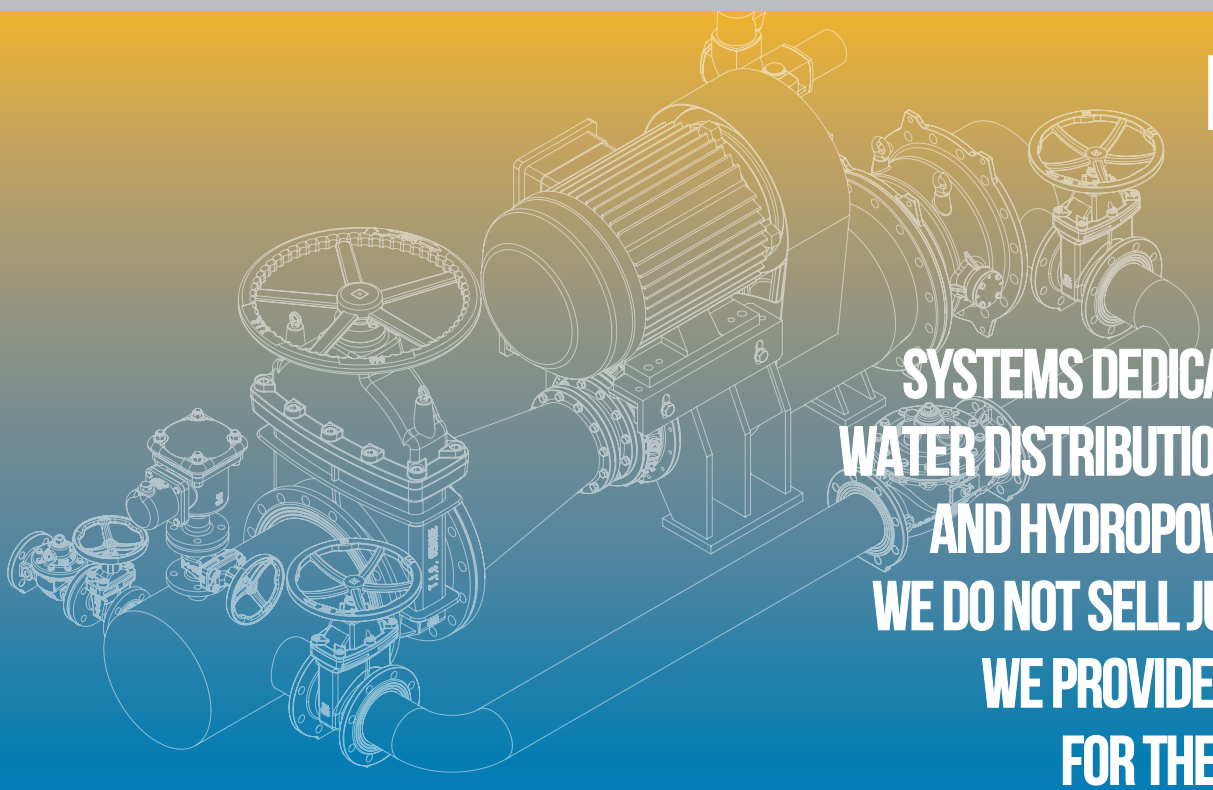
T.i.S Service

PRESSURE REDUCING STATION WITH ELECTRICITY PRODUCTION

FR LINE



SYSTEMS DEDICATED TO THE WATER DISTRIBUTION NETWORK AND HYDROPOWER SECTOR
WE DO NOT SELL JUST VALVES, WE PROVIDE A SOLUTION FOR THE EFFICIENCY OF THE WATER NETWORK

T.I.S SERVICE S.p.A., an Italian company that specializes in the production of equipment for managing pressure in water network services, has launched the FR LINE: an innovative solution that meets water pipeline and irrigation systems needs that have never been addressed before.

A system that has originated from years of experience in the field and a through analysis of the industry's requirements.
Indeed, water pipeline networks feature numerous pressure reducing stations that play a crucial role in ensuring that water reaches the end users with controlled flow and pressure. Each station has a control valve whose function is to reduce pressure by dissipating energy.

With FR Line this dispersion is converted into electricity which can be directly used or fed into the grid. The system's output is sufficient to repay the investment made in a few years.

The goal set by T.I.S. Research and Development Centre - made up of experts in the design and management of water network services with a particular focus on drinking water, and in the design and construction of various types of valves and hydroelectric power facilities - was to design a pressure reducing station, capable to generate energy, that would meet all the essential constraints for effective management of drinking water services, i.e. that would:

1. **Guarantee supply continuity, in terms of both pressure and flow rate, as required by the user**
2. **Offer quick and easy installation and start-up, so as not to undermine supply continuity**
3. **Feature a compact design which is compatible with existing site structures**
4. **Use certified materials with specifications that confirm their suitability for both drinking water and environmentally friendly applications**
5. **Feature an easy connection with the national electricity grid**
6. **Control pipeline back pressure**
7. **Keep water hammer at an insignificant level, ensuring compatibility with deteriorated pipelines**
8. **Ensure noise levels that are compliant with permitted parameters at the installation site**
9. **Facilitate both mechanical and electrical maintenance**
10. **Be ready to communicate with existing remote-control systems**
11. **Offer a remote management with alarms**
12. **Offer a sufficient IRR for the investment (through medium/high output)**

FR Line introduces the opportunity, within the field of water services, to effectively reduce pressure and generate electricity with significant returns at the same time, while meeting the essential requirements for the proper management of drinking water services.

FR STATION

The FR station normally consists of a line with a fixed production group “TN” or with a regulating production group “TK” and a parallel bypass line, including a special control valve for safety operation and flow compensation.

The station is flexible and can be designed in various configurations, with multiple production group in parallel for high flow rates (Figure B) or in series, for high pressures (Figure C).

Particular attention was paid to the “in-line” installation of the production group, which allows their installation on straight sections of pipe, even pre-existing ones.

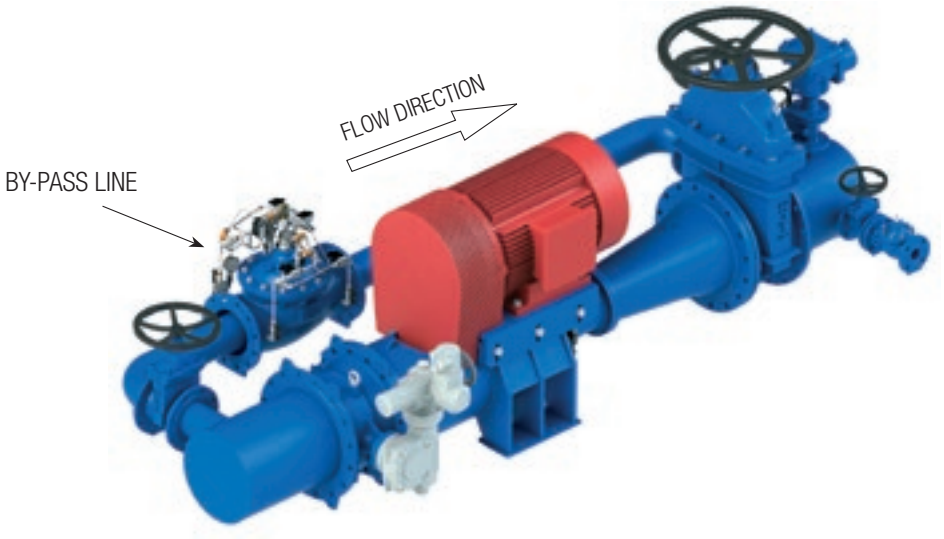


FIGURE A - STANDARD STATION WITH TK GROUP

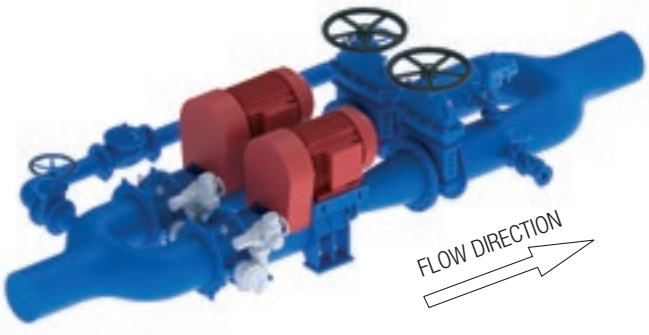


FIGURE B - STATION WITH TWO TK GROUPS IN PARALLEL

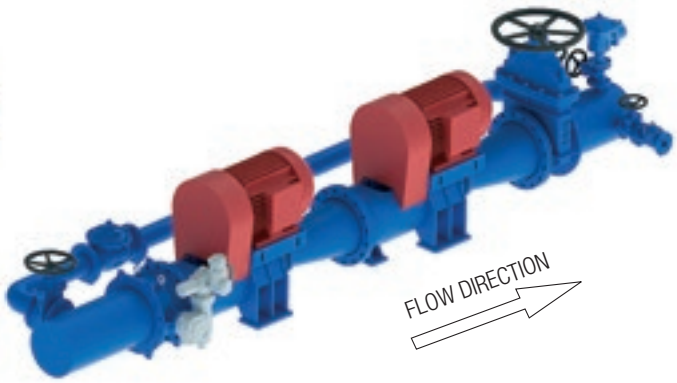


FIGURE C - STATION WITH TWO TK GROUPS IN SERIES

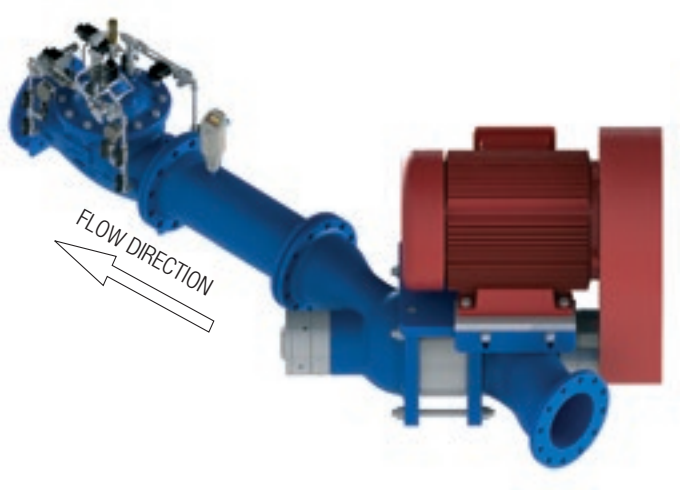


FIGURE D - TN PRODUCTION GROUP

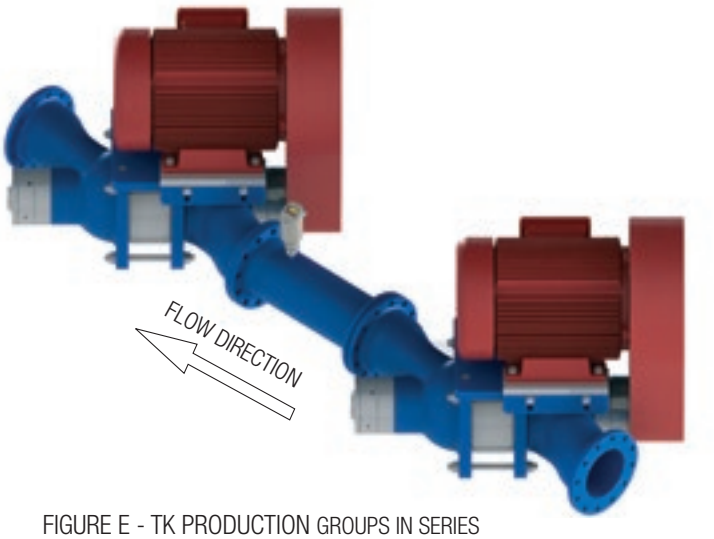


FIGURE E - TK PRODUCTION GROUPS IN SERIES

A COMPLETE, RELIABLE SYSTEM

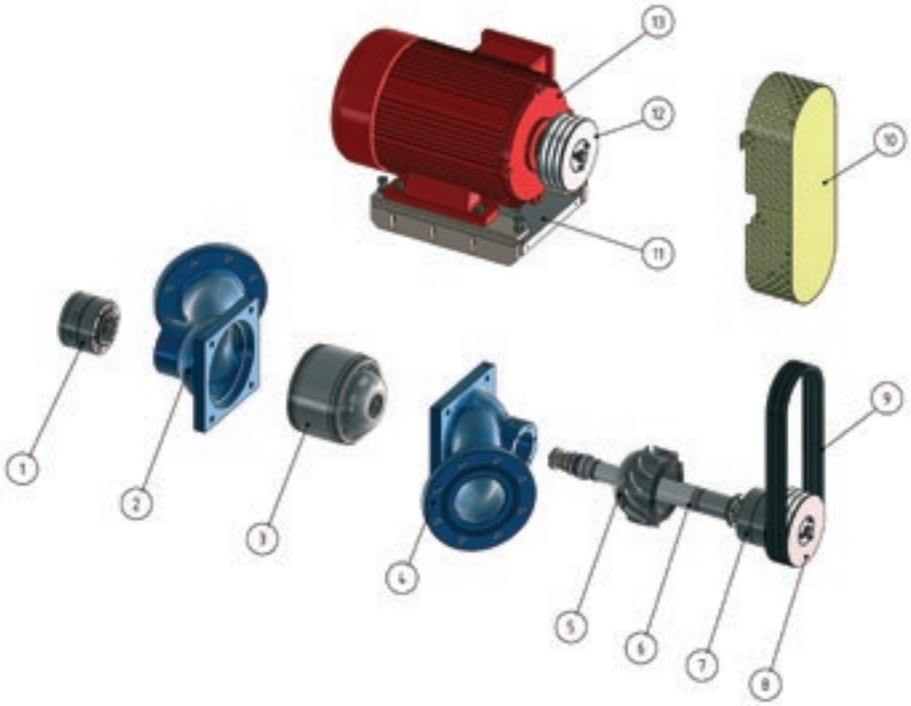
The core of the FR station is the production unit, divided into 2 big families:
- TN production groups (for flow rates between 5 and 350 l/s)
- TK production groups (for flow rates between 200 and 500 l/s)

When designing the system, particular attention was focused on the selection of materials and coating that can be used in contact with drinking water. More specifically, all carbon steel parts will be coated internally and externally with epoxy resin powders applied with Fusion Bonded Epoxy Process (FBE) with thickness of 250 micron.

The small production groups of the TN family can modulate the water flow with a special valve installed downstream. The TK group is, however, regulating and essentially consist of a distributor with mobile blades, an impeller with fixed blades with specific wing profiles (adjustable when the group is stationary to better adapt to the specific conditions of the installation site) and a shaft line with bearings and pulleys for coupling to the generator.

TN GROUP

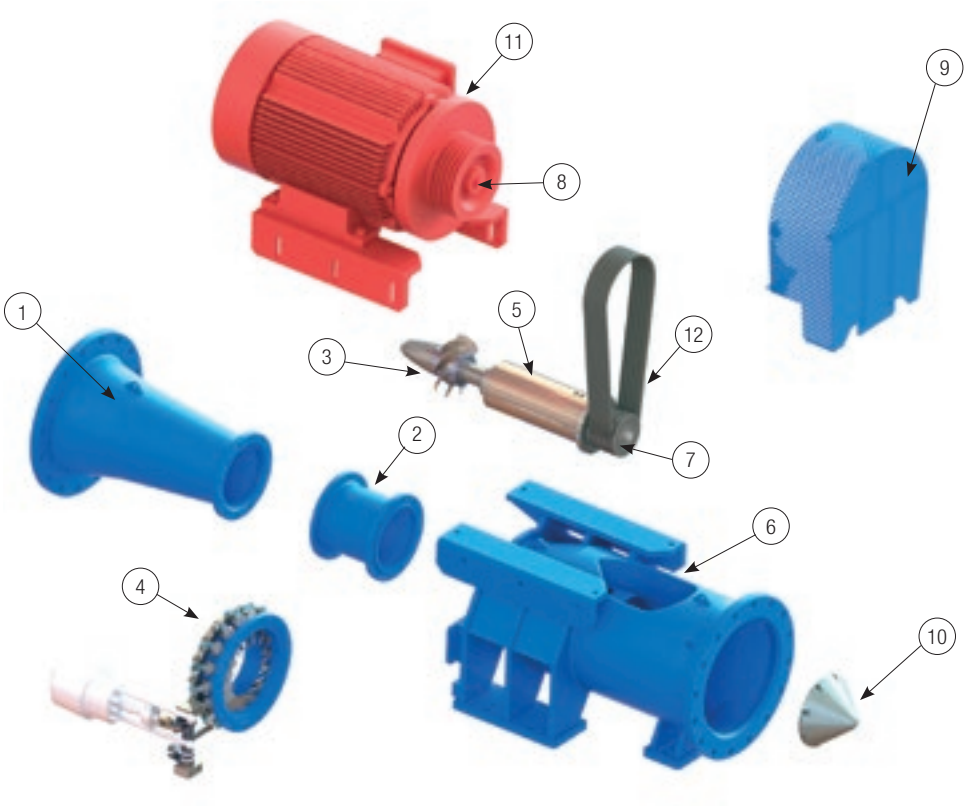
In the TN group the flow of water that passes through the inlet section (4) is directed by the fixed distributor (3) towards the blades of the impeller (5) and then to the outlet section (2). The shaft of the group (6) passes through two sliding type mechanical seals and comes supported by two bearings at the ends (1-7). The coupling of the shaft line with the generator (13) can be of the type belt/ pulley (8-9-11-12), protected by a special protective casing (10) or direct type by means of an elastic joint.



ITEM	COMPONENT	MATERIAL	NOTE
1	Bearing support N.D.E.	AISI316 stainless steel	Ball bearing
2	Output elbow	AISI316 stainless steel	
3	Distributor	1.4313 martensitic stainless steel	
4	Input elbow	AISI316 stainless steel	
5	Runner	1.4313 martensitic stainless steel	
6	Runner shaft	AISI420 martensitic stainless steel	
7	Bearing support D.E.	AISI316 stainless steel	SKF roller bearing
8	Drive pulley	C45 carbon steel	NITEK nickel-plated
9	Transmission belts		V-belts
10	Protective casing	SR355 JR carbon steel	250 µm epoxy coating
11	Generator frame	SR355 JR carbon steel	NITEK nickel-plated
12	Driven pulley	C45 carbon steel	NITEK nickel-plated
13	Generator		Asynchronous or permanent magnets

TK GROUP

In the TK group, through the microprocessor-controlled electric actuator, the mobile vane flow distributor (4) adapts the tilt of the distribution vanes, modulating the water flow to the blades of the runner (3), which rotates in its seat (2). This modulation allows precision control of the flow rate, which passes through the body of the production unit (6) to the discharge cone (1), and therefore control of the downstream pressure in the water networks. The belt/pulley type shaft line (7) coupling is protected by a special casing (9).



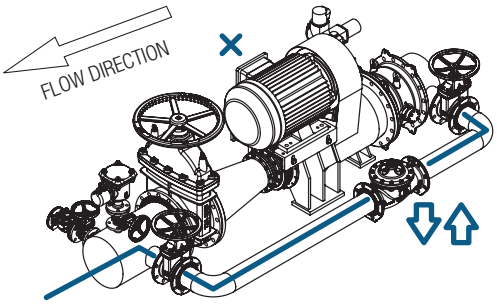
ITEM	COMPONENT	MATERIAL	NOTE
1	Discharge cone	SR 355 JR carbon steel	250 µm epoxy coating
2	Runner seat	SR 355 JR carbon steel	250 µm epoxy coating
3	Runner	1.4313 martensitic stainless steel	
4	Mobile vane flow distributor	AISI316 stainless steel	
5	Bearings cartridge	Rear: SKF roller bearings Front: SKF ball bearings	
6	Production unit body	SR 355 JR carbon steel	
7	Drive pulley	NITEK nickel-plated C50 carbon steel	
8	Driven pulley	C50 carbon steel	250 µm epoxy coating
9	Protective casing	Carbon steel	250 µm epoxy coating
10	Input nose cone	AISI316 stainless steel	
11	Generator		Asynchronous or permanent magnets
12	Transmission belts		V-belts

FLOW RATE MANAGEMENT

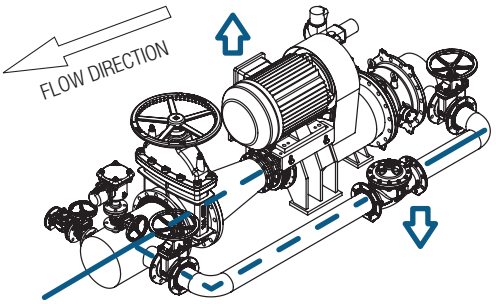
As mentioned, the management of the water flow through the FR station is managed differently, depending on the production group installed. For TN groups, the in-line control valve will modulate the flow rate to maintain the downstream pressure, while TK groups can directly modulate the flow rate using their mobile distributor.

- when the production unit is in service, it controls the opening of the flow distributor and maintains the flow rate/pressure at the required value.
- when the production unit is out of service, for example during ordinary maintenance, the flow runs entirely through the bypass valve, which does not require automatic controls or electrical power for its modulation.

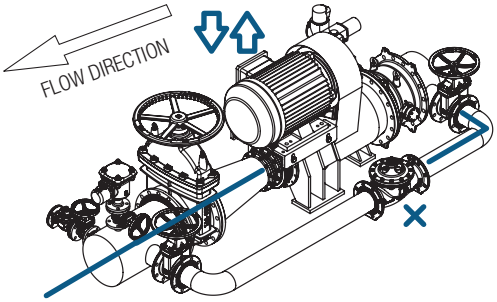
When the unit is in service however, the bypass valve can compensate any higher flow rate requirements.



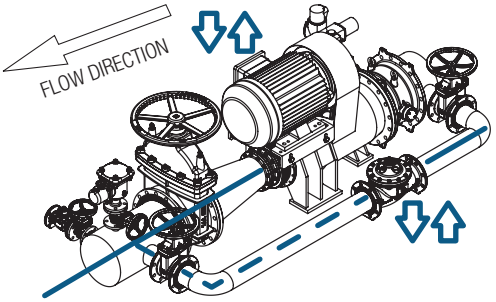
Regulation of flow from bypass line with production unit out of service



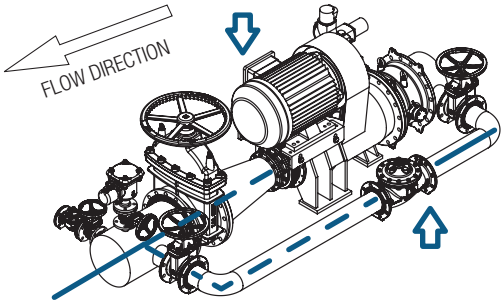
TK unit start-up and gradual closing of the bypass valve



Flow regulation with TK unit and control valve closed



Surplus flow compensation with modulation of the bypass line valve

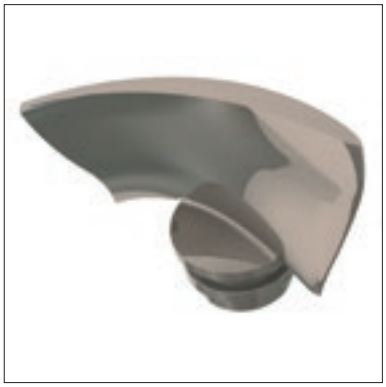


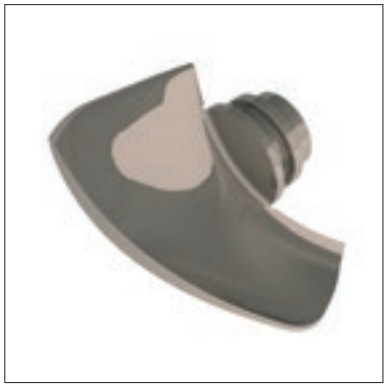
TK unit shut down and flow control switching

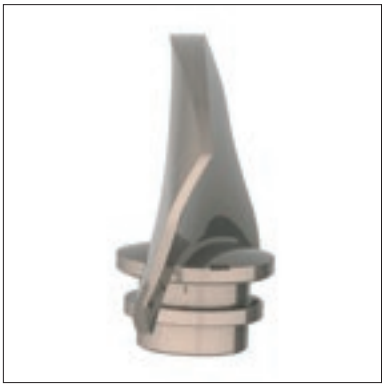
THE FLUID DYNAMICS

For the design and industrial validation of the TN and TK production groups, the engineers at T.I.S. have employed the most advanced technologies available. Dynamic simulation was carried out using Ansys Fluent software.

In order to obtain a high performance of TK groups, a new approach to the fluid dynamics of the meridian channels and the blade shape, including their angles of incidence to the flow, have been formulated.



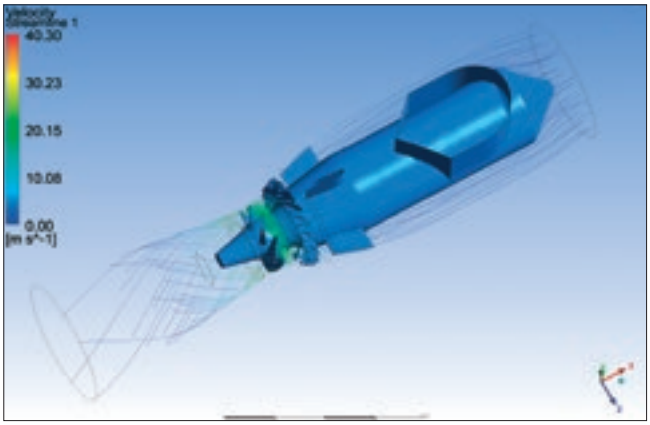


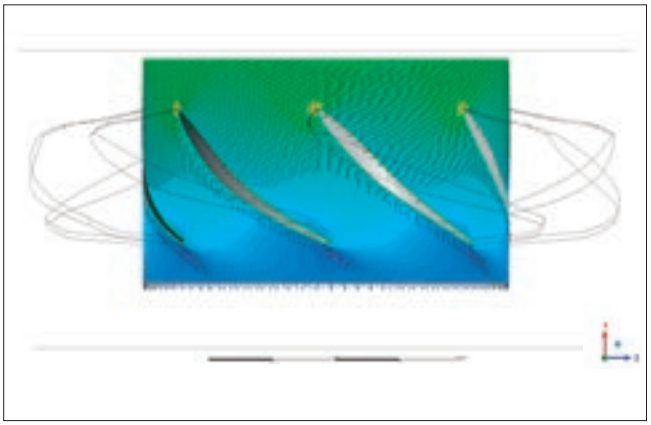


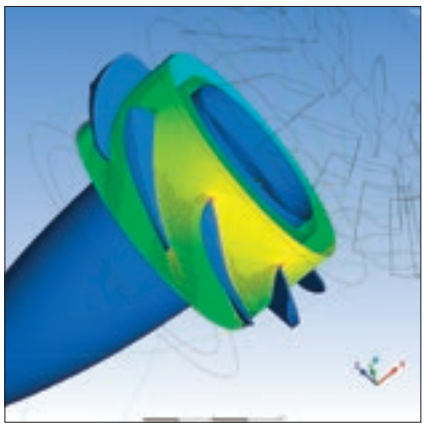
Once the design/planning stage was finished and the wheel model had been designed, T.I.S. verified and validated the results obtained by CFD simulation, which provided a detailed view of the complex water flow phenomena that enabled to optimise the airfoils prior to production.

The particular geometry of the hydraulic profiles of the TN and TK groups guarantees the absence of water hammer phenomena in the pipelines, in every working condition.

The results obtained met and in some points exceeded expectations for units performance, as it emerged that the product obtained could actually play a key role, in the near future of renewable resources.







APPLICATION RANGE

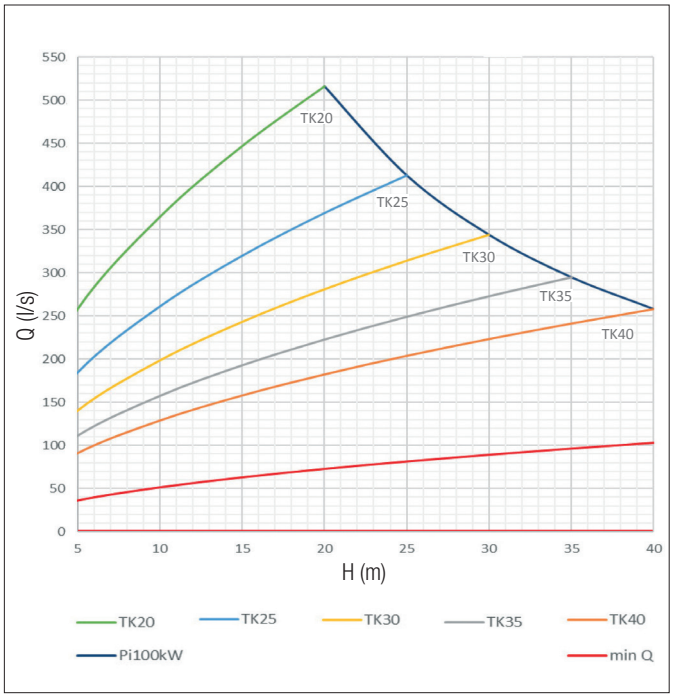
The production groups have been designed in various models, to cover a very wide range of water flow with high efficiency. The various models are distinguished by inlet diameter (TN) and rated head (TK). Each model can cover a vast range of water flow conditions:

T.I.S., based on the specific data, will help the client to determine the most appropriate solution.

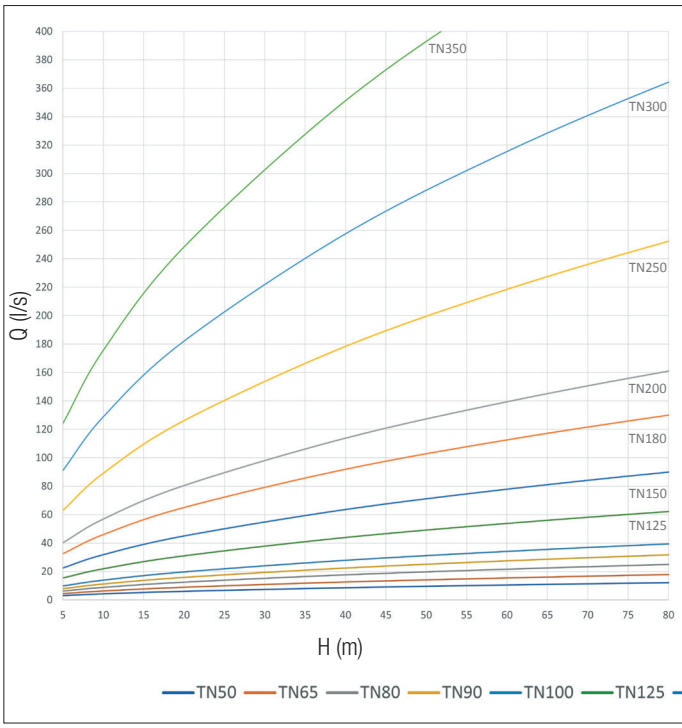
Note that TN groups can work with a hydraulic head (difference between the upstream and the downstream pressure) up to 80 mH2O, with a maximum pressure input of 40bar.

TK groups handle a hydraulic head of up to 40 mH2O with a maximum inlet pressure of 16 bars.

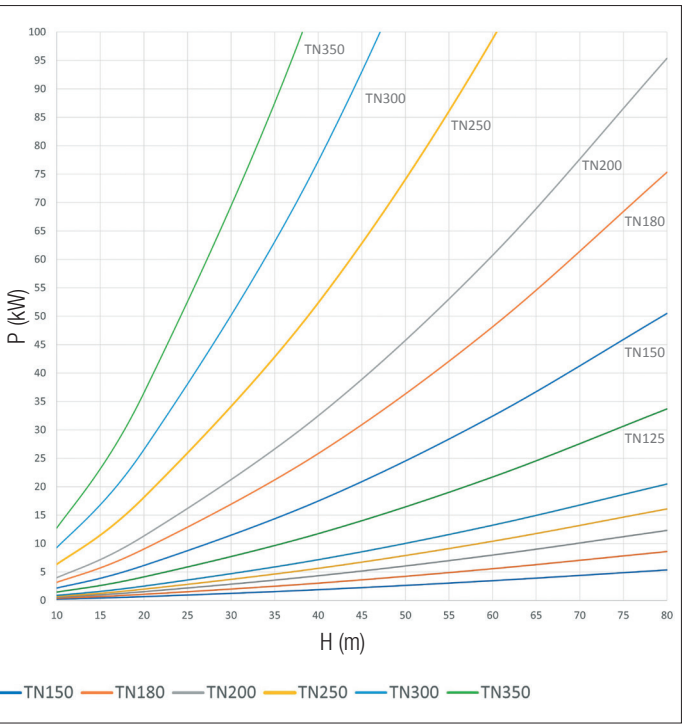
TK APPLICATION RANGE



TN APPLICATION RANGE

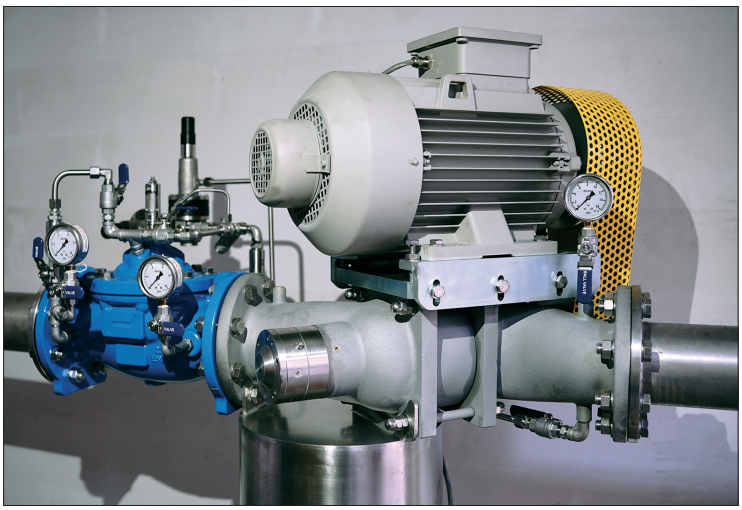


TN POWER PRODUCTION

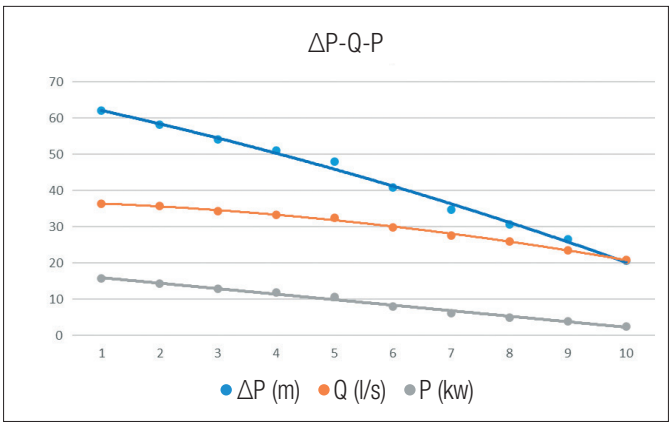


EFFICIENCY

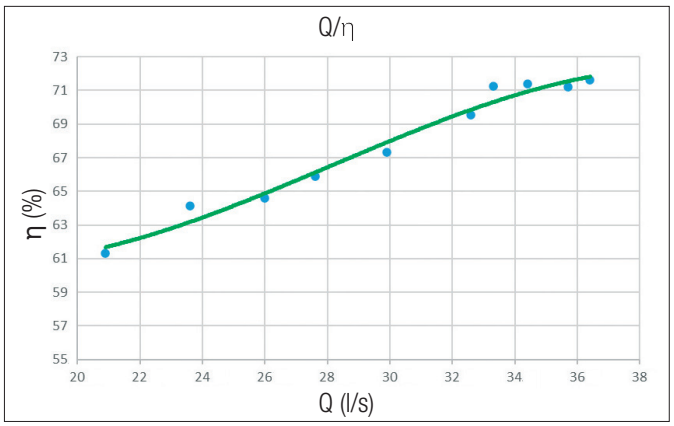
The efficiency of TN groups is, on average, greater than 70% at their nominal flow point (from approx 65% of small TN50s to over 82% of TN350s).
It is very important to underline that the tests carried out in our laboratories have confirmed that the performance of the groups does not change significantly as the flow rate varies. See below the results of the tests we conducted on the TN100 group, in our test laboratory, using an electromagnetic brake for load and speed control.



TN100 - TEST REPORT

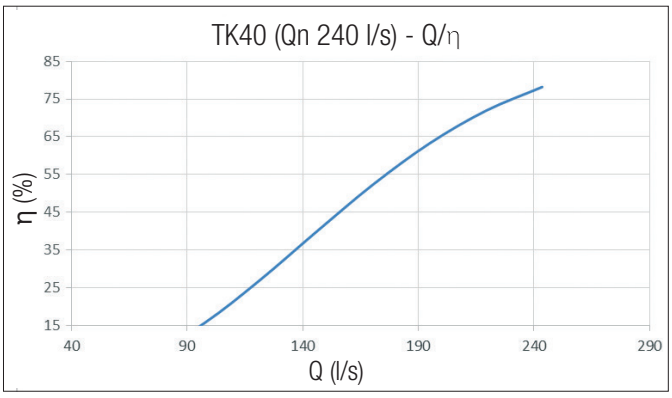


TN100 - TEST REPORT - Q/η

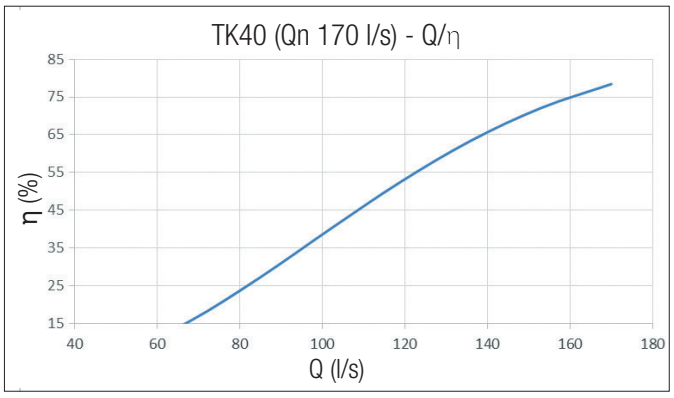


With TK groups, by previously adapting the angle of the impeller blades to the nominal flow rate of the installation site, it is possible achieve a high efficiency at various points of the nominal flow rate.
See below, for example, the expected efficiency curves for the TK40 group, corresponding to different angles of the impeller blades. Even for these groups, efficiency increase when runner diameter increases.

PRODUCTION UNIT EFFICIENCY



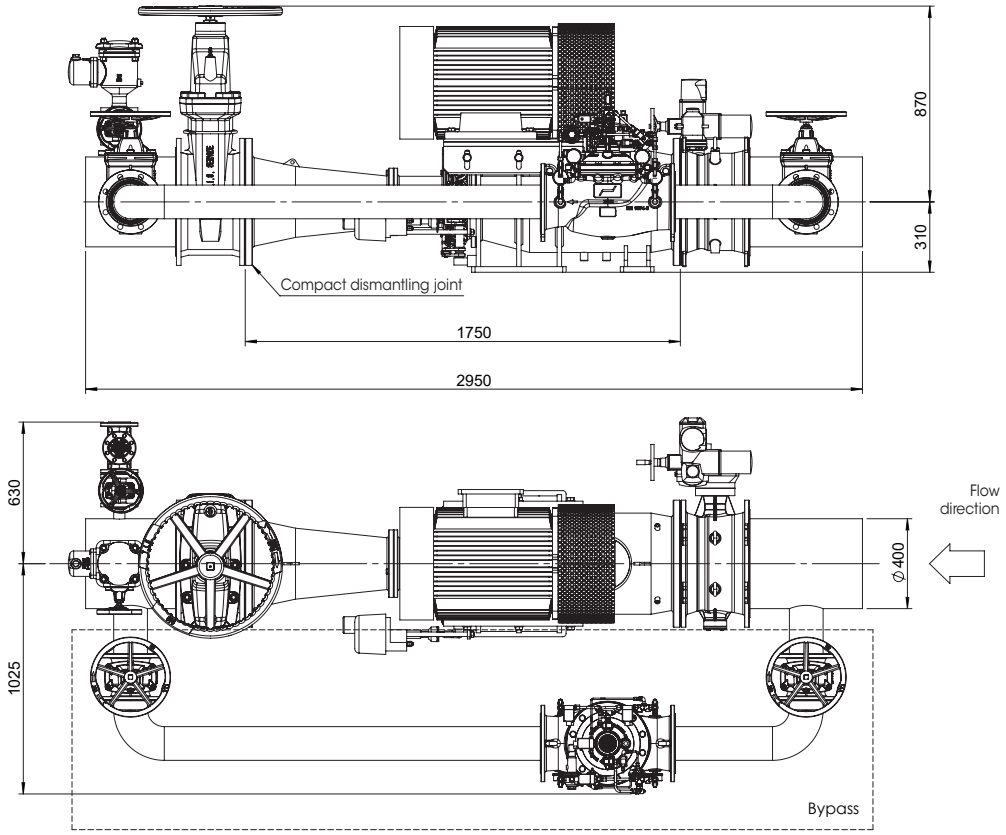
PRODUCTION UNIT RANGE



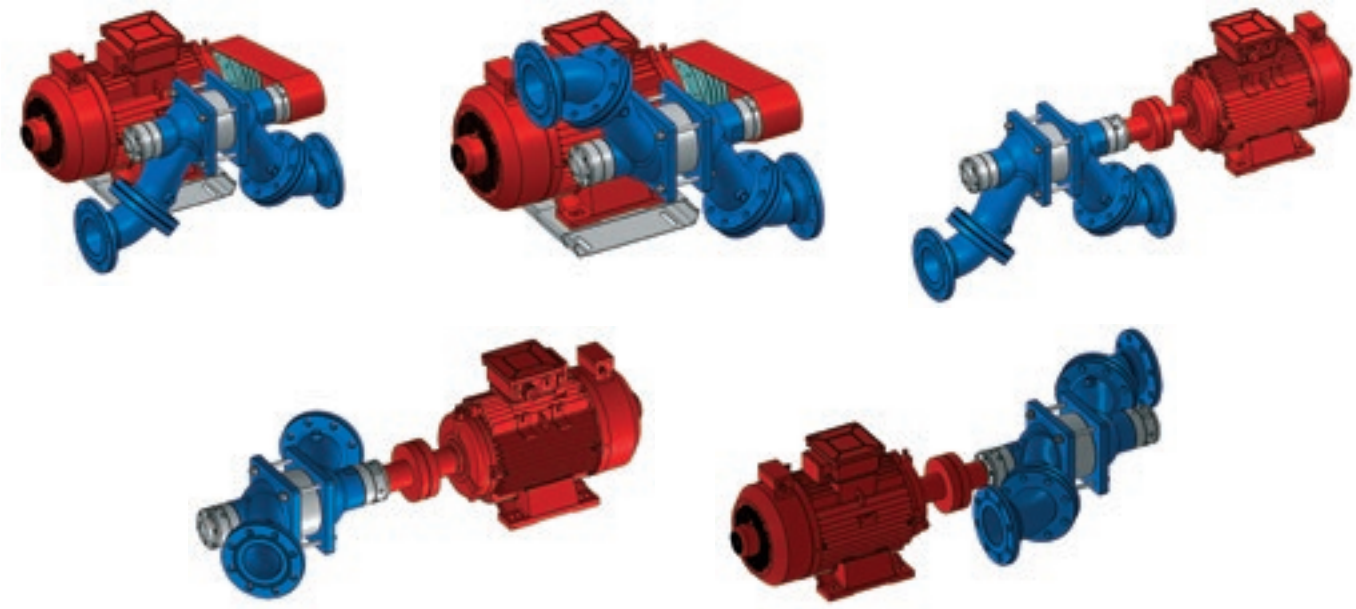
DIMENSIONI E LAYOUT

The pressure reducing station overall dimensions are extremely compact, which make it easily adaptable to existing pipelines and infrastructure.

See below, for example, the overall dimensions of the FR station with the TK40 production unit, complete with bypass circuit.



The TN groups, having very compact dimensions (for example the distance between the flanges of the TN100 model is only 600mm), can be installed in various configurations, with generators coupled by belts and pulleys or directly with flexible coupling. The inlet and outlet flanges are normally aligned with each other but a simple rotation of a part of the machine body can allow different alignments with the existing pipes.



THE CONTROL SYSTEM

As brain of the system, the PLC is responsible for coordinating the start-up, operation, and shutdown phases of the production unit, with the simultaneous management of the bypass valve, in order to adapt the system to the different operating conditions and/or flow rates required.

In the event of anomalies or a sudden power outage, the system will stop automatically, and flow control will be handled by the bypass valve. The safety of the station will be guaranteed by fail-safe actuators. When normal operating conditions return, the system will start up again and restore parallel operation autonomously.

The PLC adjusts pressure/flow/level while running in parallel with the public network. The production unit working point will be based on the best performance curve of the unit. In the case of the most common disturbances, however, the PLC is overridden by the protection relays, which switch off the unit directly and activate the shutdown device.

The human machine interface panel (HMI Touch Panel) installed on the front of the control panel can be used for:

- Viewing and storing alarms and reports
- Viewing and storing measurements such as power, openings, temperatures, levels, etc.
- Producing schematic graphic representations of the system and displaying operating data
- Setting reference values
- Producing graphs

There is also a GSM system enabled in the event of an alarm or failure, to notify the personnel in charge. The priority of each event, as well as the recipient of the alert, can be set without limitations. The same system will also allow access to the plant's Ethernet network, via password-protected VPN, for remote management and assistance purposes.

The connection to the electrical distribution line is normally made through a regenerative AC/DC/AC "AFE"unit which manages the energy exchange with the drive or drive system network by controlling the DC Bus voltage. Furthermore, with an intelligent conversion system based on IGBT technology, it provides a power exchange with the line of active power only (cosΦ close to one) maintaining the sinusoidal line currents.

T.I.S GROUP

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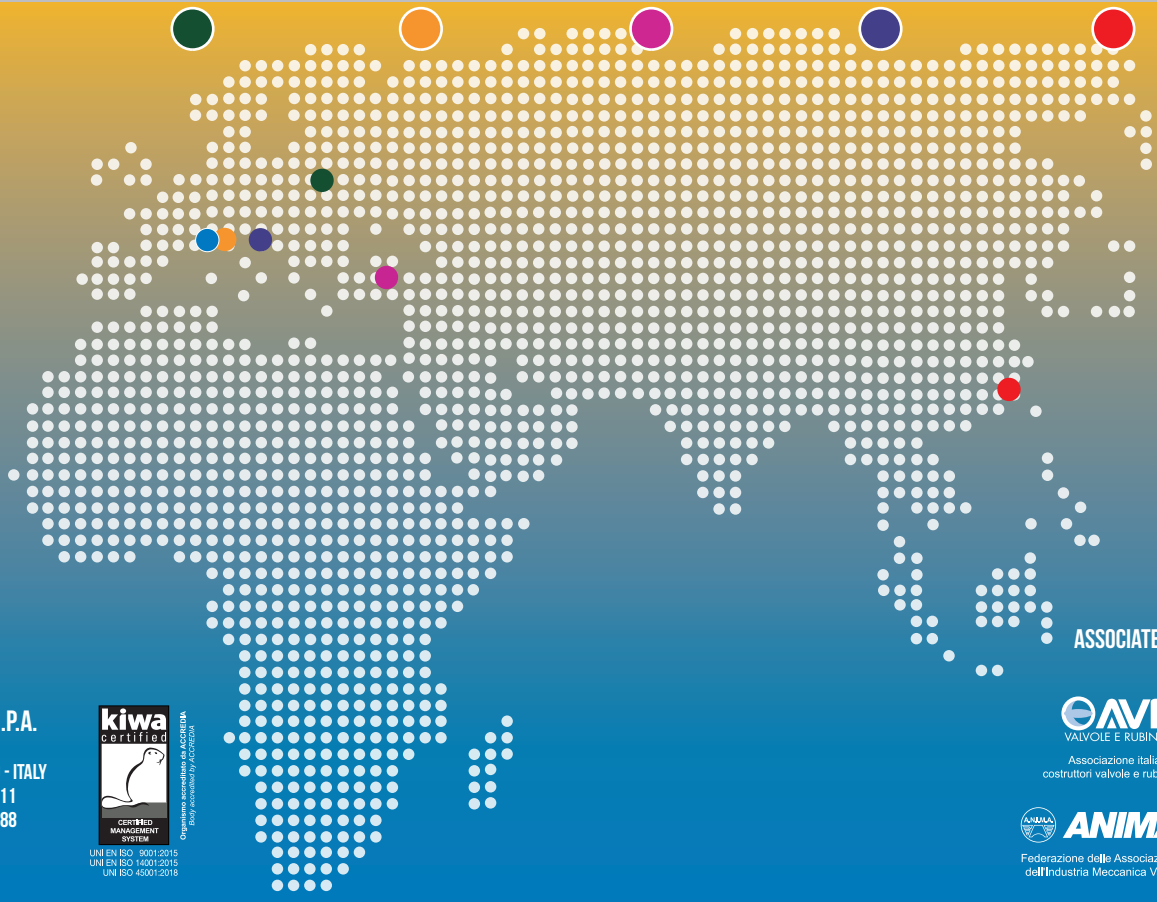

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