

An Experimental Study of Parameters of Wet Scrubber for Environmental Benefit

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ABSTRACT: On a global scale, environmental pollution by industries, vehicles, and chemicals from consumer products contributes to air pollution which is a complicated problem with many causes and effects and few solutions. One of the most commonly used as pollution control devices by industry or transportation devices are “Wet Scrubber”. Wet scrubber is a device that removes pollutants from a furnace flue gas or from other gas streams. In a wet scrubber, the polluted gas stream is brought into contact with the scrubbing liquid. The scrubbing liquid is sprayed on to the flue gas so as to remove the pollutants. Wet scrubbers are generally the only single air pollution control device that can remove both particle matter and gases pollutants. The polluted gases are soluble in the liquid and the large particles are readily captured by the use of a scrubbing reagent such as lime or water.

KEYWORDS: Environmental Pollution, Pollution control device, Wet Scrubber, Scrubbing Liquid.

I. INTRODUCTION

Wet Scrubber is air pollution control devices for removing particles [1] and gases from industrial exhaust stream [2]. It is operated by introducing the dirty gas stream with a scrubbing liquid as water. Then gases are collected in the scrubbing liquid. They are usually the most appropriate air pollution [3] control devices for collecting both, particulate and gas in a single system alone.

Scrubber systems are a diverse group of air pollution control devices that can be used to remove particles [4] and/or gases from industrial exhaust streams. Traditionally, scrubbers have referred to pollution control devices that used liquid to "scrub" unwanted pollutants from a gas stream. Recently, the term scrubber is also used to describe systems that inject a dry reagent or slurry into a dirty exhaust stream to "scrub out" acid gases. Scrubbers are one of the primary devices that control gaseous emissions, especially acid gases.

Wet scrubbers [5] are PM control devices that rely on direct and irreversible contact of a liquid (droplets, foam, or bubbles) with the PM. The liquid with the collected PM is then easily collected. Scrubbers can be very specialized and designed in many different configurations. Wet scrubbers are generally classified by the method that is used to induce contact between the liquid and the PM, e.g. spray, packed-bed, and plate. Scrubbers are also often described as low-, medium-, or high-energy, where energy is often expressed as the pressure drop across the scrubber.

In a wet scrubber, the dirty gas [6], [7] stream is brought into contact with the scrubbing liquid by spraying it with the liquid, by forcing it through a pool of liquid, or by some other contact method. Generally the design of any air pollution control device [8] (wet scrubbers are no exception) depends on the industrial process conditions and the nature of the air pollutants involved.

Exhaust gas characteristics and dust properties, if particles are present, are of primary importance. Scrubbers can be designed to collect particulates and/or gaseous pollutants. Wet Scrubbers remove particles by capturing them in liquid droplets. Wet scrubbers remove pollutant gases by dissolving [9], [10] or absorbing them into the liquid. Any droplets that are in the flue gas must then be separated from the clean exhaust stream by means of another device referred to as a mist eliminator or entrainment separator (these terms are interchangeable). Also, the resultant scrubbing liquid must be treated prior to any ultimate discharge or reused in the plant.

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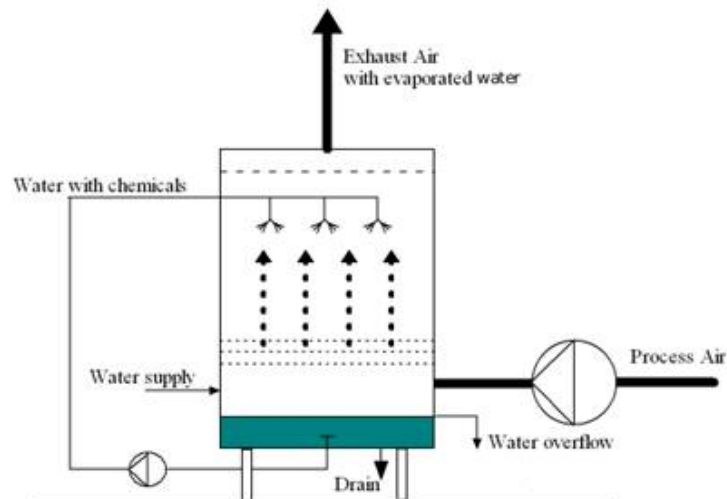


Fig. 1 Wet Scrubbing Process

Some advantages of wet scrubbers over these devices are as follows:

- 1) Wet scrubbers have the ability to handle high temperatures and moisture.
- 2) In wet scrubbers, flue gases are cooled, resulting in smaller overall size of equipment.
- 3) Wet scrubbers can remove both gases and particles.
- 4) Wet scrubbers can neutralize corrosive gases.
- 5) Minimal fire and explosion hazards.

II. WET SCRUBBER SYSTEM

Wet scrubber systems generally consist of the following components:

1. Body is the major part and it protects all parts which are inside the body
2. Fans transport (push or pull) exhaust gases through ducts to and from the scrubber, while pumps transport liquids through pipes. Although not part of the scrubber chamber, both fans and pumps are essential to its operation.
3. Ducts, or ductwork, transport exhaust gas to and from the scrubber. Ducts are carefully designed to keep pressure losses and, consequently, operating costs at a minimum.
4. The sprinkler is made up of a cast iron pipe with a diameter 0.5 inches is bended in a circular form by using tube bender and welded the edges to produce smooth circle shape.
5. Electric-motor-driven centrifugal pumps are the pumps most frequently used in wet scrubbing systems. In a centrifugal pump, the rotating impeller produces a reduction in pressure at the eye (centre) of the impeller, causing liquid to flow from the suction pipe into the centre of the impeller.
6. Pipes transport liquid to and from the scrubber. As with pumps, pipes are susceptible to abrasion, corrosion, and plugging. Pipes can be made from a wide variety of materials to reduce these problems.

III. PARTICLE COLLECTION

Wet scrubbers capture relatively small dust particles with large liquid droplets. In most wet scrubbing systems, droplets produced are generally larger than 50 micrometers (in the 150 to 500 micrometer range). As a point of reference, human hair ranges in diameter from 50 to 100 micrometers. The size distribution of particles [11] to be collected is source specific. For example, particles produced by mechanical means (crush or grind) tend to be large (above 10 micrometers); whereas, particles produced from combustion or a chemical reaction will have a substantial portion of

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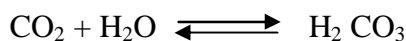
small (i.e. less than 5 micrometers) and sub micrometer-sized particles. The most critical sized particles are those in the 0.1 to 0.5 micrometer range because they are the most difficult for wet scrubbers to collect. However, impaction and diffusion are the two primary ones.

Table 1: Particle collection mechanisms for wet scrubbing systems

Mechanism	Explanation
Impaction	Particles too large to follow gas streamlines around a droplet collide with it.
Diffusion	Very tiny particles move randomly, colliding with droplets, because they are confined in a limited space.
Direct interception	An extension of the impaction mechanism. The centre of a particle follows the streamlines around the droplet, but collisions occur if the distance between the particle and droplet is less than the radius of the particle.
Electrostatic attraction	Particles and droplets become oppositely charged and attract each other.

IV. EXPERIMENTAL INVESTIGATION

Three hundred litres of ground water is taken in container. The water pumped to the sprinkler by using half hp motor with delivery rate of 1000 lit/hr. The sprinkler sprinkles the water with fine amount of spray on balls of varying sizes. When the exhaust gases [12] are entered in to the scrubber the water absorbs the pollutants in the gas. The drain water is re-circulated by using immersible motor. As a result of which the water used becomes acidic in nature since water & CO₂ forms mild carbonic acid.



Experiment 1

Table 2: Experimental Results for Ph Value with Time

Sample number	Time interval in (min)	PH value
1	Initial	8.6
2	20	8.2
3	40	7.4
4	60	7.1
5	80	6.8

The table 2 shows the obtained data for pH value of water with time for diameter of ball 10 cm, using balls 130 balls with normal water.

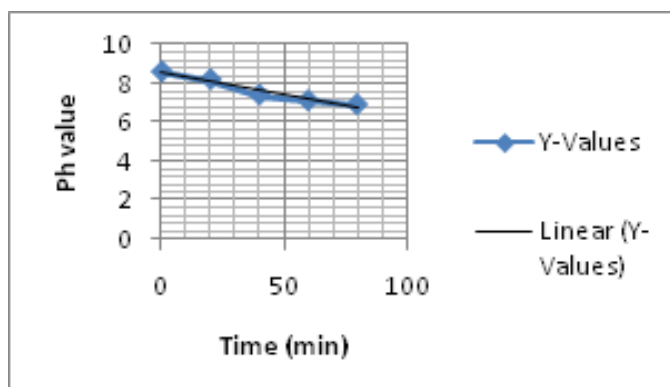


Fig 2: Graphical Representation of the results for pH value Vs Time in experiment 1 using 130 balls of 10 cm diameter.

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Experiment 2

Table 3: Experimental Results for Ph Value with Time

Sample number	Time interval in (min)	PH value
1	Initial	8.7
2	20	8.2
3	40	7.9
4	60	7.4
5	80	7.1

The table 3 shows the obtained data for pH value of water with time for diameter of ball 5 cm, using balls 500 balls with normal water.

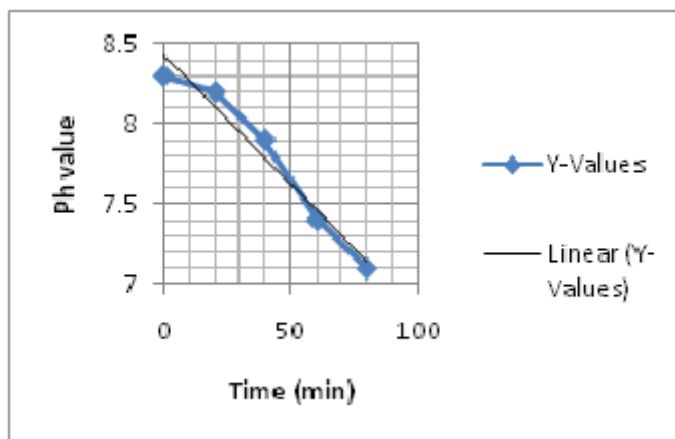


Fig 3: Graphical Representation of the results for pH value Vs Time in experiment 2 using 500 balls of 5 cm diameter.

Experiment 3

Table 4: Experimental Results for Ph Value with Time

Sample number	Time interval in (min)	PH value
1	Initial	8.7
2	20	8.3
3	40	7.9
4	60	7.7
5	80	7.3

The table 4 shows the obtained data for pH value of water with time for diameter of ball 2.5 cm, using balls 1300 balls with normal water.

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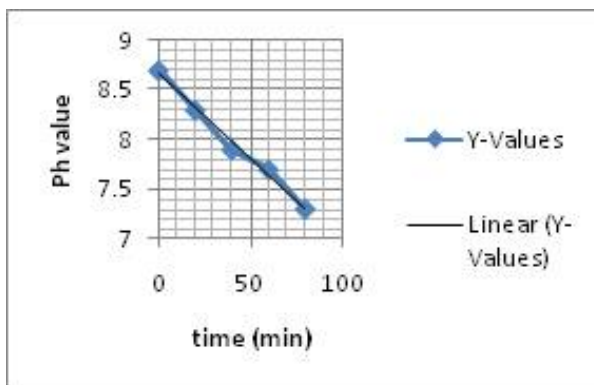


Fig 4: Graphical Representation of the results for pH value Vs Time in experiment 1 using 1300 balls of 2.5 cm diameter.

Experiment 4

Table 5: Experimental Results for Ph Value with Time using lime water

Sample number	Time (min)	PH value
1	0	12.3
2	30	12
3	60	11.6
4	90	10.5
5	120	8.7

Procedure of the experiment is same as the experiment no 03. In this experiment we use the lime water instead of water. The sample of drain water is taken for every 20 minutes of time interval for testing of change in PH value of water.

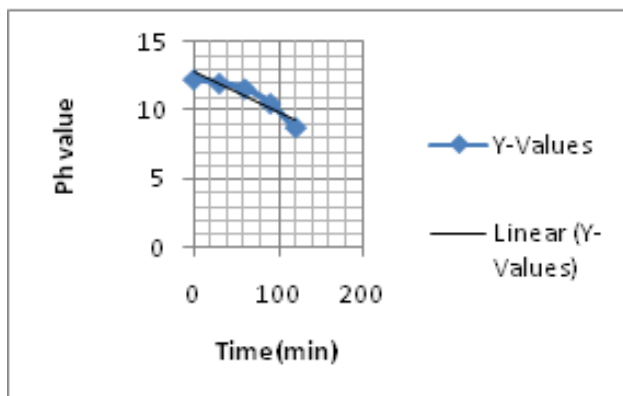


Fig 5: Graphical Representation of the results for pH value Vs Time in experiment 5 using lime water.

V. RESULTS AND CONCLUSION

As it is clear from the above experimental investigations [13], [14], [15] the gradual increase in PH value with respect to time. It clearly visualizes the proper increase in acidity of water. The PH value of water reduced from 7 to 3 within time period of forty minutes. When the carbon dioxide dissolves in water it exists in chemical equilibrium producing Carbonic Acid.

Flue-gas emissions resulting from burning of fossil fuels, coal, etc..., in several industries, has adverse effects on human beings as well as on environment. Scrubber efficiently extracts the atmospheric pollutants, in flue-gas emissions by scrubbing technique, to meet the requirement of pollution free gas. The scrubber body

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fabricated with glass-epoxy composite tower which in turn results for resistance to corrosion and it is eco friendly system.

Wet scrubbers have important advantages when compared to other PM collection devices. They can collect flammable and explosive dusts safely, absorb gaseous pollutants, and collect mists. Scrubbers can also cool hot gas streams. There are also some disadvantages associated with wet scrubbers. For example, scrubbers have the potential for corrosion and freezing. Additionally, the use of wet scrubbers can lead to water and solid waste pollution problems. These disadvantages can be minimized or avoided with good scrubber design.

SCOPE FOR FUTURE WORK

The efficiency has been improved due to the change in packing media. While placing the sprinkler position both upstream & downstream, can also increase the efficiency of the scrubber up to 85% to 95%. The water can be saved by placing the drift plates. If, we place the mist eliminators the pollutant particles will be eliminated, which are less than 5 microns. Further water treatment can be done by adding the adsorbent like GAC (Granular Activated Carbon).

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