



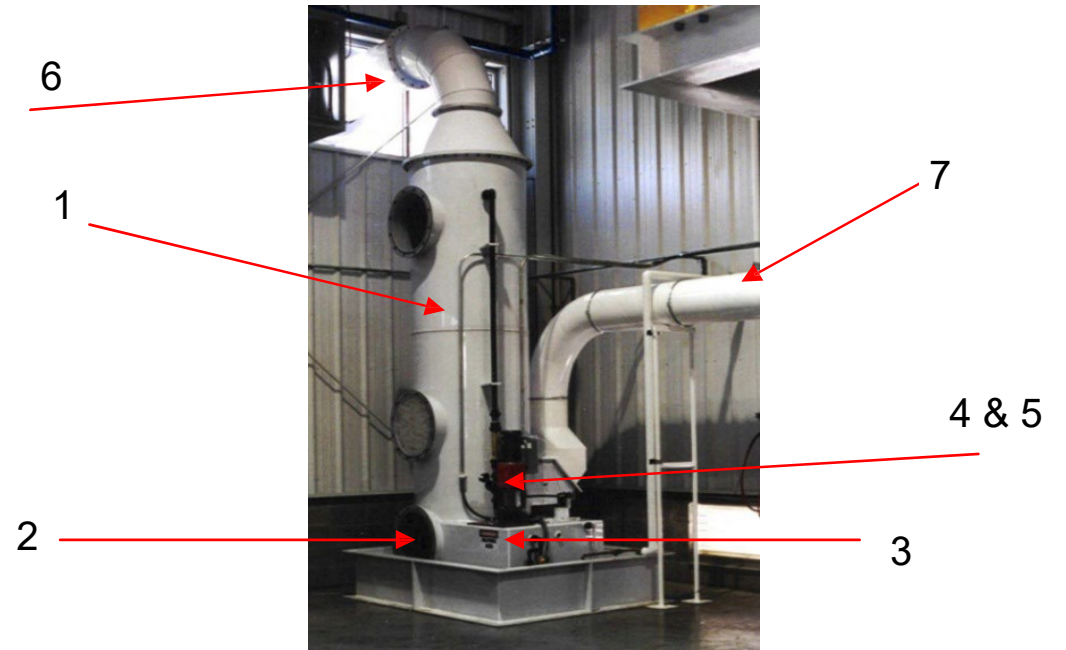
Amine Scrubber General Design & Operating Principles

Amine Scrubber - Description

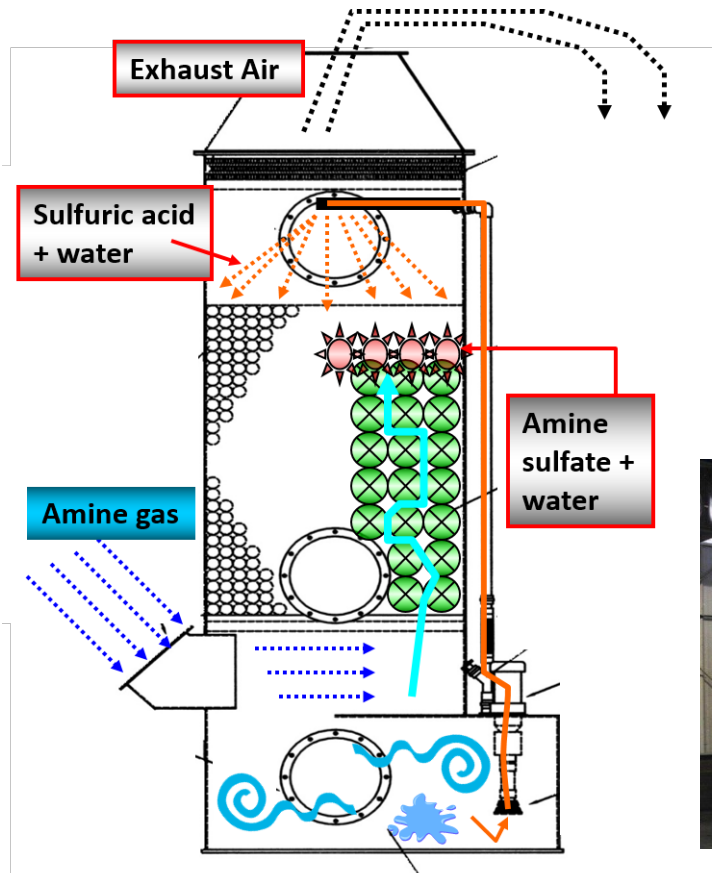
Most acid scrubbers are manufactured with similar design parameters, and the subsequent operation follows the same principles.

The basic components of the scrubbers are:

1. Treatment tower or column, filled with packing material
2. Acid solution sump
3. Recirculation pump
4. pH meter
5. Level control and operating system
6. Exhaust blower to the atmosphere
7. Intake from PUCB machines



Amine Scrubber – Basic Operating Principals



Basic operating principle of the scrubber:

An acid solution is pumped from the reservoir and introduced into the top of the treatment tower. From there, it reacts with amine vapor (flowing up the tower in a counter-flow direction) as it falls back to the reservoir.

The most popular scrubber design is a packed tower design which uses inert material in the treatment tower to increase the surface area coated by the acid solution. This also enhances the contact and reaction between the amine vapor and acid.

Amine Scrubber – Fresh Acid Charging Procedures

Caution! Extreme caution needs to be exercised when charging the scrubber.

Sulfuric acid is very corrosive and harmful to employees coming into contact with the solution. Sulfuric acid rapidly penetrates clothing and severely burns the skin and body tissue upon contact, so all precautions should be taken to avoid worker exposure.

Proper saturation of the scrubber solution for the amine recovery requires a sulfuric acid concentration of **approximately 40% H₂SO₄** in a water solution.

Many foundries elect to purchase battery acid for charging their scrubber, which has a concentration of approximately **37% H₂SO₄**.

Alternatively, higher concentrations of H₂SO₄ may be used and diluted with water during the charging procedure. An appropriate acid solution is available through Chemtech Services, Inc.

Caution! If concentrated H₂SO₄ is used, extreme caution should be exercised during the dilution process to avoid contact with workers.

Workers should always wear appropriate personal protective equipment (PPE), and an eyewash and safety shower should be available in the immediate vicinity of the operation. Caution should also be taken as the process is exothermic and generates a lot of heat. Always charge the acid into the water to avoid splashes of concentrated solution.

Amine Scrubber – Discharging Saturated Scrubber Solution

The scrubber solution will ultimately become saturated with the amine removed from the vapor discharged from the core box. The Specific Gravity and the pH of the solution will measure the saturation level and indicate when the solution needs to be discharged and replaced with fresh acid.

To ensure the efficient operation of the acid scrubber and the production of a reclaimable solution, the scrubber solution should be regularly monitored. An acid scrubber charged with fresh sulfuric acid (37% H₂SO₄) will typically have a pH of 0 and a density of 10.5 lbs/gallon.

During the Phenolic Urethane Cold Box process, amine vapor is captured by the scrubber and reacts with the acid to form an amine sulfate salt. This two-step reaction progresses from the initially formed mono-ammonium sulfate salt to the final di-ammonium sulfate salt.

As the pH of the solution progresses to 4.5, the maximum solubility of the amine salt is achieved, and the scrubber solution is ready to be exchanged.

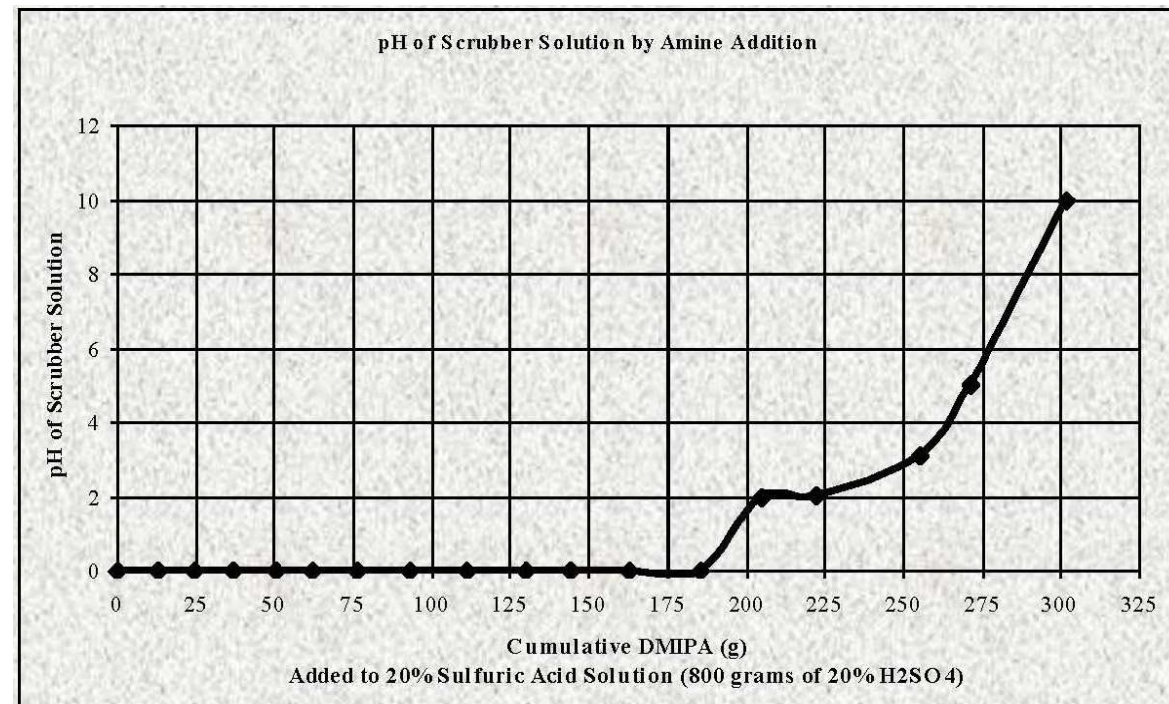
Amine Scrubber – pH is a critical indicator

The pH of the acid solution will remain relatively unchanged ($\text{pH} = 0$) through the first stage of the reaction and until the second stage of the reaction is almost complete.

The curve below indicates that approximately 70% of the saturation expected will be achieved before the pH rises above zero. Once the pH begins to increase, its rate of rise will be significant and must be closely monitored to prevent an increase above $\text{pH}=4.5$.

When the pH reaches a value of $\text{pH}=3.0$, it is time to prepare samples for analysis at the reclamation facility and exchange the solution with new sulfuric acid.

Under no circumstances should the pH be allowed to rise above $\text{pH}=4.5$. At levels above $\text{pH}=4.5$, the solution is less stable, and the free amine content is likely to result in a noticeable amine odor and free amine content in the vicinity of the solution above 1ppm (1.0 part per million).

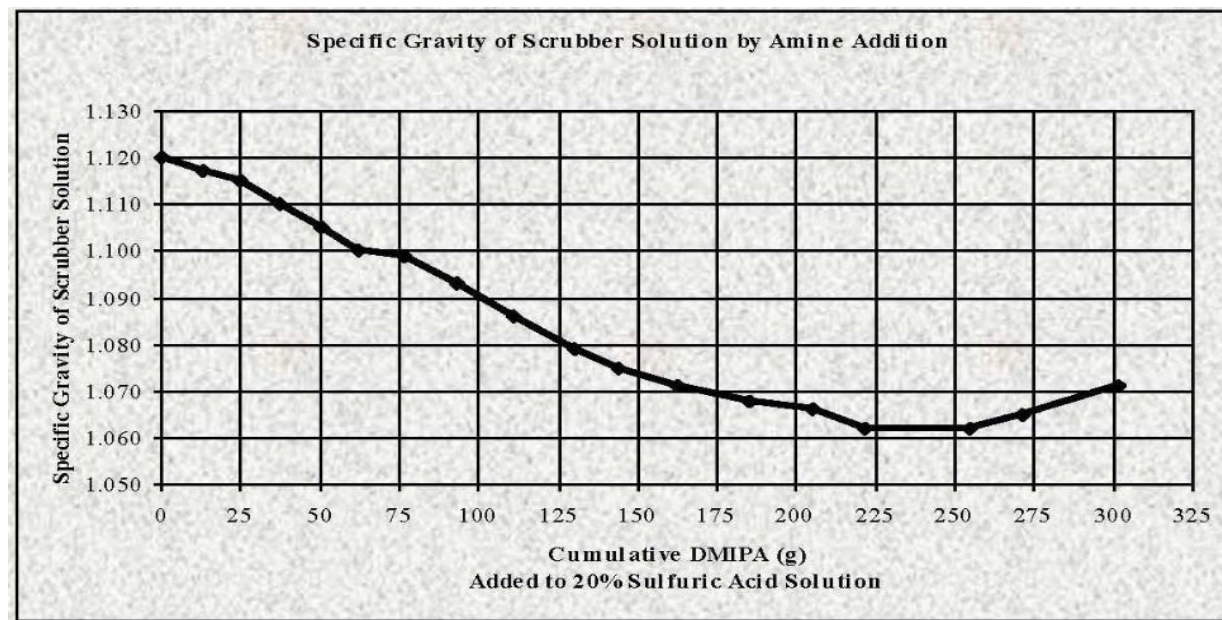


Amine Scrubber – Specific Gravity

SG can also be used in conjunction with the pH measurement to monitor the saturation (with amine) of the acid scrubber solution. Recognizing that the amine molecule is relatively light compared to the sulfuric acid solution (e.g., 37% concentration), as amine saturates the acid solution, the SG will decrease, and this trend will indicate the saturation level.

Specific Gravity represents the ratio of the density of the material being tested vs. the density of water. As indicated previously, the density of a 37% sulfuric acid concentration is approximately 10.5 lbs./gallon, representing an SG of approximately 1.27.

The graph was generated in conjunction with the pH graph presented in the previous section and indicates the reduction in Specific Gravity as the saturation of the acid solution with amine increases.



As indicated, the Specific Gravity gradually falls until saturation conditions are reached, and free amine begins to move the slope of the curve to a positive value.

Amine Scrubber

HAI Services recommend that both the pH of the solution and the Specific Gravity should be monitored in order to:

- (1) Ensure that the concentration of the scrubber is correct when recharged (e.g., start at SG > 1.25) and discharged (e.g., terminate after SG begins to increase).
- (2) Ensure that the pH level is maintained below 4.5 to ensure proper removal of the amine from the vapor stream and preclude discharge into the atmosphere.



Contact your HAI Representative for more details.

– OR –

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Specifics at each customer site, such as: local codes, plant layout, soils condition, & environmental issues, are beyond the scope of this presentation. This presentation is intended to assist HA International customers of Sigma Cat cold box catalysts in the effective handling and tracking of the amine scrubber solution sample bottles and totes. It is suggested that for the handling of any other container besides the HARP sample bottles and scrubber solution totes, you contact your HA International representative.

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