Desmet Ballestra Italy
Chemical Plants

Sulphuric Acid Plants

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Desmet Ballestra is the right choice for …

Long experience in Sulphonation

Desmet Ballestra Italy (DBI) proprietary processes and know-how for SO_3 gas sulphonation has been implemented since 1960 in 510 plants installed worldwide. DBI, leveraging its SO_3 production know-how, gained a deep experience in the fundamentals of modern H_2SO_4 production technology.

Wide Range of Expertise

DBI, through its Chemical Plant Division, is active in a wide range of organic and inorganic chemicals plants business including Sulphuric Acid, Phosphoric Acid, Linear Alkylbenzene, Fertilizers and others. Process technologies are proprietary as well as sourced from Licensors (such as DuPont™ MECS®, Prayon, UOP and others) and/or product manufacturers (such as Industria Chimica Puccioni, Marchi Industriale and others) which DBI has consolidated and well proven cooperation schemes with.

Tailor-made solutions

DBI, thanks to its deep experience, can identify the most appropriate solution to meet Client needs for the production of sulphuric acid, oleum, SO_2 and SO_3, respecting the most strict emission limits considering different energy recovery solutions and giving the priority to safe, environmental friendly and cost effective design.

Project Execution Capabilities

DBI can support its Clients from the initial project conceptual phases through feasibility studies and cost estimates up to the project implementation, from the initial technology selection and process design definition up to the management of the startup phases based on agreed execution and contractual schemes.

DBI provides Flexibility, reliability and low operating cost, according to the best quality standards (ISO 9001 certification)

Safety & Environment

Plants supplied by DBI are designed in full compliance with the most stringent international safety and environmental laws and standards.

Post-Sales Support

DBI supports clients during the operating life of the plant with a dedicated spare parts management and technical assistance programs.

Worldwide presence

DBI has a network of operating and representative offices distributed worldwide.

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Available technologies for Sulphuric Acid Production
DBI can propose:

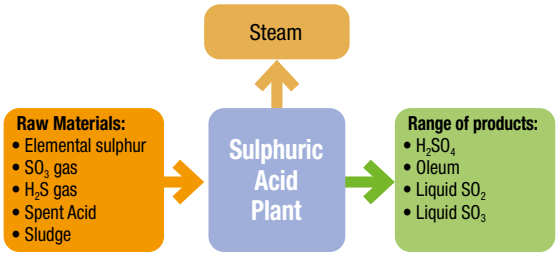
- DuPont™ MECS® leading technology for large integrated H_2SO_4 plants
- Proprietary know-how (which uses DuPont™ MECS® catalyst and key components) for low capacity plants (up to about 200 TPD)

The processes that DBI makes available can produce sulphuric acid from several sources:

- Elemental sulphur, based on dry air combustion (conventional process)
- Exhaust SO_2 gas, coming from roasting/smelting of pyrites, copper, zinc, lead, nickel ores and similar
- Spent acid or sludge obtained from alkylation processes
- H_2S and SO_2 off gas from various other chemical processes

Several fields of application. Sulphuric acid is widely used in different business areas such as:

- Fertilizers
- Mining industry
- Waste gas treatment



Possibility to produce high quality H_2SO_4 for special applications like battery grade, analytical grade, electronics and others.

Option for production of Oleum as well as liquid SO_2 and liquid SO_3.

Waste heat recovery by steam production, with steam turbine power generation systems to increase the overall plant efficiency and boost the return on investment.

DuPont™ MECS® HRS™ technology to maximize the heat recovery from the plant.

Wide range of production capacities, from small size for local or very specific applications to world scale production units.

Compact plant layout, for investment cost optimization (e.g. piping and duct routing), taking into account safety / maintenance / operation principles and according to customer site requirements.

Air pollution control system, to contain the plant emissions to the minimum level required by the most stringent laws and standards.

High quality construction materials and use of acid resistant special alloys.

High yield of conversion, granted by the best available technology together with DuPont™ MECS® catalysts allowing for an extended life time, low pressure drop and low screening losses.

Sulphuric Acid Plants...

Conventional Process (Dry route) principle

Process technology is based on the production of Sulphur dioxide (SO_2) by Sulphur burning using dry air, followed by catalytic conversion to produce Sulphur trioxide (SO_3) which is finally absorbed in water (H_2O) to obtain sulphuric acid (H_2SO_4)

All the above reactions are extremely exothermic at high temperatures and therefore the recovery of the heat generated during the process is highly valuable.

The typical converter configuration is based on 4 stages of catalytic conversion with the possibility to increase by 1 stage and/or to use a combination of vanadium/cesium based catalist when lowest emissions are required.

Single or Double absorption

According to the requested production capacity, the selected conversion yield, the specific plant requirements, flexibility, startup time, the plant can be designed for:

- Single Contact Single Absorption (SCSA) – Ballestra technology.
- Single Contact Single Absorption (SCSA) - DuPont™ MECS® technology.
- Double Contact Double Absorption (DCDA) - DuPont™ MECS® technology.

The conversion factor for a Ballestra SCSA plant is 98.5%, typically requiring a tail gas scrubber to control the SO_2 stack emissions. This plant is specifically designed to achieve a very fast startup, thus granting a high operational flexibility.

DuPont™ MECS® DCDA are designed for higher conversion factor, typically >99.8%, thus granting SO_2 emissions at stack within the limit of 280 ppmV without the need for a tail gas scrubber.

Minimization of gaseous emissions

Improvement of SO_2 stack emissions can be achieved by a combination of the following:

- Cesium-based catalyst instead of Vanadium-based ones.
- 5 stages catalytic conversion.
- Dedicated Acid Tank and cooler for Final Absorption Tower.

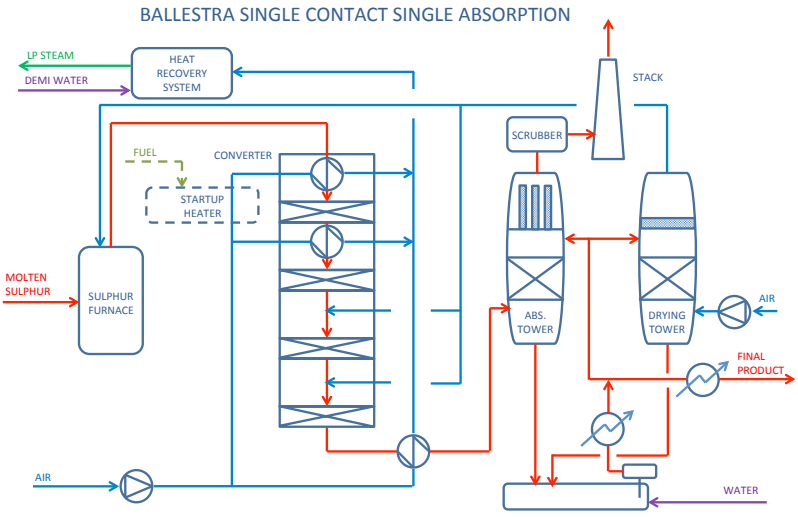
The solutions above allow to have SO_2 emissions at stack within the limit of 100 ppmV (equivalent to a conversion factor over 99.92%) without the use of a tail gas scrubber.

Emissions control: DuPont MECS® SolvR™

SolvR™ is a proprietary DuPont-MECS® technology for selective removal of SO_2 from exhaust gases that can achieve nearly zero emissions, with a regenerative SO_2 recovery

The system is composed of four different sections: (a) Dynawave Humidifying Tower to quench the tail gas and remove H_2SO_4 and HCl; (b) SO_2 absorbing tower to lower gas SO_2 content down to 20 ppmv by solvent extraction; (c) SO_2 stripping tower to recover dry SO_2 from the solvent (d) solvent regeneration to remove sulphates and residual acidity. Solvent is recycled back to process.

The SolvR™ unit can be retrofitted into existing plants, due to its modular design. Plot space is limited and compact, solvent losses are minimal due to low vapour pressure and regeneration performed at atmospheric pressure.



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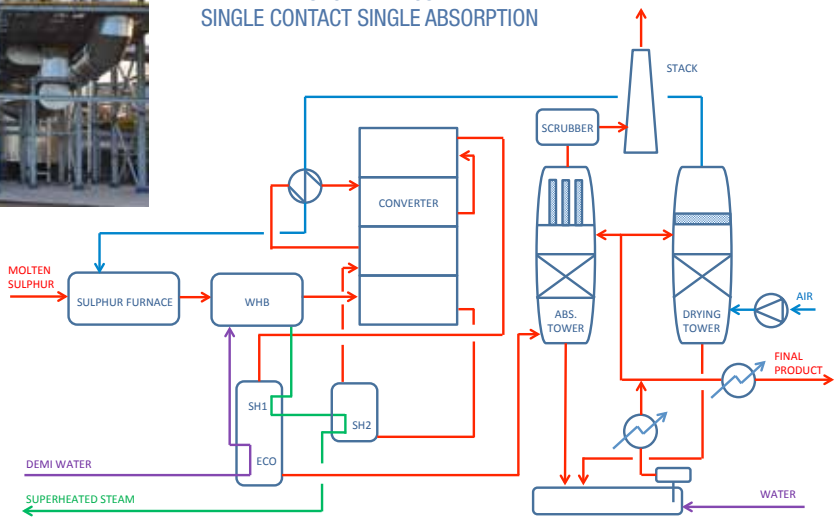
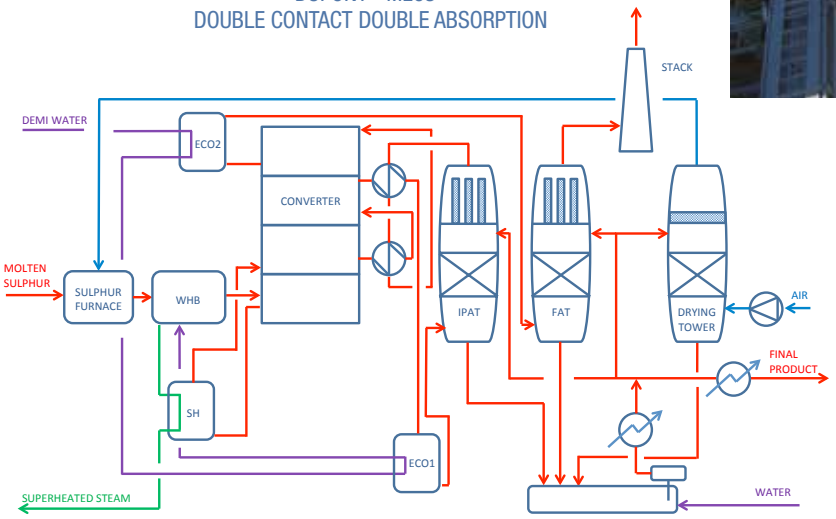
Sulphuric Acid Plants

… from sulphur burning

DUPONT™ MECS®
SINGLE CONTACT SINGLE ABSORPTION



DUPONT™ MECS®
DOUBLE CONTACT DOUBLE ABSORPTION



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Energy Recovery Systems …

Waste Heat Recovery

Energy recovery is extremely important in the economics of new sulphuric acid plants.

DBI can offer sulphuric acid plants based on the conventional heat recovery systems as well as on the DuPont™ MECS® HRS™ system.

The heat recovery system of a conventional sulphuric acid plant recovers most of the heat produced during the sulphur combustion and the $SO_2 \rightarrow SO_3$ conversion, producing 1.2 ÷ 1.3 tons of MP superheated steam (at 25 ÷ 42 bars and about 400°C) per ton of sulphuric acid.

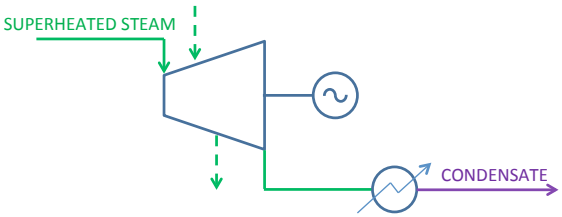
The steam produced can feed a turbogenerator for electric power production or it can be delivered at unit battery limits, according to the plant requirements.

Electric Power Production

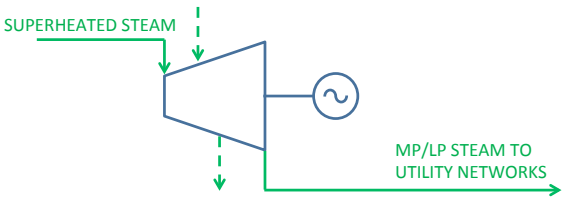
Turbogenerator units can be condensing steam turbines, to maximize electric power generation, or backpressure steam turbines, to still have exhaust steam available as utility at unit battery limits.

Intermediate pressure level injections and extractions are possibe to satisfy specific plant requirements.

CONDENSING STEAM TURBINE



BACK PRESSURE STEAM TURBINE



… including DuPont™ MECS® HRS™

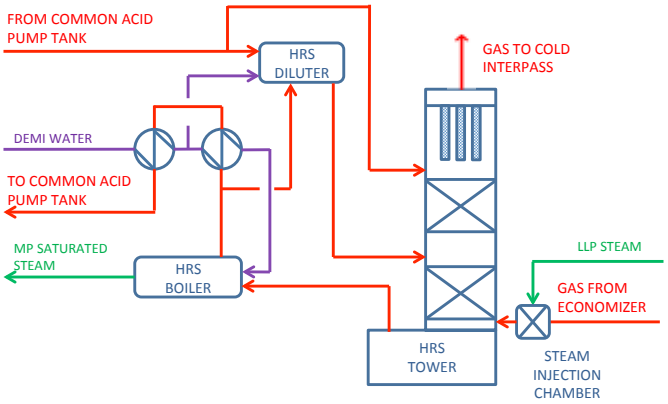
DuPont™ MECS® HRS™

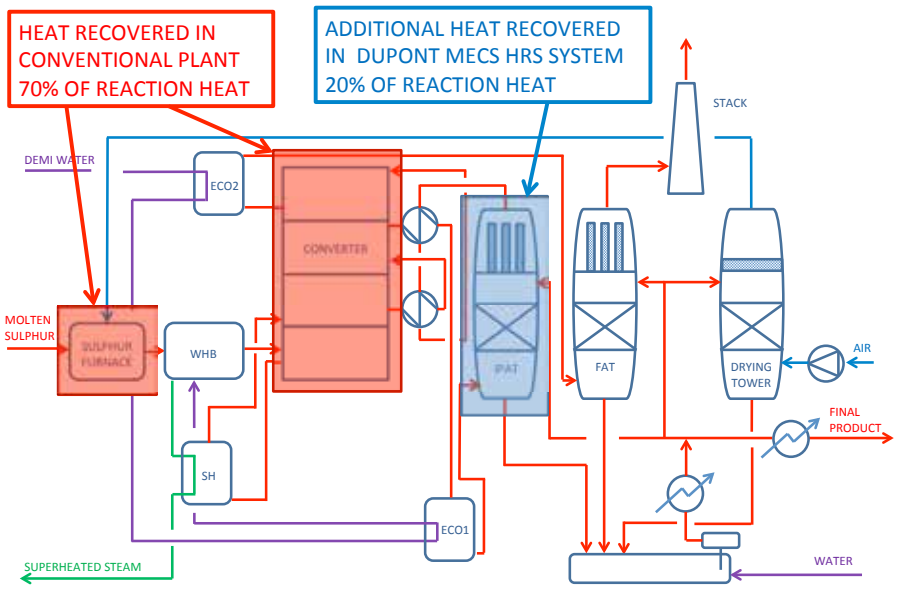
DuPont™ MECS® HRS™ is a system designed to enhance the Sulphuric Acid Plant performances in terms of waste heat recovery.

The system includes the HRS tower and its ancillaries that replace the interpass absorbing tower and allow the recovery of the heat generated during the interpass absorption thus reducing the heat that would have been lost to cooling water. As a result, additional LP saturated steam is produced and, as a collateral benefit, size of cooling water system (*e.g.* cooling towers) is reduced together with relevant consumptions.

With DuPont™ MECS® HRS™ system, the heat recovered can be increased up to 90% of the total reaction heat produced in the Sulphuric Acid Unit.

	Conventional plant	HRS plant
HP steam ton / H_2SO_4 ton	1.3	1.3+
HRS steam ton / H_2SO_4 ton	0	Up to 0.40 ÷ 0.48
Total Heat Recovered	70% approx	Up to 90% approx





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Sulphuric Acid Plants

Oleum, liquid SO_2 and SO_3, SAEG

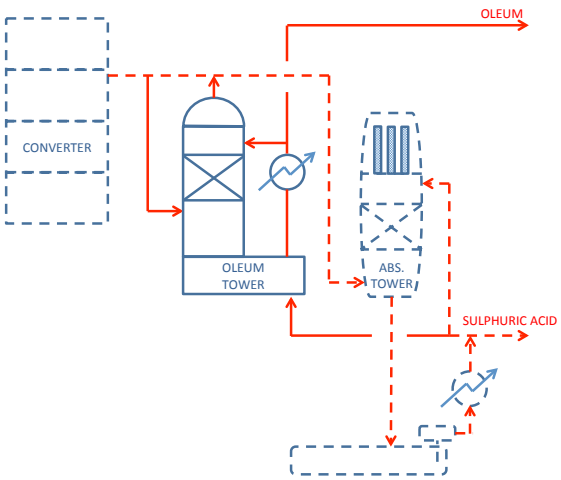
Oleum and SO_3 Production

The Oleum and the SO_3 production are strictly connected to the H_2SO_4 production technology.

Liquid SO_3 is produced by evaporation of Oleum and subsequent cooling and condensation.

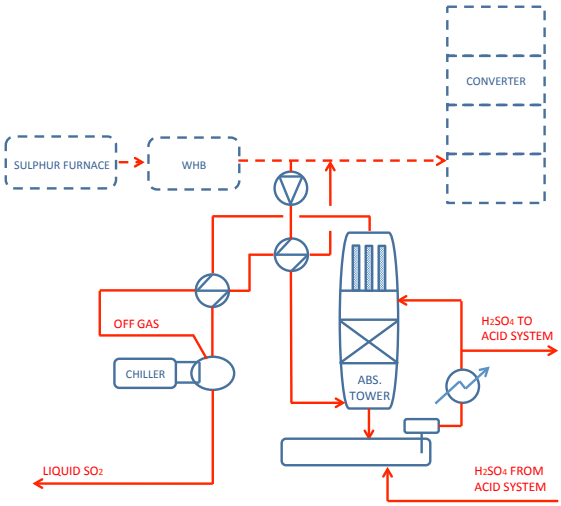
Oleum can be produced by absorbing part of the SO_3 leaving the sulphuric acid converter in a circulation of Oleum at the required strength and maintaining a steady concentration by adding sulphuric acid at 98.5% w.
This absorption is carried out in a dedicated Oleum tower installed immediately upstream the absorption tower.

Typical grade of Oleum is at 20÷35% or 65% free SO_3.



Liquid SO_2

DBI preferred design for liquid SO_2 is based on the cryogenic condensation process.
The feed is an SO_2 rich gaseous stream produced in a sulphur furnace that is fed to an absorption tower for SO_3 entrainments removal. Then the gas is sent to a chilling group for SO_2 condensation. The condensed fraction flows to battery limit, while the uncondensed gas stream is sent to a SO_2 converter for H_2SO_4 production.



The cryogenic condensation process is strictly connected to the H_2SO_4 production, hence the unit can be a stand-alone plant or a secondary product package unit installed within a large scale H_2SO_4 production plant.

SAEG (Sulphuric acid electronic grade)

DBI is developing internal R&D activities to make available to its Clients solutions to achieve Sulphuric Acid Electronic Grade purity

Wet gas technologies

The MECS® Sulfox wet gas technology is an alternative process to the conventional "dry" sulphuric acid route.
This process is designed to produce H_2SO_4 acid from SO_2 or H_2S off-gas, spent acids, sulphates regeneration feedstocks or organic wastes bearing sulphur.

The Sulfox process can effective process the wet gas without gas drying upstream of the reaction section.

The core process consists of a reaction section that converts the wet stream of SO_2 into a wet stream of SO_3, followed by a condensation column that condenses H_2SO_4. A final mist precipitator grants low acid mist emissions at the stack.

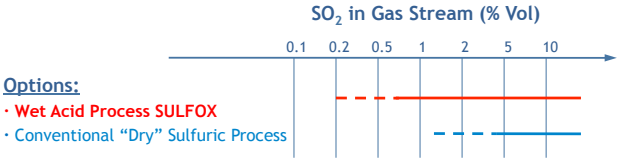
The Sulphuric acid concentration from a Sulfox plant depends on the feedstock composition. Typically 96%÷98% concentration is achievable.

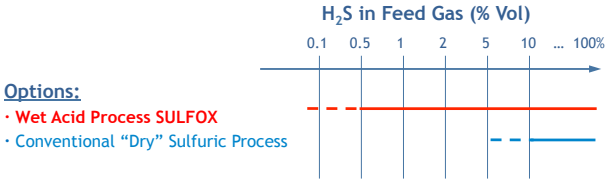
Sulphuric Acid from off-gas

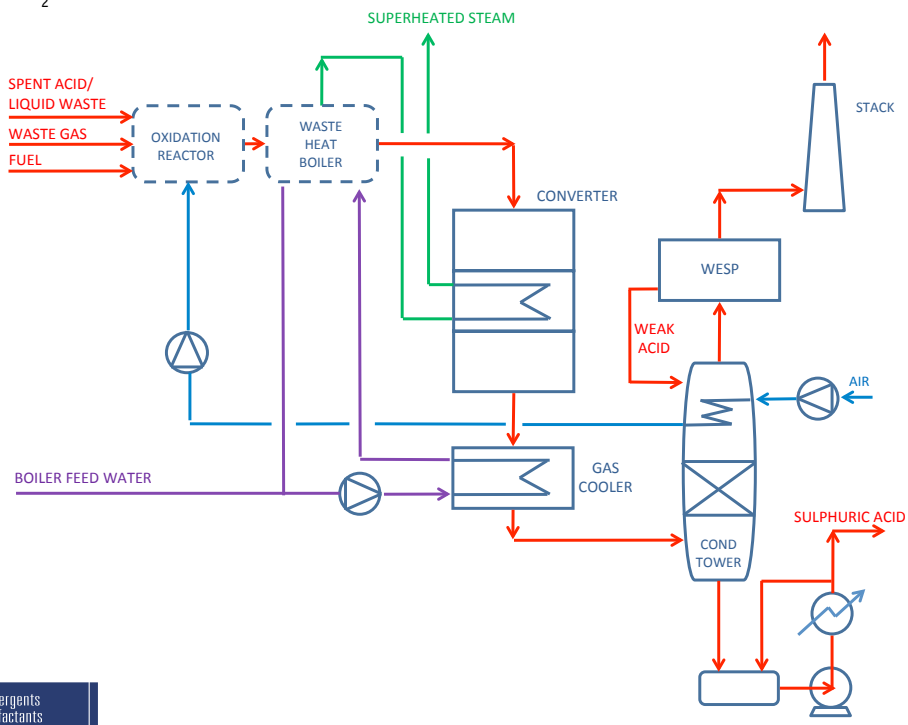
Off-gas is produced from essentially any metallurgical process; it contains SO_2 gas that can be transformed into sulphuric acid, reducing emission levels as required, but also cutting energy and water use, enhancing plant economics.
The technology can handle off -gas with high levels of impurity including arsenic, fluorides and mercury and/or high SO_2 concentrations.

A first stage includes gas cleaning sections that remove both liquid and particulate matters to prevent corrosion and fouling of the acid plant. The gas is then dried and compressed, heading to the SO_2- SO_3 conversion system
When off-gas is rich in SO_2 a pre-treatment is included, converting a portion of the high strength gas to SO_3 ahead of the main converter, thus reducing CAPEX while maximizing energy recovery.

The solutions that DBI can propose are based on DuPont-MECS® technology, including proprietary equipment (*e.g.* DynaWave) and the worldwide experience and references on the specific application.







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Sulphuric Acid Plants

Tail Gas Emission Control

Full compliance

DBI plants based on DuPont™ MECS® double absorption technology already fully comply with the most stringent international standards and laws and therefore, in principle, do not need additional gas pollution control systems.

In case of special requirements, or when the single absorption technology is foreseen, a tail gas scrubbing system is provided.

Using a tail gas scrubber SO_2 stack emissions within the limit of 10 ppmV can be achieved.

Different scrubbing technologies

DBI can supply different scrubbing technologies, including the DuPont™ MECS® DynaWave™ system, based on different reagent media:

- Sodium Hydroxide NaOH
- Hydrogen Peroxide H_2O_2
- Calcium Hydroxide $Ca(OH)_2$
- Calcium Carbonate $CaCO_3$
- Magnesium Hydroxide $Mg(OH)_2$
- Ammonia Solution NH_4OH
- others

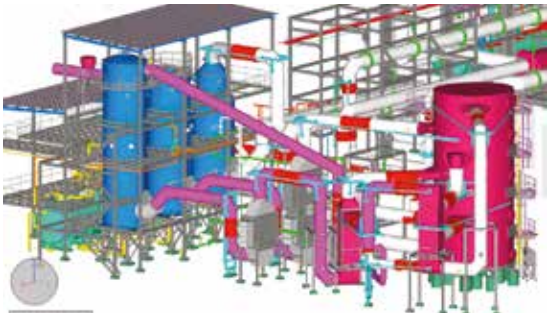
Desmet Ballestra capabilities

From initial design to plant start up

DBI can support Clients during all the project phases: from the feasibility study, through the definition of process design up to the detailed engineering, material supply and project implementation for effective and cost saving design and execution.
A team of 300+ experienced people in Milan and Rome Offices is available to achieve the project targets.

Full 3-D design

DBI takes advantage of the most up to date engineering techniques, such as full integrated 3-D design (*e.g.* PDMS), to grant optimized plant layout and straightforward construction at site.



Site Assistance

DBI has experienced people that can provide support during construction and commissioning phases up to the startup of the plant.

Technical Assistance

DBI offers full assistance to Client after the plant startup, with technical support to study plant improvements or revamping and with a dedicated team for spare parts.

Worldwide Presence

DBI has several operational offices in different countries offering worldwide assistance to its Clients.

The Desmet Ballestra Group

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