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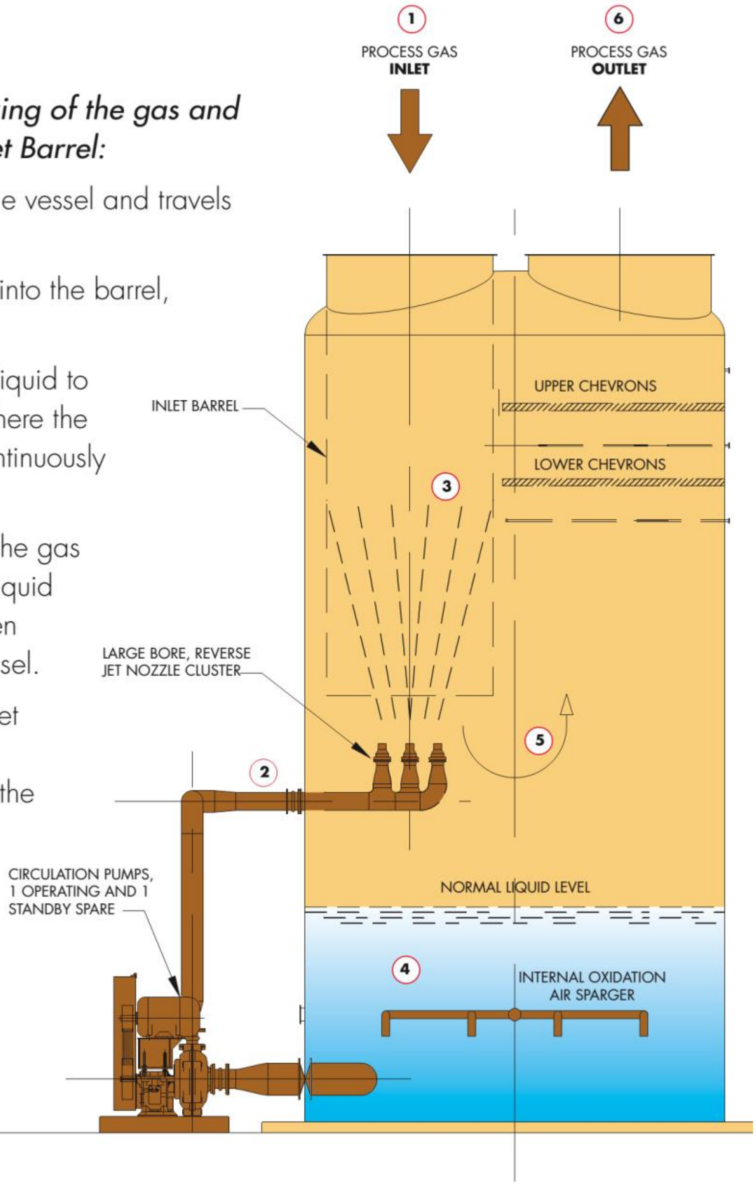
# General Process Description for DynaWave Scrubber

The DynaWave scrubbing system is illustrated in below. The heart of this system is the Reverse Jet, a gas-to-liquid contactor that creates a zone of intense mixing. The feed gas stream enters the top of a vertical duct and collides with the scrubbing liquid that is injected upward through large bore injectors.

*The key is the intimate mixing of the gas and scrubbing liquid in the Inlet Barrel:*

1. Gas enters at the top of the vessel and travels down the inlet barrel.
2. Liquid is sprayed upward into the barrel, counter to the gas flow.
3. The gas collides with the liquid to create a turbulent zone where the gas/liquid interface is continuously and rapidly renewed.
4. Where the momentum of the gas and liquid balances, the liquid reverses direction, and then falls to the base of the vessel.
5. The gas, on exiting the inlet barrel, turns and moves vertically upward through the tower. The gas encounters a set of chevrons that removes any remaining liquid droplets.
6. After the chevron, the gas exits the tower.




A standing wave of highly turbulent flow, called the Froth Zone, is created at the point the liquid is reversed by the gas. The Froth Zone creates a very high rate of liquid surface renewal and efficiently quenches the gas to the adiabatic saturation temperature and absorbs the $SO_2$. Even under upset conditions, the scrubber is capable of quenching hot gases up to 1,200°C. In addition to quenching and acid gas absorption, the *DynaWave* scrubber also efficiently removes particulate.

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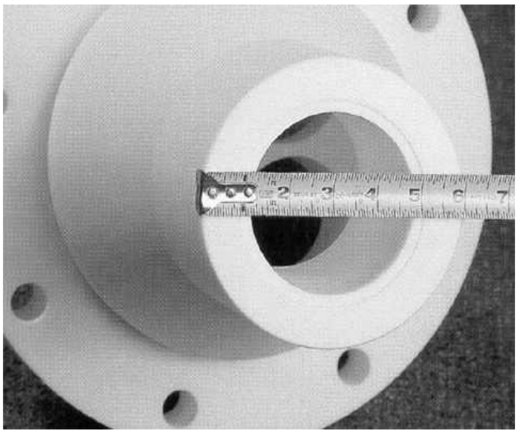
After contacting, the gas-liquid mixture enters a separation vessel where the liquid drops to the sump of the vessel and the gas exits the vessel through a vane demisting device. The collected liquid is recycled back to the circulation pump and flows to the Reverse Jet nozzles.

The Reverse Jet nozzle is a very large bore, open throat nozzle that creates a full cone liquid flow that is essential to producing the required Froth Zone. The nozzle is fabricated of silicon carbide to resist erosion. The Reverse Jet nozzle is pictured below.




The DynaWave scrubber is a particularly effective device for slurry scrubbing. The scrubber is designed to handle suspended solids without plugging through the use of very large open bore nozzles and slurry type pumps.

**DynaWave Slurry Scrubbing System**
DynaWave Scrubbers were developed to solve air pollution control problems requiring reliable operation with dirty, hot gases. DynaWave Scrubbers are an excellent fit with FGD slurry scrubbing applications because they are able to operate reliably in dirty environments with high collection efficiencies. The scrubbers utilize large diameter liquid injectors and nonrestrictive, open vessels. This allows routine operation with scrubbing slurries such as limestone or lime kiln dust without pluggage or downtime.

**Typical Slurry Preparation and Storage System:**
The DynaWave system uses a slurry as the scrubbing reagent for SO2 removal. Lime kiln dust can be metered from a silo into a slurry mix tank located directly below the silo. In this mix tank, water is added to the reagent to form a 20% by weight slurry. The slurry is pumped from the slurry mix tank to the scrubber vessel sump under pH control to maintain optimum operating conditions for acid gas removal. A recycle line off of the slurry feed line returns a large portion of the slurry to the feed system. The recycle line prevents settling of slurry in the feed lines. The recycle method is used to reduce the possibility of slurry settling.

**The Slurry Scrubbing:**
The heart of the DynaWave Engineered Scrubbing System is our Reverse Jet, a gas-to-liquid contactor designed to create a zone of intense mixing. Its primary functions are gas quenching and acid gas absorption.

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After passing through the Reverse Jets, the scrubbed gas exits the inlet barrel into the disengagement vessel where significant levels of entrained liquids will be separated from the gas stream by impingement on the liquid surface. Finally, the cleaned gas will pass through a two-stage chevron demister with an intermittent water spraying system located near the top of the vessel for final gas/liquid separation. In addition, makeup water is automatically added to the system by level control to replace evaporation and effluent losses. The gas then exits the top of the disengagement vessel and continues into the stack.

The hot gas entering the Reverse Jet will evaporate some liquid. The remaining liquid will flow into the disengagement vessel. This slurry then flows to the circulation pump and is returned to the Jet. The liquid in the scrubber will run with a solids loading of approximately 20%. To avoid settling of solids, some of the liquid is recycled back to the bottom of the sump to keep it agitated.

The reaction of SO2 with CaCO3 produces a mixture of calcium sulphite and sulphate. The mixture generated in the scrubber is discharged to the ex-situ oxidation system on density control (approximately 20% w/w). The oxidation of this slurry happens in the sump of the vessel by means of an air sparge.

### Typical Baker Oxidation and Dewatering System

In order to oxidize the sulphite to sulphate, an Oxidation Reactor is used. This Oxidation Reactor is operating with air. As the calcium sulfite dissolves in the reactor it comes into intimate contact with oxygen. The oxygen is provided as a component of the air, which is induced into the oxidation reactor. The dissolved oxygen reacts with the calcium sulfite to form calcium sulfate. The calcium sulfate is precipitated as it is converted from calcium sulfite. The presence of gypsum crystals provides precipitation sites in the reactor. Residence time and gypsum suspended solids concentrations have a direct effect on the particle size distribution and filtration characteristics of the slurry, which must be dewatered.

The Gypsum Dewatering System consists of hydrocyclones followed by a horizontal belt vacuum filter. The hydrocyclones are fed by pump from the oxidation reactor and are designed to produce a 50 wt% slurry. Overflow from the hydrocyclones is collected in the filtrate tank. Some purge is necessary to maintain dissolved salt concentrations at less than 15wt% and to purge the system of some gypsum fines that makes filtering more difficult. The slurry is discharged from the hydrocyclones to the horizontal belt vacuum filter to produce a cake with less than 10% moisture. Cake is discharged directly from the filter into a hopper. Most of the filtrate from the filter system is recycled to the DynaWave scrubber. The amount of recycle will be optimised upon start-up.