turbine bypass systems

VECTOR & WELLHEADS ENGINEERING, S.L.

Engineering

Vector & Wellheads Engineering Division offer you the best solutions in the following fields:

**Engineering**
   Design of all kind of valves.
      Detail drawings.
      Assembly drawings.
      Calculations.
   NDT procedures, welding, tests, fabrication.
   Technical consulting.
   Process oriented valve and procedures selection.

Structural analysis
   Design, optimization and test of mechanical components (FEA).
   Analysis of installed valves .

Fluid mechanics
   Fluid system analysis.
   Distributions of flow, velocity, pressure, turbulence, pressure drop.
   Steady state and transitional analysis.

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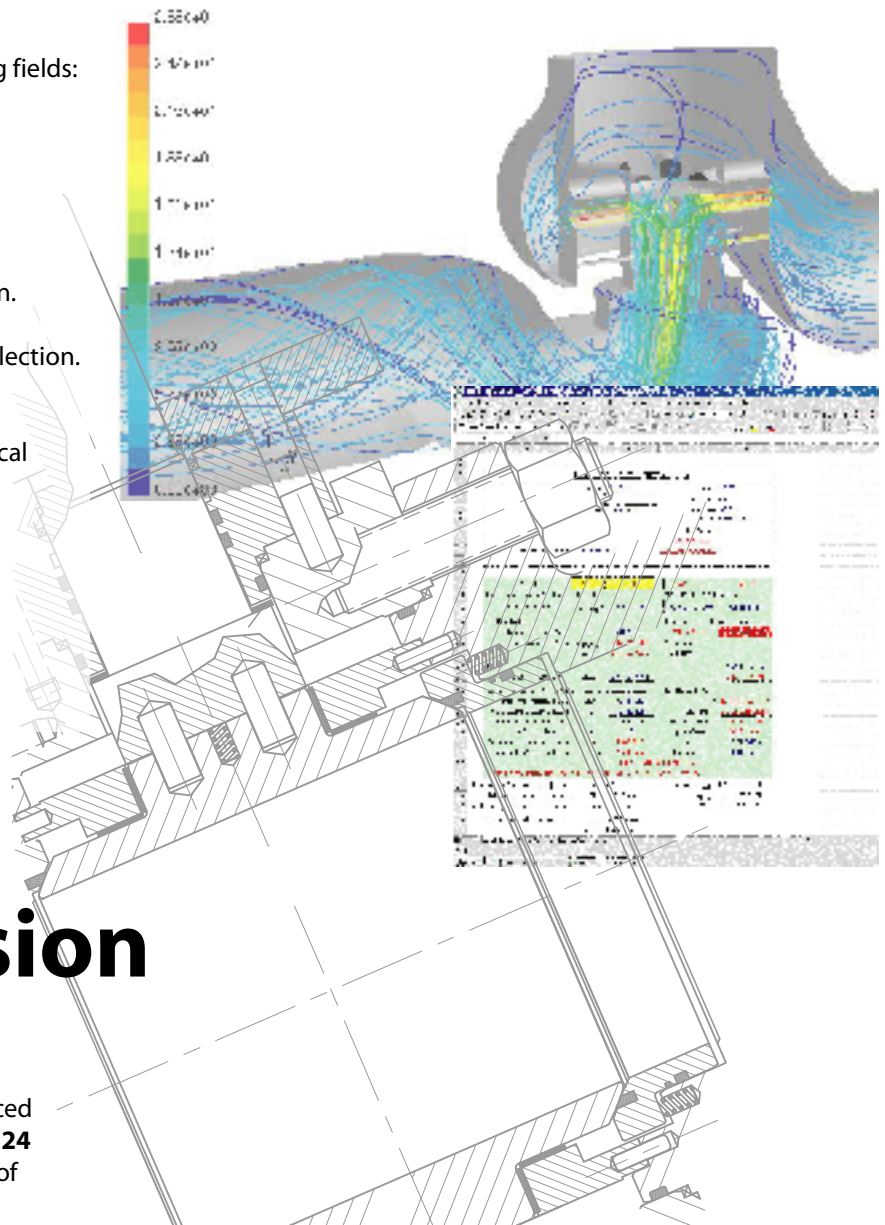
Service division

Formed by a highly qualified and experienced team, our service division is **available on a 24 hour basis** to meet urgent needs, capable of performing jobs at site during:

- Outage and start-up periods
- Installation
- Commissioning
- Supervision

Activities
Preparing and planning prior to the job: detailed studies for scheduling the supply of spare parts necessary for the intervention.
Identification of failures.
Maintenance, repairs, replacement and test of ball, safety, butterfly, gate, check, globe, control and pressure-seal valves.
Maintenance, repairs, replacement and test of manual, pneumatic, hydraulic, and electric actuators.
Installation of valve instrumentation.
Diagnosis of control valves.
Leackage and functional tests.
Training courses for maintenance: valves, instrumentation and actuators.

overview

The turbine bypass system is a basic component of a power plant, that has evolved over the years to increase operational flexibility and plant life, protectin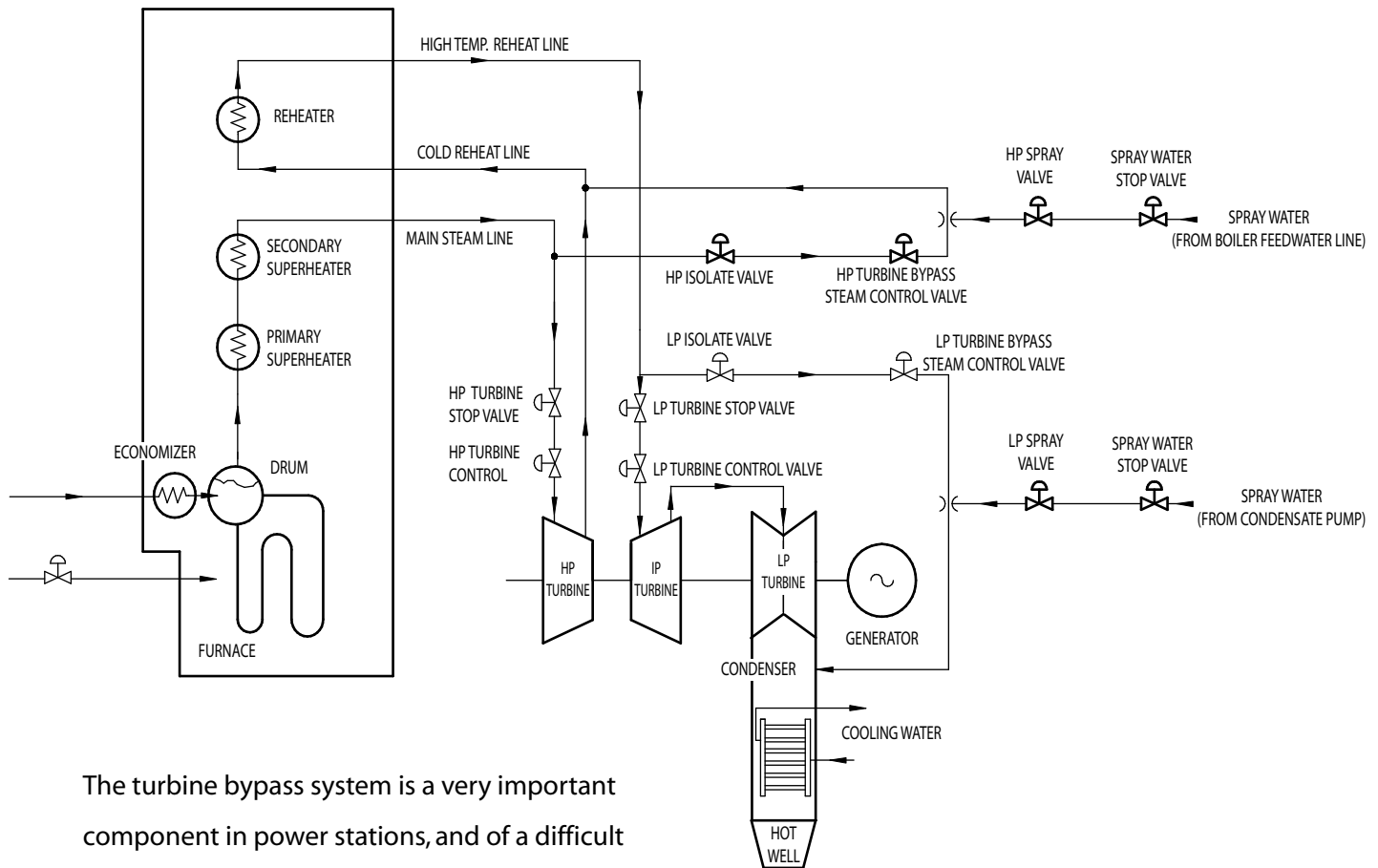g its components during transient mode operation. The turbine bypass system enables independent activity of the steam generator and the turbine during start-up, load rejection, shutdown and variable pressure operation. This autonomous operation reduces start-up and reloading times, and increases overall plant availability, efficiency and lifetime.

Correct sizing is critical to meet the needs for variable demands of transient operation modes, and flawless integration of the turbine bypass system in the complete plant design. V&W is fully commited to provide our clients the highest levels of long term service. For an excellent solution, V&W support and experience becomes essential.

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turbine bypass systems

Diagram labels:

HIGH TEMP. REHEAT LINE
REHEATER
COLD REHEAT LINE
SECONDARY SUPERHEATER
MAIN STEAM LINE
PRIMARY SUPERHEATER
ECONOMIZER
DRUM
FURNACE
HP TURBINE STOP VALVE
HP TURBINE CONTROL
HP ISOLATE VALVE
HP TURBINE BYPASS STEAM CONTROL VALVE
LP ISOLATE VALVE
LP TURBINE STOP VALVE
LP TURBINE CONTROL VALVE
LP TURBINE BYPASS STEAM CONTROL VALVE
HP SPRAY VALVE
SPRAY WATER STOP VALVE
SPRAY WATER (FROM BOILER FEEDWATER LINE)
LP SPRAY VALVE
SPRAY WATER STOP VALVE
SPRAY WATER (FROM CONDENSATE PUMP)
HP TURBINE
IP TURBINE
LP TURBINE
GENERATOR
CONDENSER
COOLING WATER
HOT WELL

The turbine bypass system is a very important component in power stations, and of a difficult service too. Although it does not operate continuously, when it is required to operate it has to be fast and reliable. Its main job is called steam conditioning. It means pressure reduction and desuperheating of steam that has been produced by the boiler but, due to transient or unexpected conditions, can not flow through the turbine.

The percentage of total steam handled by the turbine bypass system depends on plant design philosophy. Capacity usually ranges between 30% up to 100% of the maximum continuous rating (MCR) boiler steam flow.

V&W turbine bypass systems are custom designed, suitable for the specific needs of the individual plant.
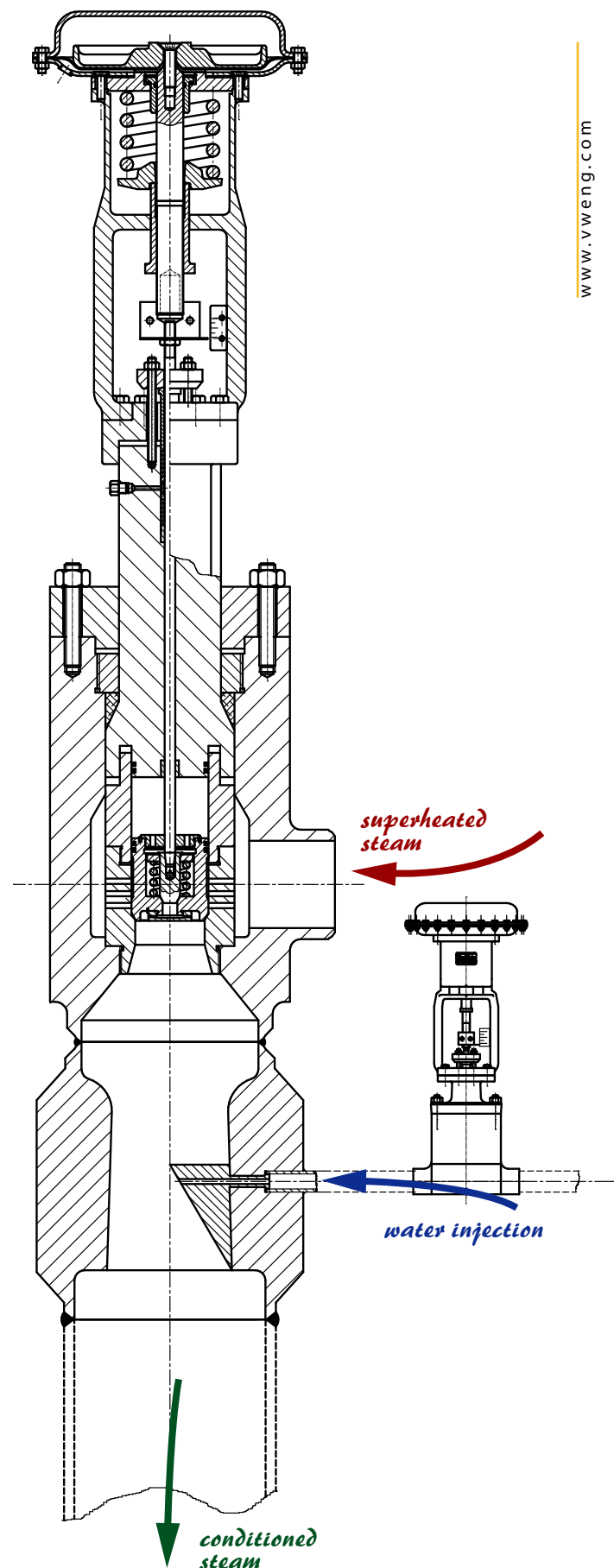
turbine bypass systems

Different bypass stations are dedicated for the high pressure (HP) and the low pressure (LP) turbine stages.

The high pressure turbine bypass system provides an alternate flow path at the high pressure side of the turbine, taking the steam from the turbine inlet to the reheater inlet section.

This bypass system permits stable operation of the boiler when the turbine trips off line or during start-up operations. Steam flowing through the high pressure bypass control valve is throttled and cooled to a temperature slightly above the HP turbine exhaust temperature, by spraying feed water at the outlet of the bypass control valve. This flow is then combined with high pressure exhaust steam and passes through the reheater.

The control system must provide the logic to open the valve quickly and modulate the feed back control to pressure and temperature set points. Opening speeds of less than five seconds are typical. During operation, the HP bypass provides the same expansion and cooling which would have happened in the HP turbine. It protects the reheater and quickly unloads the turbine without requiring boiler trip.

The low pressure tubine bypass system presents a flow path around the LP turbine, taking steam from the reheater outlet and conditioning it to be fed into the condenser. For condenser protection, high pressure and temperature drops are taken by valve throttling and by addition of large amounts of desuperheating spray water, preventing that superheated steam reaches the condenser.

superheated steam

water injection

conditioned steam

turbine bypass systems

Fast start-up

For all start-up modes (cold, warm and hot), a turbine bypass system recirculates steam until the turbine reaches a certain temperature, allowing optimum metal to steam temperature matching. Thermal stress and turbine blades erosion is minimized. It also serves as a slide operating parameter during start-up modes, keeping an excellent firing rate and minimizing thermal transients in the boiler. Using the turbine bypass system during a short shut down, the boiler may be kept hot and ready to reach full load again quickly. This improves efficiency of the plant.
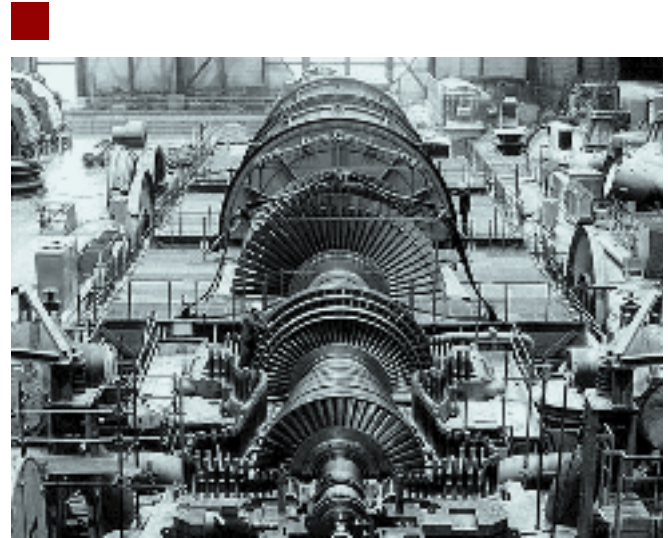
No boiler trip after load rejections

A load rejection or a turbine trip makes the flow of steam produced by the boiler exceed the amount demanded by the turbine. This unbalance in the steam header increases pressure that eventually is relieved to atmosphere by conventional safety valves. However, a fast-acting turbine bybass system, sized for 100% boiler steam flow, can absorb and recirculate this excess of flow, and save steam that otherwise would be dumped to atmosphere.

components

The V&W turbine bypass system includes the classical pressure reducing control valve, featuring advanced characteristics.

pressure reducing control valves

Low noise steam pressure reduction

For the most demanding applications, V&W pressure reducing control valves use the multicylinder trim technology, developed through years with great success. Pressure is reduced in several steps, so that no critical (sonic) conditions are reached at any stage.

For less critical pressure reductions, our low noise cage provides successful noise reduction by means of frequency shifting technology, as is recognized by IEC 534-8-3 and ISA SP75.07.

Computational fluid dynamics (CFD) is used extensively during design process.

Tight shut off

Our unique double trim operated plug allow us to give shut off Class V at any conditions. When the valve is closed, the plug is positively pushed against the seat by steam pressure. When throttling, the pilot is open and the plug becomes balanced, thus requiring a small force to be stroked. This results in a small actuator and smooth operation.


Computational grid and flow path lines in a multicylinder trim, showing features to optimize by our engineers.

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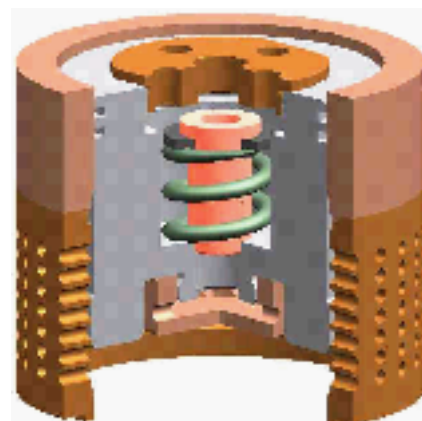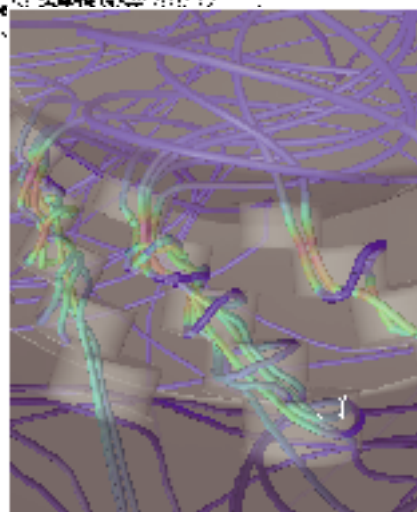
components

## water injection

V&W high integrity water injection valves, with our delta trim, is in operation in hundreds of power stations in spray control. It can handle very high pressure drops with no internal wearing, due to its multi-stage design for pressure reduction that inhibits cavitation damage. For special applications, rangeability can go up to 80:1.

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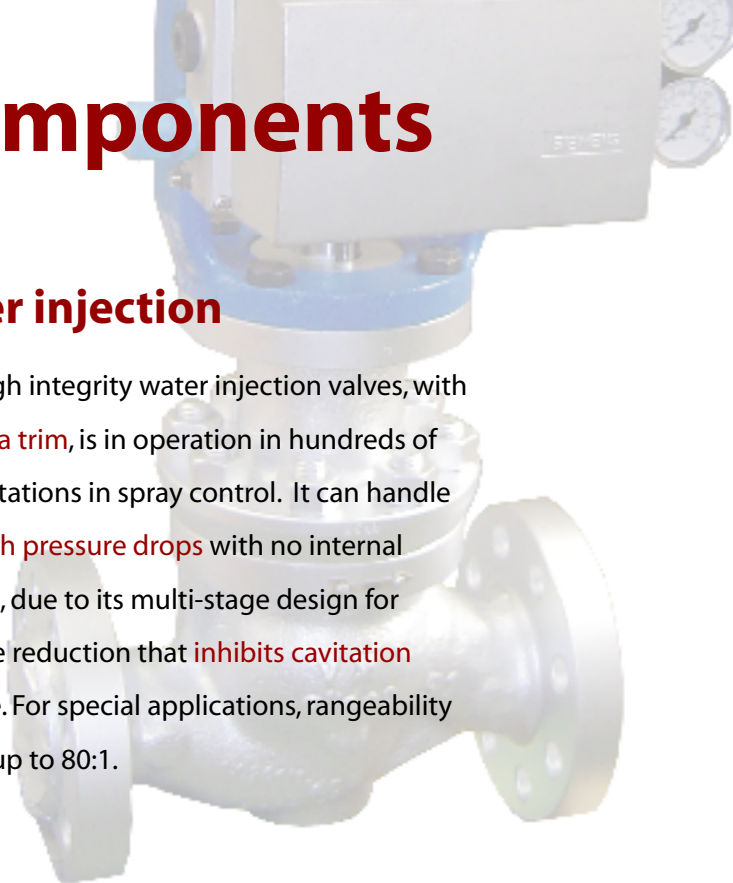
inline venturi desuperheater

V&W turbine bypass systems feature a inline venturi-style Imtech-Kiekens desuperheater. Imtech-Kiekens is world-wide recognised as the leading supplier of desuperheaters based upon the venturi technology. The company has been active in the very specialised market for steam desuperheating for over 40 years now, installing over 4,600 desuperheaters in 93 different countries. In all that time , Imtech-Kiekens has never received a single warranty claim on any unit supplied. This is a proof of the excellent quality and service we are offering our customers.

Imtech - Kiekens

components
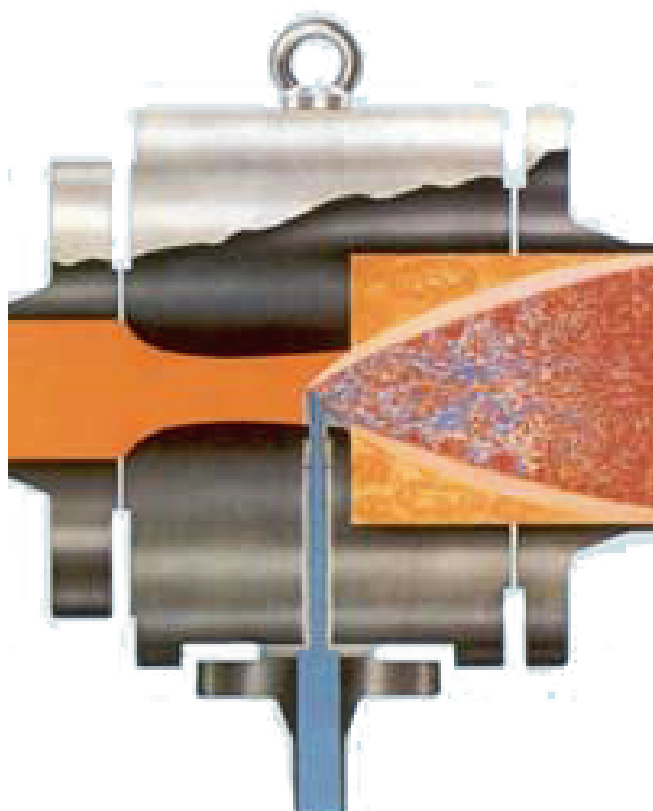
venturi desuperheater

Working principles

In the venturi style desuperheater, the cooling water enters the venturi through a special streamlined spray nozzle. On the surface of this spray nozzle a thin film of the water will be formed. The dynamic energy of the incoming steam flow breaks the surface tension of the film, creating a conical shaped spray (at slightly lower pressure) of atomized cooling water.

Correct mixing is attained by the turbulence of the steam flow, which is caused by the interaction of the venturi effect and the specially shaped spray nozzle. The result is rapid and total evaporation of the cooling water. As a consequence, optimal and swift temperature control adjustments are possible. This also avoids the need for any protective liners in downstream piping.

Construction

The body of a venturi style desuperheater can be made of various kinds of forged steel, ranging from carbon, light- & high alloy and stainless steel to special materials. Spray nozzle and its matching parts are always made of stainless steel.

It can be installed into a piping system with either flanged connections or welded joints. All units are made according to ANSI, BS, DIN, JIS or any other accepted international standard as specified by the customer.

Advantages

Custom design. For any size, standard or capacity.

Simple installation. Installation is possible in any position. Short straight pipe runs. Limited control loops.

Easy maintenance. No moving parts, no pipe liners and no welding in the construction. Large spray aperture avoids the spray nozzle becoming clogged.

Energy saving. No need for a water supply pressure significantly higher than operating steam pressure and no need for atomizing assist steam.

Large desuperheating range. It is possible to handle extremely large differences in enthalpy between the incoming and outgoing steam flow.

Reliability. Units can be in operation for over 30 years, without any maintenance required.

components

bypass control system

Control functions for the pressure control valves are supplied via the bypass control system (BCS). The BCS may be also coordinate action and exchange information with the furnace safety supervision system, the turbine digital electro-hydraulic control system, and the coordinate control system. It is also able to work under pressure control and temperature control, at several operating modes like:

- Boiler start up from cold condition.
- Turbine operation (normal boiler operation).
- Load reject of the turbine.
- Start up after turbine trip or load rejection.

electro-hydraulic system

Performance requirements for the turbine bypass valves include quick opening and closing, and precise plug positioning. For demanding applications, valves are driven by hydraulic piston actuators and the electro-hydraulic system, which includes fluid reservoir, redundant oil supply pumps and motors, fluid filtering system, high performance proportional valves and feedback transducer.

The electro-hydraulic system is also equipped with its own controller to handle the hydraulic power unit.
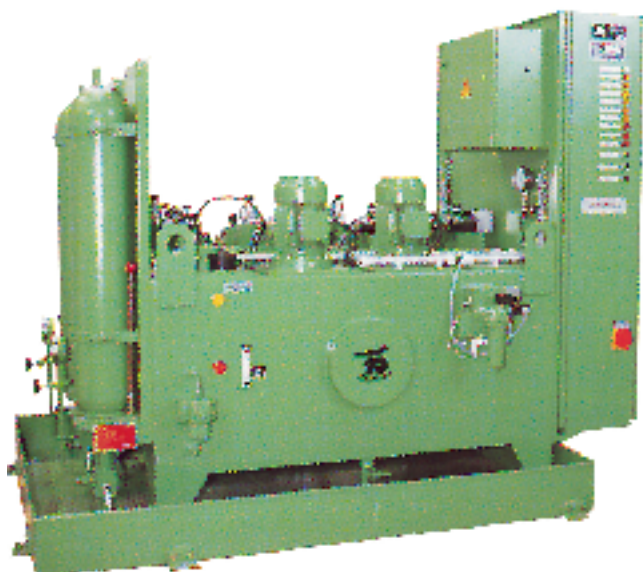
Quality

All Vector & Wellheads Engineering products are manufactured in strict accordance to our Quality Assurance Manual requirements, which covers all the production stages, including design, purchasing, manufacturing, welding, testing, etc.
Our excellent Quality Assurance Program has enabled us to obtain the following certifications:

UNE-EN-ISO 9001
API-6D
CE marking
RePro (Achilles) registered supplier

Each aspect of our activity is based on operating within strictly defined procedures, including: ultrasonic, x-ray, magnetic particle inspection, welding, photoelasticity, and fire safe test.
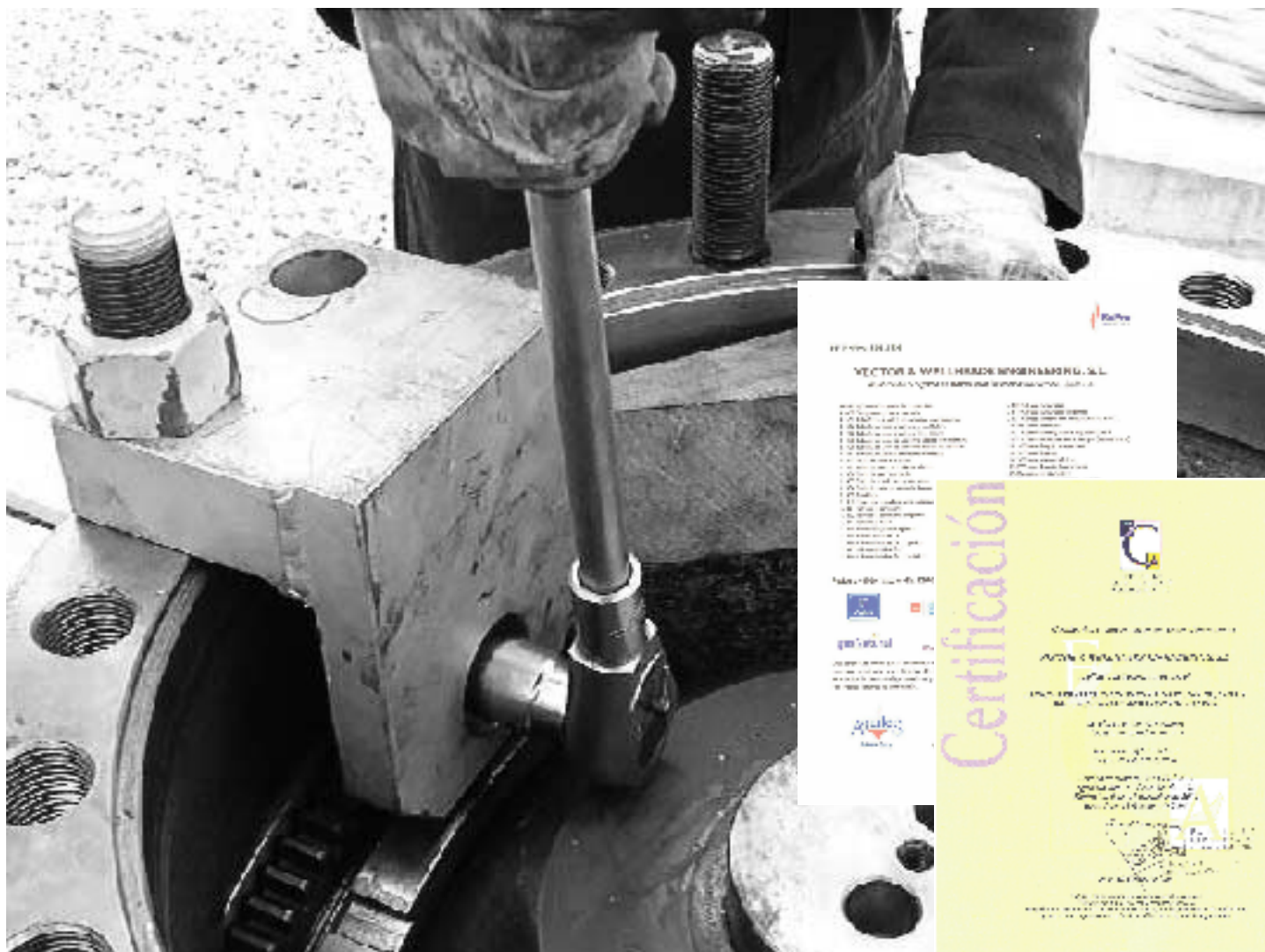
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Achilles

V&W valves

Vector & Wellheads

Engineering, S.L. is a

leading suppplier of

valves and related

products, used in the

petrochemical, nuclear,

fossil fired, oil & gas

and process industries.

Headquarters & Office
C/ Fray Luis Amigó, 4
Edificio Rubí, principal A
50006 Zaragoza
Spain
Tel. +34 902 196 092
Fax. +34 976 301 991

Factory
Autovía de Zaragoza-Logroño, km 13
Polígono Industrial "El Águila", nave 98
50180 Utebo (Zaragoza)
Spain
Tel. +34 976 462 789
Fax. +34 976 462 790

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