Sulfuric Acid

Where does it come from? How is it used in mining?
Sulfuric acid (H_2SO_4) is a strong acid. It is an odorless, clear to dark brown, oily liquid that is corrosive. Sulfuric acid has many industrial purposes and is produced in greater quantities than any other chemical worldwide. In metal mining, sulfuric acid is used to leach copper oxide minerals. In one process, a solution of sulfuric acid laden with copper sulfate is stripped of copper via a solvent extraction and electro winning with the used sulfuric acid recycled back into the process. Alternatively, the copper can be precipitated out of the copper sulfate solution by contacting it with scrap iron; a process called cementation. Other uses include metal cleaning, explosive production, processing bauxite and metallurgy.

What are the primary health effects from exposure to Sulfuric acid?
Sulfuric acid can cause irritation of the eyes, nose, and throat. Breathing in the mist or vapor can cause difficulty in breathing, teeth erosion or the mouth to become sore. Splashes to the eyes or on the skin will cause severe burns and can cause blindness. Inhalation of concentrated mists and aerosols may also cause pulmonary edema (fluid in the lungs). Long term exposure to sulfuric acid may cause chronic (or long term) irritation to the skin and eyes and/or chronic inflammation of the nose, throat, and bronchial tubes (lung airways). Strong acid mists can cause cancer in humans.

What are the occupational exposure limits for Sulfuric acid?
30 CFR Part 56.5001(b) requires that mine operators control exposure to airborne contaminants below the 1973 American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs). The 1973 ACGIH TLV for sulfuric acid is 1.0 mg/m^3 for an 8-hour time-weighted average. The 1968 Pittsburg Short-Term Exposure Limit is 3.0 mg/m^3 for a period of 5-minutes.

While not required by the Mining Safety and Health Administration, it is highly recommended to comply with the most current recommended airborne concentration guidelines. The 2011 ACGIH TLV for sulfuric acid is 0.2 mg/m^3 (T) for an 8-hour time-weighted average. The "T" notation means that the TLV is limited to the thoracic fraction of the aerosol, which is located in the upper to mid-areas of the respiratory system. The Immediately Dangerous to Life and Health concentration (the level that can cause immediate death) is 15 mg/m^3.

How often shall I complete exposure monitoring for Sulfuric acid?
If your mine uses sulfuric acid for metals leaching, cleaning or other purpose, air sampling is necessary. 30 CFR Part 56.5002 requires that dust, mist, and fume surveys be conducted *as frequently as necessary* to determine the adequacy of control measures. It is standard practice to sample initially (called a baseline evaluation) to determine potential exposure concentrations. Routine or periodic monitoring (usually annually) is also recommended. Sampling may need to be done more often if the tasks change, if engineering controls change, or if sampling results are above the "action limit" which, for most chemicals, is defined as 50% (or half) of the TLV.

How do I measure potential exposure to Sulfuric acid?
To measure worker exposure to sulfuric acid, air sampling should be completed for the entire shift to compare with the 8-hr time-weighted average limit or for 5 minutes to compare with the MSHA short-term exposure limit. Multiple short-term samples can be collected over the work shift to calculate a time-weighted full shift exposure.

NIOSH Method 7903 is used to measure sulfuric acid in air. This method uses a solid sorbent tube (washed silica gel; 400 mg/200 mg with a glass fiber filter plug) for media. The flow rate of the air sampling pump is calibrated between 0.2 – 0.5 liters of air per minute and the acceptable volume for each sampling tube is between 3 – 100 liters of air. Analysis is performed by Ion Chromatography by a certified laboratory. Multiple sampling tubes are necessary to collect samples over the work shift and calculate a time-weighted full shift exposure.

A Drager detector tube with Drager pump kit can also be used for short term sampling as a screening tool though the user must be aware that the error associated with detector tubes is large (+/- 25%).

Once the laboratory provides you with the mass of sulfuric acid in milligrams measured on the air sampling tube, you can calculate the air concentration as:

$$C = \frac{M}{Q \times T}$$

where C is the concentration of sulfuric acid in mg/m^3, M is the mass of sulfuric acid measured on the filter/in the solution in mg, Q is the pump flow rate in liters per minute and T is the total time of sampling in minutes. Note that many laboratories will do this calculation for you if you provide the flow rate and total sample time or the sample volume on your chain of custody. Many laboratories will also loan you the necessary equipment to obtain the samples and provide you with the appropriate sampling tubes.

Certified laboratories that can assist with measuring Sulfuric Acid:
Galson http://www.galsonlabs.com/
Analytics Corporation http://www.analyticscorp.com/

How do I control exposures to Sulfuric acid?
30 CFR Part 56.5005 requires the control of employee exposures to harmful airborne contaminants, by prevention of contamination, removal by exhaust ventilation, or by dilution with uncontaminated air. The standard allows for respiratory protection when accepted engineering control measures have not been developed or when necessary by the nature of the work. The following table may be helpful when selecting a respirator for sulfuric acid.

Concentration (mg/m^3)	APF	Respirator
Up to 15	25	supplied-air operated in continuous-flow mode or powered air-purifying with a HEPA filter (eye protection needed)
Up to 15	50	Chemical cartridge respirator (full face) with acid gas cartridge(s) in combination with a HEPA filter; any air-purifying, full face respirator (gas mask) with a chin-style, front- or back-mounted acid gas canister having an HEPA filter; any self-contained breathing apparatus with full face piece and any supplied-air respirator with a full face piece

In addition to either exhaust/dilution ventilation or respiratory protection, employees should use protective wear to cover exposed skin and the eyes. These often include acid resistant clothing, gloves, and face shields or splash goggles. Glove material should be made of butyl rubber, Teflon, or Saranex to avoid permeation of the sulfuric acid through the glove material. Gloves should be changed out and thrown away after eight hours of use.

References:
MSHA. 2007. Metal Nonmetal Health Inspection Procedures Handbook. PH06-IV-1(1). http://www.msha.gov/readroom/handbook/PH09-IV-1.pdf
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