Industrial Hygiene Report

Control of Hydrochloric Acid Vapors in a Lab Setting

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BACKGROUND:

Hydrochloric acid, an inorganic acid, is formed from a reaction between water and hydrogen chloride. This reaction produces a strong, mineral acid whose usage in industrial application is ubiquitous. Large scale manufacturing of PVC, polyurethane and many other materials use hydrochloric acid as an ingredient or solvent in further chemical synthesis. Many industrial and lab scale processes use hydrochloric acid solutions to control pH, clean process equipment, or as a reagent. This common usage is a result of hydrochloric acid's simple preparation, widespread availability, excellent solvent properties, and relative stability compared to other mineral acids such as Hydrofluoric acid and chromic acid.

There are many methods of manufacturing hydrogen chloride (HCl), the main reagent used in preparing a hydrochloric acid solution. Solutions of hydrochloric acid can range from a theoretical 40% solution all the way down to very dilute 1% and 0.1% solutions, though typical industrial applications will utilize a 30% "concentrate" in typical usage.

Hydrochloric acid can pose a moderate to severe risk to users due to its predisposition to emit significant amounts of HCl fumes even with moderately dilute solutions. The American Industrial Hygiene Association (AIHA) lists the Emergency Response Planning Guideline – 1 (ERPG-1) for HCl to be about 3 parts per million (ppm); the ERPG-1 is the highest concentration where a worker can be exposed to it for up to an hour and have no perceivable negative consequences acute or chronic. Typical lab environments should be kept below this level. If proper precautions such as adequate ventilation are not taken it can be quite easy for workers to be exposed to significantly dangerous concentrations of hydrochloric acid fumes. The AIHA lists the Emergency Response Planning Guideline – 2 (ERPG-2) for hydrochloric acid to be 19 ppm. The ERPG-2 is a measurement of the highest concentration at which 1 hour of exposure will not cause permanent or life threatening injury. Finally, the National Institute for Occupational Safety and Health (NIOSH) has set the Immediately Dangerous to Life or Health (IDLH) limit for hydrochloric acid at 48 ppm. The IDLH is the minimum level at which life threatening or permanently debilitating injuries would occur immediately on exposure.

TEST OBJECTIVE:

A test was set up in accordance with NIOSH Test Method 7903 to test for airborne concentrations of inorganic acids, in this case HCl. (This method can be viewed on the NIOSH website: http://www.cdc.gov/niosh/docs/2003-154/pdfs/7903.pdf) The test objective was to determine the effectiveness of Sentry Air Systems' Acid Gas filter media in keeping operator ambient hydrochloric acid concentrations to a minimum while the interior of the hood was subjected to a large quantity of hydrochloric acid fumes. This test was intended to show to what degree Sentry Air Systems' Acid Gas Filters remove hydrochloric acid from an airstream.

An important point to keep in mind is that the purpose of this test is to determine the performance of an appropriately used filter. For this test, the filter media used in the ductless containment hood (DCH) were brand new and contained uncontaminated, "virgin" treated-sorbent filter media. It is important to note that there is a finite capacity for any filter media and it is likely that as the media nears its end-of-life its effectiveness will decrease to some extent.

TEST SETUP:

The test enclosure was a standard Sentry Air Systems model# SS-330-DCH, with a filter configuration typically used by laboratories and workshops using or handling HCl solutions. The filter media was our standard model# SS-310-AGF, 10lb activated-carbon chemically treated acid-gas sorbent media filter.

The gas sampling was done in accordance with NIOSH method 7903 with SKC brand personal air sampling pumps, and the sorbent media specified in NIOSH 7903 and as recommended by SKC the sampling pump manufacturer, and the analytical lab that processed the samples, HIH Laboratories.

A commercially available cleaning solution, Muriatic Acid was used as the source of hydrochloric acid in this test; the acid used listed its concentration as 31.5%. 4 separate sampling pumps were calibrated using the Bios Defender 510 to 200 ml/min (5% tolerance), which is within the recommended flow range suggested in NIOSH sampling method 7903. The 4 sampling pumps were each equipped with the recommend sampling tube (specially cleaned silica gel) and then placed in 4 locations within the lab.

- Location 1: Inside the hood enclosure, near the top attached with double sided tape to the interior of the fan/filter chassis inlet. As seen in Figure 1 below.
- Location 2: Outside the hood enclosure, on top of the fan/filter chassis, attached with double sided tape to the outlet of the fan/filter chassis.
- Location 3: Clipped to the outside of the enclosure near the top of the enclosure body, about at the height of an average lab operator's neck, around 5 feet from the ground.
- Location 4: 7 feet across the room from the SS-330-DCH enclosure about 6' off the ground, on a shelf.

Figure 1: Sampling Location 1

After sampling, the 5 tubes used in the experiment were capped and sent to an independent AIHA LAP-certified laboratory to be analyzed. Their results are reported in Table 1.

PROTOCOL:

1) Sentry Air Systems Model# SS-330-DCH was set up as described above. The SS-330-DCH fan generates sufficient air flow to keep the average linear face velocity of the hood above 100 feet per minute. This is measured at the opening in the front of the hood.

2) A total of 200 ml of the hydrochloric acid solution was measured and then poured out onto a plastic tray and placed inside the SS-330-DCH. The fan was then switched on.

3) The sorbent tubes were then placed in their respective locations in the laboratory (as stated above). The sampling pumps were switched on as the SS-330-DCH fan was also being turned on. The test commenced at the switching on of the sampling pumps and proceeded for approximately 40 minutes, during which time some volume of the hydrochloric acid evaporated from the tray.

4) After the 40 minute sampling period, the sorbent tubes were removed from the sampling pumps, capped and labeled.

5) The test was sent to an independent AIHA LAP-certified lab for analysis.

Results:

No hydrochloric acid was detected in the ambient room atmosphere throughout the test (Location 4), nor was any detected at the operator's breathing location (Location 3), nor at the outlet of the hood (Location 2). Taking into account potential error in the sample analysis and the analysis method's detection limits, the filter appears to have removed >99.99% of the hydrochloric acid fumes.

Chemical Tested	Sample Location	Amount Absorbed by Sorbent Tube	Volume Sampled	Average Sample Concentration	Concentration
HCl Solution	**Blank**	**< 0.006 mg**	**n/a**	**n/a**	----
HCl Solution	**Location 1 (Inlet)**	**0.74 mg**	**7.8 L**	**94.4 mg/m^3**	**58.6 PPM$_v$**
HCl Solution	**Location 3 (Operator Ambient)**	**< 0.006 mg**	**7.5 L**	**0.8 mg/m^3**	**< 0.003 PPM$_v$**
HCl Solution	**Location 2 (Outlet)**	**< 0.006 mg**	**7.6 L**	**0.8 mg/m^3**	**< 0.003 PPM$_v$**
HCl Solution	**Location 4 (Ambient Room)**	**< 0.006 mg**	**7.6 L**	**0.8 mg/m^3**	**< 0.003 PPM$_v$**

Table 1 – Results: Hood running with Acid Gas Filter

Analysis:

The results of this test are unequivocal in recommending the Acid Gas filter for use in applications involving the use of, or potential exposure to, hydrochloric acid. The filter removed, as nearly as can be determined, all acid from the airstream being treated and reduced the potential operator exposure from upwards of 50ppm at Location 1 to a concentration at Location 2 that is less than the detection limits of the analysis methods used (approximately 0.003 PPM).

Further studies in this area are planned in order to verify the accuracy and consistency of these results as well as to address the issue of filter capacity.

For additional information, please contact Sentry Air Systems, Inc.

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