



Amine Recoverable Concentrate Program

A Service Provided By:

No
is
Works

400 Schroyer Avenue SW
Canton, OH 44702
(330) 453-4646

Amine Catalyst Recovery for the Phenolic-Urethane Cold-Box Process

Foundries that utilize the Phenolic-Urethane Cold-Box process are required to capture and contain amine gases used in the curing process. Utilizing the ARC[®] Program, Triethylamine (TEA), Dimethylethylamine (DMEA), Dimethylpropylamine (DMPA) and Dimethylisopropylamine (DMIPA) can all be contained for recycling. The actual containment or "capturing" of the amine after the cores/molds are cured is done through the use of a chemical scrubber. The packed tower scrubber utilizes a sulfuric acid solution to concentrate the free amine into amine salts which prevents the amine from escaping back into the atmosphere. As the amine enters the scrubber and contacts the water-acid concentration, a reaction takes place between the components to form sulfates within the scrubber solution. Over time the sulfuric acid solution in the scrubber becomes saturated with amine salts and needs to be replaced.

Amine sulfate scrubber solutions can be sent to Novis Works' partner facility. Here the scrubber solution will be put through a process that will liberate the amine out of solution allowing for capture. The reclaimed amine is chemically identical to freshly produced amines. The recycled amine is repackaged and resold to the foundry industry.

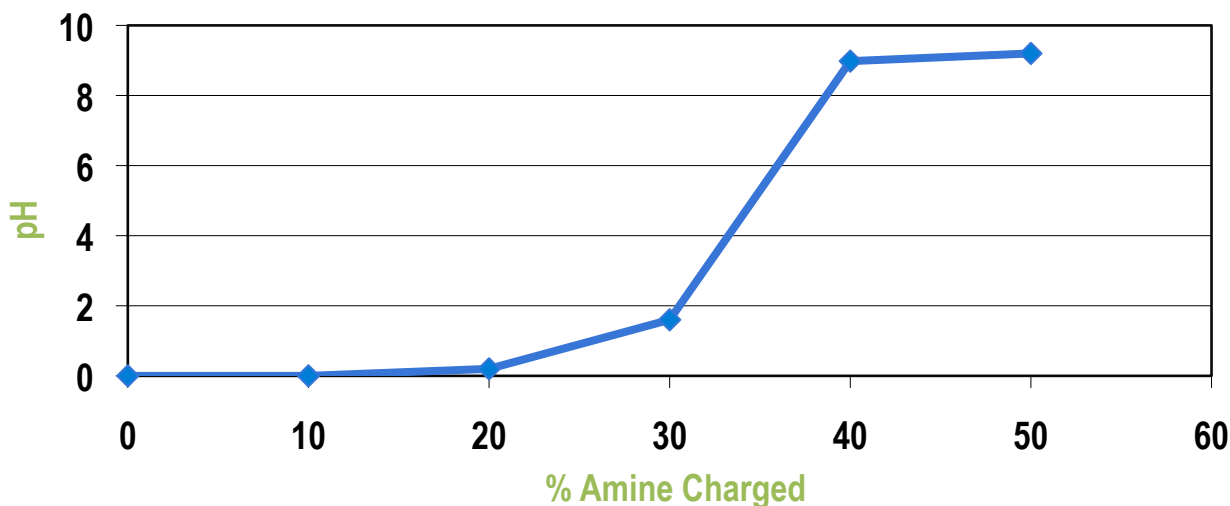
Benefits of recovering amine through the ARC[®] Program include, minimize the foundry's environmental impact, elimination of a waste stream, VOC credits and cost reductions.

Operating Procedures

Charging and operating the scrubber in a batch format is a requirement for the ARC[®] Program (unless your scrubber is equipped with the MT Systems mass flow scrubber regeneration technology - see Scrubber Mass Flow Regeneration Section for details). A concentrated spent scrubber solution suitable for recovery results if the following process is used. The scrubber volume must be set at the normal operating level and it must be equipped with a float switch to maintain the volume. Determine the sump size of the scrubber. Scrubber must be charged using 75% water by weight and 25% sulfuric acid (66 Baume) by weight.

- Charge the water first as considerable heat will be generated with the addition of the acid. Add the acid slowly with good agitation while using the proper Personal Protective Equipment (PPE).
- As the volume of solution decreases during operation only water should be added to maintain the level. This is done automatically in most scrubbers equipped with a float switch.

- The pH of the solution is the critical indicator. The pH will remain relatively unchanged (pH=0) until the second stage of the reaction is almost complete.



- Once the pH begins to increase, its rate of rise will be significant and must be monitored closely. At no time should the pH be allowed to exceed the 4.5 level.

NOTE: Before running a pH test, be sure to follow your pH Meter instructions for calibration of the instrument.

- Once the pH of the scrubber solution reaches 3.75, the scrubber may be drained and accumulated for recycling. A small amount (5% or less of the original charge) of acid may be added to keep the pH below 4.5 pH for convenient discharge.
- Specific Gravity can also be used in conjunction with pH to monitor the scrubber. SG is the ratio of the density of the material being tested against the density of water and is easily monitored using a set of Hydrometers and Hydrometer Cylinder. Both pH and SG should be monitored to ensure the concentration is correct.

Scrubber Mass Flow Regeneration

With the addition of MT Systems Mass Flow Scrubber Regeneration Technology, scrubbers can be supplied or modified to run and regenerate during production. This eliminates downtime as the scrubber does not need to be shutdown to run a Batch Mode. By using Mass Flow Technology the scrubber control system monitors the pH and the specific gravity in the recirculation flow. With this data the scrubber will control waste removal, acid addition and water addition automatically.

For automatic operation of the scrubber, the scrubber is charged with a sulfuric acid solution with the same initial concentration as the batch operations (75% water by weight and 25% sulfuric acid [66 Baume] by weight). This is done automatically as part of the scrubber startup cycle. The scrubber adds a predetermined amount of water, then adds the full required amount of sulfuric acid, and lastly tops off with any additional required water. Once the first initial charge of acid is completed the scrubber operates until the circulating solution increases to a pH of 4.0 and the desired Specific Gravity level (~1.080-1.090). At this point, a portion of the waste liquid is pumped through a flow meter to the waste tank. The remaining solution in the scrubber is recharged with sulfuric acid solution based on the volume of waste removed. Example: Pump out 250 gallons x .3737 (factor for 25% concentration Sulfuric Acid) = 93.4 gallons of sulfuric acid pumped back into scrubber through a flow meter. The pH will continue to drift lower over the following minute or two. Once the sulfuric acid is added the scrubber will be topped off with water to achieve the desired operating height.

The scrubber can run in constant operation cycling through discharge of waste and addition of acid and water. The scrubber can also be setup to go into a standby mode until required to run by receiving a signal from your core machines that they are ready to run. This can conserve substantial energy and water.

The reliability of the scrubber depends upon four important aspects of scrubber operation; liquid pH, liquid specific gravity, reservoir liquid level and replacement of spent scrubber waste liquid.

Contact your Novis Works® Representative at (330) 453-4646 for more details on Scrubber Mass Flow Regeneration.

Sample Testing Pre-Shipment

The ARC® Program requires a representative sample from every scrubber solution container be sent to Novis Works® before recycling. Each container of scrubber solution that ships for reclamation must be pre-approved by means of the sample. At no time are the scrubber solutions to be shipped to Novis Works® without prior approval. The minimum requirements for recycling are:

pH Range: 3.25 – 5.5
Sulfuric Acid: Maximum 5%
Recoverable Amine (yield): ~30% Minimum
Density: 1.08 - 1.20

An approved standard sample bottle kit (with 8 or 16-ounce High Density Polyethylene "HDPE" Wide Mouth Bottles; Novis Works® Code Number: 8-ounce = LS-17655, 16-ounce = LS-17657) will be provided and is a requirement for shipment. Proper packaging will prevent leakage and breakage during transit. You may order pre-shipment sample bottle kits by calling Novis Works® at (330) 453-4646.

The scrubber solution should have a Novis Works® reference number written on the label which helps identify the "type" of scrubber solution in the sample kit. Novis has set up reference numbers for the three types of scrubber solutions that can currently be shipped once approved. These are as follows;

Type of Scrubber Solution	Novis Works® Reference Number
Dimethylisopropylamine (DMIPA)	SL-300120
Dimethylethylamine (DMEA)	SL-300140
Triethylamine (TEA)	SL-300160
Dimethylpropylamine (DMPA)	SL-300180

Once the representative sample is placed into the bottle (sample bottle should be filled to within 3/4-inch from the top cap) from the sample bottle kit. Follow the printed instructions for proper packaging of the sample to prevent leakage. After the sample package has been properly sealed, a shipping label should be affixed to the box and mailed to;

Novis Works®, LLC
Attn: Novis Works® QC Lab
400 Schroyer Avenue S.W.
Canton, OH 44702

Upon the samples arrival, Novis Works® will check for amine content, free sulfuric acid, density, and pH. After testing, the customer will be notified whether the spent scrubber solution is within specifications and suitable for recovery.

After the Novis Works® analysis has been completed, a Certificate of Analysis (C of A) will be sent to the customer. If approved, a copy of this certificate must accompany the driver with the load and be given to the recovery facility upon delivery. Lack of attaching the C of A to the scrubber solution(s) will cause rejection of the product. For mini tanks, one way to ensure the C of A is not lost during transportation is to affix the C of A to the tote in a packing list envelope.

Again, one sample per mini-tank or one sample per bulk load must be sent to Novis Works® for analysis and approval prior to shipping.

Shipping Instructions

Spent scrubber solution contains free-sulfuric acid and it is important to follow all Department of Transportation (DOT) shipping regulations when sending scrubber solution(s) to the recycling facility. Failure to abide by all of the regulations could result in fines and other penalties.

NOTE: It is the responsibility of the shipper to attach the appropriate shipping placards when shipping drums, totes or bulk loads of spent scrubber solutions. A total of four placards must be given to the freight driver before the driver will accept the shipment. The shipper must provide the appropriate placards to the carrier for all shipments. An example of the placard is shown below;



NOTE: Incorrect labeling and/or placarding may represent a violation of DOT regulations. The customer is responsible for citations which may result from such violations. DO NOT ship any tote that has noticeable damage or leakage.

The placards can be purchased from a variety of online vendors. One such vendor is "<http://www.labelmaster.com/store/scripts/view-product.cfm?product=ZEZ41760>".

Once approved for shipment, contact Novis Works® at (330) 453-4646 to schedule a truck to pick up the material. The estimated amount of material that needs picked up should also be given at this time. Novis Works® will generate all of the shipping paperwork and send it to the customer to give to the carrier when the material is picked up.

When the carrier arrives to load the spent scrubber solution, the customer will also need to provide the carrier with a co-shipment sample at this time. The co-shipment sample should be labeled as indicated in Table 2. This sample will be run through the Novis Works® laboratory to ensure the sample has the same analysis as the original pre-shipment sample and that no contamination of the scrubber solution has taken place.

NOTE: It is important to ensure that the scrubber equipment has a filtering system to reduce the amount of sludge and sand that go into the spent scrubber solution. The maximum heel allowed to prevent clogging up pumps is 10 to 20 gallons per tanker. Excess heel material in the tank wagon may result in additional cleaning and waste disposal fees.

Handling and Safety

Spent scrubber solution contains free-sulfuric acid and should be handled as a corrosive liquid. Lines, pumps and storage tanks compatible with 10 percent sulfuric acid can be used. Contact with strong alkalis may cause the formation of noxious and flammable fumes. Spent scrubber solution contains ingredients that could be harmful if mishandled. Contact with the skin or eyes should be avoided and necessary personal protective clothing and equipment should be worn. For additional health and safety information, consult the SDS for the scrubber solution and the SDS published by your sulfuric acid supplier.

Safety data sheets for sulfuric acid and scrubber solution should be available close to the scrubbing operator or storage tank for scrubber solution.

Physical Properties of the Spent Scrubber Solutions

Physical properties relating to product bulk storage such as vapor pressure, specific gravity, and flash point are provided in Table 1.

Table 1: Typical Physical Properties of Bulk Storage Spent Scrubber Solutions

% Concentrate	Vapor pressure (mm Hg @68°F)	Viscosity (cP @ 25°C)	Specific Gravity	Flash Point (°F)	pH
30 - 50	17.5	60-85	1.08-1.20	>201	3.25- 5.5

Note: these values are not specific to any type of scrubber solution.

Material Compatibility

For trouble-free handling of scrubber solution, all equipment such as scrubbers, pumping, valves, draining and storage should be selected with careful consideration of chemical compatibility with amine salts and sulfuric acid. All of this equipment should be able to handle corrosive liquids.