# Pickling Line Fume Control with Wet Scrubber

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***Abstract*** — Wet scrubbers require less maintenance and generate less effluent than conventional dry scrubbers when removing acid gases such as hydrogen chloride, hydrogen fluoride and nitric acid from pickle line fume exhaust streams. This paper discusses the various methods to control Hcl emissions in to the atmosphere. Pollution control requirements have become so strict now, that many manufacturers are realizing that the best effluent is no effluent, and that the 'zero discharge' concept has many attractions. In order to have zero discharge, the established ways of doing things must be re-thought and improved with this object in mind. Traditionally, fume scrubbers for pickle lines have used large volumes of water. This paper is about wet scrubbers, which moderate amounts of water, and produce a relatively strong acid, that can be returned to the pickling process, instead of having to be neutralised. Most of the discussion will refer to hydrochloric acid (HCl) scrubbers, because this acid is the most widely used pickling acid, and HCl is targeted as one of the regulated compounds of Title III of the United States' 1990 Clean Air Act. However, plate scrubbers can be used for other acids, too. Better scrubbers are only a part of the solution; improved fume control systems which minimize the exhaust flows and contaminant loadings are just as important – the 'fumeless pickler' used on strand galvanisers is the ultimate design.

## I. INTRODUCTION

A **wet scrubber** or **wet scrubber system** is one type of scrubber that is used to remove harmful materials from industrial exhaust gases known as flue gas before they are released into the environment. It was the original type of scrubbing system, and utilizes a wet substance to remove acidic gases that contribute to acid rain. When using a wet scrubber, flue gas is funneled through an area and sprayed with a wet substance. Water is used when dust and particulate matter is to be removed, but other chemicals can be added. These chemicals are chosen to specifically react with certain airborne contaminants generally acidic gases. This process adds significant amounts of vapour to the exhaust which causes the release of exhaust that appears as white smoke when vented. Particulate or gases are collected in the scrubbing liquid. Wet scrubbers are generally the most appropriate air pollution control device for collecting both particulate and gas in a single system. Pollution systems offer a variety of wet scrubber systems specifically designed for process application. Many important operating variables are considered when evaluating the size and type of scrubber for any specific application.

### *A. Problem Definition*

1. Excess emission of HCL from scrubber which is harmful to the environment.
2. Corrosion of the scrubber stand because HCL Solution in water this is why so corrosive to plant environment in the smallest trace of condensation.

### *B. Objectives*

To develop wet scrubber that is economically and environmentally sustainable. Determine the operating efficiency of the wet scrubber. Optimization of the packed tower wet scrubber. Design and manufacturing of scrubber stand with FRP Coating

## II. LITERATURE REVIEW

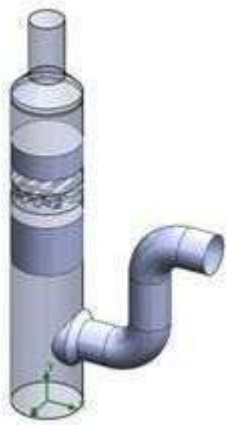
Chih-Liang Chien, Chuen-Jinn Tsai, Shiang-Ru Sheu, Yu-Hsiang Cheng [1] introduces Numerous wet scrubbers were studied for controlling either inorganic acid and basic gases or volatile organic compounds (VOCs). To control emissions, the Taiwan EPA promulgated strict emission standards which require greater than 95% control efficiency for either HF, HCl or HNO3 for packed towers in the semiconductor factory; 85% or 75% control efficiency for HF and HCl when the inlet concentration is greater than 3 ppmv or less than 3 ppmv, respectively, for packed towers in the optoelectronic factory.

A.G. Bhave, D.K. Vyas, J.B. Patel1 [2] introduces paper describes the development and evaluation of a compact, wet packed bed scrubber-based producer gas cooling and cleaning system, suited for small-scale applications.

Manisha Bala, Thamatam Tejaswini Reddya, B.C. Meikapa b, [3] "Removal of HCl gas from off gases using self-priming venturi scrubber", Journal of Hazardous Materials 364 (2019) 406–418 Growing concern about the effect of hydrochloric acid gas (HCl) on environment and abatement of it is now a very serious issue. This present paper is focused on developing a realistic model in order to remove the HCl from the off gases using self-priming venturi scrubber. A detailed parametric study of throat gas velocity (36–72 m/s), liquid level in outer cylinder (0.40–0.77 m) and inlet concentration of HCl (100–500 ppm) on HCl removal efficiency have been done with normal water as a scrubbing liquid. Also the removal efficiency was enhanced by using NaOH solution as a scrubbing liquid in submerged and non-submerged conditions. Therefore, the maximum removal efficiency of HCl was obtained as 87.83% with normal water and 92.54% with 0.005N NaOH solution as the scrubbing liquid at inlet HCl concentration of 500 ppm, throat gas velocity of 60 m/s and liquid level of 0.77m in submerged condition. Experimental results were validated with the developed empirical model and showed excellent agreement with less deviation.

Economopoulos, A.A., Harrison, R.M., 2007. Graphical analysis of the performance of venturi scrubbers for particle abetment part 1: rapid collection efficiency evaluation aerosol. Sci. Technol.41,51-62.

## III. WET SCRUBBER SETUP AND CAD DRAWING

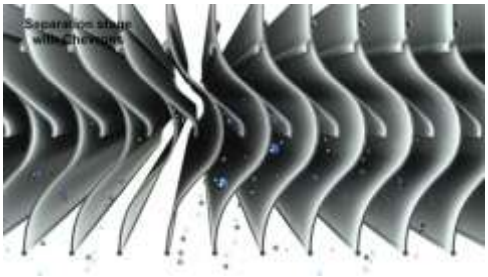
Fume control in pickle lines is achieved by drawing a flow of air from the hoods over the tanks; with proper design, this flow is just enough to prevent the acidic vapors which are generated by the hot acid from escaping into the plant working area. The hydrochloric acid which is purchased for pickling (usually 20 Be) is actually a solution of the gas hydrogen chloride (HCl) in water, containing 32% by weight of HCl. the exhaust from a continuous pickle line contains 200-2000 ppmv of HCl, depending on operating conditions and hood design. Then this hcl fumes is passed to the wet scrubber through the fan in which its pressure gets increased. This fumes or exhaust air is passed upward through the packing material. Scrubbing water which flows over packing is constantly splashed and mixed, giving good contact with gas. Due to which fumed hcl undergo condensation and condensed hcl with water Collected at bottom which is again used in pickling line. After condensation some amount of hcl fumes remains in scrubber. It cannot remove 100 percent hcl in the exhaust air. After packing material stage there is demister which acts as separator. Separate hcl droplets and air is vented out.

## IV. METHODOLOGY OF MODIFYIED SCRUBBING PROCESS

We know scrubbing of hcl fumes in the scrubber is achieved with the help of packing material. Therefore, to we have make some modifications that allows optimization of efficiency, pressure drop, pluggage resistance. we Observe and study the existing and required scrubbing process in wet scrubber to build a new setup. Literature survey about methods of fumes control in various types of scrubber. Make a Modification in process. Prepare cad geometry of setup. Analysis and economic feasibility evaluation of new scrubbing process.

## V. MODIFIED SETUP WITH ADDITION OF CHEVRON BLADES

The wet scrubber has three main components which are packing material, water sprayers and demister. but in existing scrubber we cannot recover the all of the hcl used. Therefore, we have to add the chevron blades in the existing setup after packing material and before the demister. The exhaust air after passing through packing material hcl is condensed but some amount of fumes as it is. Then this remaining fumes is passed through the chevron blades which is of zigzag shape restrict the fumes. With the help of water sprays the hcl fumes is converted into the droplets which is separated in demister, in this way optimum efficiency can be achieved.



**VI.** Cad model of chevron blades

- Stand for installation of blades in scrubber.

## VII. ANALYSIS

| Specification | Existing | Modifying setup |
|---|---|---|
| Hcl fume flow rate | .42 meter cube per hour | .56 meter cube per hour. |
| Ph value of hcl | 3.2 | 4 |
| Water rate required | 3-4 gpm per sq. Foot | 4-6 gpm per square foot |

## VIII. MATERIALS FOR CHEVRON BLADES

- Polypropylene
- Fluroplastic
- PVC
- Stainless steel
- Carbon Steel
- Nickel Based alloys

## IX. ADVANTAGES OF CHEVRON BLADES

1. It requires less cost hence it is economical.
2. It requires less space and easy to install.
3. It has long life span, since it is made up of pvc, or any other nonmetallic material.

4. It does not corrode due to hcl acid.

## X. CONCLUSION

Hence we have studied working of the wet scrubber to minimize the hcl emission to the atmosphere and to achieve optimum efficiency we added chevron blades with water sprays after the packing material by the use of which efficient amount of hcl in the exhaust air is removed.

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