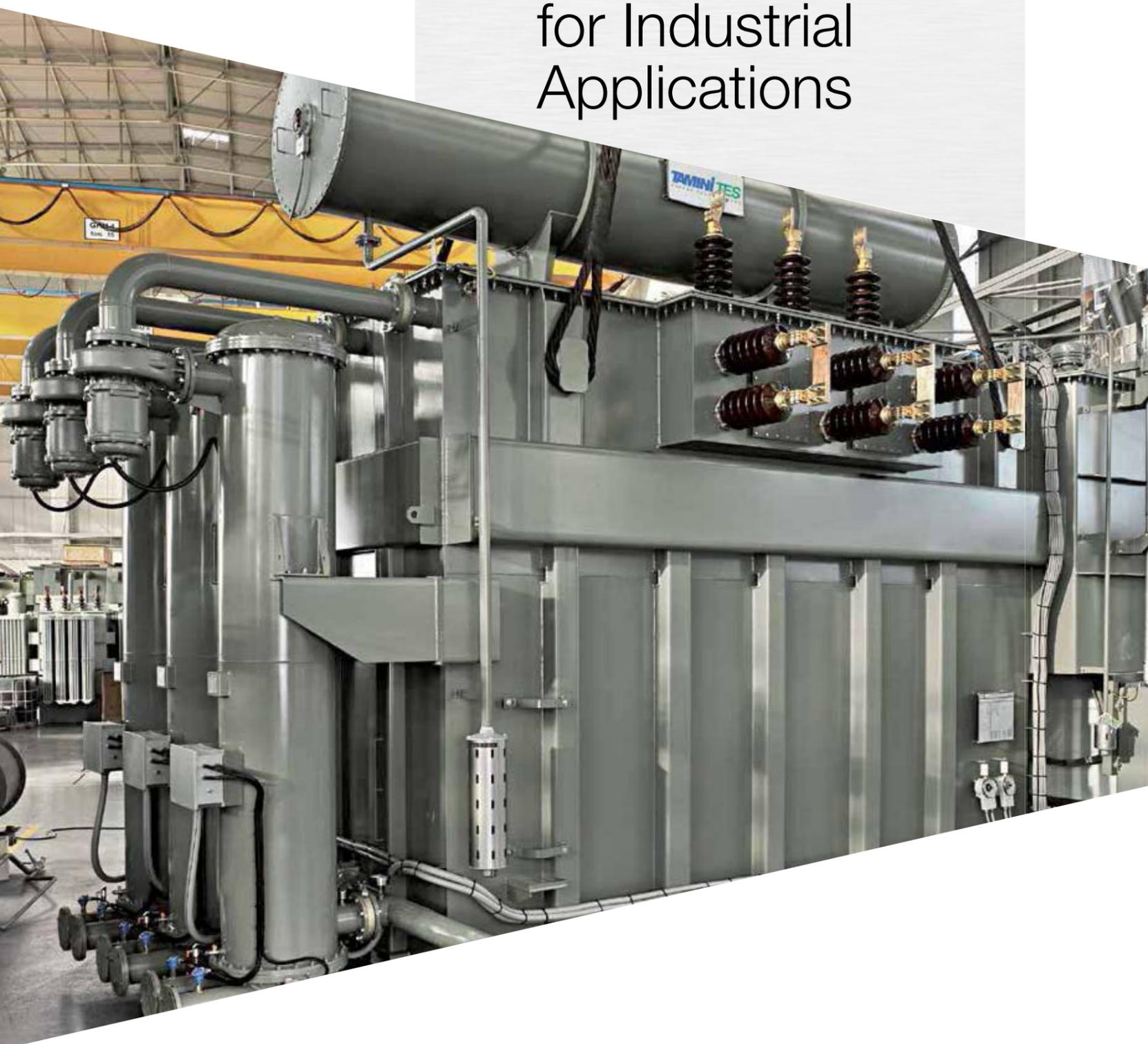




TAMINI TES
ENERGY TRANSFORMERS

Industrial Applications

Transformers for Industrial Applications



Tamini has always produced industrial transformers of high quality and reliability, designed to satisfy the most diverse and complex technical requirements. A large share of its resources are devoted to the development of special transformers for any industrial application, such as furnace transformers, reactors, power transformers for industrial distribution and rectifier transformers.

In the last ten years, Tamini has manufactured almost 1.000 transformers. Among them more than 400 units are industrial transformers and the majority is exported all over the world.



After the business combination with TES, one of the most advanced and qualified actors in the market of industrial high power transformers, Tamini has become a leading market player and now even stronger to effectively cope all future challenges. The two companies have been operating as a single entity with the aim of focusing their efforts, further accelerating their own growth and sharing the best available skills.

The integrated Tamini and TES also operate through their own branches in USA, North Africa and India. At the moment, approximately 80% of company turnover comes from exports, particularly from emerging countries.

Research & Development

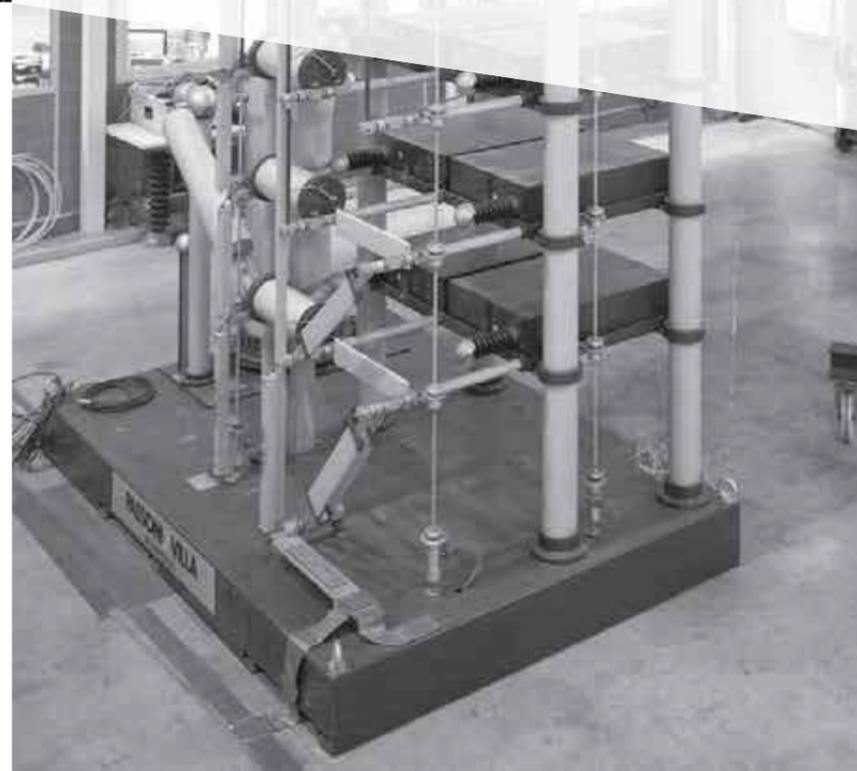
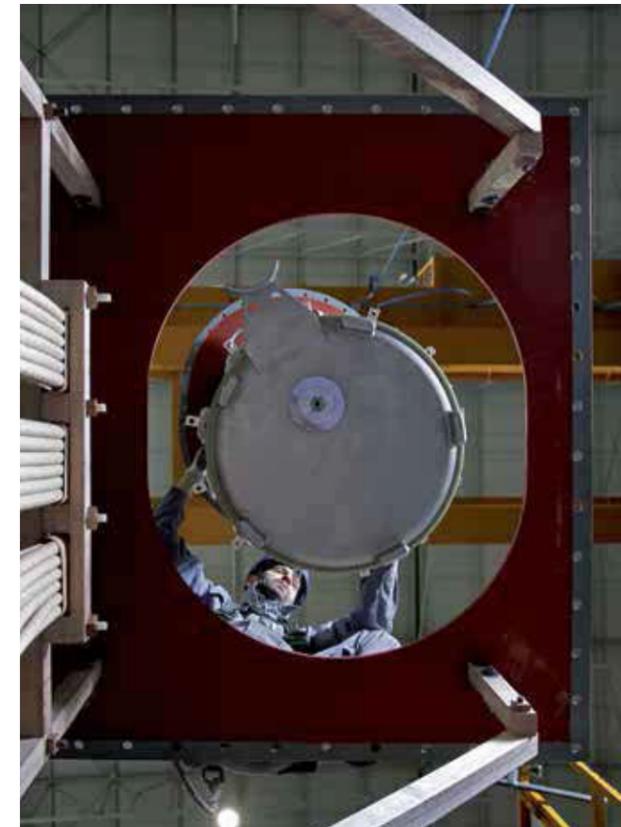
In order to adapt the design and the characteristics of the industrial transformers to the most advanced technology, a constant liaison between engineering and manufacturing is carried out by Tamini. As a result, they have reached a prominent worldwide positioning in the supply of furnace transformers, rectifier transformers for electrolytic processes, aluminium smelters and other metal refining processes, DC furnaces for electrometallurgy industries and DC electric traction.



A significant share of Tamini production is devoted to rectifier transformers, the majority being for export all over the world. More than 70 rectifier transformers have been manufactured by Tamini in the last 10 years for other than the iron and steel industries.

Quality Assurance, Quality Control and Safety

QA procedures are carried out and certified according to ISO 9001-2008 Standards. QC is performed at every step: engineering, production cycles, procurement, testing and on site installation. All Tamini factories have their own testing facilities suitable for routine, type and special tests in accordance with IEC or IEEE (ANSI) and any other worldwide recognized Standards (ASA, CSA, BSS, SEV etc.). They definitely comply with the most updated international legislation for safety and environmental protection.



AC and DC Furnace Transformers for Metallurgy

The Electric Arc Furnace and Ladle Furnace Transformers are the key equipment in a steel plant, therefore specific engineering solutions are adopted in order to guarantee over time the best performances under the dielectric, thermal and mechanical stresses which daily involve these transformers. Furnaces transformer's life is affected by heavy stresses during operation. Frequent on and off switching, high magnitude inrush currents, high operation currents, often close to short circuit values, fast transient overvoltages, significant harmonic content and elevated number of operations carried out by the on load tap changer are the everyday challenges for a furnace transformer. Electrical stresses are due to overvoltages generated both by the melting process and by transient state resulting from a sudden disconnection of HV circuit breakers, especially if vacuum-type ones are installed. Tamini pays special attention to this issue adopting a specific design and manufacturing procedures to guarantee a stronger transformer insulating structure. Moreover during furnace operation, the transformers undergo thermal and mechanical stresses due to the continuous daily



steel melting process. Continuous stresses and vibrations might make the windings loose if they are not properly treated and robustly clamped. In order to avoid any inconvenience due to such heavy and frequent stresses, Tamini has adopted improved procedures for windings pressing and thermal treatment operation.

Different solutions can be adopted according to the customer requirements:

- Single or double core “booster” solution;
- LV delta closure either inside or outside the tank;
- LV bushings either in copper bars or water-cooled pipes;
- LV outlets either on the top cover of the transformer tank or on the lateral side.

Product scope:

- Rated power up to 360 MVA (the highest rating ever built);
- L.V. current up to 140 kA.

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Tamini also provides:

- Special furnace transformers as Submerged Arc Furnace (SAF), Electroslag Remelting (ESR) and Smelter Transformers used to power furnaces for the production of special iron alloys. These alloys often require the deployment of three single-phase furnace transformers instead of a single three-phase transformer in order to balance the total phase impedance through an equilateral-triangle layout of the units or in applications of modern steel processes.
- Regulating transformers, with either stepped or stepless regulation of the output voltage, for those applications/ processes where a fine regulation is needed.



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Series Reactors for Furnace Applications

Series reactors connected to Furnace Transformer are often used to stabilize the arc current. In order to achieve better efficiency of the melting process, series reactors may have tapplings to adjust the reactance in coordination with arc furnace needs.



Series reactors can be designed as Gapped-Core Reactors or Coreless Reactors (with core-frame).

Product scope:

- Up to 150 Mvar.

Reactors are used in the furnace operation with the purpose of:

- Arc stability and power regulation;
- Optimisation of electrodes consumption;
- Limitation of current during melting process;
- Reduction of flicker on the feeding network.



Core and windings are of the same type of the transformer with the difference that in the magnetic core limbs suitable gaps designed for specified reactance and reactive power values are inserted. The reactance is generally requested to be constant up to 2 times the rated current; when higher, a core-less solution is normally applied.

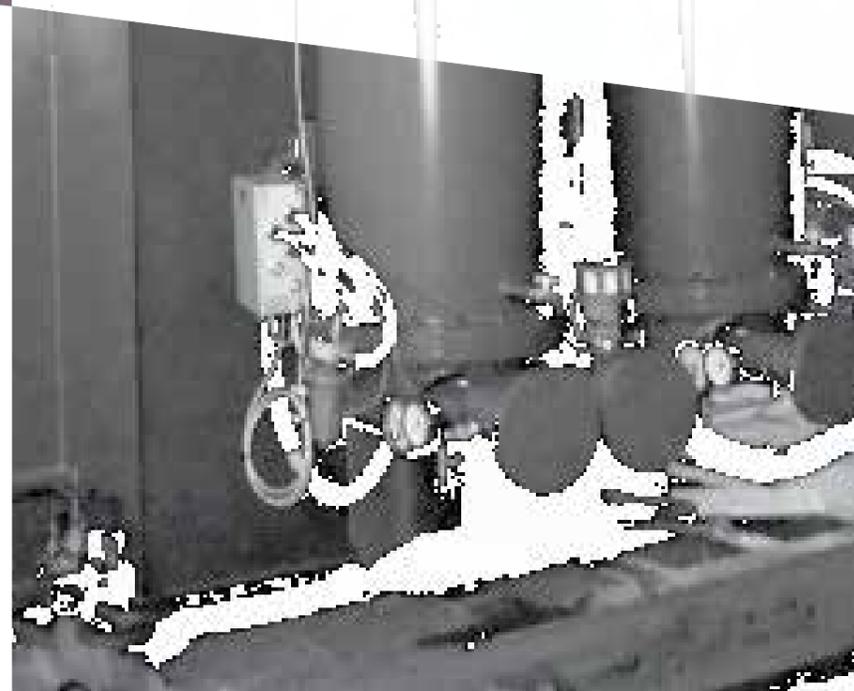
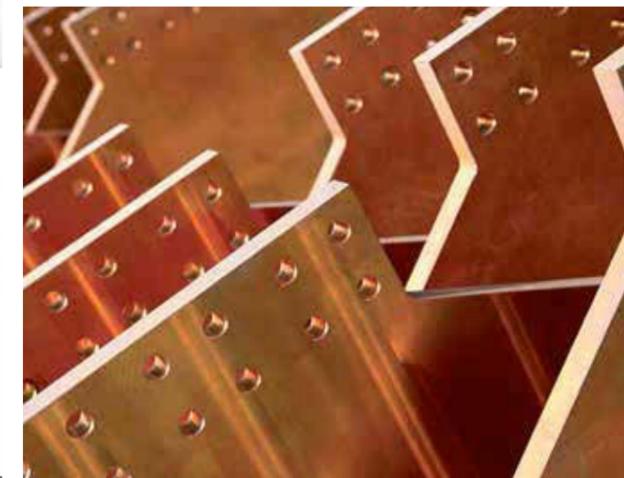
Reactors are adjustable in steps by a tap changer (TC), in order to select the proper value of reactance at any operational set-point achieving a quick furnace regulation.

Tamini has designed and successfully supplied many different types of transformer-reactor solutions. Among them the "Booster-type" one, in which the reactor is built-in, is the solution that optimizes the voltage/current values in the transformer regulation circuit.

The reactor can be also assembled:

- Inside the main transformer tank;
- Entirely separated from the transformer;
- Located next to the transformer (On Board Reactor).

In the OBR (On Board Reactor) solution, the reactor and the transformer are linked by a removable cable duct.



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The rectifier transformer is the link between the electrical grid and the AC/DC converter. Therefore, it has the aim to provide the number of phases, the voltage shifts needed to realize the conversion and to adjust the rectifier input to vary the DC output voltage. To do it, the rectifier transformer is often coupled with components as regulating transformers (or autotransformers), saturable reactors and interphase transformers.



Rectifier Transformers

All these components may be assembled in one or in separate tanks for transportation optimization and site restrictions.

Product scope:

- Rated power up to 140 MVA;
- L.V. current up to 150 kA.



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Rectifier Transformers face high operating currents combined with a huge amount of harmonic content due to the distorted waveform caused by the semiconductor converters connected to the transformer.

Typical applications are for: DC arc furnaces, electrolysis, scrap melting furnaces, aluminum smelter, graphitising furnaces, traction substations, metal refining and inverters for variable speed drives.



Distribution Transformers for Industrial Applications

Distribution transformers for industrial applications are used wherever it is necessary to connect systems for transmission, distribution and utilization of electrical energy, which function at different voltages, in order to transfer large quantities of active and reactive energy between these systems. Tamini's experience has allowed the company to become a leading brand both nationally and abroad in the HV/MV distribution transformers market. The company's products are used across a wide spectrum of applications by a plethora of major clients.



HV/MV Transformers

Distribution transformers are used to interconnect high voltage and medium voltage systems.

These transformers can be manufactured either with off-circuit tap changer or on-load tap changer and with different cooling method. Furthermore transformers for railway application with various loading guide can be manufactured as well.

Product Scope:

- System voltage up to 420 kV;
- Power rating up to 400 MVA.

MV/MV and MV/LV Distribution Transformers

Distribution transformers MV/LV type for energy distributions are usually three or single phase, oil immersed, with different cooling method (K/L) ONAN - (K/L) ONAF with detachable radiators or corrugated tank (depending on transformer size and ambient temperature), with conservator technology or sealed construction (with or without nitrogen/air filling).

These transformers can be manufactured either with off-circuit tap changer or on-load tap changer, for environments with risk of explosion (ATEX) or for off-shore application. Furthermore transformers for railway application with various loading cycles can be manufactured.

Product Scope:

- System voltage up to 52 kV;
- Power rating up to 30 MVA.

Dry Type MV/MV, MV/LV and LV/LV Distribution Transformers

Dry-type transformers are used to minimize fire hazard and other environmental contamination on surroundings and people, like in large office buildings, hospitals, shopping centers and warehouses, sea going vessels, oil and gas production facilities and other sites where a fire has potential for catastrophic consequences.

Distribution transformers MV/MV, MV/LV and LV/LV, in our production range, are dry type AIR FILLED, with AN or AF (or combined) cooling method, class H or F, in accordance with E0, F0 and C0 class.

Our transformers can be offered also with protection box IP 21/31/44/54, in accordance with international std. Transformers in this range are three phase or single phase and can be manufactured with off-circuit tap changer or on-load tap changer.

Product Scope:

- System voltage up to 36 kV;
- Power rating up to 10 MVA.



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Transformers Accessories

LV Outlets

In the past, outlets for furnace transformers were mainly done by copper bars positioned either on the top cover of the transformer tank or on the later side.

The increase of transformer ratings requires many bars in parallel for each LV outlet. The bars have different arrangements depending on the type of connection to the furnace electrodes. Today, the improvement in technology for LV connections brought an alternative solutions for transformers of large rating: water-cooled bushings are often used instead of bars.



The design and construction of these water cooled bushings avoid any risk of water leakage into the transformer oil.

The arrangement of the LV outlets depends from the connection of the LV windings. The delta closure of the LV windings can be realized either outside or inside the tank. When delta closure is requested inside the tank, the LV outlets normally have a triangle shaped arrangement.

This solution facilitates the connection to the furnace and, at the same time, guarantees a good symmetry of the three phases and current distribution among them.

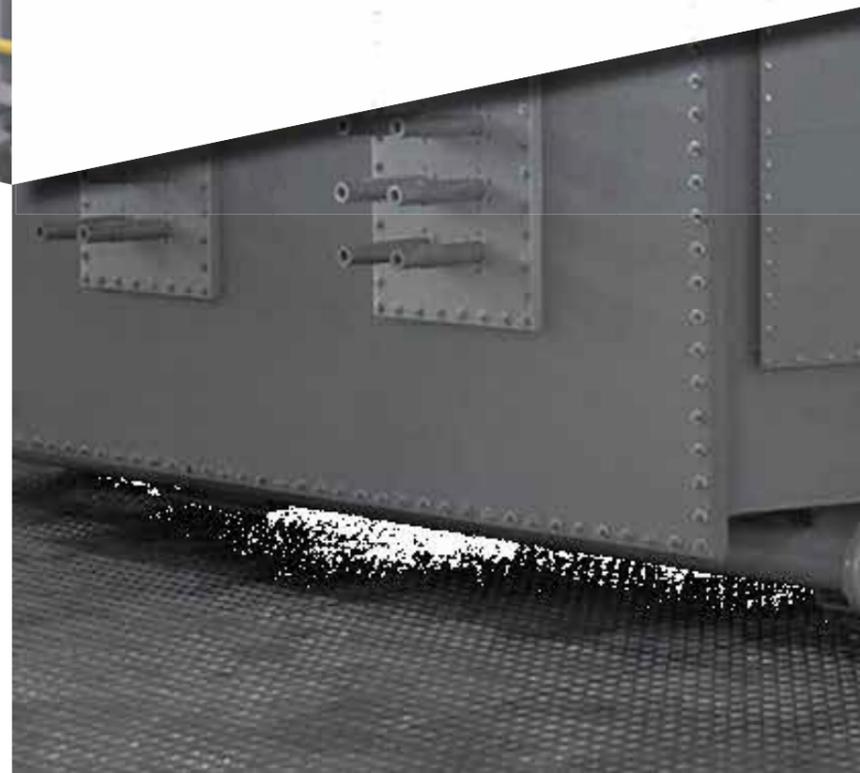
For rectifier units the used solution is the copper bars. The shape and size is customized based on rectifier input interface.

Tank

The tank is made by welded steel sheets creating a strong and stiffened structure to support full vacuum and over pressure. The internal walls of the tank are painted with an hot oil resistant coating while externally the tank is painted according to a standard procedure established by the Tamini Quality Assurance Department. Specific painting requirements can be adopted on request.

In furnace and special transformers the tank is equipped with an oil conservator divided in two sections for the transformer oil and for the OLTC oil switch. Suitable manholes for internal inspection and maintenance are provided on the tank.

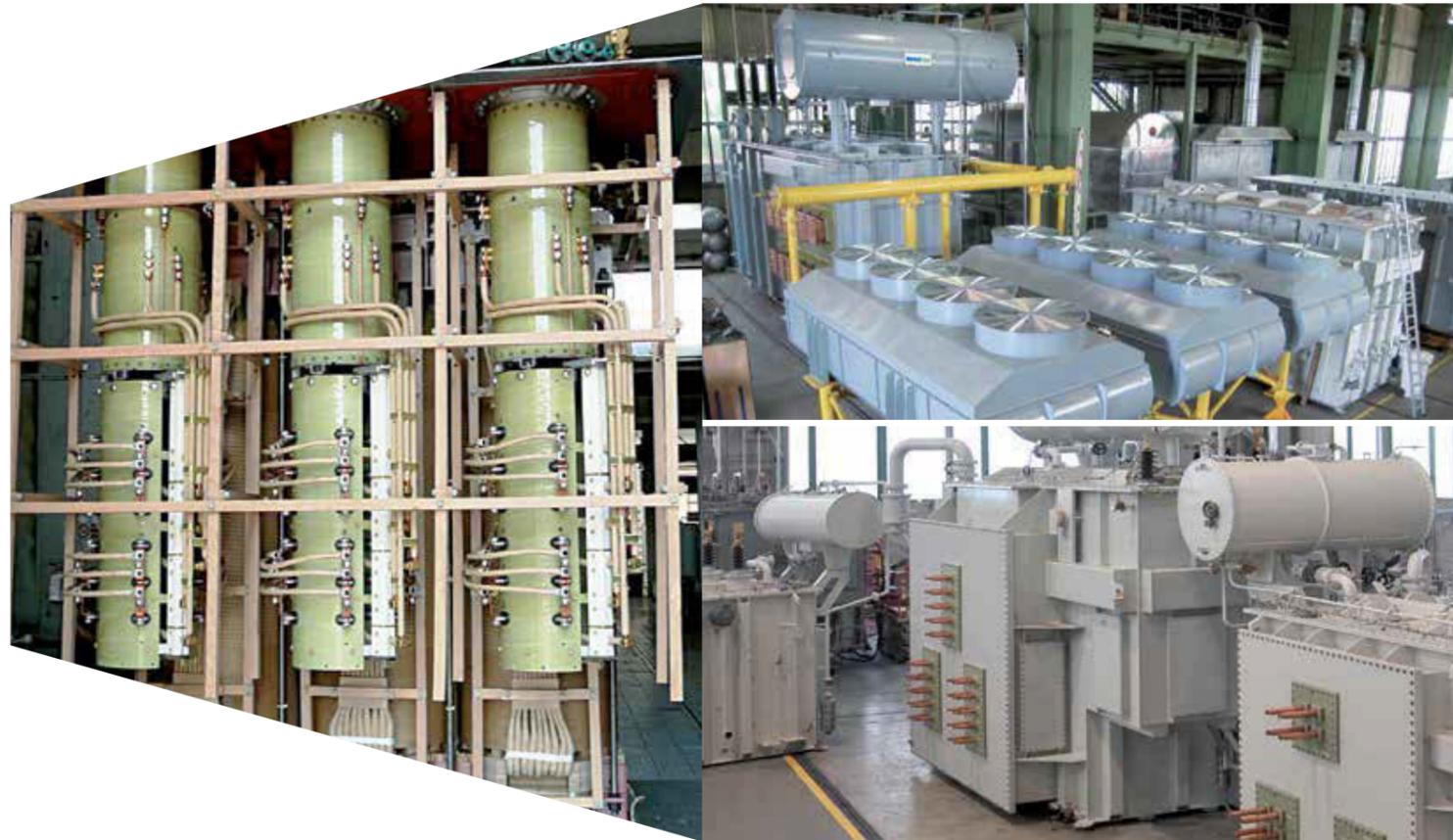
In correspondence of the LV outlets, the tank has one or more non-magnetic insulating plates bolted to the tank through suitable gaskets.



Bushings

The bushings can be either of the oil/air type or oil/oil, in case of connections to cables in oil filled terminal boxes, or also oil/SF6 for connection to SF6 filled bus-bar ducts.

HV Bushings are usually of the condenser type with oil impregnated or with resin impregnated paper.



Tap Changer

The transformers can be equipped either with on-load tap changer fitted on the HV side.

The on-load tap changer is composed by a tap selector normally immersed in the same oil of the transformer and by a diverter switch located in an oil filled sealed container separated from the transformer oil. On request, a barrier board inside the transformer tank can be provided to divide the oil of the transformer and the oil in which the selector is immersed. With this solution it is possible to check the tap changer selector by only removing the oil from the separate section in which it is positioned.

Moreover, as a further solution, the whole OLTC can be located in a separately associated oil filled tank and connected through bushings.

Ancillaries

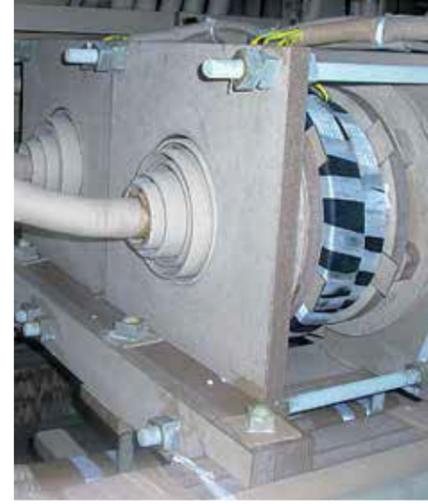
The industrial transformers are equipped with the following fittings and accessories:

- Two air silica gel breathers for the two conservator sections;
- Two oil level indicators with electric contacts for the two conservator sections;
- Buchholz relay with alarm and trip contacts;
- Oil drain, filling and filtering valves;
- Oil thermometer complete with alarm and trip contacts and, on request, a device for remote temperature monitoring;
- Current transformers as per customers requirements;
- Over-pressure protection;
- Lifting lugs for core and winding;
- Lifting lugs for the complete transformer;
- Marshalling box for signaling and protection auxiliary circuits;
- Earthing terminals;
- Oil sample valve.

Upon request additional and/or specific accessories could be fitted on the transformers.

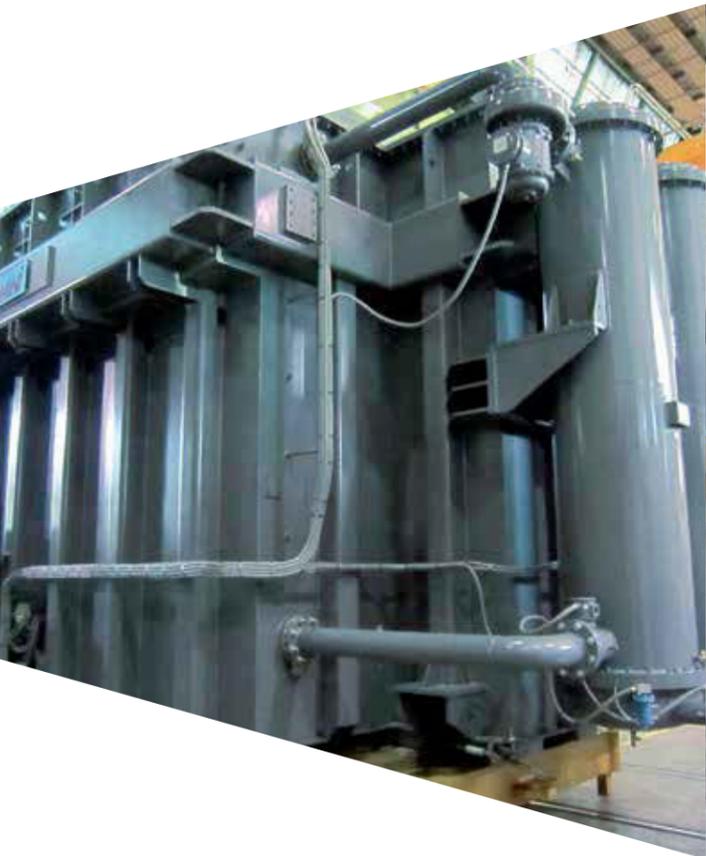
As example:

- Surge arresters on HV side;
- RC filters on HV side;
- Capacitors on LV side;
- PLC and/or i/o cards.



Cooling System

The transformers can be designed for any applicable cooling system following the requirements of the end user. The industrial transformers are mostly provided with an OFWF cooling system. Different positioning of the coolers, including horizontal installation, can be adopted to satisfy specific requirements for easier connection to the external water piping system. The coolers are normally composed by a single-walled or, on request, a double-walled system. The design of the coolers is such that any possible risk of water leakage into oil is absolutely avoided.



The coolers can be equipped with many accessories line: water and oil flow indicators with alarm contact, water and oil thermometers, water and oil drain taps or other special ones, on request. When water is not available, the cooling is generally OFAF.

The most used cooling systems for power transformers are ONAN and ONAF. These systems are achieved by radiator banks, mounted on the sides of the transformer tank, or in separate banks, with or without cooling fans. The cooling can also be OFAF (or ODAF) and OFWF (or ODWF) with coolers assembled on the transformer tank or in a separate bank.

