BOLIDEN TECHNOLOGIES FOR GAS HANDLING AT SMELTERS

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ABSTRACT

Boliden's technologies in the field of gas cleaning and effluent treatment will be described. Special attention will be given to high pressure venturi, Editube wet electrostatic precipitator, mercury removal processes and effluent treatment in two stages.

INTRODUCTION

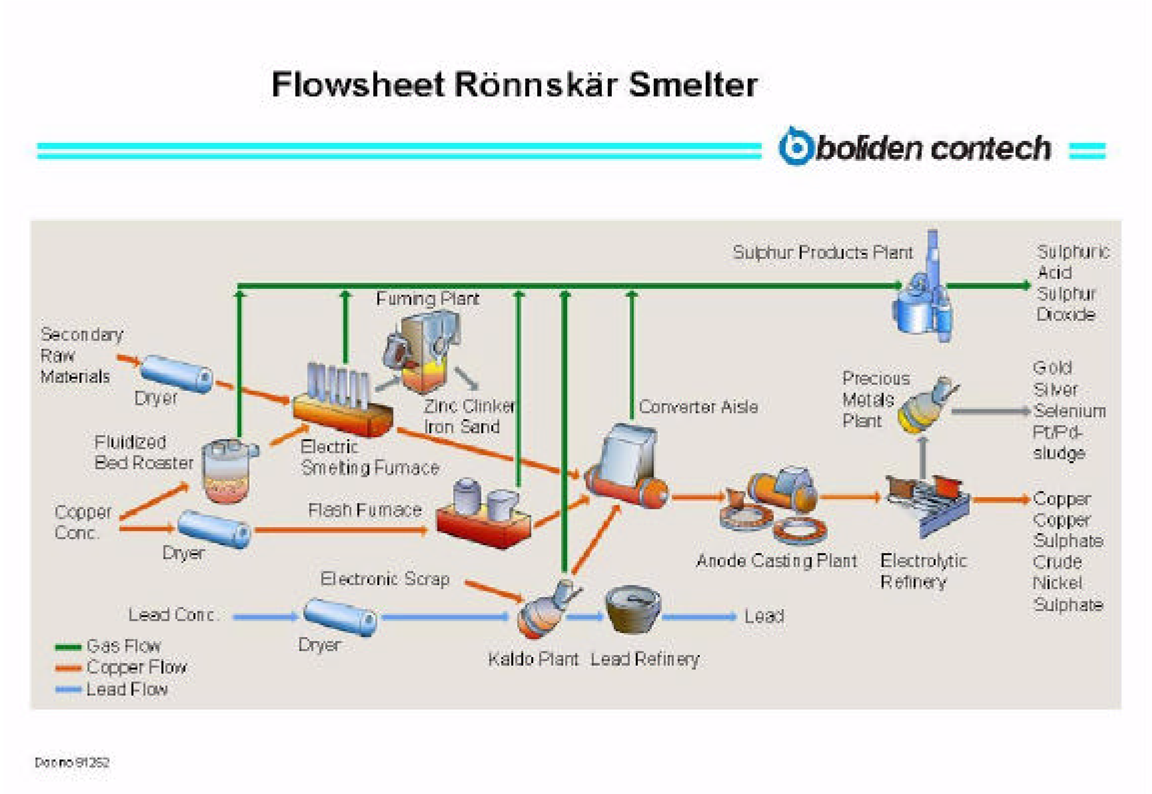
Boliden operates mines in Sweden and Canada and two smelters in Sweden, the Rönnskär Smelter in the North and the Landskrona Smelter in the South. The activities in Sweden are shown in Picture No 1.

In the Rönnskär Smelter following production was achieved for the main products in 2001.

Table 1. Production at Rönnskär 2001

Production	*Tonnes*
Copper cathodes	216 200
Zinc clinker	34 800
Refined lead	31 300
Gold	14,1
Silver	319,9
Sulphuric acid	489 900
Liquid SO_2	56 500

The flow-sheet of the Rönnskär Smelter is shown in Picture No 2.



In the Landskrona Smelter more than 3,5 million used lead batteries are recycled every year instead of being thrown away as waste. Products are lead, tin and their alloys.

Following developments in the Smelter Gas Handling system are described

Converter Hoods
High pressure venturi
Editube Wet Electrostatic Precipitators
Mercury Removal Processes
Effluent treatment

Boliden technologies for gas cleaning purposes were originally developed to be used for non-ferrous metal smelter applications, first in own smelters and later contracted for other smelting companies. However, many of these technologies, which comprise metals such as mercury and arsenic and fine dust and mist in high and low concentrations have demonstrated their applicability to handle environment problems for other industries.

CONVERTER HOODS

The converter hood consists of two parts, the primary hood for the process gas that need dust and SO_2 cleaning and the secondary hood for fugitive gas from the converter. Gas from secondary hood should be removed from the workplace (converter aisle) and can be dust cleaned. With Boliden hood system, more than 95% of the SO_2 is collected in the primary system, actual figure for Rönnskär smelter is 99%.

Even if the primary hood fits very tight to the converter, some air will always leak into the system. This dilution brings down the temperature of the gas mix, but it should be restricted in order to keep costs for gas handling down. Normally the temperature can be 500 to 900?C after the primary hood.

For a long service life, it is necessary to have a water cooled primary hood. Water cooled hoods were introduced in Rönnskär 30 years ago and have been continuously improved since then.

The hot side of the primary hood is made of steel sheet (10-20 mm) and the cooling channels are welded to the outside. Leaks can only occur on the outside, where they are easy to repair.

The water is connected at two spots on each side of the hood, which facilitates erection. In the lower part of the hood there is a channel with a distributor for an even flow of water in all the channels. The outlet of water is at the top, and the design allows the hood to boil for a short time in case of an emergency.

The water in the hood is circulating in a closed circuit, over heat exchangers. As all hoods are connected to the same system, they are all automatically heated in the winter (to protect from freezing) and the cooling water consumption in the summer minimized.

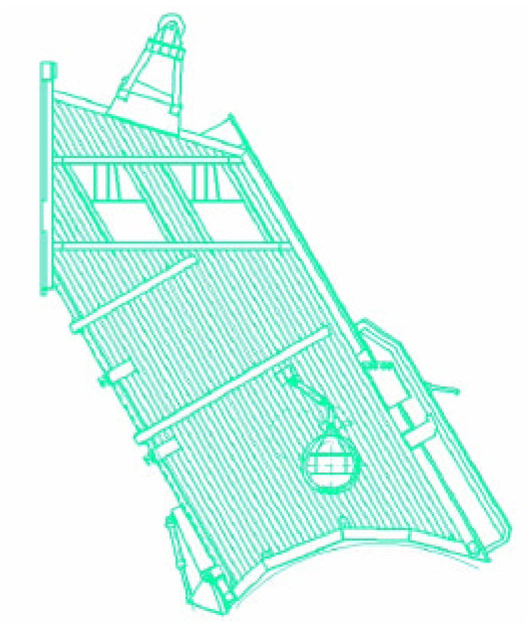
At the front of the hood there is a sliding door, which can be raised for charging of the converter. At the back there is a flap, operated by a hydraulic cylinder, which seals against the converter shell.

After the primary hood (on the outside of the building) there is a dust bin, water cooled as the hood. The dust collected is transported by a screw conveyor to a container.

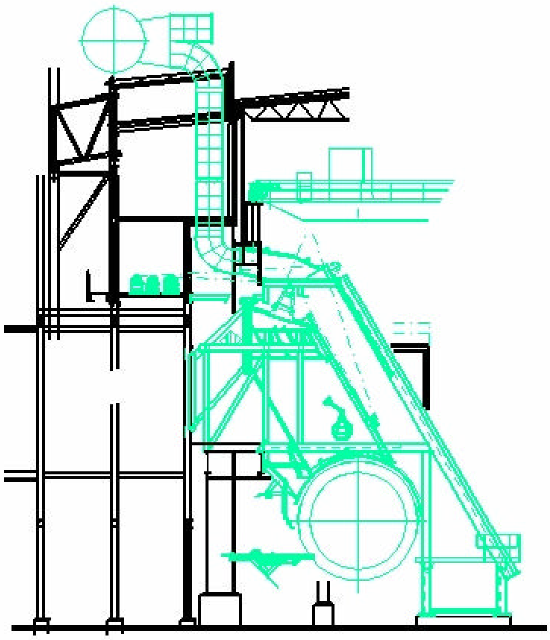
The secondary hood is made of steel beams, made from rectangular pipes. It has steel sheet cladding on the inside. At the front there are two sliding doors, which are used as protection against slag spray when rolling down the converter and which also helps to collect the gas. They can be raised for charging and service.

Charging of silica during blowing is done via a retractable chute through openings in the hoods. The primary hood has a door, which can be closed.

The Converter Hood system is demonstrated in Enclosure No 3 and 4.



Picture No 3.



Picture No 4.

HIGH PRESSURE VENTURI

A. Applications

Boliden Contech high pressure venturi system has found applications when the technical demands are difficult:

1. High gas temperature, up to 1300^{o}C
2. High dust concentrations, up to 100 g/m^{3}
3. Presence of Cl, F, SO_2 and SO_3
4. High efficiency is required, up to 99,9%
5. High operational reliability is required

Boliden Contech has delivered 10 high pressure venturi systems to clients in many countries.

B. Technical description

The high pressure venturi scrubber has three stages, one quencher stage followed by a venturi stage and finally a cyclone stage.

In the first step, the quencher, the gas will be cooled to saturation temperature by vaporisation of water in a vertical quencher. The quencher is a simplified venturi with an annular slot between the housing and a centre cone. Water is introduced tangentially ahead of the slot through the centre cone.

The excess water together with collected material will be continuously drained from the hopper under the quencher.

The quencher is designed with a distinct difference between the dry and wet surfaces to avoid dry-wet zones.

The gases will proceed to the second stage, the venturi, where the gases will be further cleaned from particulates.

The venturi stage will be circular with an annular slot between the housing and a cone in the centre. Water is introduced tangentially ahead of the throat to give a wet approach to the scrubber throat and in the centre of the gas flow above the venturi throat.

The gas will be accelerated to a very high velocity before the throat. The high velocity will atomise the water and the particles collide with, and are captured in millions of small droplets. In the diverging section behind the venturi throat, static pressure is regained as the velocity of the gas stream is reduced. Sub-micron size particulate and water droplets coalesce during this interval providing additional collection.

The centre cone is adjustable and will be set to match operational data. The pressure drop across the venturi will be automatically controlled to match variations in the gas flow by raising and lowering the centre cone with an electric actuator, which will vary the throat area. It will also be possible to operate the centre cone manually. This control is also necessary to open the throat during emergency operation.

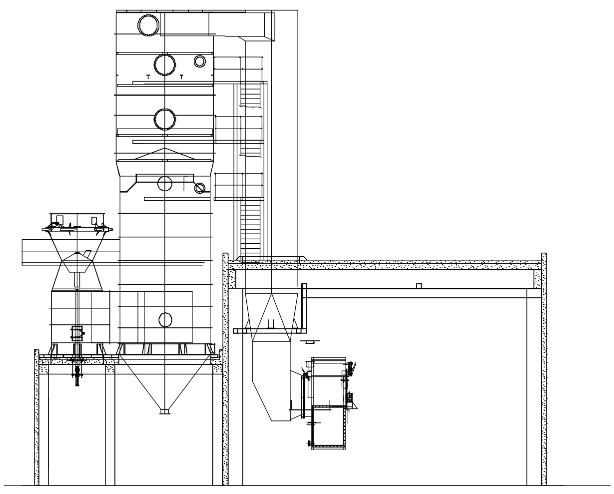
After the venturi the gas direction changes from vertical to horizontal in a flooded elbow. A pool of water in the bottom of the flooded elbow forms a cushion, or abrasion barrier, which prevents the high velocity water-laden gas from eroding the elbow itself.

After the venturi the gas proceeds to the cyclone stage in which droplets are separated.

Water and collected dust will be separated from the gas stream and continuously drained to the water treatment plant.

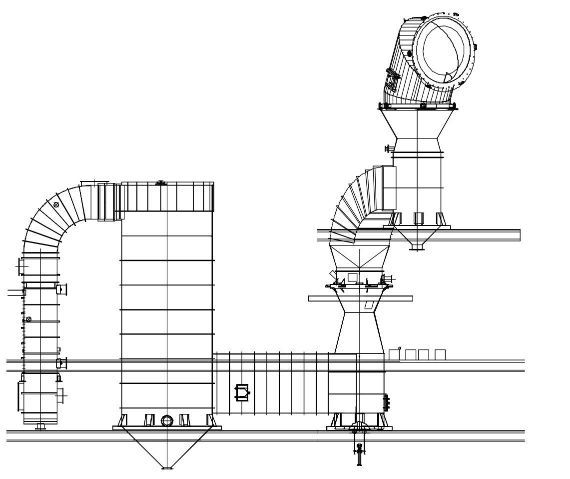
The high pressure venturi is demonstrated in Picture No 5 and 6. In Enclosure No 5 your find the system in which is incorporated a process stage for absorption of HCl and HF by having a bed of saddles in built into the cyclone. In Enclosure No 6 is shown the system for high incoming gas temperatures.

HIGH PRESSURE VENTURI WITH
ABSORPTION/COOLING SECTION



Picture No 5.

HIGH PRESSURE VENTURI FOR HIGH
INGOING GAS TEMPERATURES



Picture No 6.

EDITUBE WET ELECTROSTATIC PRECIPITATOR

A. Applications

The Boliden Wet electrostatic precipitator, EDITUBE, has found its applications in following industries

1. In sulphuric acid plants
2. For incinerator offgases
3. In the pharmaceutical industry

Boliden Contech has delivered 40 Editubes for above mentioned applications.

B. Technical description

Boliden developed the Editube wet electrostatic precipitator at the beginning of the 80's. In a large field test of new stainless steel qualities in process gases it was demonstrated that these new stainless steel qualities should be an alternative to earlier used construction materials. Due to the obvious advantages with steel the first fullsize Editube was built in 1984. Still it looks as new and the maintenance costs are close to zero.

An Editube unit consists of gas inlet- and outlet chambers connected by a bundle of tubes. There are standard sizes with 19, 37, 61, 91, 127, 163, 199 and 253 tubes. A tube has always an inner diameter of 237 mm. The normal length of the tubes is 3 or 5 meters. The lower chamber is equipped with a perforated plate to achieve uniform distribution of the gas entering the tubes. This plate also serves as a floor for service personnel entering the precipitator. The gas passes through a large number of parallel earthed tubes which act as collecting surfaces for dust and mist. The separated dust and mist is drained through the outlet in the lower chamber.

In the centre of each circular tube is a discharge electrode. The discharge electrodes are fixed by upper and lower frames. The upper frame is supported by beams, which are introduced into the upper chamber through gas-tight, electrically heated insulators. The high voltage current to the electrodes is supplied by a rectifier-transformer unit. The tube bundle and all other parts in contact with the process are made of special corrosion resistant stainless steel. Normally Avesta 254 SMO, ASTM S31254 is chosen.

The Editube is equipped with an automatic flushing system for removal of possible deposits.

The discharge electrodes are made of solid rods with needles. The design used with needle points creates a high current field along the entire electrode.

The design of the filter allows for enforced cooling of the filter. By adding a steel shell around the electrode bundle the filter can also work as a gas cooler. In such a case the cooling water is introduced to cool outside the tubes.

The stainless steel material that is normally used, 254 SMO, has been developed by Avesta to provide corrosion resistance in environments where halides and acids are present. The corrosive atmosphere in a wet electrostatic precipitator is characterised by the composition of the condensate, which is separated from the gas in the precipitators.

Dependent on that composition and expected tube temperature the steel quality has to be decided. The experiences with the use of different kinds of stainless steel qualities both from a corrosion point of view and other maintenance related factors have been very good and in many cases they can almost be stated as maintenance-free!

From a process point the filter has following advantages:

1. The special discharge electrode design gives enhanced dust and mist removal efficiencies due to operation of higher electrical field strength at the same voltage and other operational factors equal.

2. Possibilities to operate at high underpressure. In practice it means that the Editube can be placed immediately after a venturi scrubber and the fan on the clean gas side after the Editube. In its standard design the Editube can operate at an underpressure of 1500 mm water column and can easily be modified to withstand higher underpressures.

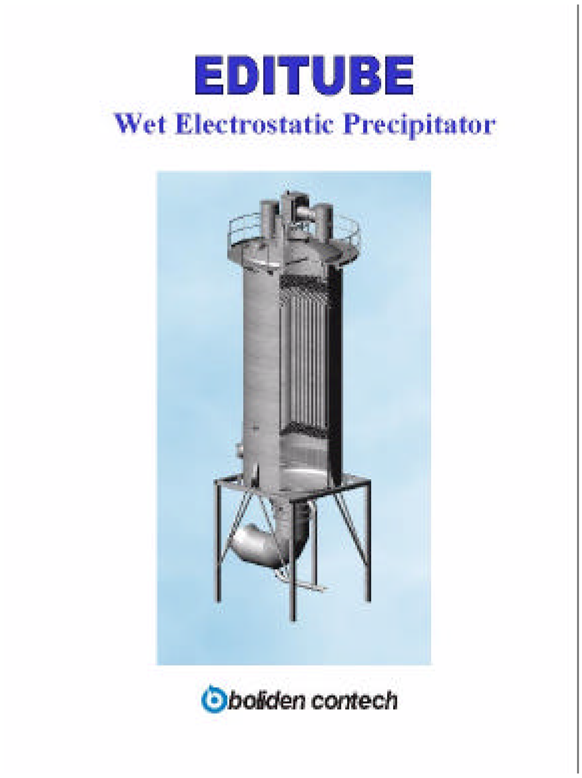
3. The Editube is to a big extent self-cleaning. The automatic flushing system operates during normally one or two minutes in 8 hours.

4. The insulators are kept dry by electric heating, without air flushing. This means that there is no dilution of process gases with air.

The Editube is delivered as a complete, factory-made and tested unit. It is ready for operation after a few days for connection.

To test for new applications Boliden Contech has a pilot unit available. It is made of one fullsize tube.

The Editube is shown in Picture No 7.



Picture No 7.

MERCURY REMOVAL PROCESSES

A. Applications

The Boliden Contech mercury removal processes have found their applications when elemental mercury has to be removed from a process gas:

?? Primary copper, lead and zinc smelters
?? Secondary non-ferrous smelters
?? Incinerators

The Boliden Contech mercury removal processes have found use in more than 50 cases worldwide.

B. Technical description

A crucial property of mainly elemental mercury is its tendency to form vapours already at very “normal temperatures”. The Boliden processes have taken that tendency into account.

For process gases there are 3 main Boliden processes to recover elemental mercury

1. Boliden/Norzink mercury removal process
2. Boliden Thiosulphate mercury removal process
3. Selenium filter

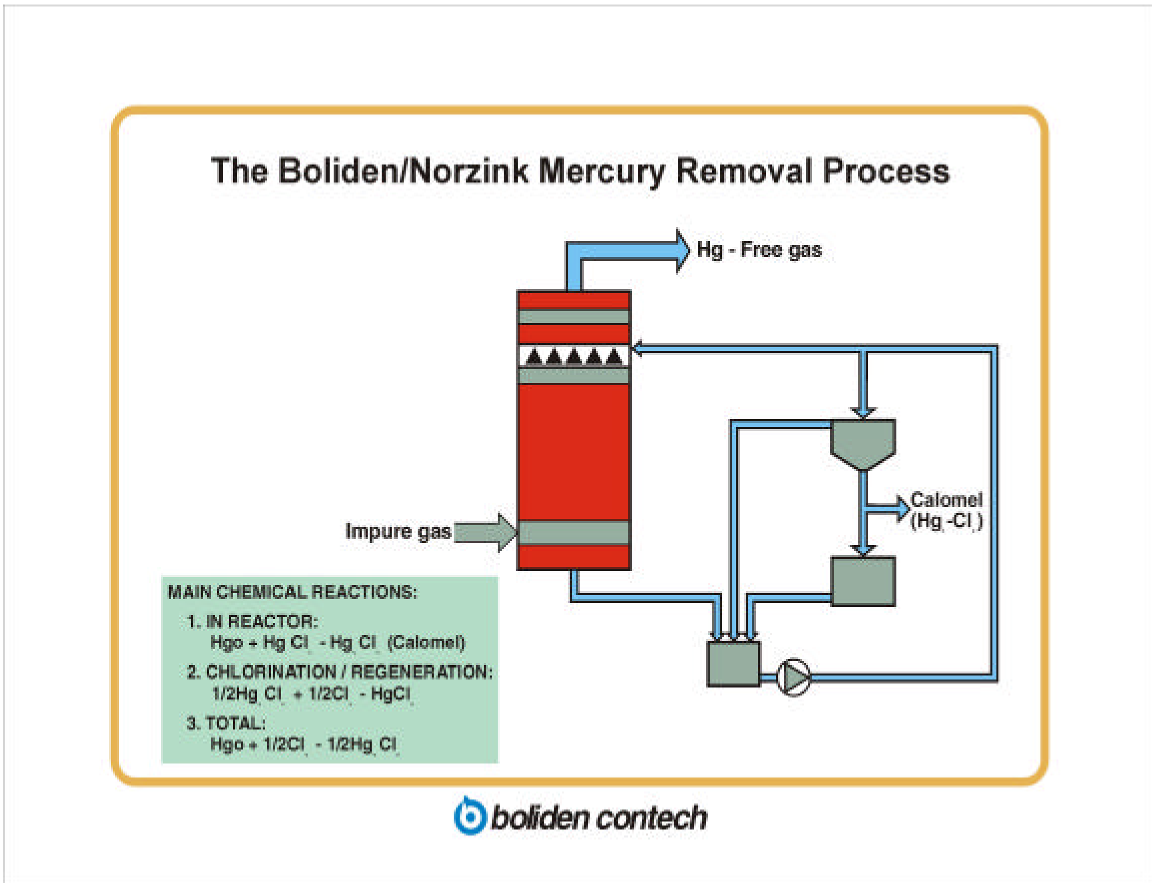
Each of these processes has found its special application.

The Boliden/Norzink mercury process forms calomel, Hg_2Cl_2, or elemental mercury, whereas the Boliden Thiosulphate mercury removal process forms HgS.

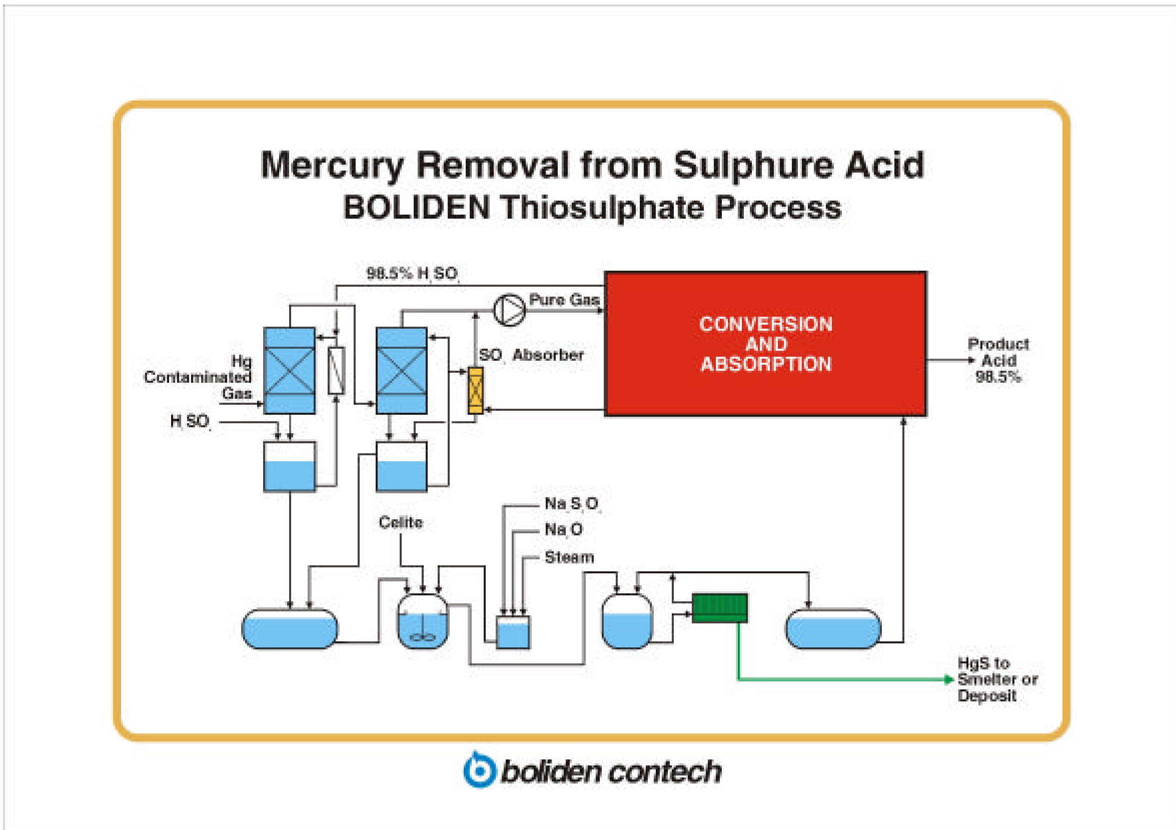
The selenium filter forms HgSe as the final mercury product.

More stringent legislation for mercury emissions in many countries make it necessary to upgrade old installations and use more advanced technology for new ones. In these cases one of the Boliden mercury removal processes is a logical choice.

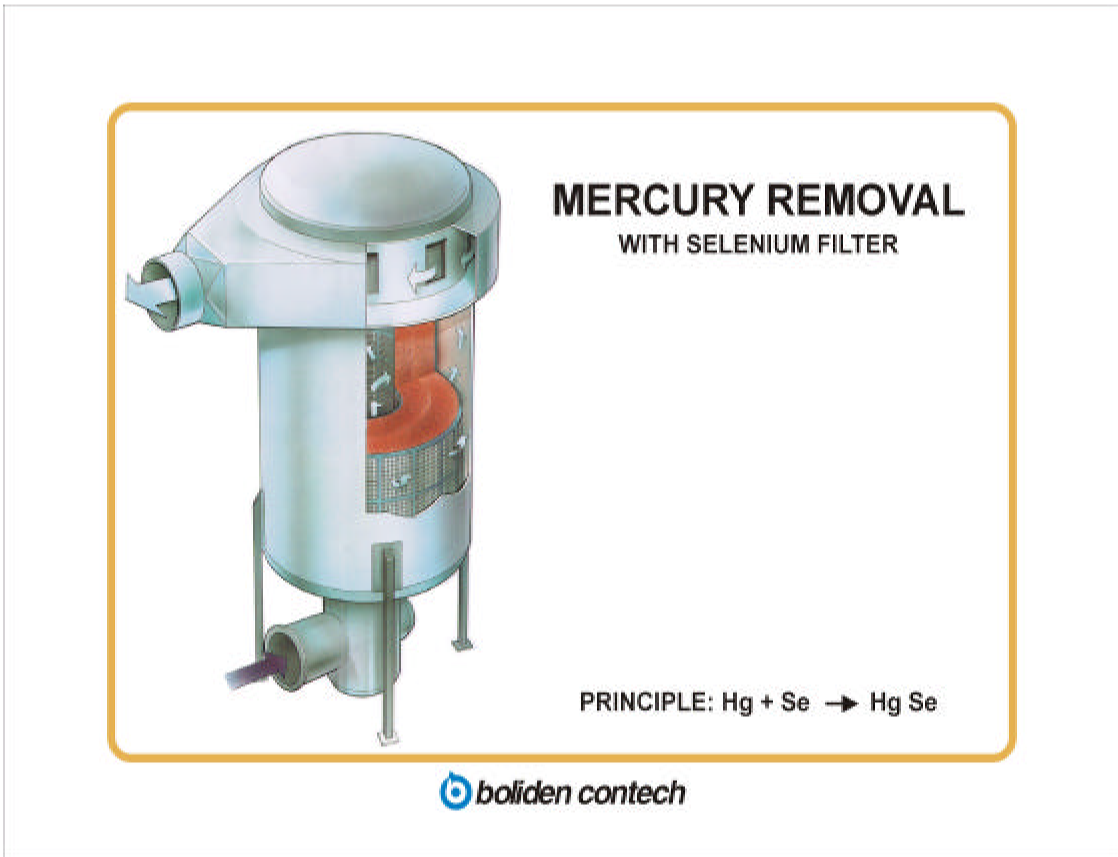
These processes are demonstrated in Picture No 8, 9 and 10.



Picture No 8.



Picture No 9.



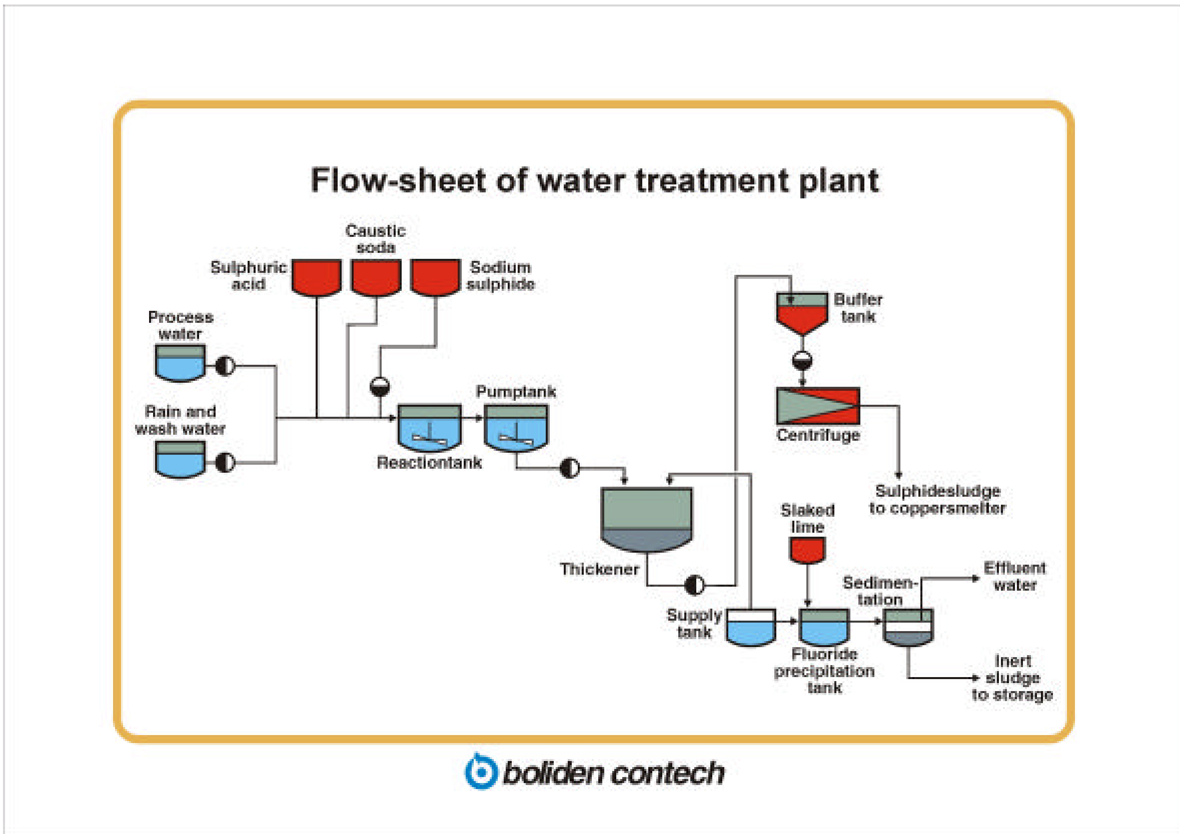
Picture No 10.

EFFLUENT TREATMENT

At the central water treatment plant, shown in Enclosure No 11, contaminated waters originating from different processes at the site are collected in one tank, while less contaminated rain and wash waters are collected in another one. The two streams are mixed, the pH is controlled, and then sodium sulphide is added to precipitate the heavy metals. A X-ray diffraction instrument developed at the laboratory is utilised for the automatic control of the process. This control is very important for an optimum metal precipitation, as it is for the possibility to get a sludge that is easy to separate from the water. Flocculent is added to enhance the sedimentation properties of the sludge. After separation in the thickener, the sludge is de-watered in a centrifuge before it is transported to a storage tank from which it is pumped into the copper fluid bed roaster.

The sulphide precipitation method is chosen because of the possibility it gives for metal recovery. The sulphide sludge contains on a dry base about 15-20% zink, 10% copper, 10% arsenic, some mercury, cadmium and even precious metals, but it is mainly of environmental and not economic reasons it is chosen to recover this by-product.

Since some years sodium sulphide has been replaced by less expensive green liquor from the sulphite pulp industry in Sweden.



Picture No 11.