7. SCRUBBEERS

Scrubbers are most often used as an air pollution control device to remove particulate matters and chemicals from waste gas streams of stationary point source. They are also applied where the slurry is used in other parts of the process or where the mixture is in a slurry form. In some scrubbers are applied so that chemical reaction will be generated within the scrubbing action.

7.1 Orifice scrubbers

In an orifice scrubber also known as an impaction scrubber, the gas stream flows over the surface of a pool of scrubbing liquid. As the air impinges on the water surface, it entrains droplets of the liquid. The waste gas stream then flows upward and enters an orifice with a narrower opening than the duct. The orifice brings turbulence in the flow which atomizes the entrained droplets. The atomized droplets capture the particulate matters in the air stream. Air velocity in the orifice scrubbers can be controlled by using adjustable orifices. The main advantage of this type of scrubber is that it does not need the recirculation pump for the scrubbing liquid, which is the major contributor to operating costs for most of the scrubbers. The disadvantage is difficulty in removing the sludge generated during the scrubbing process. In most scrubber design waste continuously drains from the bottom. Orifice scrubber consists of a static pool for scrubbing liquids, so waste generated is removed with a sludge ejector, which operates like a conveyor belt.

7.2 Venturi scrubbers

Venturi scrubber has a converging-diverging section, in this type of system the cross sectional area of the channel decreases then increases along the length of the channel. The narrowest area in the channel is referred as the throat. In venturi scrubber, liquid is introduced slightly upstream of the throat or directly into the throat section. In the converging section the decrease in area causes the waste gas stream velocity and turbulence to increase (figure 5.6). The scrubbing liquid is atomized by high velocity air stream and improves the air –liquid contact. Further the air –liquid mixtures decelerate as it moves through the diverging section, which helps to creates particle droplet impacts and agglomeration of the droplets. The separation of the liquid droplets from the air stream takes place in the entrainment section. The entrainment section usually consists of cyclonic separator and mist eliminator. For venturi scrubber collection efficiency for the fine particulate matter is higher but the equipment is more expensive than spray tower, cyclonic or tray tower scrubber. High air velocity and turbulence in the venture scrubber throat result in high collection efficiencies ranging from 70 to 99% for particles larger than 1 μm in diameter and greater than 50% for submicron particles. Increasing the pressure drop increases the collection efficiency, but the system's energy demand also increases leading to higher operational cost.

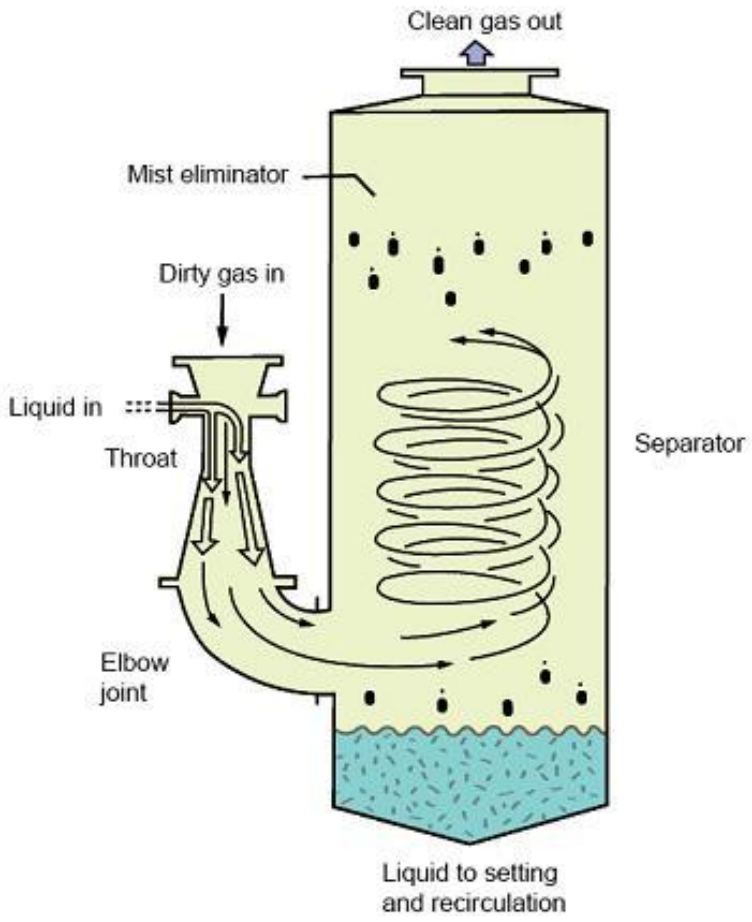

Figure 5.6: Venturi scrubber with cyclone separator and eliminator

7.3 Jet scrubber

In this scrubber, water flow is used in jet ejector to aspirate dusty air and to provide droplets for collecting particulates. Jet scrubber is used when it is not economical to used fan for a dust collection system (figure 5.7). Also, it can be used as a gas absorber.

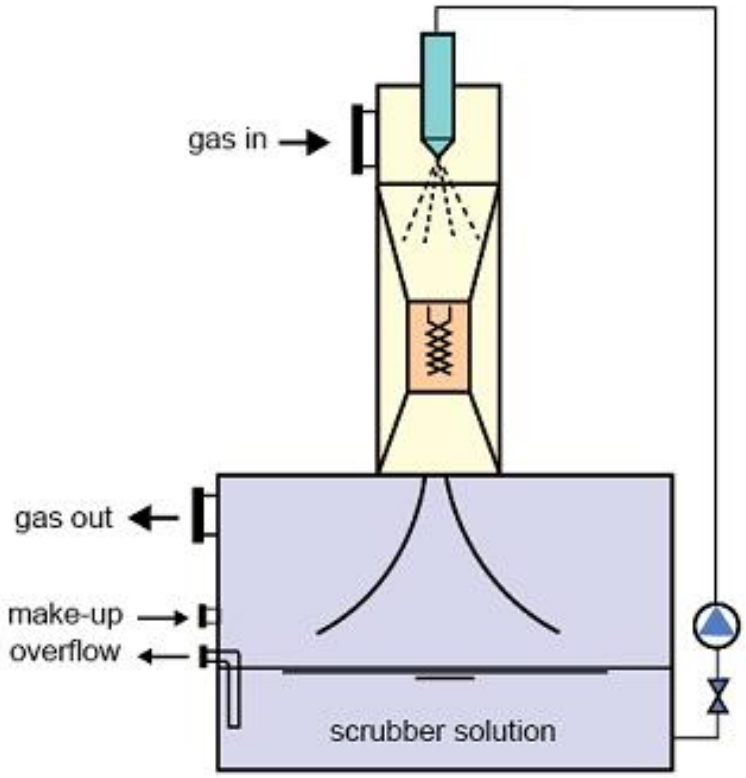

Figure 5.7: Jet scrubber

7.4 Dynamic scrubber

This type of scrubber is similar to spray towers, but only difference is that the dynamic scrubber uses power driven rotor that breaks the scrubbing liquids into finely dispersed droplets. Dynamic scrubbers are also known as mechanically –aided scrubbers or disintegrator. Liquid is sprayed into the suction of a fan and the wetted impeller and casing captures dust particles. Most dynamic scrubber systems humidify the waste air upstream of the rotor to reduce evaporation and particle deposition in the rotor area. This type of scrubber efficiently removes fine particulate matter, but the use of rotar in the system increases the maintenance cost. Pretreatment device, such as cyclone often used before dynamic scrubbers to remove the large particulate matter from the waste air stream. Collection efficiencies for dynamic scrubbers are similar to those for cyclonic spray towers.