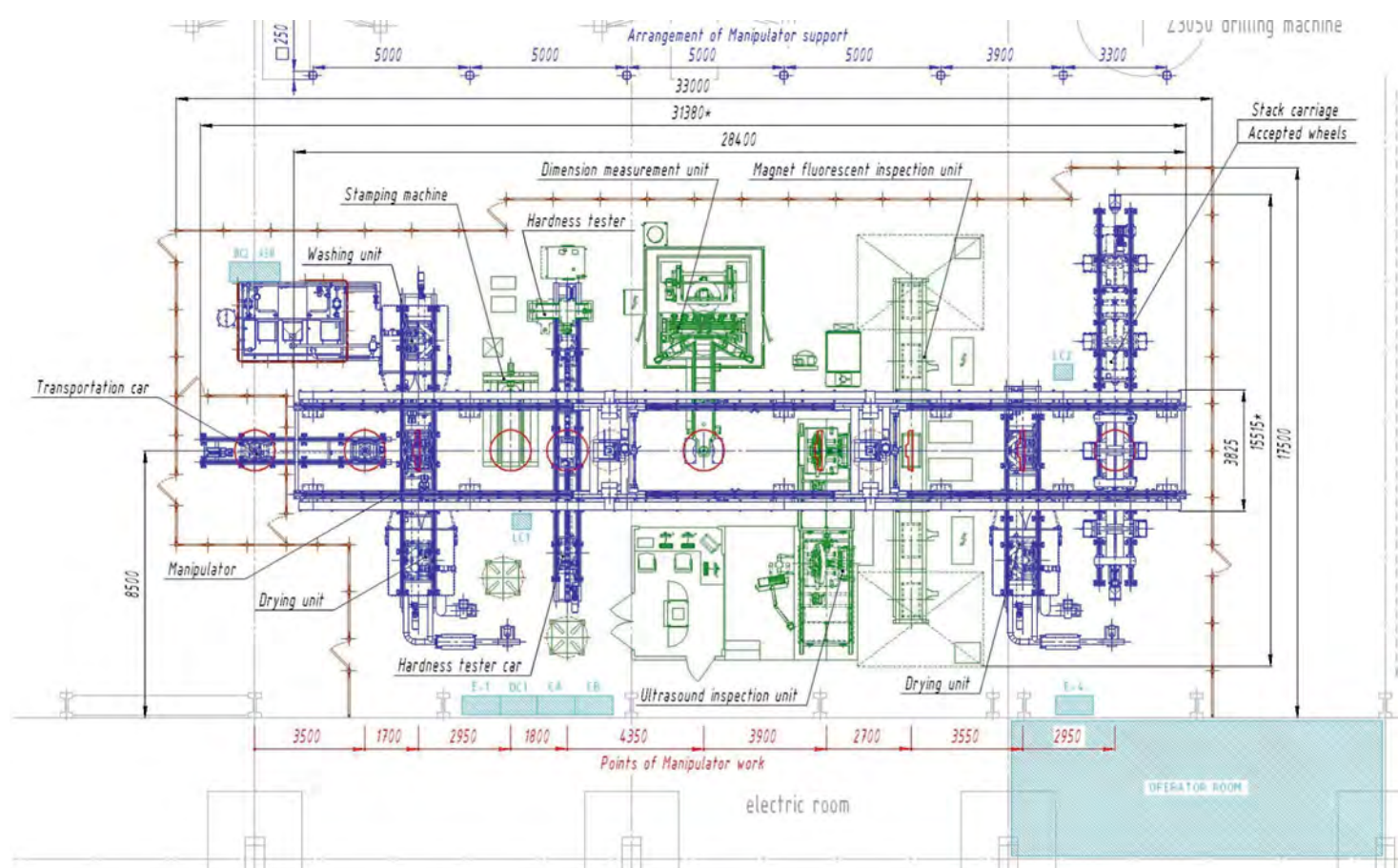
In terms of this project SME «TEC» developed project and design documentation, manufactured and supplied robotized transportation line (27,4 m length), wheels loading and unloading equipment with the process line. The process units for high speed trains wheels surface preparation ere also designed and installed. The whole equipment was commissioned successfully.

The line equipment is listed below:

- Manipulator (TEC, Russia)
- Wheel washing unit (TEC, Russia)
- Hardness testing machine (Laizhou Huayin, China)
- Marking stamping machine (China)
- Dimensional inspection unit (Mermec, Italy)
- Ultrasonic testing plant (NDT, Canada)
- Unit of fluorescent-magnetic particle inspection (China)
- Wheel drying unit (TEC, Russia)
- Wheel painting unit (TEC, Russia)
- Transportation cars (TEC, Russia)

Process line parameters

| | |
|---|----------------|
| Operation cycle, sec/wheel | 300 |
| Diameter of wheels under inspection, mm | from 770 up to |
| Maximum wheel weight, kg | 1000 |
| Production capacity, pieces/year | 100 000 |
| Positioning accuracy in all axis, mm | 0.5 |



Railway wheels processing and inspection line for Tangshan Wenfeng Shanchuan Train Wheel Co., LTD

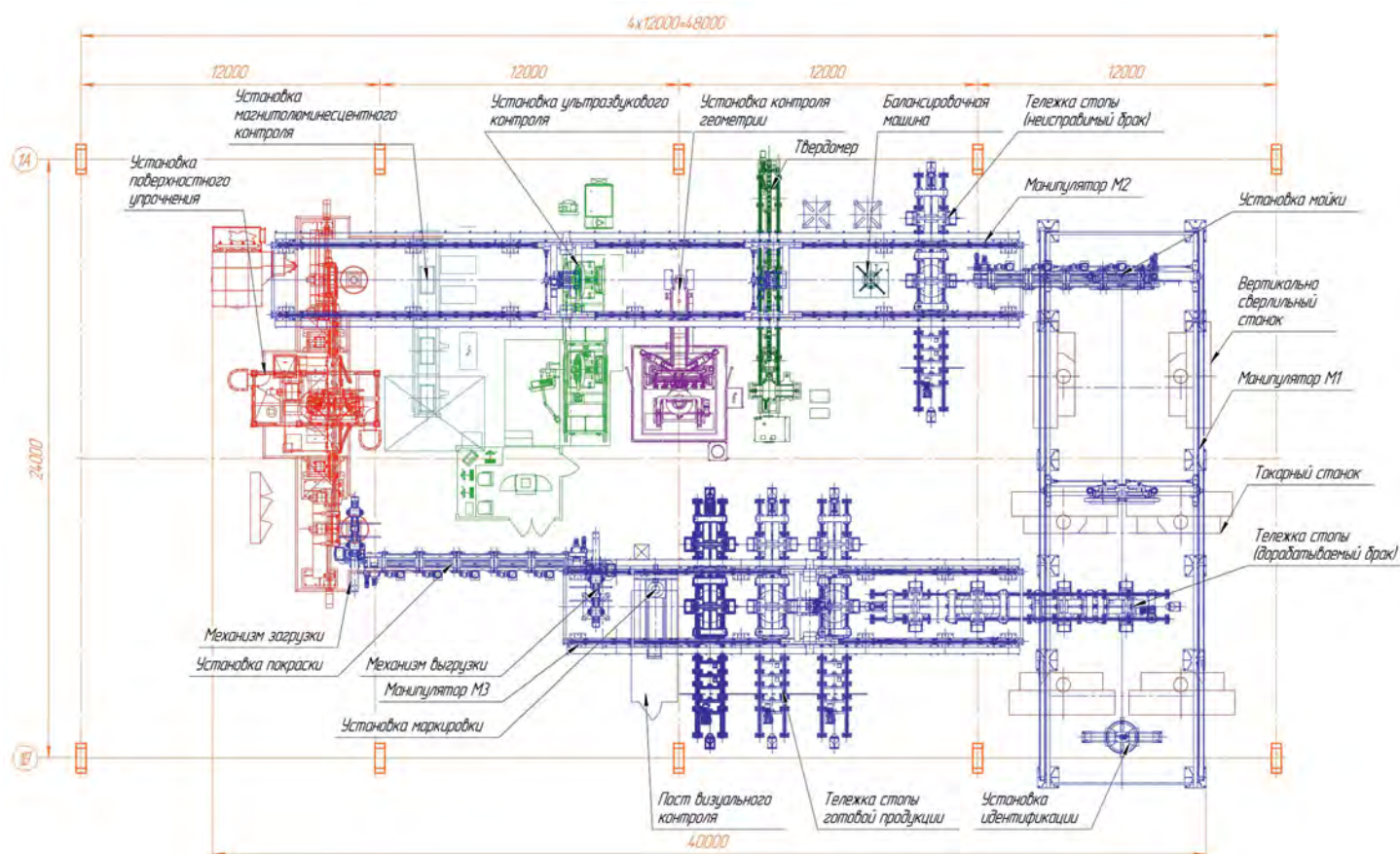
SME «TEC» has developed an offer for high speed processing and inspection line for Tangshan Wenfeng Shanchuan Train Wheel Co., LTD Company (Tangshan, China). A special feature of that line is an opportunity of rejected wheels re-processing.

The line equipment is listed below:

- identification machine (TEC, Russia);
- manipulators (TEC, Russia)
- upright drilling machine (PITTLER, Germany);
- lathe machines (PITTLER, Germany);
- wheel washing unit (TEC, Russia)
- balancing machine (Hofmann, Germany);
- hardness testing machine (Laizhou Huayin, China)
- dimensional inspection unit (Mermec, Italy)
- ultrasonic testing plant (Fraunhofer, Germany)
- unit of fluorescent-magnetic particle inspection (Karl Deutsch, Germany);
- wheel surface shot peening plant (Wheelabrator, Canada);
- wheel painting unit (TEC, Russia)
- transportation cars (TEC, Russia)
- wheel loading/unloading devices into/out of process units (TEC, Russia).

Process line parameters

| | |
|---|------------------------|
| Operation cycle, sec/wheel | 300 |
| Diameter of wheels under processing, mm | from 770 up to 1250 |
| Production capacity, pieces/year | 100 000 |



Wheels processing and inspection line for Taiuan

The final inspection line is designated for automated acceptance of railway wheels (including acceptance tests) after full scale machining of the railway wheels in compliance with international standards requirements.

Output capacity

| | |
|--|---------|
| Standard railway wheels, pcs/year | 350 000 |
| High speed CRH3 railway wheels, pcs/year | 50 000 |
| Cycle of a wheel output, sec/wheel | 60 |
| High speed CRH3 railway wheels output, sec/wheel | 300 |

The purposes of final inspection line project

The main project target is the development, installation and commissioning of an automated final inspection line with state-of-the-art equipment that ensures the following:

- enhancement of railway wheels quality;
- increase of production output of higher wear resistance railway wheels;
- full automaton of the railway wheels acceptance testing process:
 - railway wheels washing and drying;
 - wheels transportation through the process area (unstacking, handling, piling or cassetting, rejected wheels piling);

- wheels disbalance control;
- dimensional control of the railway wheels;
- wheel rim hardness inspection;
- visual inspection of the wheels surface defects;
- ultrasonic inspection of internal wheel soundness;
- surface flaw inspection by magnetic particles;
- wheel hardening shot peening;
- anti corrosion coating;
- diameter marking on the wheel surface;
- ID marking on the wheel surface;

- information support with a generation of full electronic wheel passport including all wheel parameters (coating, shot peening, internal structure etc.) and wheel travel along the handling system;
- automated control of the final inspection line operating parameters;
- acquisition, processing, transfer and storage of the line process equipment data;
- visualization of process parameters and generation of the current status reports to the operating and maintenance staff of the line in terms of inspection line operating parameters;
- fully automated and remote control of the line equipment.



Heat treatment lines

Robotized wheel and tire heat treatment complex

In November 2007 SME «TEC» in cooperation with the German company Andritz MAERZ GmbH started to develop transportation line and manipulators for heat treatment line of railway wheels and tires within the frame of the third revamping stage of wheel and tire production at JSC «Nizhniy Tagil Iron and Steel works». The first stage of the process line was commissioned the 22nd December 2008.

The robotized line of the heat treatment area is designed to handle and transport the below listed products within heating, quenching and tempering equipment:

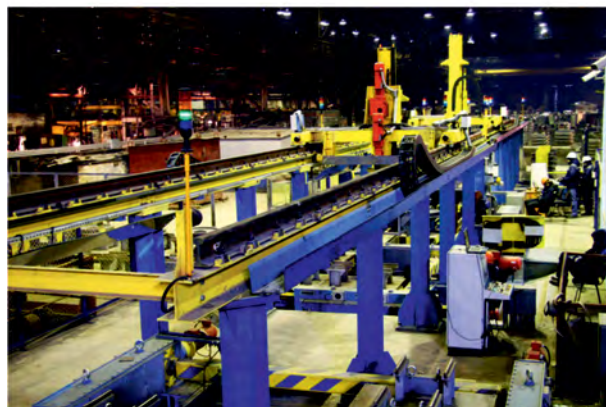
- railway wheels feedstock from 710 mm up to 1260 mm diameter according to GOST 9036-88, GOST 10791-2004;
- export wheels feedstock according to UIC 812, M107/M208;
- crane and other equipment wheels feedstock from 710 mm up to 1260 mm diameter according to TY 14-15-199-89, TY 14-102-170-96;
- rolling stock, locomotive and subway carbon steel tires according to GOST 5000, UIC, ASTM;
- gear wheels feedstock according to GOST R51220.

Feedstock and tire materials:

- wheel steel as per GOST 10791;
- steel 20 – steel 60 as per GOST 1050;
- 45XH steel grade as per GOST 4543;
- steel grades 55Φ as per GOST R51220; UIC812; BS; M 107; GB 1804; TB/T2708; T as per TY 0943-209on-01124323-2005.

Feedstock weight:

- from 280 kg up to 1200 kg.



SME «TEC» performed the following works within the above mentioned project:

- equipment layout development and approval with the Customer including Andritz MAERZ GmbH scope of supply;
- making a civil works requirements by Andritz MAERZ GmbH in line with Russian standards and development of common civil works requirements for a complex;
- development of installation works estimated costs including the scope of Andritz MAERZ GmbH equipment;
- arrangement of installation works on the construction site and making an installation contract with a local installation company;
- generating reports and acceptance certificates of the equipment installation (KS-2, KS-3) for Andritz MAERZ GmbH;
- development of design documentation for and manufacturing of robotized complex equipment;
- commissioning works including connection to the existing press and rolling line.

The startup of the complex allowed achieving the following:

- To move from the production of wheels and tires 320 HB hardness to the production of those with stable hardness properties up to 360 HB.
- To assure that the feedstock temperature drop after the heating furnace does not exceed 50 °C through guaranteed transportation time of the feedstock from the heating furnace to the farthestmost quenching tables within 28 seconds (15 meters).
- To integrate the information system of the complex into the IT system of the workshop press and rolling line and the whole workshop thus assuring the information support from the heat start till the finished products are shipped to the Customers.



Data sheet

| | |
|--|------|
| Actual annual operating time, hours | 7436 |
| Rated output, pcs/hour | 100 |
| Rated line operation cycle, sec, not exceeding | 36 |
| Weight of the equipment supplied, tons | 500 |
| Power consumption, kW | 800 |
| Positioning accuracy, mm | 0,5 |
| Lifting capacity, kg | 5600 |
| Line capacity, pcs | 869 |

Differentiated rail heat treatment using «TEC-DT» process

Since 2007 SME «TEC» has been developing the rolled products heat treatment process. The main target here is the heat treatment of railway rails according to the requirements of GOST R 51685-2013, EN13674-1 and AREMA standards.

The SME «TEC» has developed a TEC-DT heat treatment process based on the control of air humidity level.

Under this TEC-DT process the steel cooling rate is from 2 up to 14 C/sec and could vary during the rail quenching process through the properties of the air cooling media by changing the air humidity by a desired law (gas media).

This process allows using standard carbon rails without adding chrome, vanadium or other alloying elements and achieve the properties of DT350NN, DT370IK and higher.

The TEC-DT process equipment is designed for heat treatment of all Vignoles rail types, including CWR and switch point rails with «heat treated» designation. The process allows also saving the alloying elements and manufacture «Luxe» rails with high wear resistance, low temperature reliability and controlled level of residual stresses.

The process and equipment for differentiated heat treatment of rails are patented on the territory of Russian Federation, CIS and Europe.



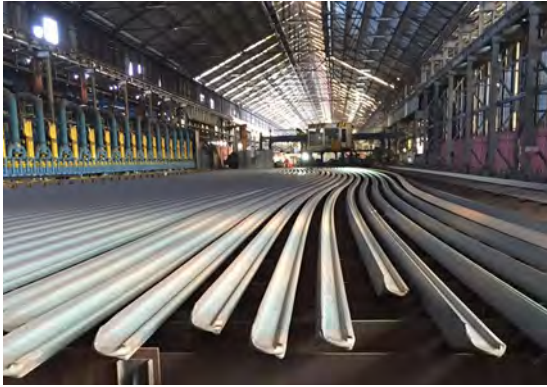
Patents

- RU № 2369646 «Differentiated heat treatment process of shaped rolled products including rails and the equipment to perform this treatment»
- RU № 2487177 «Process and installation for heat treatment of rails»
- RU № 2484148 «Process and unit for heat treatment of rails»
- RU № 2456352 «Process and installation for heat treatment of rails»



International patents and applications

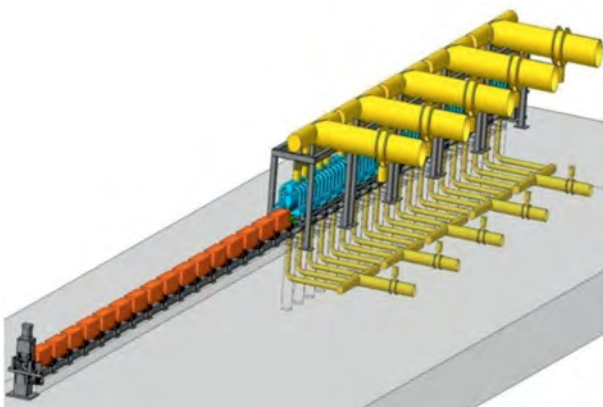
- WO2013/036166, EP2700724 «Process and unit for heat treatment of rails»
- EP2573 194 B1 «Process and installation for heat treatment of rails»



- **Installation for differentiated heat treatment of rails using rolling process heating TEC- DTP, charging type.** Application: heat treatment of Vignoles rails with a meter weight from 49 up to 70 kg. Length of rails to be heat treated: 25 – 120 m.

Compliance to standard: category DT350, DT-350NN, DT370IK as per GOST R 51685-2013, category R350HT, R350LHT as per EN13674-2011.

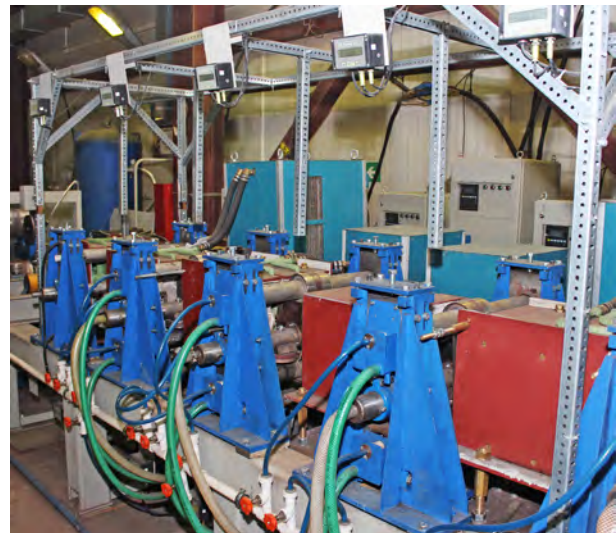
TEC-DTP production output amounts to 150 000 to 1 000 000 tons of rails per year. The TEC-DTP modularity in length allows producing heat treated rails with different length as may be required.



- **Installation for differentiated heat treatment of rails TEC-DTO using continuous induction heating.** Application: heat treatment of Vignoles rails with a meter weight from 49 up to 70 kg. Length of rails and continuous welded rails to be heat treated: 25 - 800 m. Compliance to standard: category DT350, DT350NN, DT370IK as per GOST R 51685-2013, category R350HT, R350LHT as per EN13674-2011.

Grace to the modularity the TEC-DTO production output amounts to 50000 - 400 000 tons of rails per year.

The installation modularity allows increasing the production output depending upon the production requirements.



- **Installation for differentiated heat treatment of switch point rails with hills TEC-DTO using continuous induction heating.** Application: heat treatment of switch point rails OR50, OR65 with hills Length of switch point rails with hills to be heat treated: 4 - 25 m.

The installation production output is from 4000 up to 10000 pieces of switch point rails per year.

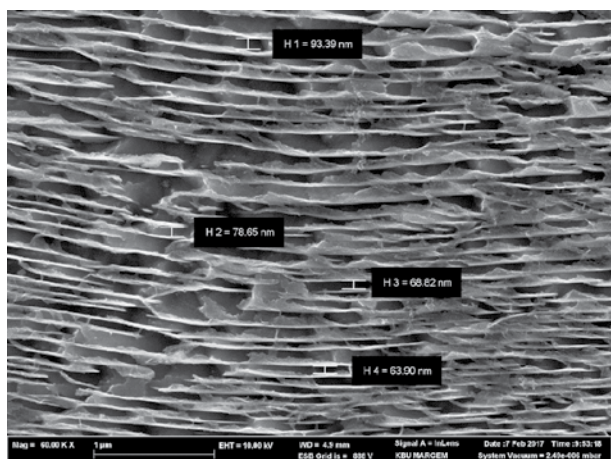
The performance of TEC-DT process is confirmed by the research works of the top institutes and namely «VNII Zheleznodorozhnogo transporta», «UIM» and Russian and foreign rails manufacturers EVRAZ, Mechel and Kardemir A.S., Turkey. The application of TEC-DT process allows achieving the below stated properties of the rails:

Mechanical properties of rails

| Rail | Category | $\sigma_{0.2}$ | σ_B | δ | ψ | KCU, J/ sm ² | |
|---------------------------------|----------|-------------------|------------|----------|--------|-------------------------|-------|
| | | H/mm ² | | % | | +20°C | -60°C |
| TEC-DT, R350HT | | 924 | 1300 | 13 | 31 | 31 | - |
| EN 13674-1: 2011 | R350HT | 780 | 1175 | - | 9 | 15 | - |
| TEC-DT, DT350 | | 856 | 1263 | 17 | 51 | 34 | |
| 76F, DT350 GOST R 51685-2013 | | 800 | 1180 | 8 | 25 | 25 | - |
| 90AF, DT370IK GOST R 51685-2013 | | 870 | 1280 | 9 | 14 | 15 | - |

Hardness values

| Rail | Category | Hardness, HB | | | | | | | |
|---------------------------------|----------|--------------|-------|-------|-----------------|------|-----|------|-----|
| | | Head | | | | | Web | Foot | |
| | | Head tread | 10 mm | 22 mm | Round-off 10 mm | | | 1 | 2 |
| TEC-DT, R350HT | | 393 | 394 | 383 | 386 | 388 | 300 | 330 | 331 |
| EN 13674-1: 2011 | R350HT | 350-390 | ≥340 | ≥321 | ≥340 | ≥340 | - | - | - |
| TEC-DT, DT350 | | 383 | 370 | 354 | 368 | 370 | 303 | 314 | 325 |
| 76F, DT350 GOST R 51685-2013 | | 352-405 | 341 | 321 | 341 | 341 | 341 | 363 | 363 |
| 90AF, DT370IK GOST R 51685-2013 | | 352-409 | 363 | 352 | 363 | 363 | 352 | 388 | 388 |



Microstructure of the railhead being heat treated under TEC-DT process

The distance between ferrite lamellae in pearlite is from 60 up to 10 rail fracture toughness (K_{IC}).

The rail properties fully meet the requirements of GOST R 51685-2013 for rails DT350, DT370IK and those of EN13674-2011 for rails R350HT and R350LHT.

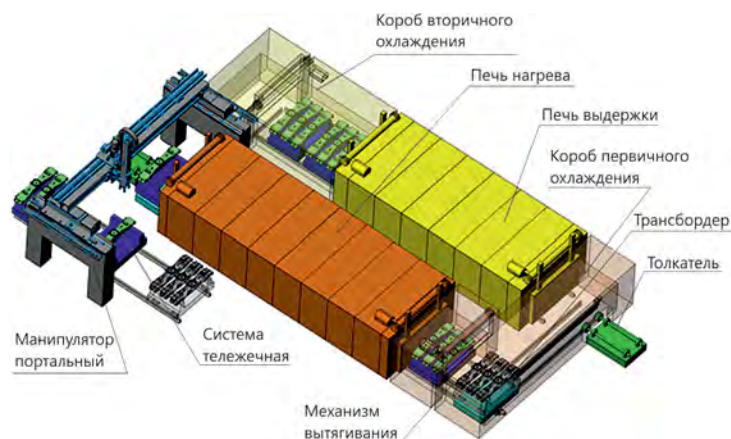
Implemented project:

Since March 2017 the TEC-DT process and the installation for differentiated heat treatment of rails using rolling heating TEC-DTP-300-78-3 has been successfully operating at Turkish plant Kardemir A.S. (the production output is up to 400 000 tons per year, rail length is 78 m). Currently the TEC-DT heat treated rails type R350HT sections 49E1, 54E1 and 60E1 as per EN13674-2011 are supplied to Turkey and Iran.

Heat treatment complex for railway castings

This heat treatment complex is designed to perform heat treatment of railway purpose castings such as side frames and bolsters to homogenize the chemical inhomogeneity, grain size and mechanical properties according to the requirements of OST -32-183-2001.

This heat treatment process results in a full phase recrystallization of steel grades 20GFL and 20GL. The heat treatment process improves the plastic and toughness properties of the products comparing to the properties in as cast condition. This is obtained through making the grain finer, relieving the internal stresses and decreasing the structural inhomogeneity.



Process equipment

- heating furnace;
- primary cooling chute;
- soaking furnace;
- secondary cooling chute;
- transportation system: cars, transborders, pushers, pulling device, rail tracks; cars stoppers.

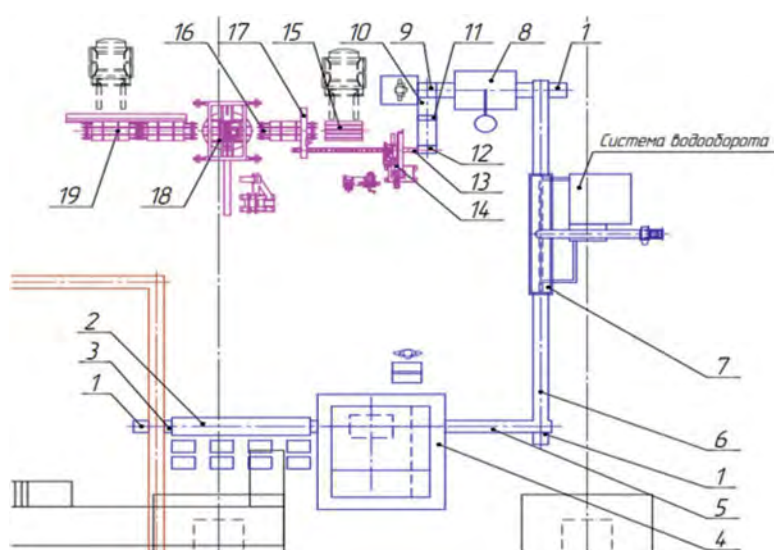
Data sheet

| | |
|---|--|
| Complex production output, pcs/hour | 10 |
| Furnace type | electrical |
| Operation time | three shifts |
| Annual operating time, hours/year | 6000 |
| Parameters of the products to be heat treated | |
| Overall dimensions, mm | |
| - side frame | 2413 x 671 x 580 |
| - bolster | 2590 x 480 x 486 |
| Maximum wall thickness, mm | 35 |
| Weight, kg | |
| - side frame | 399 |
| - bolster | 520 |
| Material | steel grade 20G1FL, 20GL GOST 977-88 |
| Chemical composition, % | C - 0,14...0,21; Si - 0,5...0,8; Mn - 0,9...1,3; V - 0,07...0,13; S - up to 0,03; P - up to 0,035 |
| Utilities | |
| Voltage, V/Hz | ~380/50 |
| Water, kgf/cm ² | 5 |
| Temperature, °C | 12-25 |
| Compressed air, kgf/cm ² | 6 |

Rail tie plates production line

Data sheet

| | |
|--|--|
| Production output, tons/year | 90 (with opportunity to increase up to 180 tons/day) |
| Blank heating for die-forging | induction HFC heating |
| Heating temperature, °C | 700±10 |
| Equipment weight, tons | 90 (transportation equipment – 25 tons) |
| Total power consumption, kW | 750 |
| Air flow rate, m ³ /min | 5 (P=0.5 MPa) |
| Industrial water flow rate, m ³ /hour | 6 |



General layout of the rail tie plates production line

- 1 - Pusher
- 2 - HFC heating area
- 3 - Transporter for HFC heating
- 4 - K1739 press
- 5 - Roller table
- 6 - Transporter - cooling bed
- 7 - Cooling area (water spraying and aspiration)
- 8 - Scarfing machine with transporter
- 9 - Random inspection area
- 10 - Transporter
- 11 - Unloader
- 12 - Bundles preparation area
- 13 - Bundles transporter
- 14 - Bundles packing
- 15 - Pallets area
- 16 - Pallets transporter
- 17 - Manipulator
- 18 - Packing unit
- 19 - Unloading area transporter

After cutting operations at the single point press (model K04.119.240) the tie plates are handed over to the transportation line. The tie plates are transported to the Pusher 1 (pos.1) and are moved into induction heating area, onto HFC area transporter (pos. 3) where they are heated by HFC unit (pos. 2) to a required temperature not exceeding 700 °C.

The total power consumption of the HFC heating area is not lower than 900 kW. Power voltage is 220/380 V. Heating current frequency is from 5 to 12 kHz.

The heating area consists of four induction heating sections. Each section has a rated capacity not lower than 225 kW. The induction heating section includes a frequency converter, water cooled transformer interfacing unit and at least one meter inductor.

The temperature equalizing intermediate areas are located between the heating areas to stabilize the tie plate temperature through its all cross section.

Once the required temperature is achieved the tie plates go to the press for piercing (press K1739 (pos. 4). After that the pusher 1 transfers the tie plates onto the roller table (pos. 5).

Having passed the roller table (pos. 5) the tie plates enter the cooling area that consists of cooling bed transporter 5 meters length (pos. 6) and cooling area (pos. 7) where the tie plates are cooled down to the temperature not exceeding 60 °C.

The cooling area consists of air-water nozzles that differentially spray the cooling media onto the different elements of a tie plate. The cooling area also includes auxiliary equipment (receivers, filters, pumps). The water flow rate does not exceed 4 m³/hour.

After the the colling area the pusher transfer the tie plates into scarfing machine for deburring and plate edge processing. Afterwards the tie plates follow to the random inspection area (pos. 9) and the transporter (pos. 10) brings them to unloader (pos. 11)а тв bundles preparation area (pos. 12). The bundles transporter (pos.13) delivers the bundle into the packing unit (pos. 14) and transports them further to the manipulator (pos.17). The manipulator loads the bundles onto a pallet, the latter goes to the packing unit (pos.18) and to the unloading area transporter (pos.19).

Transportation equipment for railway castings normalization

The transportation equipment is designed to perform motorization and automation of charging, discharging of normalization furnace, products transportation behind the furnace along the cooling bed towards the branch conveyor.

The transportation equipment of the railway castings normalization area is in charge of handling and transporting the products between the process units.

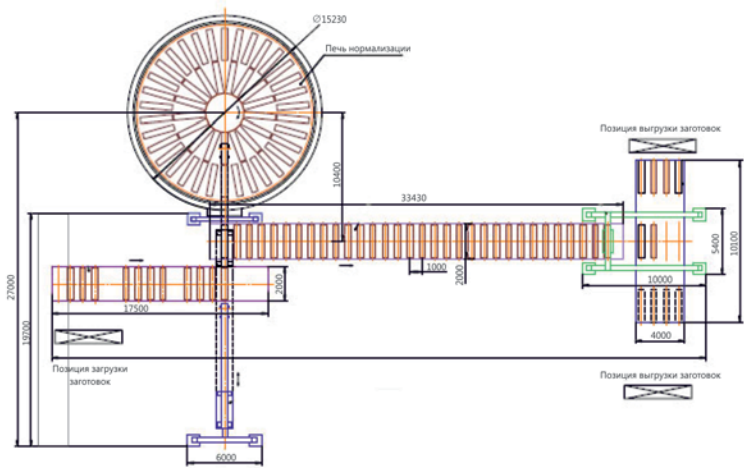
Products to be transported

| Bolster 100.00.001-5 | |
|------------------------|------------------|
| Overall dimensions, mm | 2590 x 480 x 403 |
| Weight, kg | 520 |

| Side frame 100.00.002-4 | |
|-------------------------|------------------|
| Overall dimensions, mm | 2413 x 554 x 651 |
| Weight, kg | 399 |

Data sheet

| | |
|--|------------------------|
| Area production output, max, pcs/hour | 15 |
| Item heating temperature in the furnace, °C | 950 |
| Item temperature at the transporter cooling bed exit, °C | 60 |
| Item cooling time, hours | 2 |
| Area power (without furnace), kW | 80 |
| Equipment weight (without furnace), tons | 90 |
| Operation time | 24 hours, three shifts |



The products to be normalized are loaded onto the components car by the workshop lifting equipment. The components car is able to carry four items. Once the components car is loaded it is moved to the transfer table. The transfer table lifts the products and the components car goes to the charging position.

After that the transfer car enters the transfer table and lowers the items. The car moves to manipulator and the latter picks the products piece by piece. Once the furnace is charged with four pieces the transfer car comes back to the transfer table to load other four items.

Manipulator charges the products into the normalizing furnace onto the furnace hearth guidings. Once the

Main equipment configuration

- components car;
- transfer table;
- transfer cars;
- manipulators;
- transporter cooling bed.

heating and normalizing cycle is completed the product is taken out of the furnace by the manipulator and a new product is loaded onto a free space. From the furnace the item is loaded onto the transporter cooling bed.

Traveling along the transporter cooling bed the items are cooled down to 60°C.

After the cooling bed the items go to the transfer cars. Two transfer cars are delivered to the transloading position one-by-one. Once the car has four items it goes to its unloading position.

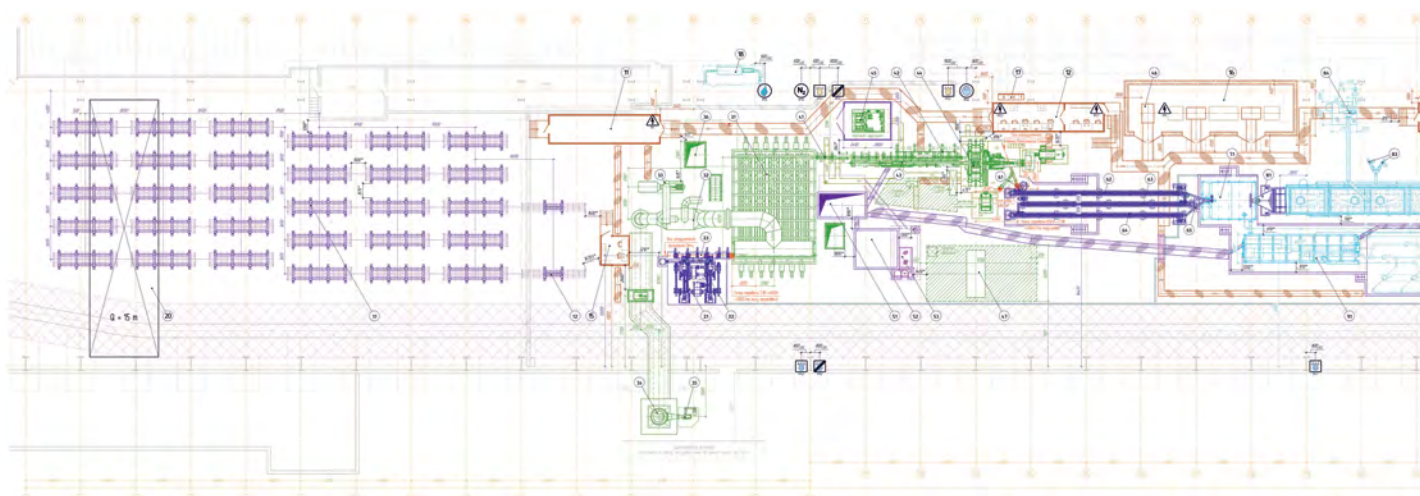
Grinding balls production line

Process development, manufacturing, supply and «turn key» installation of the grinding balls diameters 60 -120 mm with 5 hardness class and impact strength control as per GOST 7524-2015.

In 2014 SME «TEC» developed a process to produce steel balls with 5th hardness class.

In 2015 the contract for supply of production line for steel grinding balls diameter 60 - 120 mm with 5th hardness class, impact strength control and production output 135 000 tons per year (SHPS-120) was signed with JSC «EVRAZ NTMK».

The equipment supply, installation and commissioning works of SHPS-120 are performed within 2017.

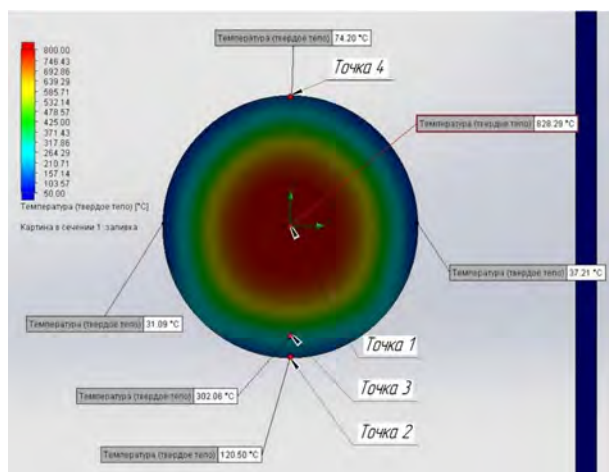


Equipment of SHPS-120 production line:

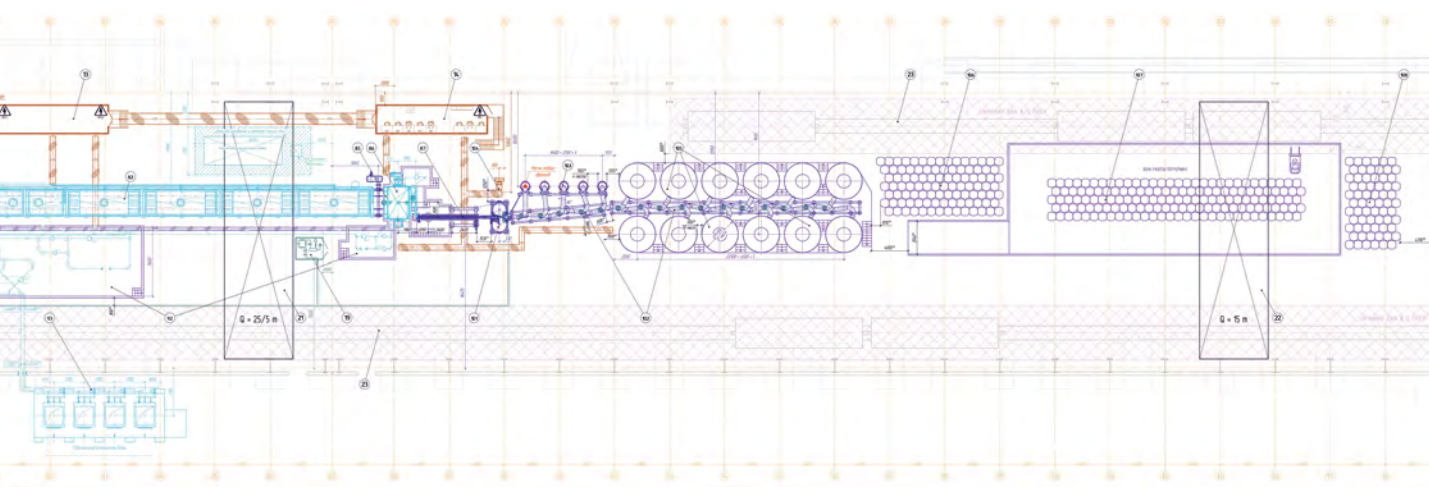
- feedstock storage area;
- feedstock gas heating furnace / feedstock induction heating area;
- rolling mill;
- ball temperature equalizing area for further quenching;
- ball quenching area;
- ball tempering area;
- ball final cooling area and shipment area.

TEC-HB Heat treatment

Steel ball heat treatment consists of two stages. Within the stage 1 the ball temperature after the rolling process 1050 C is equalized up to the quenching temperature. The stage 2 is the quenching to martensite. The 5th class ball quenching is finished at the temperature not exceeding 60°C with further temper in tempering furnace.



Carbon and alloyed steel grades with the following chemical composition are used for the production of the balls: carbon (C) up to 1,00%; manganese (Mn) up to 1,50%; silicon (Si) up to 1,00%; phosphorus (P) & sulfur (S) up to 0,025%; nickel (Ni) up to 0,50%; chromium (Cr) up to 1,30%; vanadium (V) up to 0,15%.



Below are stated the hardness values of the steel balls with 5+ hardness class after the heat treatment under TEC-HB process

| Conditional ball diameter, mm | Hardness class as per GOST 7524-2015 | | |
|---------------------------------|--------------------------------------|----------------|---|
| | 5 | | |
| | Minimum hardness, HRC | | *average hardness gradient, not exceeding |
| | surface | volume average | |
| 50-70 | 60 | 53 | 10 |
| Under TEC-HB process 60-70 | 61 | 60 | 3 |
| 80 – 100 | 58 | 48 | 10 |
| 110 – 120 | 56 | 43 | 10 |
| Under TEC-HB process 110-120 | 60 | 57 | 5 |

Notes:

** - optional parameter ensured by SME «TEC»

1. Average ball hardness limit deviation is not exceeding 5 HRC within a lot.
2. The balls of 5th class heat treated according to TEC-HB process have successfully passed the impact strength test (drop weight test) with the total impact energy of 65 kJ.
3. Volume hardness (VH) is calculated through the following formula:

$$VH = 0,289T_{\text{surface}} + 0,436T_{0,25} + 0,203T_{0,5} + 0,063T_{0,75} + 0,009T_{\text{ц}}$$

where T_{surface} , $T_{0,25}$, $T_{0,5}$, $T_{0,75}$, $T_{\text{ц}}$ – HRC hardness values from the ball surface in radius parts.

Robotic transportation systems and process automation

Any production besides the main process equipment and units that are the «vitals» of the company there is a «blood-vascular system» transportation and handling equipment and systems. The quality and quantity of manufactured products directly depend upon the precise and flawless operation of transport and handling systems being in charge of transportation of the products from one process equipment to another.



«Tomsk electronic company» has all potential required to develop and manufacture transportation and handling equipment for steelmaking, oil&gas, nuclear and power industries including the equipment operating in aggressive environment.

SME «TEC» has mastered the designing and manufacturing of the following transportation and handling equipment:

- manipulators including those with high precision positioning, complex trajectories and travel dynamics;
- handling devices;
- pick-and-place units.

SME «TEC» offers a full range of works and services including project survey, designing, manufacturing, supply and commissioning of transportation of both hot and cold steel products; selection, supply and integration of the mail process equipment, full scale production process automation with information support of steel products.

High qualified employees, full range of required processes, production facilities and wide experience being implementing projects as a General Contractor allow SM «TEC» executing projects of full process automation and integration of different manufacturers equipment into the one operating environment with informational support.



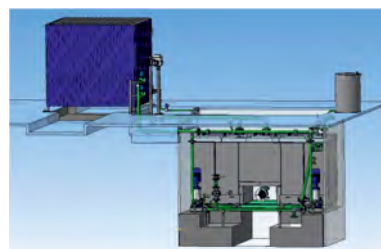
Process equipment

Surface treatment equipment

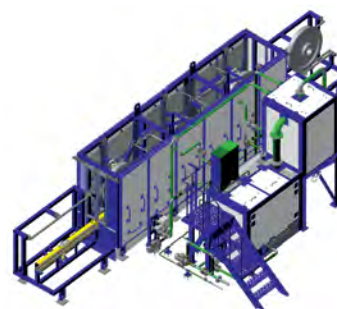
The unit being a part of a production line is designed to remove cutting coolant and dust from the product surface. This operation is widely used prior to the inspection of products. SME «TEC» offers two types of units with transportation systems:

- the product is charged into the unit horizontally. This type of unit was installed at Maanshan Iron & Steel Company Limited (city of Maanshan, China);
- the product is charged into the unit vertically. This type of unit was installed at JSC «EVRAZ NTMK» (Nizhniy Tagil, Russia).

The unit might be continuous and non-continuous type.



Surface treatment unit with a horizontal charge



Surface treatment unit with a vertical charge

Data sheet

| Parameter | Surface treatment unit non-continuous type | Surface treatment unit continuous type |
|--------------------------|--|--|
| Product | Railway | Railway |
| - weight, kg | not exceeding 1000 | not exceeding 1000 |
| - overall dimensions, mm | Ø770 - 1250 | Ø720 - 1270 |
| Overall dimensions, mm | 2122 x 2055 x 2040 | 1500 x 2550 x 10200 |
| Weight, t | 6.02 | 8.3 |

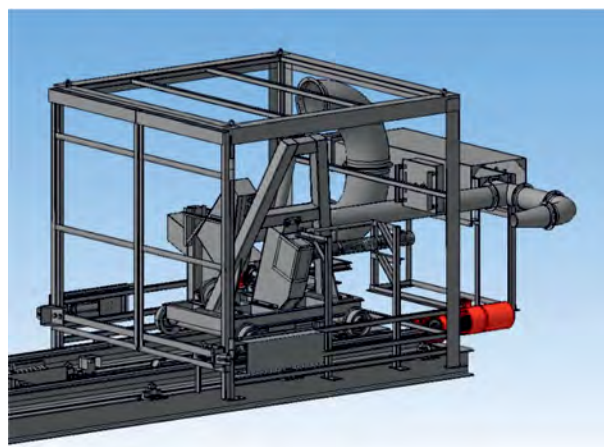
Surface anti corrosion coating

The unit being a part of a production line is designed to apply painting onto a product surface with further drying.

Drying unit

The unit being a part of a production line is designed to remove moisture from a product surface.

| | |
|--------------------------|--------------------|
| Product | Railway wheel |
| - weight, kg | not exceeding |
| - overall dimensions, mm | Ø770 - 1250 |
| Overall dimensions, mm | 2122 x 2055 x 2040 |
| Weight, t | 6.02 |

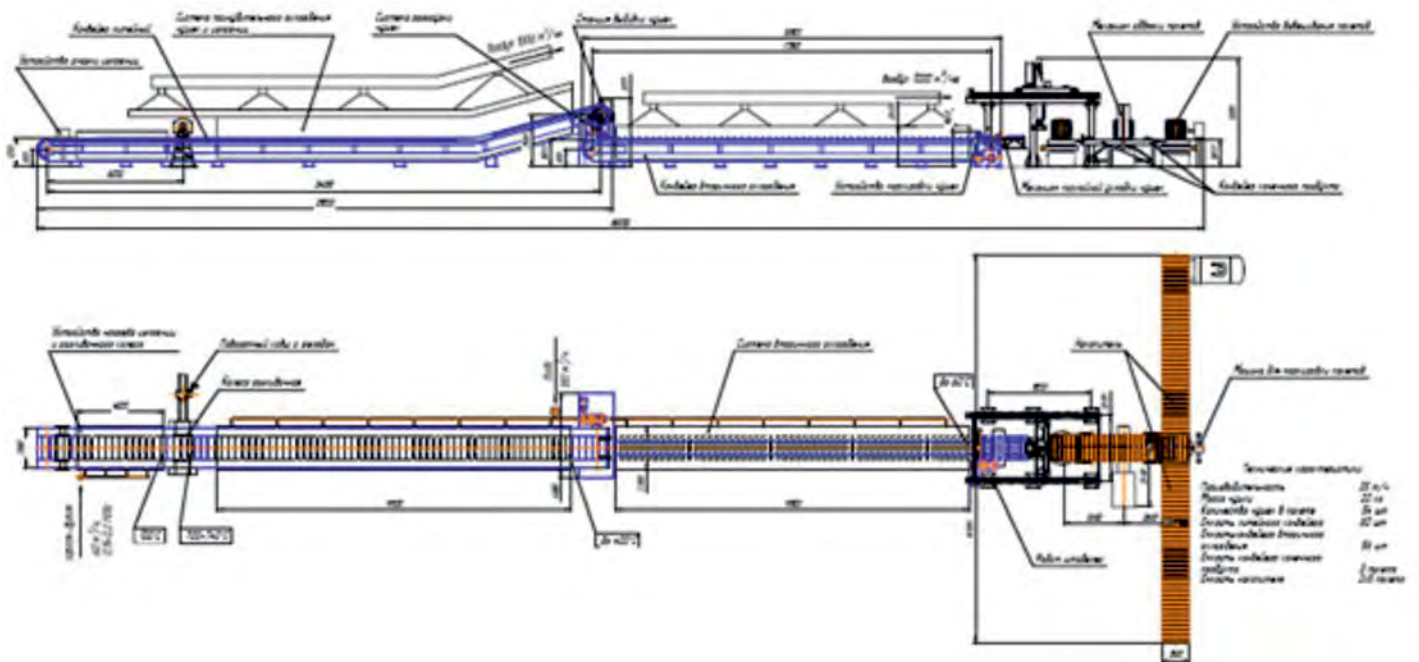


Ingots casting and packing line

This line is designed for production of 20 kg aluminum ingots with the automation of the following processes: ingot casting, ingots cooling, ingots marking, bundle packing and bundle marking.

Data sheet

| | |
|--|---|
| Production output, tons/hour | 25 |
| Ingot weight, kg | 20±3% |
| Bundle weight, kg | up to 1100 (54 ingots a bundle) |
| Product type | pure aluminum |
| Ambient temperature, °C | from 10 up to 41 |
| Molten aluminum temperature at casting station, °C | from 700 up to 740 |
| Ingot temperature, °C | <400 after the primary cooling and <60 after the secondary cooling |
| Ingot packing capacity, ingots/hour | designed 1250 |
| Noise level, dB(A) | average 80 at the working stations |
| Number of operators, persons | 2 (production line) / 1 (forklift) |



Molten primary aluminum taken out of electrolyzers by vacuum ladles is transported to casting area for refining to remove non-metallic and gas impurities and further processing into finished products (ingots). Prior to casting the molten aluminum is soaked in the mixers.

The casting into moulds of casting conveyor is performed at the casting station. The station consists of casting chute with molten aluminum level control, casting wheel and turning ladle to discharge aluminum in case of emergency.

The casting wheels fill the moulds with aluminum. The moulds are heated and lubricated prior to the casting stage. During the travel along the casting conveyor there is a forced cooling of the ingots to the temperature of 400 °C. At the end of casting conveyor the ingots are extracted from the moulds and are loaded onto the secondary cooling conveyor in auto mode.

Along the travel of the secondary cooling conveyor the forced ingot cooling till 60 °C and their marking are performed.

After that the loading device installs the ingots onto the accumulative table, turns them on 180° if so required. A layer of ingots is now on the accumulative table. A piling robot takes the layer for its loading onto the finished products conveyor.

A required number of ingots is then built up in a bundle. Conveyor moves the bundles to bundles area. Bundle strapping, weighing and marking are performed while the bundle is traveling along that conveyor. The bundles area is designed for temporary storage of 10 bundles. From the storage area the bundles are transferred to the finished products warehouse.

The line is equipped with the following:

- casting station (chute with a system controlling the molten level, turning ladle and casting wheel);
- casting conveyor;
- mould lubricating device;
- moulds and casting wheel heating unit;
- forced cooling system of moulds and ingots;
- ingots extraction station;
- ingots unloading system (arrangement of the ingots onto the secondary cooling conveyor);
- secondary cooling conveyor;
- ingots secondary cooling system;
- ingots marking unit;
- ingots loading device (layer type);
- bundling unit;
- finished product conveyor;
- bundle strapping machine;
- bundles weighing unit;
- bundles marking unit;
- bundles storage area.

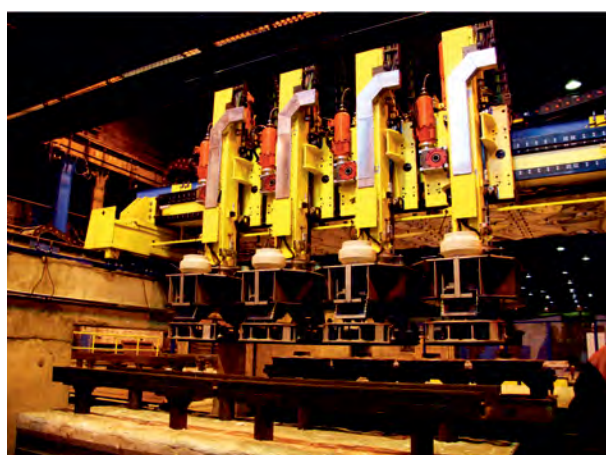
Manipulator type 1



Data sheet

| | |
|---|---------------------|
| Overall dimensions (WxDxH), m | 23.45 x 29.1 x 4.76 |
| Minimum diameter of feedstock to be charged, mm | 710 |
| Maximum diameter of feedstock to be charged, mm | 1270 |
| Maximum height/lifting stroke (Z axis), mm | 1200 |
| Maximum clamps side travel, mm | 450 |
| Rail track travel distance (X axis), mm | 20 600 |
| Manipulator weight, kg not exceeding | 90 000 |
| Maximum weight of feedstock to be charged, kg | 1200 |
| Number of clamps, pcs | 4 |
| Total rated power of the drives, kW | 168.4 |
| Motors three phase power supply, frequency 50 Hz, V | 380-10% ... 480+10% |
| Vertical travel utmost speed, m/sec | 0.53 |
| Carriage utmost horizontal speed (Y axis), m/sec | 0.33 |
| Rail track travel utmost speed (X axis), mm | 2 |
| Climatic version as per GOST 15150-69 | UHL 4 |
| Manipulator design service life, years | 10 |

Manipulator type 2



Data sheet

| | |
|---|---------------------|
| Overall dimensions without wheel (WxDxH), m | 9.32 x 15.42 x 4.95 |
| Minimum diameter of wheel to be charged (overall), mm | 710 |
| Maximum diameter of wheel to be charged (overall), mm | 1260 |
| Maximum lifting stroke (Z axis), mm | 300 |
| Maximum clamps side travel (X axis), mm | 10 500 |
| Manipulator weight, kg not exceeding | 38 500 |
| Maximum weight of feedstock to be charged, kg | 1200 |
| Number of clamps, pcs | 4 |
| Total rated power of the drives, kW | 91 |
| Three phase power voltage, V | 380±10% |
| Drive power frequency, Hz | 50±1 |
| Vertical travel utmost speed (Z axis), m/sec | 0.53 |
| Side travel utmost speed (X axis), m/sec | 0.77 |
| Climatic version as per GOST 15150-69 | UHL 4 |

Manipulator type 3, 4 and 5



Data sheet

| | Type 3 | Type 4 | Type 5 |
|---|--------------------|----------------------|----------------------|
| Overall dimensions without wheel (WxDxH) without beacon lights, m | 3.24 x 10.82 x 5.7 | 3.862 x 28.4 x 7.374 | 4.205 x 8.11 x 5.792 |
| Minimum diameter of wheel to be charged (overall), mm | 710 | 770 | 920 |
| Maximum diameter of wheel to be charged (overall), mm | 1260 | 1250 | 1070 |
| Maximum height/lifting stroke (Z axis), mm | 1636 | 1600 | 567 |
| Maximum clamps side travel (X axis), mm | 6800 | 6800 | 3750 |
| Manipulator weight, kg not exceeding | 12 500 | 26154 | 10 500 |
| Maximum weight of feedstock to be charged, kg | 1200 | 1000 | 750 |
| Total rated power of the drives, kW | 23,1 | 48 | 16 |
| Three phase power voltage, V | 380-10%... 480+10% | | |
| Vertical clamp travel utmost speed, m/sec | 1.81 | - | - |
| Carriage travel speed, m/sec | - | 1.29 | 0.55 |
| Travel time for operating stroke value, sec | 6 | - | - |
| Lifting speed on Z axis, m/sec | - | 0.46 | 0.14 |
| Climatic version as per GOST 15150-69 | UHL 4 | | |

Process automation systems

Process automation system for multihearth furnace

Customer

JSC «Kombinat «Magnezit» (Russia, Satka)

Purpose

Control of magnesite calcination process in multihearth furnace, including charging, cooling and material discharging.

Scope of works and services

- development of design documentation, costs estimates and project documentation for electric equipment, instrumentation, automation and process CCTV;
- equipment and materials supply under the above mentioned project parts;
- manufacturing of panels for the above mentioned project parts;
- installation works in compliance with design documentation of the above mentioned project parts;
- commissioning works.

Project description

The complex conditionally consists of the following areas:

- process control of the raw magnesite handling line.
- process control of the finished product shipment line (calcinated magnesite).
- process equipment control of the multihearth furnace with 40 self-contained gas burners at 10 hearths.
- process equipment control of the product cooling system at the furnace outlet including: product cooling bed, circulation pump station, cooling equipment of the coolant media.
- process equipment control of combustion air supply system and ignition devices, furnace air-gas mixture off take system.
- process equipment control of off gas cleaning and bag type gas cleaning.
- process equipment control of dedusting system with an opportunity of dust storing or recycling in the furnace.
- process equipment control of aspiration emission cleaning system including 3 systems by «Space Motor» and 2 systems by SCHEUCH companies.
- process equipment control of aspiration ducts and dusting areas aspiration points.



This multihearth furnace project is the one and only in Russia and CIS and worldwide these are quite rare cases as well.

Control of the complex

The tailor made automation system processes more than 3500 signals including 390 signals of the furnace emergency shutdown system and is split up in four subsystems. All the subsystems are based on the Modicon PLC by Schneider Electric. At this stage the following algorithms are performed: control and interactions with the existing automation subsystems, visualization of mnemonic diagrams data and data buffering of the furnace subsystem processes. The PLC applications run under the installed OS tsxp575634m_v240. The system update is performed by OS Loader that makes a part of Unity ProXL 5.0 package used for development and debugging of the system applications.



Three operator workstations are used for visualization of the process data, initial data input to select a process algorithm, process reports storage and interaction with the existing database (MS SQL). Workstations run under Microsoft Windows XP Professional and based on SCADA applications with a user friendly interface developed and executed in Wonderware InTouch environment.



The control room is equipped with a video wall made of four 46" LCD screens representing the required data without any picture quality loss.

Through a intuitive interface of the automation system one operator is able to control the whole complex of the process equipment (132 units of materials preparation and handling system and 40 gas self-contained burners in total) and monitor the required process parameters of the material handling equipment, ignition and burning parameters of the gas burners located on the 10 hearths of the furnace.

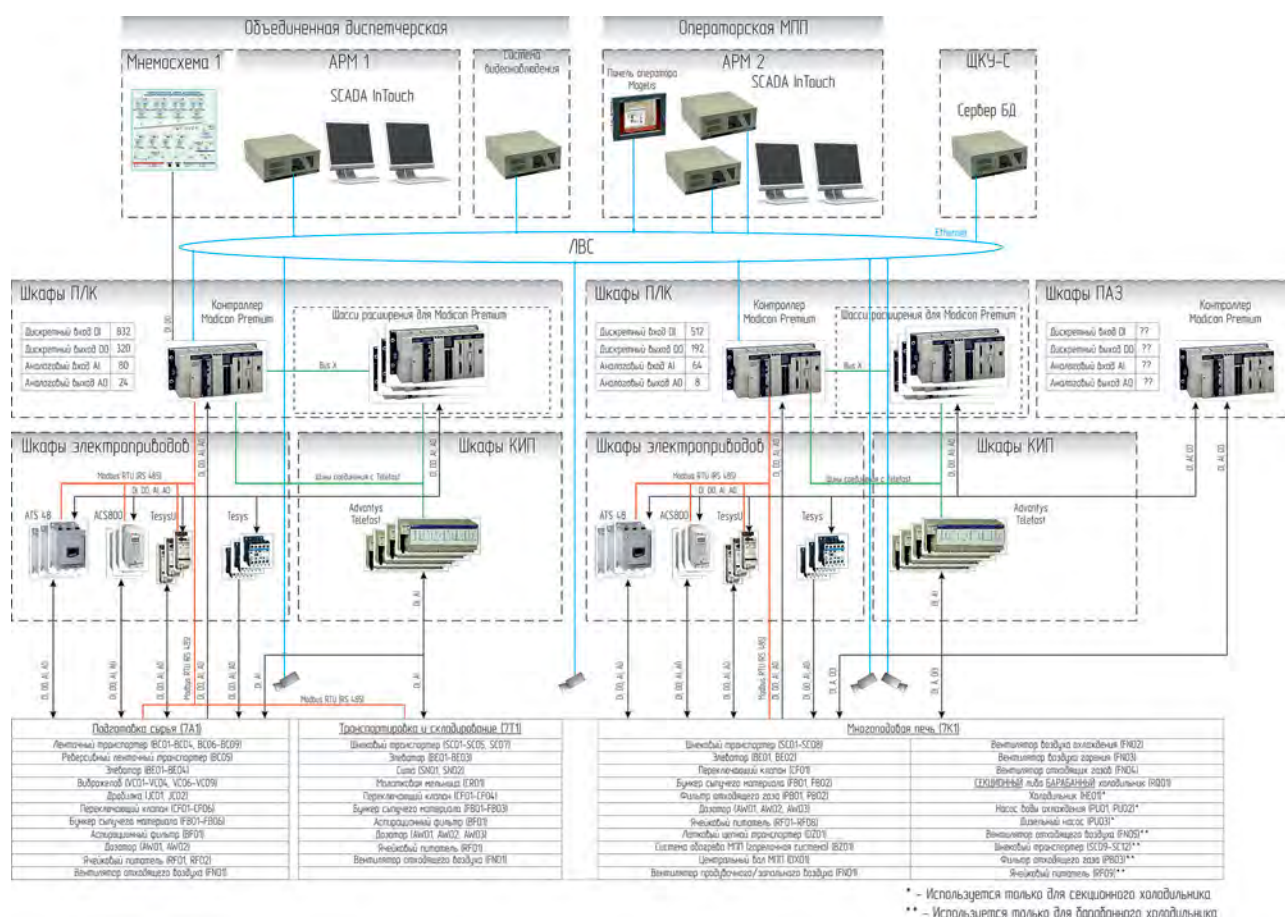
SME «TEC» has developed tailor made software to control the the whole complex equipment and the gas burners. The software also includes original solutions to adjust fuel-air ratio.

The PLC has an algorithm to maintain a preset excess air rate in the gas-air mixture for each of 40 gas burners by means of cascade PID adjustment. The special feature of this adjustment is a fully automated keeping of a preset temperature in the furnace, considering the temperature influence of the lower hearths onto the upper those and with any number of the gas burners being in operation.

The PLC also includes a tailor made emergency shutdown system of the gas furnace. This system considers the indirect gas leakages in the furnace and shuts off the gas supply.

The PLC software and HMI have modular structures and are based on the best solutions by PCS7 Siemens Automation.

The automation software was developed in line with the control functions of the different Suppliers equipment.



The system is designated for real time measurement and control of the process parameters, alarms and pre-fault signaling, visualization of the process parameters their automated control and emergency shutdown.

The system ensures the following:

- the operation of the multihearth furnace without continuous presence of the operating and maintenance staff in the area where the equipment is located;
- real time automated control of the following processes: operation of the furnace, crushing, screening, transportation and raw magnesite charging in and discharging out of the furnace, magnesite cooling, screening and storing of calcinated magnesite (the area of the magnesite calcination multihearth furnace Polysius MH78-19);
- real time automated control of the gas cleaning process and dedusting system of the calcination areas in the furnace;
- fault free start and shutdown of the furnace operation.

Emergency shutdown system is in charge of:

- process equipment protection against damage and minimization of the combustion products emissions;
- pre-fault signaling in case of a deviation from preset operation limit values in all modes of the furnace operation;
- freezing the emergency situation progress with a safe furnace shutdown and/or process equipment switching to a safe mode according to a preset program.

The system is based on the Modicon Premium platform by Schneider Electric. SCADA-system is realized on the In-Touch platform by the company Wonderware.

The furnace complex was commissioned in 2015.

Mass productions

Feeders

SME «TEC» feeders and conveying equipment are designed for transportation of materials along the process lines.

The main design features and advantages of the feeders and conveyors are listed below:

- wide range of opportunities for integration into the process lines (manufacturing on non-standard equipment);
- components are supplied by worldwide leading companies;
- wide range of output and capacities;
- adjacent and transfer steel structures are included into the scope of supply;
- designing and control system are performed as per the Customer's requirements.



Belt feeder PL

| | |
|------------------------------------|---------------------|
| Rated output, m ³ /hour | from 1.0 |
| Conveyor belt width, mm | from 300 up to 2000 |

Screw type feeder PSH



| | |
|------------------------------------|---------------------|
| Rated output, m ³ /hour | from 0.1 up to 10.0 |
| Inclination, degrees | from 0 up to 90 |



Plate feeder

| | |
|--------------------------------------|---------------------|
| Rated output, m ³ /hour | from 5 |
| Conveyor plate width, mm | from 500 up to 1600 |
| Transported material temperature, °C | |
| - standard version | up to +300 |
| - special version | up to +600 |

Drum type feeder PB



| | |
|------------------------------------|----------|
| Rated output, m ³ /hour | from 0.5 |
| Drum diameter, mm | 500 |

Rotary feeder PR



| | |
|------------------------------------|----------|
| Rated output, m ³ /hour | from 0.2 |
| Material fraction size, mm | up to 20 |

Vibration feeder

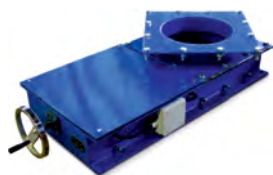


| | |
|------------------------------------|------------------|
| Rated output, m ³ /hour | up to 250 |
| Drive Type | electro mechanic |

Additional equipment



Sector gate



Slide pin gate

| | |
|---------------------|---|
| Opening section, mm | from 200x200 up to 1200x1200 |
| Actuating control | manual (screw-nut), electromechanical, pneumatic, hydraulic |

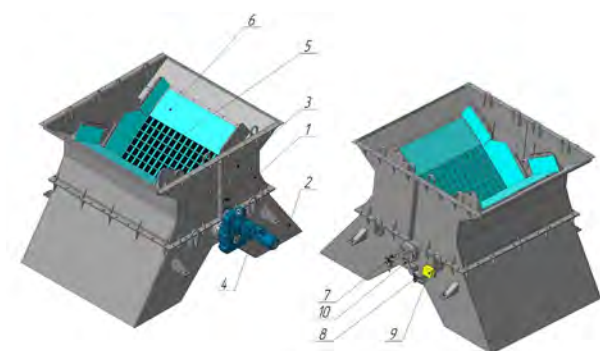


**Transportation car
with lifting table TTPS**



**Monorail
transportation car TTM**

| | | |
|----------------------|------------------------|------------------------|
| Lifting capacity, kg | from 500 up to 5000 | from 100 up to 3000 |
| Travel speed, m/sec | up to 0,5 | |



1 – upper case; 2 – lower case; 3 – inspection door; 4 – gear motor with brake; 5 – flap gate; 6 – flap position sensor; 7 – gate sensor; 8 – emergency limit switch; 9 – terminal box; 10- flag.

Flap gate

The flap gate is used to direct the bulk materials flow

| | |
|--|---------------------------|
| Inlet section, mm | 2180x2000 |
| Outlet section, mm | 800x2000 |
| Flat angle, degrees | 86 |
| Drive unit - motor power, kW - gear revolutions, rpm | Gear motor 0,75 2,1 |
| Time to change the flow direction, sec | ~8 |
| Three phase power supply with frequency (50 ± 1) Hz, V | 380 |
| Climatic version as per GOST 15150-69 | UHL2 |

In terms of design the flap gate is a fully completed stationary unit. In order to direct the materials the flat is open in one or other position.

Batchers

Weighing batchers are designed to be integrated into the process lines related to the continuous supply of bulk or liquid materials and for automation of continuous and cycle type batching processes.

The batchers are listed in the State measurement units list and are approved for operation in Russian Federation (certificate №28434) and Republic of Kazakhstan (certificate №4128).



Belt batcher continuous action

| | |
|---|------------------------------------|
| Utmost output capacity, t/hours | 6.3-630.0 |
| Accepted accuracy error as per GOST 30124-94, % | ± 0.25 ; ± 0.5 ; ± 1.0 |
| Conveyor belt width, mm | from 500 up to 2000 |

Main features

- available modes «start-stop / discrete batches» i.e. supplying of a certain batch/weight within a required time;
- automated belt length correction to avoid additional error in case of belt expansion;
- automated belt centering during the operation;
- material counting at the belt exit that allows operating in discrete weights mode;
- well distributed loads on the belt are assured by even layer of the material at the exit of charging opening.



Belt batcher non-continuous action (material temperature up to 600 °C)

| | |
|---|--------------------------|
| Utmost output capacity, t/hours | 6.3-630.0 |
| Accepted accuracy error as per GOST 30124-94, % | ± 0.5 ; ± 1.0 |
| Conveyor plate width, mm | 800-1600 |
| Batching material temperature, °C | up to +300 up to +600 |

Specific features

- designed for supply of highly abrasive and hard running materials;
- high performance in operating with materials up to 300 °C;
- special version operating with materials up to 600 °C is also available;
- recommended extra options:
 - sliding pin gate;
 - scrapper to minimize the spillage;
 - feeder to receive the spillage under the batcher.



Bin batcher non-continuous action

| | |
|---|--|
| Utmost output capacity, t/hours | 0.1-10.0 |
| Accepted accuracy error as per GOST 30124-94, % | ± 0.25 ; ± 0.5 ; ± 1 ; ± 2 |
| Bin volume, m ³ | from 0.1 |

Specific features

- designed for continuous operating lines;
- smaller in length and width due the increased height;
- material discharging with decreasing weight.



Bin scales

| | |
|------------------------------------|----------|
| Utmost weighing limit, tons | 0.1-20.0 |
| Accuracy as per GOST R 53 228-2008 | middle |
| Number of calibration points n_e | 500-3000 |

Specific features

- static weighing of the material inside the bin;
- bin material level control.



Bin batcher discrete action

| | |
|---------------------------------|------------------|
| Utmost batching limit, kg | 5-1500 |
| Accuracy as per GOST 8.610-2012 | 0.2; 0.5; 1; 2.5 |

Specific features

- operating mode by batch or cycle;
- multi-components charging.

Universal batcher control system SDU

Designed for bulk materials batching in continuous mode or with specified weights and cycles through continuous action belt batchers, bin batchers continuous or discrete action and all type of scales: truck, platform and railway cars.



Parameters input unit (BZP-06) is used to enter and monitor the SDU parameters through CAN or wireless ZegBee interfaces.

One BZP-06 is able to operate with several SDUs. BZP-06 could be installed onto a batcher steel frame or installed separately. In this case for the power supply NiMH accumulator battery AA shall be used.

SDU specific features

- modular SDU design ensures solving required purposes by a set of modules with a quick restoring of SDU operability;
- SDU location on a batcher structure results in saving of measurement cables and enhances the accuracy of weighing and batching;
- bus bar connection type between different compatible units not included into SDU but make the other functions available;
- wide choice of the upper level interfaces (ProfiBus DP, RS-485, CAN) ensures the SDU integration into the existing automation system of the customer;
- on structure SDU mounting significantly saves the costs of cable installation works;
- frequency drive might be controlled through 4-20 mA current signal or RS-485 digital interface;
- operating temperature range from -40 up to +45 °C with the accuracy tolerances stated above.

Conveyor equipment

Belt conveyors by SME «TEC» are designed for integration into process lines of continuous supply of different type bulk material (with different fraction sizes, abrasive ability, running properties etc.).

Vertical conveyors (including mine versions) with the belts by Swedish ContiTech Scandinavia AB and Italian Gummilabor

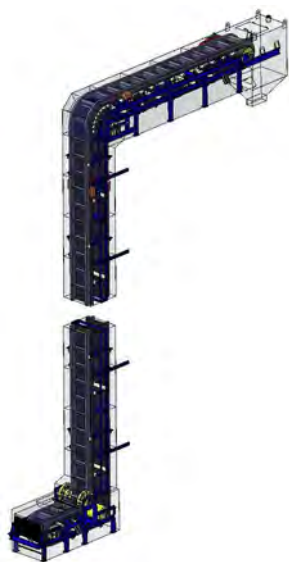


| | |
|----------------------------|----------------------------------|
| Output, t/hour | up to 750 |
| Material lifting height, m | up to 50, available up to 200 |
| Conveyor belt width, mm | from 800 up to 1200 |



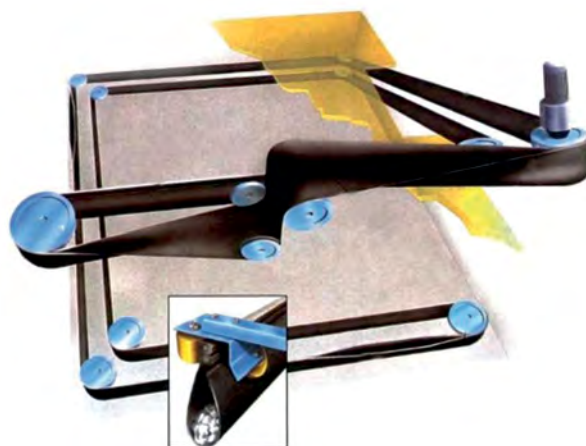
**Stationary belt conveyors
(horizontal and inclined types)**

| | |
|------------------------------------|---------------------|
| Rated output, m ³ /hour | from 13 up to 4200 |
| Conveyor belt width, mm | from 400 up to 2000 |
| Linear belt speed, m/sec | from 0.8 |
| Inclination, degrees | from 0 up to 18 |



**High inclination conveyor KLN
(Z-shaped, vertical)**

| | |
|--------------------------|---------------------|
| Output, t/hour | up to 3000 |
| Conveyor belt width, mm | from 500 up to 2000 |
| Linear belt speed, m/sec | from 0.25 up to 3.5 |



SICON conveying system

equipped with the belt by Swedish company
ContiTech Scandinavia AB

| | |
|------------------------------------|-----------|
| Rated output, m ³ /hour | up to 380 |
| Lifting inclination, degrees | up to 380 |

Sicon conveying system is a closed belt conveyor that could easily bent out the sharp angles between the charging and discharging stati up to 350° without an extra transloading station. The belt is open only during the charging process and is closed (the belt is folded) thus solving the problem with material spillage and dust generation. Easy installation and significant saving of the area and maintenance costs are the main benefits of this conveyor type.



Certificates



