

H₂SO₄



Sulphuric Acid (H₂SO₄) Technical Bulletin



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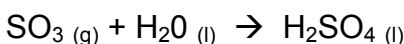
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Introduction

The production of sulphuric acid, or Oil of Vitriol, began in the Middle Ages, where it was obtained in small quantities in glass vessels in which sulphur was burned with saltpeter in a moist atmosphere. Larger rates of production became possible with the introduction of lead chambers as reaction vessels by Roebuck, in Birmingham, England in 1746. Sulphuric acid is the product of sulphur trioxide gas reacting with water.



Important uses of sulphuric acid includes fertilizer production, petroleum refining, pigment production, steel pickling, non-ferrous metals extractions and in the manufacture of explosives, detergents, plastics and man-made fibers, waste water treatment, and steam production (regeneration of weak acid cation exchange resins).

It is the objective of Sulco Chemicals Limited to maintain a high quality standard in the chemical industry. Meeting the service and product quality demands of our customers are the primary factors in determining our success. As a Responsible Care® member of the Canadian Chemicals Producers Association, Sulco Chemicals Limited is committed to taking every practical precaution towards ensuring that its products and operations do not present an unacceptable level of risk to its employees, customers, the public or the environment.

Sulco is registered under ISO 9002, ISO 14001, and ANSI/NSF 60 International Standards.

The purpose of this bulletin is to aid our customers in handling, transporting and storing sulphuric acid. If further information is required, contact Sulco Chemicals Limited at (519) 669-1332 for assistance.



Physical Properties of Sulphuric Acid

Physical Data

Sulphuric acid is a highly corrosive, dense, oily, clear, colourless liquid. It is miscible in water in all proportions but caution is required when mixing due to the tremendous evolution of heat that can cause violent reactions (ALWAYS ADD THE ACID TO WATER). Sulphuric acid is highly reactive and dissolves most metals, releasing hydrogen. Concentrated acid oxidizes, dehydrates or sulphonates most organic compounds, causing charring and severe burns to skin.

Table 1
General Physical Data for Different Concentrations of Sulphuric Acid

	Technical Grade	98/99% Grade
° Baume	66°	---
Strength	93.19% min	98.0% min
Specific gravity	1.8354	1.8437
Boiling point	287°C	327°C
Freezing point	-29.5°C	-1.1°C
Weight/US gallon	6.94 kg (15.30 lbs)	6.97 kg (15.37 lbs)

Table 2
Specific Gravity Correction Factor
According to Temperature

Degree Baume	Specific Gravity Correction (per °C)
10	0.00041
20	0.00061
30	0.00070
40	0.00074
50	0.00081
60	0.00095
63	0.00103
66	0.00097



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For temperatures above 15.6°C add the correction. For temperatures below 15.6°C subtract the correction.

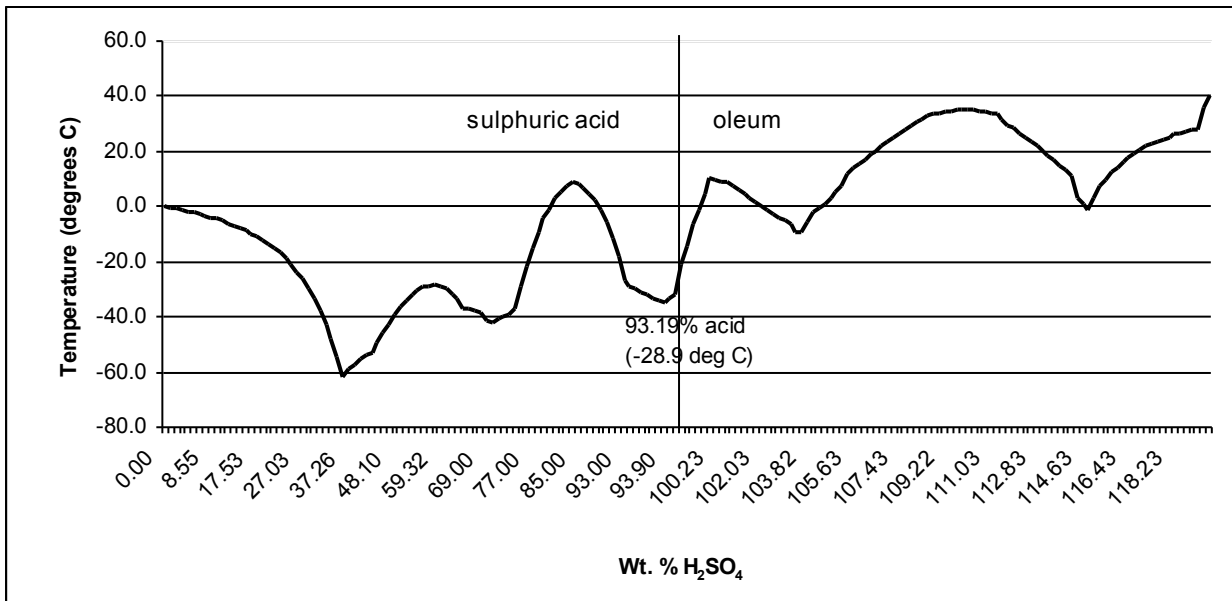
Table 3
Specific Gravity/Concentration Chart
For Sulphuric Acid

Degree Baume	Specific Gravity (15.6/15.6°C)	Percent Sulphuric Acid (% H₂SO₄)
0	1.0000	0.00
5	1.0357	5.28
10	1.0741	10.77
15	1.1154	16.38
20	1.1600	22.25
25	1.2083	28.28
30	1.2609	34.63
35	1.3182	41.27
40	1.3810	48.10
45	1.4500	55.07
50	1.5263	62.18
55	1.6111	69.65
60	1.7059	77.67
65	1.8125	88.65
66	1.8354	93.19
66.01	1.8357	93.30
66.02	1.8360	93.40
66.04	1.8364	93.50
66.10	1.8381	94.00
---	1.8407	95.00
---	1.8427	96.00
---	1.8437	97.00
---	1.8437	98.00
---	1.8424	99.00
---	1.8391	100.00

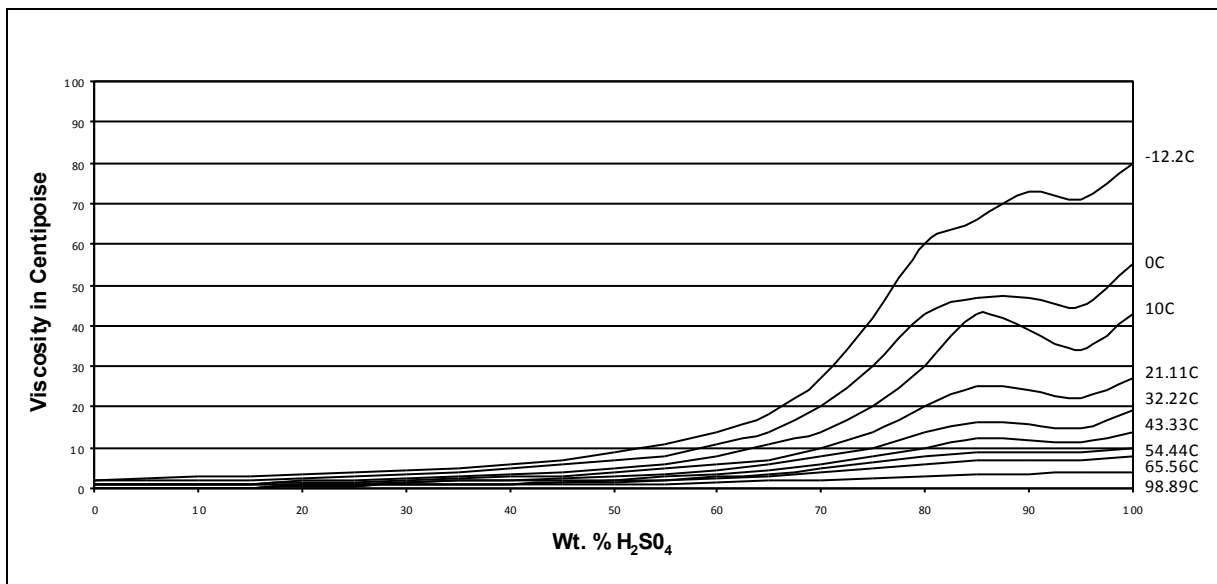
See the correction table according to temperature on the previous page.

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Graph 1
Freezing Point Curve for Sulphuric Acid and Oleum



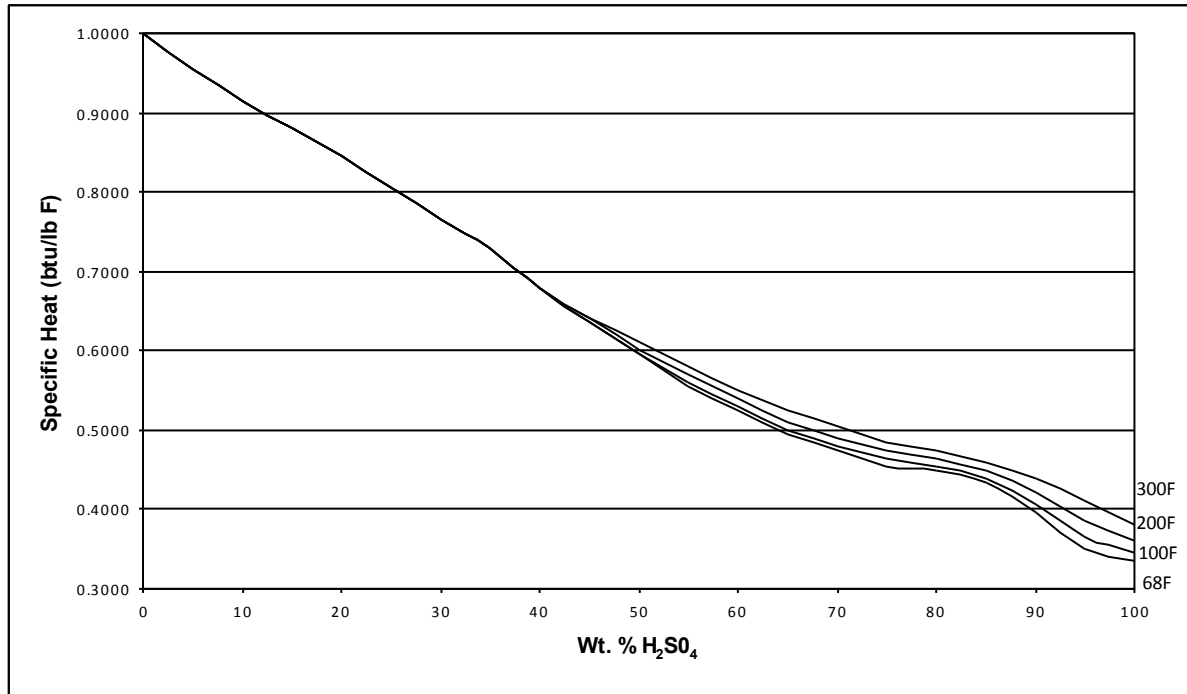
Graph 2
Viscosity of Sulphuric Acid at Various Temperatures





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Graph 3
Specific Heat of the Sulphuric Acid-Water System





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Bulk Storage of Sulphuric Acid

The following information of bulk storage of sulphuric acid is given as a guideline only since requirements will vary with the particular situation. Sulco Chemicals Limited will be pleased to offer technical advice regarding a particular installation.

Storage Tanks

1. Size and Design of Tanks

The normal practice is to size the storage tank to have 1½ times the capacity of the tank trailer to be received. Storage tank and delivery load size is also dependent on the customer usage rate and minimum inventory levels.

Maximum Trailer Size	Tank Size
40,000 kg	60,000 kg

This tank size (60,000 kg) corresponds to approximately 33,000 litre or 7,200 lGal. It is recommended that the maximum tank level be 90% for non-fuming acids and 85% for fuming acids. Both horizontal and vertical style tanks are used for sulphuric acid storage. A 1/8" corrosion allowance should be added to the design thickness of carbon steel tanks.

2. Materials of Construction

Storage tanks for unpressurized 93% sulphuric acid and most grades of oleum are normally constructed of carbon steel. The corrosion of carbon steel by sulphuric acid, results in the evolution of hydrogen, and the formation of iron sulphate, which will normally settle to the bottom of the tank. Depending on several factors, including temperature and the residence time of the acid in the tank, the iron content of electrolytic grade sulphuric acid may increase to beyond acceptable limits. To prevent this, storage tanks may be lined with a phenolic resin such as Heresite or anodically protected. 316-stainless steel may also be used to avoid iron contamination, however elevated levels of chrome and nickel may be experienced when acid is stored for prolonged periods of time.

3. Tank Location

Storage tanks should be located such that tank trailers have free accessibility within 10 feet of the tank loading nozzle. If possible, tanks should be elevated to take advantage of gravity feed to process since an acid pump will add to both the



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overall initial cost of storage facilities as well as increased maintenance costs. Avoid catch basins and storm sewers in the truck unloading area.



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4. Foundation and Diking

Storage tanks should be supported by reinforced concrete footings. It is also recommended that storage tanks should be surrounded by a dike, which is 125% times the capacity of the tanks. Dike material should be of concrete or earth lined with compacted clay or a synthetic liner such as Dunseal Hypalon. Both the local branch of the Ministry of the Environment and the Municipality concerned should be consulted for more specific guidelines regarding installation and diking.

5. Tank Fittings

All storage tanks should be equipped with the following:

- A 2" schedule 80 carbon steel or schedule 40, 316-stainless steel, 150 lb flanged end-loading line brought down to waist level for easy accessibility. Depending upon the piping arrangement, it may be desirable to equip this line with a flanged plug valve adjacent to the main hook up flange to allow rapid shut off and containment of the acid in the line in the event of the tank being over filled.
- A minimum 2" schedule 80 vent/overflow line piped down to ground level and away from the loading line within the dike. PVC may also be used as this will avoid corrosion deposits on the carbon steel pipe which may choke the vent off over time.
- A 24" manway with a 2" schedule 80 secondary outlet equipped with a blind flange to allow dipping of the tank. Installation of a level indicating system with a high level alarm is recommended.
- A 2" schedule 80 flanged bottom outlet with a 4" standpipe (for horizontal tanks) inside the tank to prevent any accumulated iron sulphate from carrying over to process. This outlet should be equipped with a quarter turn plug valve as well as an emergency shut off plunger type valve (for large tanks). The plug valve should be located as close as possible to the tank outlet nozzle.
- A 2" schedule 80 outlet with no standpipe, to allow for periodic draining of the tank. This outlet should be equipped with a plug valve and a blind flange.

Piping, Valves, Fittings and Gaskets



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Piping to the process should be of schedule 80 carbon steel, or schedule 40, 316-stainless steel with slip on welded flanges. Piping should be sized for an acid velocity of 3.5 feet/second or lower to minimize the erosive effects of the acid. Care should be taken at both the design and operation stages to avoid liquid full sections of pipe between closed valves since the hydrogen produced by steel corrosion can cause dangerous pressures especially in warmer weather.

Quarter turn plug valves have been found to give good service with sulphuric acid. The recommended type should have a flanged end ductile iron body with an alloy 20 plug or Teflon encapsulated plug and a Teflon lining.

Gasket material should be Teflon.

Unloading Facilities – Air Supply

It is recommended that a compressed air supply be made available at the unloading area. All of Sulco Chemicals Limited tank trailers are equipped with education pipes for unloading by pressurizing the tank trailer. The recommended pressure at the trailer is 30 psi but must be less than 35 psi. The air supply should be equipped with a shut off valve, a pressure reducing valve, a pressure gauge, a safety relief valve (set at a maximum of 40 psi), a quick opening manual relief valve, and 50 feet of 1" flexible air hose. The air supply valves should be freely accessible and located away from the storage tank and associated acid piping.

Trucks equipped with air compressors are available on request.



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Tank Truck Unloading - Responsibilities

Sulco Chemicals Limited, as a Responsible Care® company, has a commitment to both carrier and customer for the safe handling of our products.

To better illustrate our concern, we have carefully reviewed the function of the truck driver and customers in the delivery of sulphuric acid from tank-trucks. We have set up certain guidelines, which identify the responsibilities of the truck driver and the customer.

Customer Responsibilities

1. It is necessary to have safety showers and eye wash fountains in the unloading area such that they are easily accessible at the time of an emergency. Running water should be available at all times at the site. Both the truck driver and the customer's employee must be wearing protective clothing (during any chemical handling) such as a suit made of impervious material (PVC), safety goggles, faceshield, rubber boots, and rubber gloves.
2. The customer must make sure that suitable equipment and facilities are in good working order and readily available to safely handle the material.
3. The customer must ensure, prior to off-loading, that there is sufficient capacity in the storage tank to accept the entire incoming quantity. The only way to be absolutely sure is by physically dipping the tank. The customer must also check the truck unloading connections to make sure that the material is being unloaded into the proper tank.
4. The customer must check the bill of lading for the incoming material to make sure that the proper material is being off loaded into the proper storage tank. A check should be made to make sure the bill of lading agrees with the customer's order and the placard on the truck.
5. The customer is responsible for the unloading of the entire shipment. The truck driver is available to assist but only under the supervision of the customer. Two people must be responsible for unloading. This will minimize the possibility of accidents and enable prompt assistance should any emergency arise.



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6. The customer must make sure that the facility for unloading is designed to minimize the seriousness of any accident. Particular attention should be paid to the location of the overflow vent. If the tank is overfilled then the overflow vent should direct the liquid away from buildings, isolation valves and air shutoff valves and into the dike. Also, in the case of a ruptured unloading hose the air shutoff valve and liquid isolation valves should be far enough removed from the loading area so that the leak can be stopped quickly and safely.

Truck Driver Responsibilities

1. The truck driver must make sure that all equipment on his truck, including unloading hoses, is in good order. He must carry a set of protective clothing including safety goggles, rain suit, face shield, gloves, boots and any other equipment as required by the customer.
2. The truck driver is responsible for all connections made at the truck. He/she will assist with connections to the customer's equipment but only at the customer's request and under their supervision.

It is important that both the customer and the truck driver be suitably trained so that they know the proper action to be taken in the case of a spill and what medical treatment would be necessary in the case of injuries.

This information is provided with the objective to prevent accidents. Should further assistance be required, please contact Sulco Chemicals Limited at (519) 669-1332.



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General Trailer Unloading Procedures

Safety Precautions

1. PPE required: hard hat, safety goggles, face shield, steel-toed work boots, rubber gloves, acid resistant clothing (PVC jacket and pants).
2. Safety shower and eye wash sources: Locate in the event of a personal splash injury. Confirm operation.
3. Wheel chocks: Position to prevent movement of the trailer while offloading.
4. Trailer spotted: Check unloading setup (If unloading hose is stretched to the limit). If required, reposition the trailer before continuing.
5. Ignitions off: During the unloading process, unless tractor air is required for unloading.
6. Post any warning signs: Advise operators to route traffic away from offloading area.
7. Drains/catch basins: Insure all drains in the unloading area are covered or sealed for containment in event of a spill.
8. Regulated air supply: (Maximum 35 psi, normal 30 psi)

Unloading Steps

1. Instruct the driver where the trailer is to be parked for unloading.
2. Obtain the bill of lading and necessary quality documents from the driver (Certificate of Analysis, samples, weight ticket etc.).
 - Verify the product is correct.
 - Verify the amount of material on the trailer and confirm storage tank availability.
 - Sign the bill of lading if all is correct to acknowledge acceptance.
3. The unloading hose must be hooked up from the trailer to the unloading connection before any valves are opened. Note the location of any emergency shutoff valves equipped with the trailer.



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4. Open the main valve on the trailer and any valves to the storage tank. This allows the acid to begin flowing as soon as enough pressure is available in the trailer.
5. Connect the regulated air supply line (**Maximum 35 psi**) to the trailer and open all valves leading from the air compressor to the tank truck with the last valve opened at the tank truck. Confirm air pressure < 35 psi before opening last valve at the tank truck.
6. The acid will begin to flow as the pressure builds up in the trailer. The acid will continue to flow until the entire truckload is off loaded. The hose will jump and the sound of air rushing through will be evident when the trailer is empty. During the unloading period, the tank level must be continuously monitored.
7. Shut off the air supply at the trailer first and all the way back to the air compressor. Disconnect the air supply line from the trailer.
8. The main unloading valve on the trailer can be left partially open to blow any product free of the line for one minute.
9. The trailer can be vented slowly through the air supply valve to atmosphere.
10. Close the main valve on the trailer unloading line followed in succession by the valves leading to the storage tank.
11. The drain valve on the unloading line can be opened to drain any product from the unloading line. Once the line is confirmed to be free of product and any pressure, the unloading hose can then be disconnected at the trailer and the tank connection. Alternatively, permanent truck unloading hoses can just be flanged and loaded back on the trailer.
12. Remove wheel chocks and warning signs before moving trailer.



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Containment and Clean-up Procedures for Sulphuric Acid

Personal Protective Equipment

Spills involving 93% or 98/99% acid is handled the same way. The only important difference between these strengths is that while 93% acid is a viscous liquid down to -35°C, 98/99% acid freezes at approximately 0°C.

Sulphuric acid has virtually no vapour pressure so respiratory protection is not normally required. Respiratory protection is recommended for applications where acid mist is created.

The rapid and severe attack of sulphuric acid on human tissue is its most dangerous characteristic. For that reason, protective equipment and acid resistant clothing must be worn which is appropriate to the degree of risk of acid spray, acid splashes and acid pools on the ground such as safety goggles, or safety glasses and faceshield, hard hat, PVC jacket and pants, PVC gloves, and rubber boots.

It is important to also note that sulphuric acid is a dense liquid, almost twice that of water. Water will float on acid with limited mixing, but when agitated it will react vigorously with considerable heat generation.

Containment of Spills

Acid leaking from tank, cars or tank trucks will usually have drained down the right-of-way embankment to the adjoining low ground. If there is not flowing water in that area, the acid may form natural pools (except on porous, sandy soil) and no immediate containment action may be required.

If water is flowing through the area at a low rate, steps should be taken to construct earth dikes downstream to contain the acid and water. A back-hoe or front-end loader is necessary if a dam of any significant size is needed, particularly in frozen ground. If there is a high rate of flow through the area, then damming in the immediate area may not be feasible. It may be possible to find a place farther downstream where the contaminated water can be contained for neutralization before it reaches a main water course.



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Neutralization

- a. Caustic Soda – 1 tonne of 93% acid requires 1.5 tonnes of 50% caustic soda.

The most effective reagent for neutralizing large pools of acid is caustic soda solution, which is normally shipped in 50% strength solution. It freezes at approximately 13°C. However, 50% caustic soda should never be added to strong sulphuric acid as it reacts violently and considerable spray results. The acid should first be diluted with water from a safe distance using a fire hose with sufficient force that the water goes down in the acid. Once the initial dilution to 50% or less has been accomplished, 50% caustic soda and water from the hose can be run down in to the acid together. It would of course be more effective to add the water through a length of submerged steel pipe to get better mixing but this may be difficult to arrange. During dilution and neutralization, the height of the retaining dam needs to be sufficient to contain the liquid.

- b. Soda Ash – 1 tonne of 93% acid requires 1 tonne of soda ash.

Dry soda ash is an effective reagent for neutralizing small spills and areas of soil, which have been wetted with acid, but it is not too effective with deep pools of acid. It is ideal for finishing off the neutralization of acid, which has been diluted and partially neutralized with caustic soda. There is less risk of ending up with a strongly alkaline solution, since as the end-point is reached the foaming reaction which accompanies soda ash addition will cease.

- c. Lime

Quicklime and slaked lime are often more readily available than caustic soda or soda ash. However, they are difficult to use, and the formation of insoluble calcium sulphate results in poor utilization of the lime and a messy area to clean up later. Lime is an effective diking material for acid if earth is not available.

- d. Limestone

Crushed limestone (1/4" to 1/2") is excellent for constructing dams and for neutralizing and stabilizing the soil once the acid has been diluted, neutralized and discharged. Limestone spread over the area is harmless to animals and humans (the other alkalies are not), and with subsequent soil cover, vegetation can be restored.



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Disposal of Waste

The pH of the effluent liquid should be in the range of 6.0 to 9.0 and must meet local regulations before being sent for disposal.

Transfer Procedures

The method selected for transferring acid from derailed tank cars or damaged road trucks to other containers will depend on the condition of the tank, its orientation, and the accessibility of the tank fittings. Acid tanks are normally unloaded either by pumping or by the application of air pressure. If for some reason neither of these is possible, the use of a vacuum truck to remove the acid to a disposal area should be considered. With sulphuric acid the maximum suction lift is seventeen feet.

There may be occasions when it is desired to pick up spilled acid from pools in the ground. That should not be attempted if the acid has been diluted by surface water to a strength of less than 70%, since below that level acid reacts rapidly with mild steel. Acid strength can be judged by a hydrometer if one is available. (A density of 1.6 or greater indicates a strength above 70%.)

Materials of Construction

Strong sulphuric acid (over 70%) is normally handled in carbon steel piping and tanks. For components subject to wear such as pumps and valves, 316 stainless steel and alloy 20 are used for prolonged life. Copper and brass fittings must be avoided. Flexible pipe connections are preferable by using a length of PTFE lined hose.

For gaskets, PTFE should be used.



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Containers and Fittings

a. Tank Trucks

Tank trucks in acid service are variable in size and fittings. They will be made of 316 stainless steel, up to 40 tonne capacity and equipped with valves for bottom unloading or for top loading through an education pipe using air pressure or pump.

b. Small Containers

Sulphuric acid is packaged in 35 kg carboys, 350 kg drums and 1425 kg totes.

Table 4
Sulphuric Acid Transportation Information

Transportation of Dangerous Goods (TDG)
Of Bulk Product in Canada

1.	Product name	Sulphuric acid
2.	Prescribed shipping name	Sulphuric acid
3.	Product Identification No.	UN 1830
4.	Shipping mode	Tank cars, tank trucks
5.	Primary classification	Class 8 Corrosive
6.	Packing group	II
7.	Subsidiary classification	n/a
8.	Placards required	Class 8 Corrosive UN 1830
9.	ERAP Required	Yes, > 3,000 litres
10.	Emergency Response Plan Reference Number	ERP 2-0031
11.	Phone number to activate Emergency Response Plan	(519) 669-5166



How to Request Emergency Response for Chemical Emergencies Involving Sulco Products

1. Gather information that will be needed by Sulco, as described on the following page.
2. Call the following 24-hour Emergency Number:

(519) 669-5166

3. When your call goes through, state that you have a chemical emergency involving a Sulco product, and that you need assistance. Provide the information requested, and ask for the aid you require. A qualified person will return your call to provide assistance.
4. If you have not received a return call within 20 minutes, call back (519) 669-5166.
5. When your call is returned, you may be asked for additional information. Provide as much as you can without delay or guessing.

Note:

For chemical emergencies involving products not supplied by Sulco, contact the supplier. If you don't have the number, or if you need immediate advice, call the following number:

For emergencies in Canada: Call collect to CANUTEC (613) 996-6666



Information Required by Sulco to Provide Assistance for Chemical Emergencies

Have as much of the following information available as possible:

For your initial call:

1. Your name, job title, and the phone number where you may be reached.
2. Name, location and office phone number of your company or agency.
3. Nature and location of the emergency.
4. Any injuries or needs for medical assistance?
5. Names of the Sulco products involved, UN numbers, if available.
6. What assistance do you require?
7. Any other pertinent information.

For the return call from Sulco:

1. Type and number of containers, and their condition.
2. Any leaks? Approximate rate of leakage?
3. When did the incident occur?
4. Who is the carrier? Are they on scene?
5. Who has been informed? Fire department? Police? Environment officials? MOE? Other?
6. Any other products on the scene? Have their shippers been called?
7. How to get to the scene – travel directions.
8. At the scene, who will be the main contact for Sulco representative? (Fire, police, company office, carrier office, other).

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