POLLUTION COLTROL

Sulfuric Acid Mist and Sulfur Dioxide are the two main pollutants in the DCDA Process for the manufacture of Sulfuric Acid. The Emission Standards given in the literature are:

COUNTRY	SO_2 LEVEL Kg/Ton PRODUCT ACID	ACID MIST Kg/Ton PRODUCT ACID
1.UNITED STATES	2.0	0.075
2.UNITED KINGDOM	3.3	-
3.WEST GERMANY	2.9	0.4
4.SWEDEN & DENMARK	5.0	0.5
5.JAPAN	0.5 to 1.0	-
6.INDIA (200 TPD CAPACITY)	12.0	5.0

The waste gases from a contact sulfuric acid plant leaving the absorbing tower commonly called the tail gas, consist principally of nitrogen, oxygen and small amounts of sulfur dioxide, the amount of the latter being dependent upon the efficiency of the total plant operation. In addition the tail gases contain sulfur trioxide and sulfuric acid as vapor and mist. The amount of these components are normally present in small concentrations in a well-designed and well-operated contact plant. During the start-ups and upset plant conditions, however the concentrations can increase to an amount that constitutes a nuisance. Since sulfur dioxide originating from many sources, is by far the most common noxious gas which is discharged into the atmosphere, it is the first contaminant to be singled out for attention in communities that are concerned with air pollution.

If present in sufficient concentration, it can be irritating to the throat and nasal passages as well as injurious to vegetation. Sulfur trioxide is also an irritant gas but it immediately forms a sulfuric acid mist with the water vapor in the atmosphere. Sulfuric acid vapor will also immediately form a sulfuric acid mist. A very small amount of sulfuric acid will produce an appreciable, visible plume from an acid plant stack.

On long exposures, sulfur dioxide concentrations above 0.25 ppm cause injury to growing plants. Elimination of damage to plants from sulfur dioxide emissions by the industry averts any hazard to humans or animals. Permissible limits for prolonged exposure of humans are considered to be 10 ppm of sulfur dioxide, 1 ppm of sulfur trioxide or 2-10 ppm of sulfuric acid. Nitrogen oxides are quite harmful and hence their emissions must be kept low.

Various Processes for the treatments of tail gases are discussed below:

DISPERSAL OF WASTE GASES WITH TALL STOCKS:

Tall stacks represent by far the most common method of disposing of the tail gases of sulfuric acid plants. The height of the stack necessary to get proper dispersion of gases into the atmosphere in order to avoid ground air pollution will depend on the meteorological conditions which exist at the plant location and the topography of the terrain surrounding the plant, as well as building and structures in the immediate vicinity of the stack. Stacks 150-200ft in height have proved satisfactory for plants where no usual terrain or meteorological conditions exist. Stacks of more than 400ft height have been used to deal with the problems in special instances.

SCRUBBING OF SULFUR DIOXIDE FROM WASTE GASES:

SCRUBBING WITH WATER:

Several Plants scrub the tail gas with water and report a reduction of 50-75% of sulfur dioxide content. These plants are located where disposal of acidic waste water doesnot present a problem.

SCRUBBING WITH SODA ASH SOLUTIONS:

Some plants scrub the tail gases with soda ash solution, producing a marketable sodium bisulfite.

SCRUBBING WITH LIME SLURRIES:

Neutralization with lime has been employed on flue gases of powerhouses. The lime is supplied as water suspension, and the reaction products are calcium sulfite and calcium sulfate. The slurry of calcium sulfite and calcium sulfate crystals circulates over a grid packed tower. Part of the circulating acid is continuously withdrawn and after passing through an oxidizing tank, the sludge is settled out, with the clarified liquor being returned to the circulation system.

SCRUBBING WITH SALT SOLUTIONS:

The stack gases from sulfuric acid plant are treated with a slightly alkaline, heated and concentrated saline solution of ammonium sulfate. Oxygen added to the gases oxidizes the products formed by the reaction of the acidic constituents in the gas with the bases in the saline solution.

SEPARATION OF SULFURIC ACID MISTS FROM WASTE GASES:

The tail gases from contact sulfuric acid plants normally contain traces of finely divided sulfuric acid. This sulfuric acid aerosol, with particle sizes ranging from less than ½ μ to 10 μ and larger, is spoken as acid mist. Mist composed of particles of between 1 and 10 μ is visible in the exit gases if present in amounts greater than about 1 mg of sulfuric acid/ cu ft of gas. The smaller the particle size of the mist, the more easily visible is the plume. Particles of sulfuric acid larger than 10 μ are probably present as a result of mechanical entrainment of absorber acid but contribute little to visibility of the plume. Droplets of this size deposit readily on the duct and stack walls, and unless the acid plant is operating under conditions of high exit gas velocity, do not constitute an emission problem.

SOURCES OF SULFURIC ACID MISTS:

SULFUR TRIOXIDE BASED MISTS:

Exit gases containing sulfur trioxide by reason of incomplete absorbing-tower action will form mist upon contact with atmospheric moisture. If the absorbing acid is weak or cold, acid mist may be formed when the process gases containing sulfur trioxide enter the absorber. If the absorbing acid strength is too strong, the partial pressure of sulfur trioxide will increase, and sulfur trioxide will pass through the absorber. Similarly, mist may be formed when the process gases are cooled prior to final absorption, as in the manufacture of oleum. These mists are generally of smallest particle size and present the most difficult control problem.

SULFURIC ACID BASED MISTS:

This mist result from the condensation of sulfuric acid vapor formed from hot absorbing tower acid. The partial pressure of sulfuric acid vapor above the absorbing tower acid increases with temperature and concentration of absorber acid. While the amount of sulfuric acid vapor is small under normal operating conditions, it may be sufficient to produce a visible mist.

WATER BASED MISTS:

This mist is formed as a result of the presence of water vapor in the process gases fed to the converter. Poor drying-tower performance is a common contributor; efficient drying tower operation should reduce the moisture loading to 5.0 mg/cu ft or less, and no sulfuric acid entrainment. In sulfur burning plants, mist may be formed from water resulting from the combustion of hydrocarbon impurities in the sulfur. In acid sludge-regeneration plants, mists formed in the wet purification system are not completely removed in the electrostatic precipitators. These mists will pass through the drying tower and although they are volatilized at converter temperature, will reform when the gases are cooled in the absorption tower. Obviously, steam or water leaks into the system contribute to the formation of this type of mist.

EQUIPMENT FOR MIST REMOVAL:

MECHANICAL COALESCERS:

Acid mists (except those of the smallest particle size such as result from oleum producing plant) have been successfully removed by wire-mesh filters and porous ceramic filters.

CYCLONE SEPARATORS, BAFFLES, VANE TYPE SEPARATORS:

Cyclone separators and simple baffles are not effective in coalescing particles much smaller than 5 μ. Thus although considerable acid mist may be removed, the visibility of the stack plume is not greatly affected, since the smallest particles contribute most to visibility. A “Karbate” Vane-type separator, which operates at relatively high gas velocity and this makes better use of particles kinetic energy, has been found to be moderately effective in reducing the visibility of the stack plume from a contact plant having a wet purification system.

PACKED BED SEPARATORS:

These devices employ particles of sand and coke or fibers of glass or metal, which intercept the mist particles or cause the coalescence by reason of high turbulence in the small spaces between the packing. Large filter units packed with layers of closely sized coke have been used for removing the acid mist.

WIRE-MESH MIST ELIMINATORS:

Wire-mesh mist eliminators are usually employed in two stages. The stages are separated in the vertical duct by several feet. The lower high-density stage acts as a coalescer, while the re-entrained coalesced particles are removed in the upper stage. Superficial gas velocities through these units range from 11-18 ft/s. Below 11ft/s the particle’s kinetic energy is apparently too low to promote coalescence, and re-entrainment becomes a problem at the higher velocities. The gas pressure drop through the unit is in the order of 3inch of water. Since the collected mist consists of strong sulfuric acid, possibilities of corrosion must be considered when selecting the wire mesh material.

CERAMIC FILTERS:

Porous ceramic filter tubes several feet in length and several inches in diameter, with a wall thickness of about ⅜ inch have proved highly successful in removing the acid mist. The tubes are mounted in horizontal tube sheet. The uppermost ends are open, and the bottom ends are closed. Process gases flow downward into the tubes and pass out through the porous walls. Considerably more filtering area is required for the ceramic filter tube than for the wire mesh. The filter tubes are composed of small regular particles of alumina or similar refractory fused with a binder into a porous condition. Tube breakage is a source of trouble with this equipment, so that maintenance costs are higher than for the wire-mesh filter.

ELECTROSTATIC PRECIPITATOR:

The electrical precipitators of the pipe treater type are extensively used to remove sulfuric acid mist particles from the cold sulfur dioxide gas stream of wet purification process. The same type of equipment has been used for treating sulfuric acid tail gases.

SONIC AGGLOMERATORS:

Sonic agglomerators operate on the principle that sound waves cause smaller particles in an aerosol to vibrate and thereby coalesce into particles several times larger than the original particle. These larger particles can then be removed from the gas stream by use of conventional cyclones. Since some of the sound frequencies are in the audible range, this nuisance factor must be taken into consideration.