

Sulfuric Acid Handbook

An information source for industrial consumers, handlers, transporters and other users.



NorFalco

Delivering *MORE* than H_2SO_4

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Responsible Care®
Beyond what's required.

Published April 2007



the formula for one of
the world's most
versatile and widely
used industrial
chemicals.

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This guide is intended as a general overview of the use and handling of sulfuric acid. The objective is to provide a common reference for general information on the characteristics of sulfuric acid distributed by NorFalco, as well as on the sulfuric acid manufacturing process, transportation options, storage practices, safe handling and emergency measures.

** Please note all specifications and technical information are provided free of charge. This information is intended for guidance only to supplement, but not replace, owner's design and safety criteria. The information is intended for use by responsible personnel having appropriate skills and know-how. The information is believed to be reliable; however no warranty of any kind, express or implied, is made with respect to the data or the references. Information provided may not be all inclusive, and suitability to local laws, codes and practices should be confirmed by the user of this information. The use of any part of this document is at the user's sole risk and Norfalco can make no guarantee of results and assume no responsibility or liability for results obtained or damages incurred from use of the data in whole or in part.*

Introduction

A powerful, virtually irreplaceable constituent of countless industrial processes, sulfuric acid is produced, transported and used safely by trained personnel around the world. Global production exceeds 190 million tons annually.

NorFalco is North America's largest merchant marketer of sulfuric acid, responsible for the marketing and distribution of over 2.3 million tons of sulfuric acid per year. Through parent company Xstrata, NorFalco has exclusive access to sulfuric acid production from five major North American production facilities. These five facilities combined with NorFalco's fully integrated network of trains, trucks, terminals and ships help ensure excellent supply reliability to a diverse range of consumers.

NorFalco is a company built from the combined histories of Noranda Inc., Falconbridge Ltd. and Xstrata. In 2005, NorFalco's parent company Noranda amalgamated with Falconbridge under the Falconbridge banner. In 2006, Falconbridge was acquired by Xstrata to form one of the world's largest mining and metals companies. Xstrata's global sulfuric acid production exceeds 5 million tons annually.

Sulfuric acid's varied properties of acidity, reactivity and corrosiveness, its sulfur content and its affinity for water play essential roles in the manufacture of products such as fertilizers, paints and pigments, explosives, pulp and paper, plastics, detergents, textiles, batteries and a variety of specialty chemicals. It is also used to produce ethanol fuels, process petrochemicals and mineral ores, refine metals and for water treatment. Its unique properties continue to be useful in the ongoing development of new products and processes.



The importance of sulfuric acid in such a wide variety of industries and the huge volumes transported every day demonstrate the need for universal commitment on the part of producers, transporters, and consumers, to the safe, responsible handling of the product. Awareness of the product's characteristics, a well trained workforce and established precautionary, procedural and emergency measures are all essential. Much of the information in this guide focuses on these needs.

Being Responsible

Through our involvement with the Canadian Chemical Producers Association and the National Association of Chemical Distributors, NorFalco fully supports the guiding principles, ethics and codes of practice of Responsible Care® and the Responsible Distribution Process SM (RDP). This commitment ensures responsible management of chemicals by minimizing risk to employees, customers, the public and the environment. Responsible Care® and Responsible Distribution practices are in evidence throughout every phase of NorFalco's

distribution system, where strict safeguards and established practices are in place. Compliance with Responsible Care® and The Responsible Distribution Process is re-verified every three years by advocates and chemical industry experts.

Throughout its history NorFalco has benefited in having access to the significant resources of its parent companies. NorFalco is backed by decades of experience. As a result of this synergy, product safety and quality needs are quickly addressed by customer service and technical support staff based in both the U.S. and Canada with the support of our manufacturing plants as well as a major technology center based in Sudbury, Ontario. In the event of a need for emergency support, NorFalco's Sulfuric Acid Emergency Response network is one of the largest in North America.





The vast quantities of sulfuric acid transported every day requires a universal commitment to the safe, responsible handling of the product.

Delivering More than H₂SO₄

To be our customers' supplier of choice, NorFalco must deliver much more than just sulfuric acid. We must deliver *solutions* that make it easier to order, receive and use our product.

At NorFalco, *Delivering More Than H₂SO₄* means:

- Reliable and secure supply from multiple plants
- Safe deliveries and Responsible Care®
- 24/7 Customer Service support
- Regional Safety Seminars
- Technical support and training delivered to your site
- Consistent quality
- Multi-modal logistics system
- Extensive terminal network
- Experienced sales force
- Working directly with the producer
- A reliable acid supplier for over 25 years

All NorFalco's *More Than H₂SO₄* support and services are offered free of charge as part of NorFalco's supply commitment to our customers.

For more information on what is available consult our web site at www.norfalco.com or contact your NorFalco commercial representative.



NorFalco plants and terminals

NorFalco, in close cooperation with production sites and technology staff, offers a full range of client services.

- Sales service
- Product information
- Engineering and technical assistance
- Shipment method advice
- Unloading/Storage/Handling advice
- Safety advice
- Emergency response
- Product performance evaluation
- Quality control reporting
- Market information



●	Plants
●	Rail-to-Truck Terminals
●	Storage Tank Terminals
●	Loaded Car Storage

Product Quality

Product quality is a top priority, and NorFalco regularly supplies customer requirements for acid to meet the following industry standards (and others):

- FDA Food Chemical Codex
- NSF 60 Certification for Drinking Water, (CEZ, Valleyfield plant and Elizabeth, NJ terminal)
- Department of Defense Electrolyte Class 1
- Kosher Compliance

NorFalco has a dedicated Quality Assurance Manager on staff to ensure quality control and compliance with customer and industry specifications. Each plant has its own analytical laboratory for quality monitoring and the preparation of certificates of analysis for acid shipments. All plants use equipment specifically tailored to sulfuric acid analytical methods such as ultrasonic concentration measurement, colorimetric determination, atomic absorption analysis, inductively coupled plasma analysis, and wet chemical analytical procedures.

Production Facilities

NorFalco is the exclusive marketer of production from five plants owned and operated by parent company Xstrata and the Noranda Income Fund Limited Partnership (CEZinc). This supply position is complemented by sources in the central and southern United States. NorFalco's multi-modal distribution network delivers more than 2.3 million tons of sulfuric acid annually to customers in a wide variety of industries.

Xstrata's sulfuric acid production facilities are well positioned to serve most markets. With capability to ship by truck, rail, or vessel, NorFalco is able to provide responsive, reliable and flexible product supply backed by superior service and support.

The Xstrata Nickel smelting facility located near Sudbury is part of a world-class nickel production system. It has both rail and truck shipping capability.



Xstrata Copper's Kidd Creek metallurgy site in Timmins, Ontario is an integrated copper / zinc metallurgical plant with a large acid production capability also having truck and rail loading capability.

Located in Rouyn-Noranda, Quebec, Xstrata Copper's Horne smelter is one of the world's major custom copper smelters. The modern sulfuric acid plant is complemented by an 80,000-ton storage system with truck and rail shipping capability.



The Noranda's Income Fund Limited Partnership (CEZinc) plant is a refinery producing high quality zinc. Located on the St. Lawrence Seaway near Montreal, its proximity to markets and multi-modal loading capabilities make it a versatile supplier by truck, rail or vessel. CEZinc's three acid plants are ISO 9002 certified, making it one of the world's largest single sources of ISO certified sulfuric acid.

Xstrata Zinc's Brunswick smelter operates a sulfuric acid plant at its lead smelter near Belledune, New Brunswick. This site has multi-modal distribution capabilities including a year-round marine vessel shipping facility.



The Production Process

The criteria of purity and accuracy of grade are the primary goals of sulfuric acid production. The Contact Process, described here, is almost universally used to convert SO_2 to H_2SO_4

Historically, sulfuric acid production was based on the Lead Chamber Process, involving the oxidation of sulfur dioxide by nitric acid and nitrogen oxides in the presence of water. This has been replaced by the Contact Process in which sulfur dioxide is oxidized by atmospheric air at high temperatures and in the presence of a vanadium pentoxide catalyst.

Specifics will vary from one plant to another, but this description is provided as an overview of a typical Contact Process.

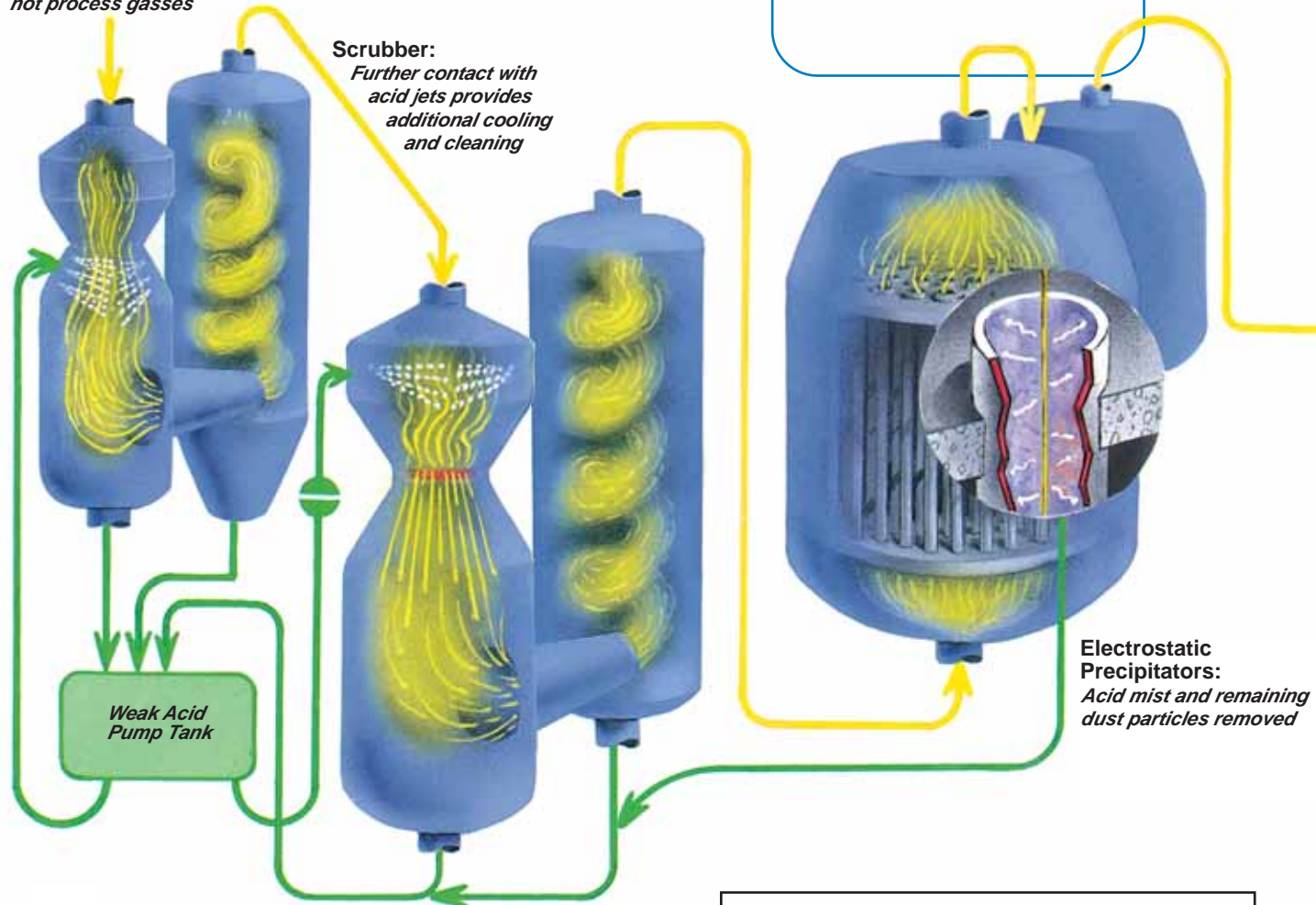
The process begins with cleaning of the gas. The sulfur dioxide from smelting and roasting operations passes through a series of gas cleaning steps that cool and remove almost all metallurgical dusts. The gas is then drawn through electrostatic precipitators where acid mist and any remaining dust particles are removed. The wet gas is dried in a tower by direct contact with 93% sulfuric acid and a blower then forces the gas through a series of heat exchangers and

Quench Tower:

Weak acid jets remove particulate matter from hot process gasses

Scrubber:

Further contact with acid jets provides additional cooling and cleaning

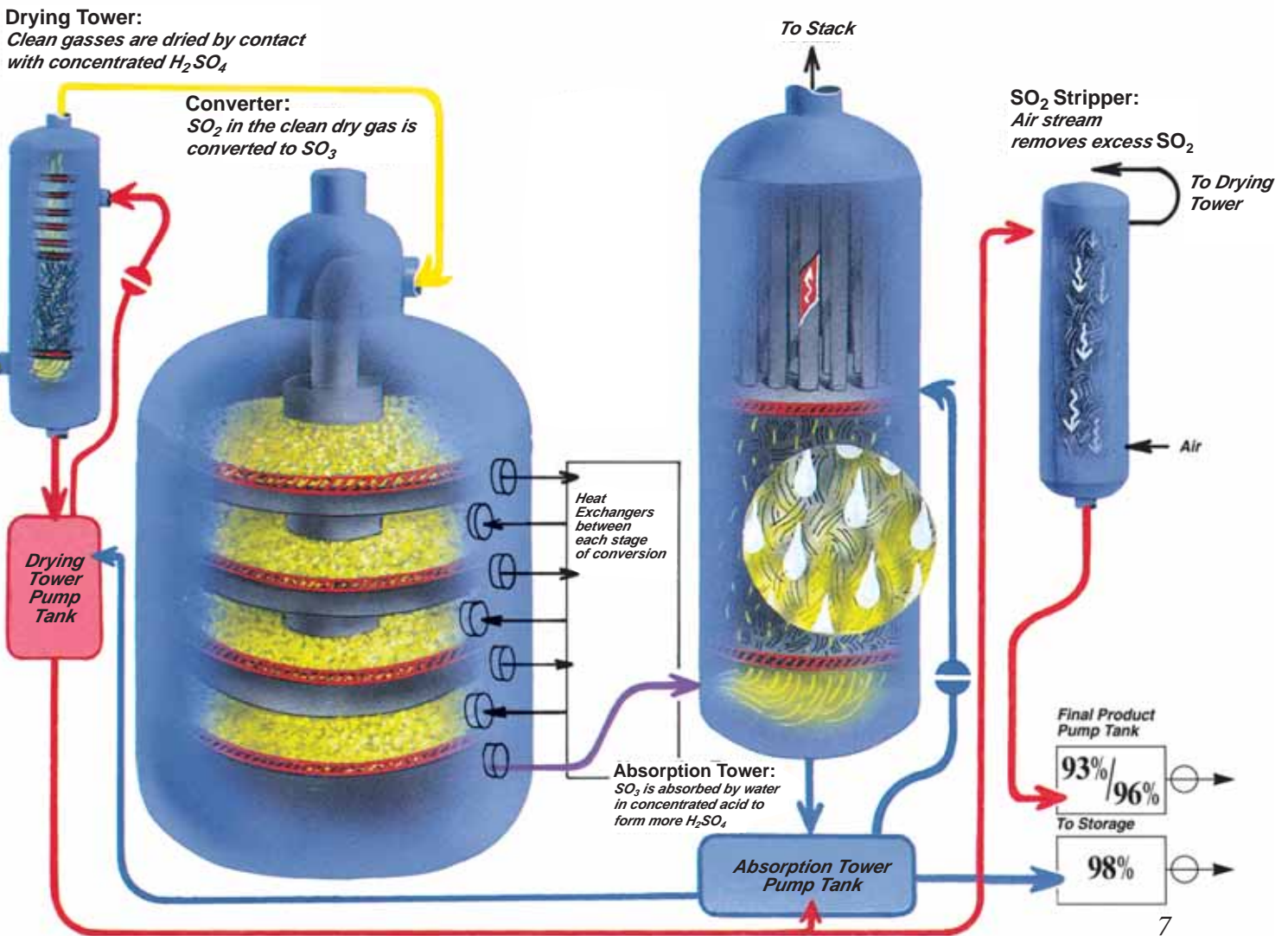


■ Weak Acid Solution	■ 98% Acid Stream
■ 93% Acid Stream	■ SO_3 Gas Stream
■ SO_2 Gas Stream	Acid Pumps

converter beds, where, in the presence of vanadium pentoxide, the sulfur dioxide is oxidized to sulfur trioxide.

The purpose of the heat exchangers is to utilize the heat of reaction in the converter beds to heat the incoming cool gas to the reaction temperature. The SO_3 gas then passes through an absorption tower where it combines with the water in 98% sulfuric acid to make additional sulfuric acid.

Depending on the required product strength, acid from the absorption or drying towers can be stripped of SO_2 , cooled, and pumped to storage. Some acid is exchanged between the absorption and drying circuits to maintain acid strength.



GENERAL PROPERTIES OF SULFURIC ACID

NorFalco markets sulfuric acid from 93% to 99%.

The non-fuming form of sulfuric acid is clear, odorless, slightly oily, with a specific gravity almost double that of water. Handlers of sulfuric acid should be aware of the reactive nature of sulfuric acid including the following:

- Very small quantities of organic materials will decompose into carbon in the presence of sulfuric acid and may cause discoloration.
- Sulfuric acid attacks most common metals. However, for most applications at ambient temperatures, carbon steel is generally satisfactory for storage tanks, tank cars, lines and other equipment in contact with acid at strengths at or above 93%. Agitation, higher temperatures or lower acid strengths will increase corrosion.
- Stainless steel and several non-metallic coatings are becoming more widely used, especially where severe conditions are encountered and/or where product integrity is critical.
- Hydrogen gas will form as a result of the corrosion of most metals, and must be a consideration when designing or working on any handling system to avoid the possibility of an explosive mixture being formed.
- Sulfuric acid has a strong affinity for water and will react violently and generate heat when coming into contact with water or a different concentration of sulfuric acid.
- Sulfuric acid reacts vigorously with alkaline solutions; metal powders; carbides; chlorates; fulminates; nitrates; picrates; strong oxidizing, reducing or combustible organic materials, with evolution of heat. Mists containing sulfuric acid can be carcinogenic. See MSDS for details.
- Hazardous gases are evolved on contact with chemicals such as cyanides, sulfides and carbides. At high temperatures and concentrations, penetrating SO₃ fumes may be released.

For further information on hazards and safety requirements, see the NorFalco MSDS.

Graphs, Tables and Data

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- 9** Viscosity by Temperature: Sulfuric Acid at Various Concentrations
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2 Densities of Sulfuric Acid

DENSITIES OF SULFURIC ACID(H ₂ SO ₄) (Kg/liter)									
%	0 C	10 C	15 C	20 C	25 C	30 C	40 C	50 C	60 C
90	1.8361	1.8252	1.8198	1.8144	1.8091	1.8038	1.7933	1.7829	1.7729
91	1.8410	1.8302	1.8248	1.8195	1.8142	1.8090	1.7986	1.7883	1.7783
92	1.8453	1.8346	1.8293	1.8240	1.8188	1.8136	1.8033	1.7932	1.7832
93	1.8490	1.8384	1.8331	1.8279	1.8227	1.8176	1.8074	1.7974	1.7876
94	1.8520	1.8415	1.8363	1.8312	1.8260	1.8210	1.8109	1.8011	1.7914
95	1.8544	1.8439	1.8388	1.8337	1.8286	1.8236	1.8137	1.8040	1.7944
96	1.8560	1.8457	1.8406	1.8355	1.8305	1.8255	1.8157	1.8060	1.7965
97	1.8569	1.8466	1.8414	1.8364	1.8314	1.8264	1.8166	1.8071	1.7977
98	1.8567	1.8463	1.8411	1.8361	1.8310	1.8261	1.8163	1.8068	1.7976
99	1.8551	1.8445	1.8393	1.8342	1.8292	1.8242	1.8145	1.8050	1.7958
100	1.8517	1.8409	1.8357	1.8305	1.8255	1.8205	1.8107	1.8013	1.7922

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Table 2-201 Densities of Aqueous Inorganic Solutions on page 2-107 and 2-108

3 Specific Gravities/ Weights/ Freezing Points: Sulfuric Acid

* Values determined at a temperature of 60 degrees F / 15.6 degrees C
* For corrections to these values for other temperatures, see table 4

Percent sulfuric acid H ₂ SO ₄	Degrees Baumé	Specific gravity 60°/60°F	Weight of 1 US gal in lbs. av	Weight of 1 l in Kg	Freezing (melting) point °F	Freezing (melting) point °C	Percent sulfuric acid H ₂ SO ₄	Degrees Baumé	Specific gravity 60°/60°F	Weight of 1 US gal in lbs. av	Weight of 1 l in Kg	Freezing (melting) point °F	Freezing (melting) point °C
0.00	0.00	1.0000	8.3373	0.9990	32.00	0.00	49.47	41.00	1.3942	11.623	1.3927	-33.00	-36.11
1.02	1.00	1.0069	8.395	1.0059	31.30	-0.39	50.87	42.00	1.4078	11.737	1.4064	-28.60	-33.67
2.08	2.00	1.0140	8.454	1.0130	30.50	-0.83	52.26	43.00	1.4216	11.852	1.4202	-25.50	-31.94
3.13	3.00	1.0211	8.513	1.0201	29.70	-1.28	53.66	44.00	1.4356	11.969	1.4342	-22.80	-30.44
4.21	4.00	1.0284	8.574	1.0274	28.90	-1.72	55.07	45.00	1.4500	12.089	1.4486	-20.90	-29.39
5.28	5.00	1.0357	8.635	1.0347	28.00	-2.22	56.48	46.00	1.4646	12.210	1.4631	-19.30	-28.50
6.37	6.00	1.0432	8.697	1.0421	27.00	-2.78	57.90	47.00	1.4796	12.335	1.4781	-19.10	-28.39
7.45	7.00	1.0507	8.760	1.0497	25.80	-3.44	59.32	48.00	1.4948	12.462	1.4933	-19.80	-28.78
8.55	8.00	1.0584	8.824	1.0573	24.60	-4.11	60.75	49.00	1.5104	12.592	1.5089	-22.00	-30.00
9.66	9.00	1.0662	8.889	1.0651	23.50	-4.72	62.18	50.00	1.5263	12.725	1.5248	-25.40	-31.89
10.77	10.00	1.0741	8.955	1.0730	22.30	-5.39	63.66	51.00	1.5426	12.861	1.5411	-29.60	-34.22
11.89	11.00	1.0821	9.021	1.0810	21.00	-6.11	65.13	52.00	1.5591	12.998	1.5575	-34.20	-36.78
13.01	12.00	1.0902	9.089	1.0891	19.40	-7.00	66.63	53.00	1.5761	13.140	1.5745	-36.00	-37.78
14.13	13.00	1.0985	9.158	1.0974	17.70	-7.94	68.13	54.00	1.5934	13.284	1.5918	-39.50	-39.72
15.25	14.00	1.1069	9.228	1.1058	16.30	-8.72	69.65	55.00	1.6111	13.432	1.6095	-45.00	-42.78
16.38	15.00	1.1154	9.299	1.1143	14.00	-10.00	71.17	56.00	1.6292	13.583	1.6276	-40.80	-40.44
17.53	16.00	1.1240	9.371	1.1229	12.00	-11.11	72.75	57.00	1.6477	13.737	1.6461	-39.40	-39.67
18.71	17.00	1.1328	9.444	1.1316	9.90	-12.28	74.36	58.00	1.6667	13.895	1.6650	-28.40	-33.56
19.89	18.00	1.1417	9.518	1.1405	7.50	-13.61	75.99	59.00	1.6860	14.056	1.6843	-9.00	-22.78
21.07	19.00	1.1508	9.594	1.1496	4.40	-15.33	77.67	60.00	1.7059	14.222	1.7042	11.50	-11.39
22.25	20.00	1.1600	9.671	1.1588	1.00	-17.22	79.43	61.00	1.7262	14.391	1.7244	29.30	-1.50
23.43	21.00	1.1694	9.750	1.1683	-2.50	-19.17	81.30	62.00	1.7470	14.565	1.7453	39.50	4.17
24.61	22.00	1.1789	9.828	1.1777	-6.50	-21.39	83.34	63.00	1.7683	14.742	1.7665	45.60	7.56
25.81	23.00	1.1885	9.909	1.1874	-11.10	-23.94	85.66	64.00	1.7901	14.924	1.7883	44.80	7.11
27.03	24.00	1.1983	9.9902	1.1971	-16.00	-26.67	86.33	64.25	1.7957	14.971	1.7939	42.90	6.06
28.28	25.00	1.2083	10.074	1.2071	-21.90	-29.94	87.04	64.50	1.8012	15.017	1.7994	40.00	4.44
29.53	26.00	1.2185	10.159	1.2173	-28.00	-33.33	87.81	64.75	1.8068	15.063	1.8049	36.00	2.22
30.79	27.00	1.2289	10.246	1.2277	-35.60	-37.56	88.65	65.00	1.8125	15.111	1.8107	31.20	-0.44
32.05	28.00	1.2393	10.332	1.2380	-44.30	-42.39	89.55	65.25	1.8182	15.158	1.8163	24.50	-4.17
33.33	29.00	1.2500	10.421	1.2487	-55.30	-48.50	90.60	65.50	1.8239	15.206	1.8221	15.00	-9.44
34.63	30.00	1.2609	10.512	1.2596	-69.50	-56.39	91.80	65.75	1.8297	15.254	1.8278	2.50	-16.39
35.93	31.00	1.2719	10.604	1.2706	-78.70	-61.50	93.19	66.00	1.8354	15.302	1.8336	-21.00	-29.44
37.26	32.00	1.2832	10.698	1.2819	-75.20	-59.56	93.77		1.8373	15.318	1.8355	-30.80	-34.89
38.58	33.00	1.2946	10.793	1.2933	-72.00	-57.78	94.00		1.8381	15.324	1.8362	-28.00	-33.33
39.92	34.00	1.3063	10.891	1.3050	-69.30	-56.28	95.00		1.8407	15.346	1.8389	-8.00	-22.22
41.27	35.00	1.3182	10.990	1.3169	-66.50	-54.72	96.00		1.8427	15.3630	1.8409	7.00	-13.89
42.63	36.00	1.3303	11.091	1.3290	-44.50	-42.50	97.00		1.8437	15.3710	1.8419	19.50	-6.94
43.99	37.00	1.3426	11.193	1.3412	-57.00	-49.44	98.00		1.8437	15.371	1.8419	30.00	-1.11
45.35	38.00	1.3551	11.297	1.3537	-50.60	-45.89	99.00		1.8424	15.360	1.8405	41.00	5.00
46.72	39.00	1.3679	11.404	1.3665	-44.00	-42.22	100.00		1.8391	15.333	1.8373	51.70	10.94
48.10	40.00	1.3810	11.513	1.3796	-38.20	-39.00							

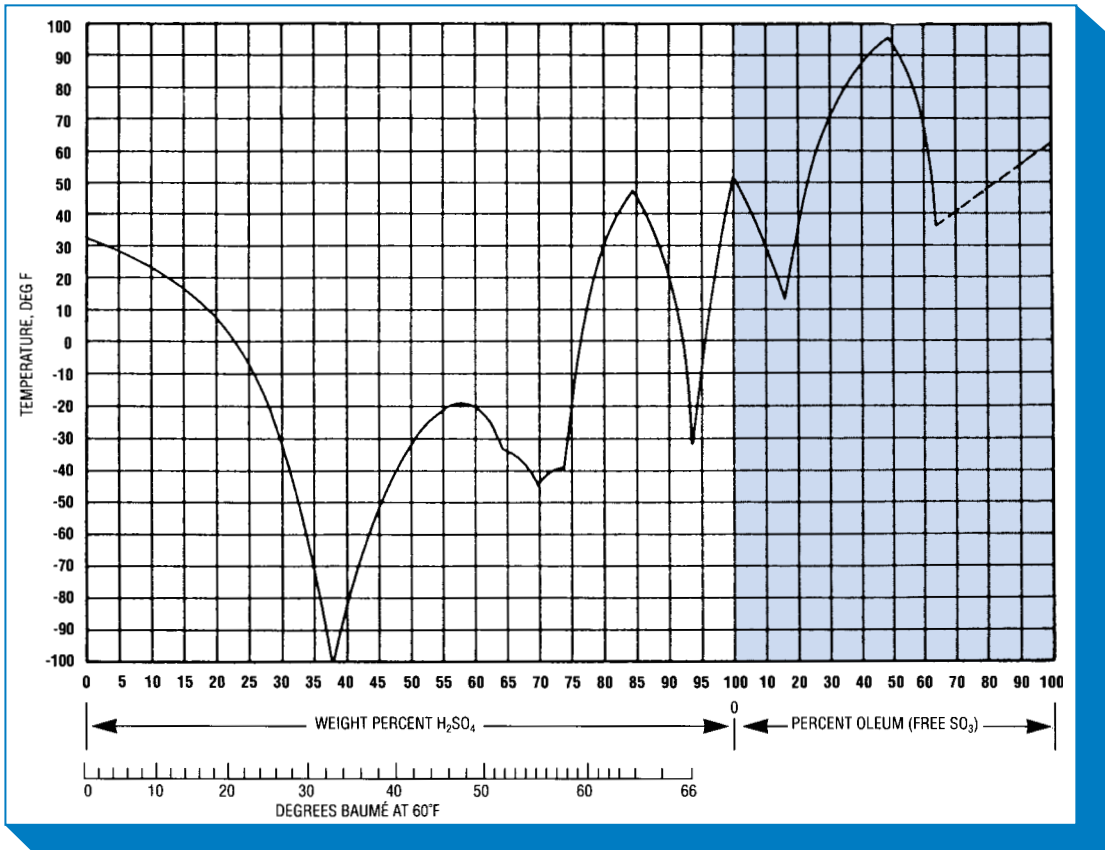
* To calculate weight in pounds per Imperial gallon, multiply specific gravity (above) by 10.

4 Temperature Corrections to Specific Gravity and Degrees Baumé: Sulfuric Acid

Acid strength as measured			Correction (per deg C)		Correction (per deg F)	
%	° Baumé	S.G.	S.G.	° Baumé	S.G.	° Baumé
10.77	10	1.0741	0.00041	0.0520	0.00023	0.0290
22.25	20	1.1600	0.00061	0.0650	0.00034	0.0360
34.63	30	1.2609	0.00070	0.0630	0.00039	0.0350
48.10	40	1.3810	0.00074	0.0560	0.00041	0.0310
62.18	50	1.5263	0.00081	0.0540	0.00045	0.0280
77.67	60	1.7059	0.00095	0.0470	0.00053	0.0260
83.34	63	1.7683	0.00103	0.0470	0.00057	0.0260
93.19	66	1.8354	0.00097	0.0420	0.00054	0.0235
94.00		1.8381	0.00097		0.00054	
96.00		1.8427	0.00095		0.00053	
98.00		1.8437	0.00094		0.00052	
100.00		1.8391	0.00094		0.00052	

To determine actual Specific Gravity or Degrees Baumé at temperatures other than 60.0 degrees F / 15.6 degrees C:
a) subtract correction factor for each degree above 60 degrees F / 15.6 degrees C, or
b) add correction factor for each degree below 60 degrees F / 15.6 degrees C
Note: Titration should be used for measurement of strength over 93% / 66 degrees Baumé

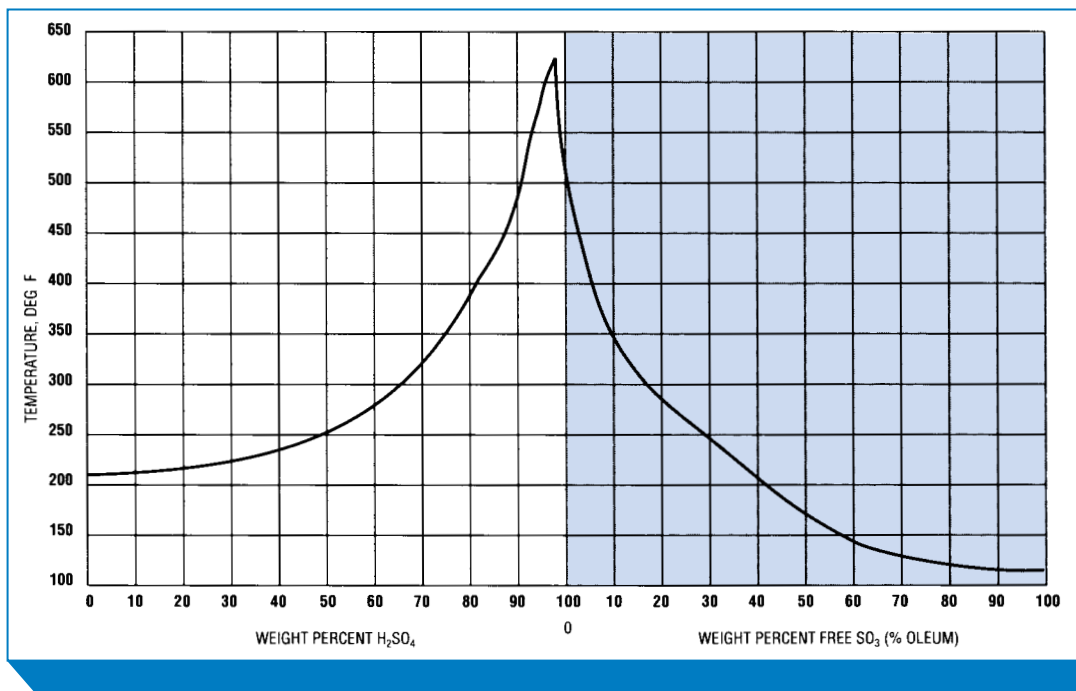
5 Freezing Points: Sulfuric Acid and Oleum



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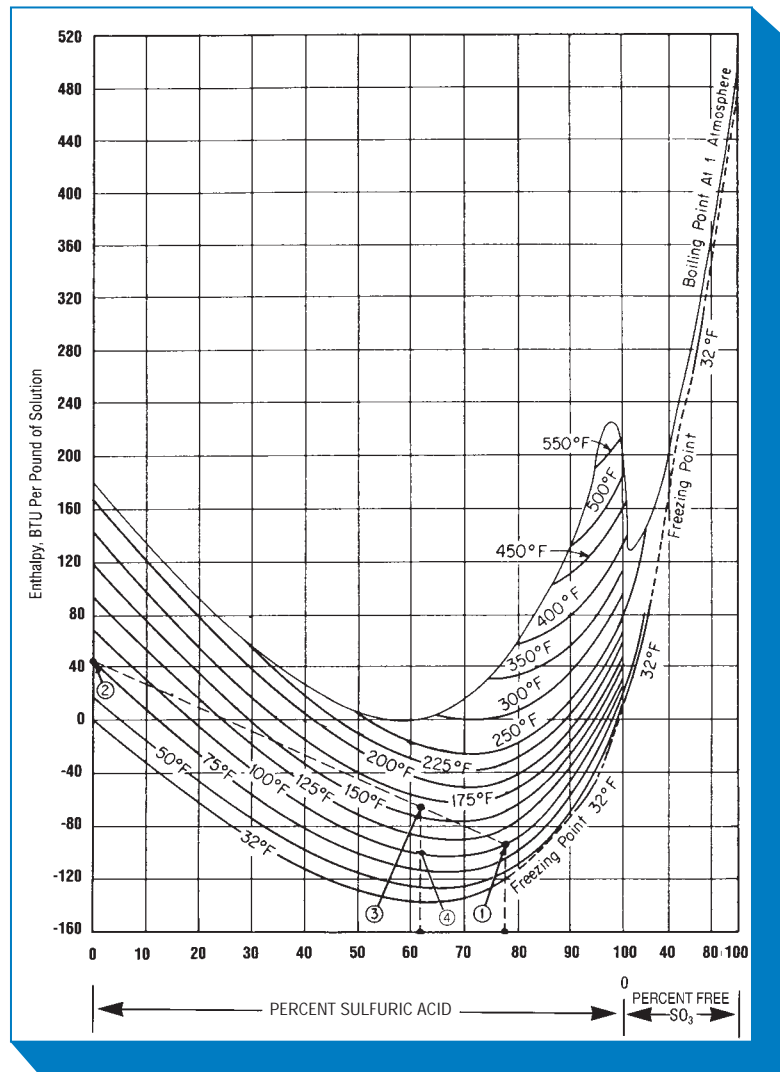
6 Boiling Points: Sulfuric Acid and Oleum

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7 Enthalpy: Sulfuric Acid and Oleum

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TO USE GRAPH:

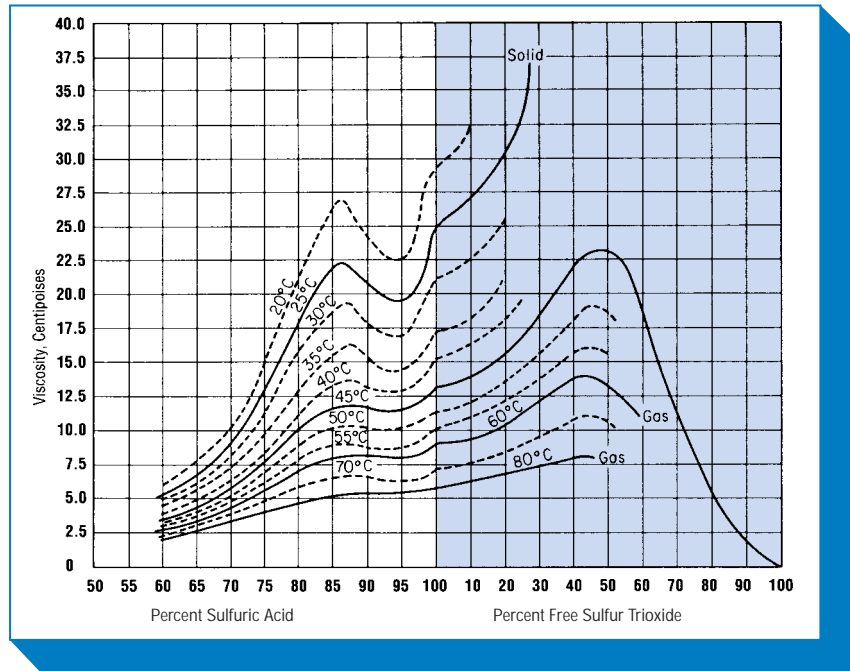
EXAMPLE: 78% acid at 100°F is diluted to 62% by addition of water at 75°F.

- To determine resultant temperature of 62% acid:
Connect points where 78% crosses 100°F temperature line ① and where 0% (water) crosses 75°F temperature line ②. Resultant temperature is indicated by the temperature line intersecting where the connecting line crosses 62% ③ (approx. 165°F).
- To determine heat dissipation required to bring resultant temperature back to 100°F:
Measure difference on y-axis between resultant temperature point ③ and where 62% crosses 100°F temperature line ④ (approx. 35 BTU/lb).

Note: 1 BTU/lb = 2.3244 kilojoules/kg

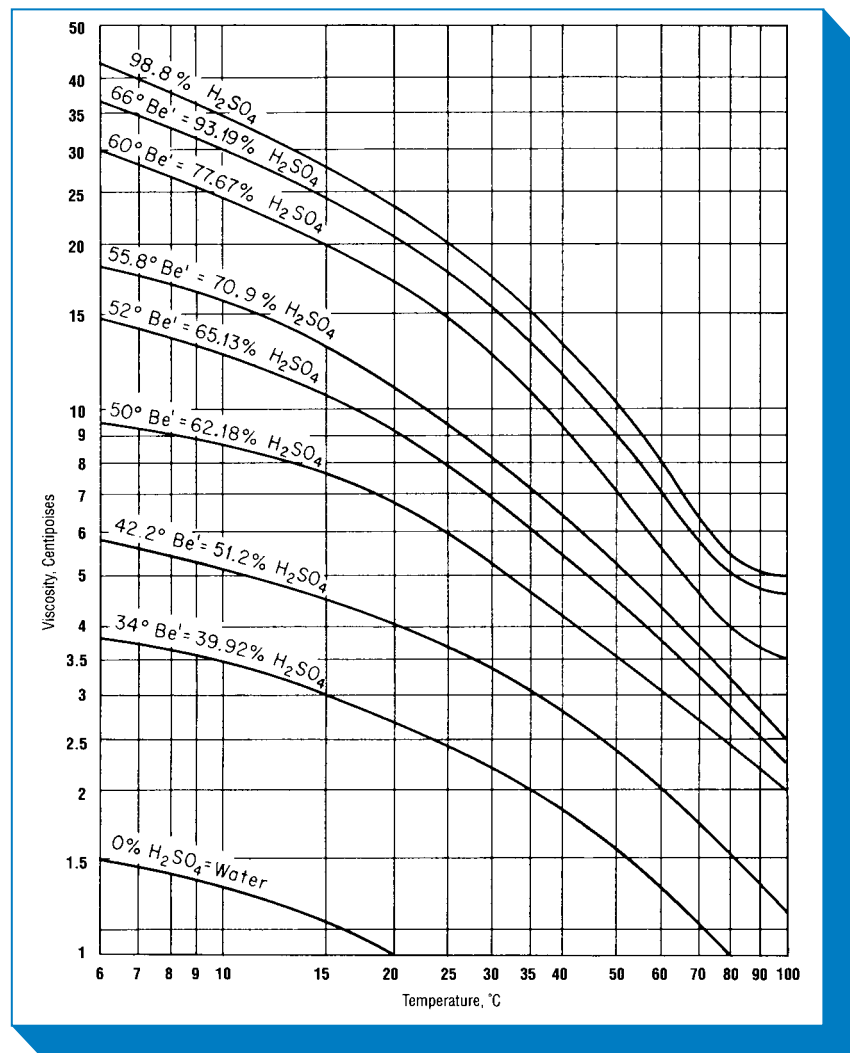
8 Viscosity by Concentration: Sulfuric Acid and Oleum at Various Temperatures

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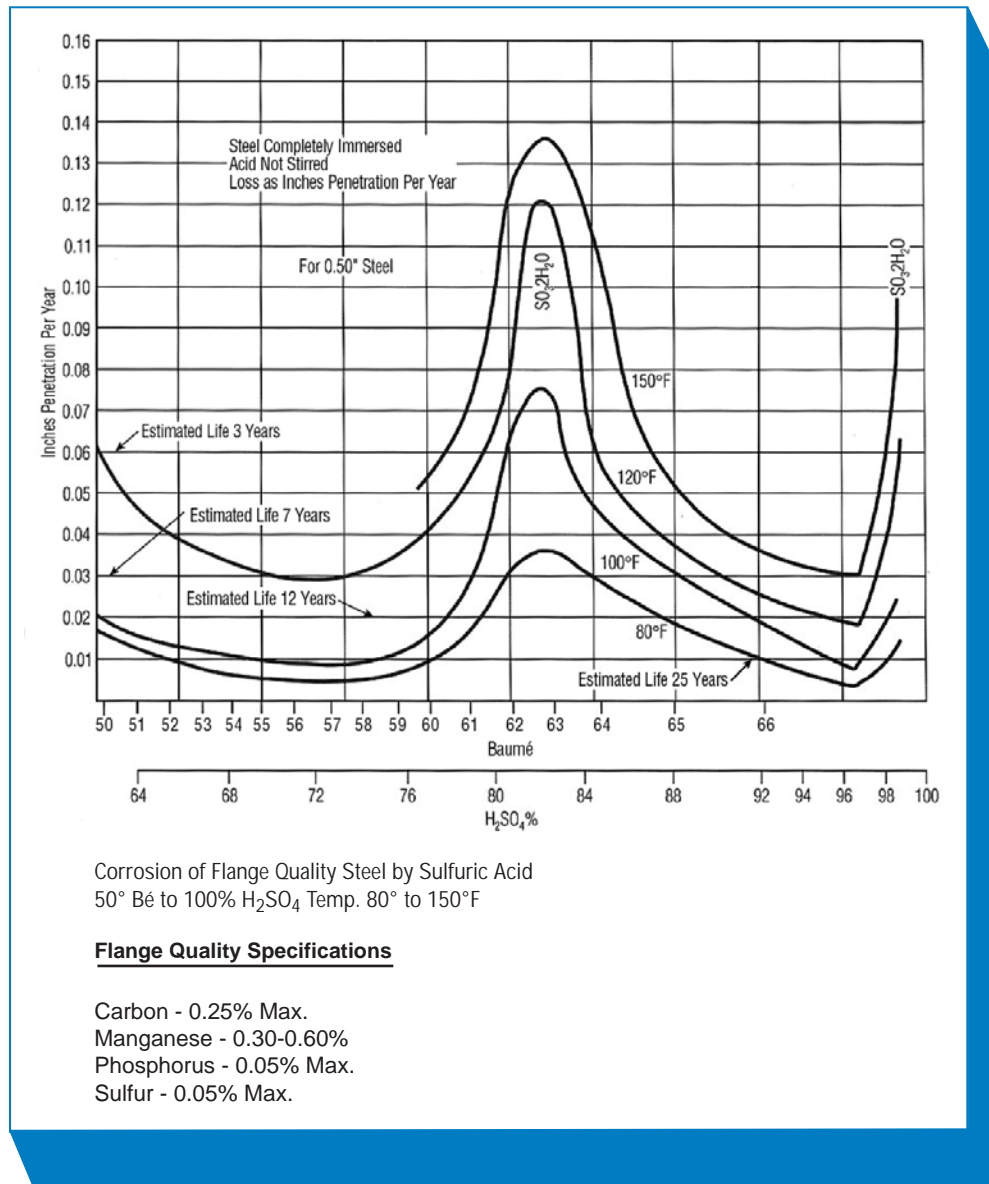


9 Viscosity by Temperature: Sulfuric Acid at Various Concentrations

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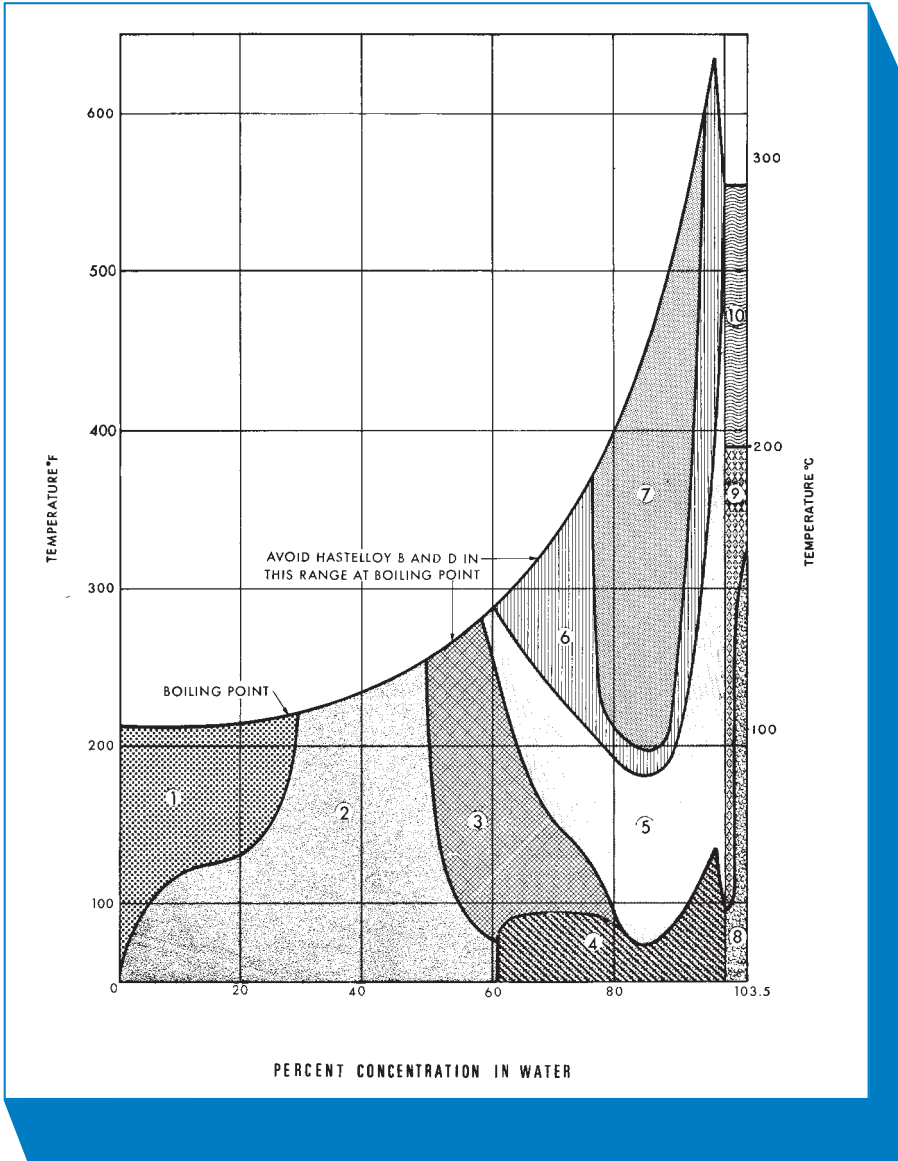
10 Corrosion Rates of Carbon Steel in Sulfuric Acid by Concentration and Temperature



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from Crane-Resistoflex



Metals and Alloys with Corrosion Rate <20 mpy in Sulfuric Acid Depending on Temperature and Concentration



- 1. No air
- 2. < 10% aerated
- 3. < 75C
- 4. < 20% at 25C
- 5. < 25% aerated at 25C
- 6. < 96% concentration
- 7. >80% concentration
- 8. < 80% aerated
- 9. < 75C, < 96%
- 10. 20 to 50 mpy

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Code for Sulfuric Acid Graph							
Materials in shaded zones have reported corrosion rate <20mpy							
Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
20Cr 30Ni	20Cr 30Ni ³	20Cr 30Ni ³	20Cr 30Ni	20Cr 30Ni ³	62Ni 28Mo ¹⁰	Gold	20Cr 30Ni
66Ni 32Cu ¹	66Ni 32Cu ¹	66Ni 32Cu ¹	62Ni 28Mo	62Ni 28Mo	Gold	Platinum	18Cr 8Ni
62Ni 28Mo	62Ni 28Mo	62Ni 28Mo	Type 316 ⁷	Gold	Platinum	Silicon iron	54Ni 15Cr
Type 316 ²	Type 316 ⁵	Gold	Gold	Lead ⁹	Silicon iron	Tantalum	16Mo
Al bronze10% ¹	Al bronze10% ¹	Lead	Lead ⁶	Platinum	Tantalum		Gold
Copper ¹	Copper ¹	Molybdenum	Nickel cast	Silicon iron			Platinum
Gold	Gold	Platinum	iron	Tantalum			Steel
Lead	Lead	Silicon iron	Platinum				
Molybdenum	Molybdenum	Tantalum	Silicon iron				
Nickel cast	Nickel cast	Zirconium	Steel				
iron	iron ⁴		Tantalum				
Platinum	Platinum		Zirconium ⁸				
Silver	Silicon cast					Zone 9	Zone 10
Tantalum	iron					20Cr 30Ni	Gold
Zirconium	Silver					18Cr 8Ni	Platinum
	Tantalum					Gold	
	Zirconium					Platinum	

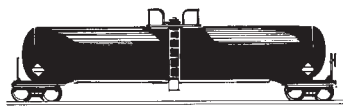
12

Sulfuric Acid Equipment - Industry References

SULFURIC ACID EQUIPMENT - INDUSTRY REFERENCES
The following are important industry references related to materials of construction, fabrication, inspection and maintenance of sulfuric acid storage equipment. This is not intended to be a complete list. Normally, the latest edition should be obtained. Appropriate engineering judgement should be exercised in the use of these or other references.
NACE International Standard Recommended Practice, NACE Standard RP0294, "Design, Fabrication and Inspection of Tanks for the Storage of Concentrated Sulphuric Acid and Oleum at Ambient Temperatures"
NACE International Standard Recommended Practice, NACE Standard RP0391, "Materials for the Handling and Storage of Concentrated (90 to100%) Sulfuric Acid at Ambient Temperatures"
American Petroleum Institute Standard (API), API-650, "Welded Steel Tanks for Oil Storage"
American Petroleum Institute Standard (API), API-653, "Tank Inspection, Repair, Alteration, And Reconstruction"
American Petroleum Institute (API) Piping Inspection Code, API-570, "Inspection, Repair, Alteration, and Rerating of In-Service Piping Systems"
Materials Technology Institute of the Chemical Process Industries, Inc. [MTI] Publication MS-1, "Materials Selector for Hazardous Chemicals. Vol 1: Concentrated Sulphuric Acid and Oleum" 1997, C. P. Dillon, including Addendum - "Carbon Steel Sulphuric Acid Storage Tank - Inspection Guidelines"
ASME B31.3, "Chemical Plant and Petroleum Refinery Piping"
ASME Boiler and Pressure Vessel Code, Section VIII, Div I.
Handbook of Sulphuric Acid Manufacturing, Douglas K. Louie, P. Eng.



1830
8



Transportation

The sulfuric acid marketed and distributed by NorFalco is transported either by tank truck, railway tank car or ship. Sulfuric acid should only be handled by personnel that have been properly trained in the specific safety requirements and procedures required to do their work. Appropriate individual company procedures and applicable government requirements, including Transport Canada or U.S. Department of Transportation hazardous materials regulations, must be followed during all phases of the handling and transportation of sulfuric acid. The same holds true for empty sulfuric acid tank cars or tank trucks being returned to NorFalco since they often contain significant amounts of residue.

TANK TRUCKS

Truck tanks are normally constructed of stainless steel and designed to hold 25 to 40 short tons of sulfuric acid. Insulated tank trucks may be required depending on the strength of the product.

Truck tanks are loaded through an open fill hole on top. Truck tanks can be unloaded from the top if equipped with eduction pipes (“down pipes” or “siphon pipes”), or from the bottom, using 30 psi max air pressure. Some trucks are equipped with a portable air compressor and air hose for self unloading. Trucks can also be unloaded using gravity feed and pumps. Generally, top and bottom fittings are constructed of stainless steel and consist of:

- ① Hinged fill hole cover
- ② 42 psi rupture disc and housing
- ③ Spring vent and 1" air inlet valve complete with cap or plug
- ④ 2" acid outlet or eduction pipe with valve and cap
- ⑤ 3" bottom acid outlet with valve and plug (2" on request)
- ⑥ Emergency shutoff valve located at the front of the tank on the driver's side
- ⑦ 4 placard holders to identify the product on both sides and at each end



Top: Document Verification
Middle: Typical Tank Truck Fittings
Bottom: Tank Truck with Emergency Shutoff Valve (inset)



RAILWAY TANKCARS

All the cars in the Norfalco tank car fleet are non-pressure general service tank cars equipped with top unloading fittings, and are used exclusively for transporting sulfuric acid. The cars are specification DOT or TC 111 A 100 W2 as stenciled on each side. Where:

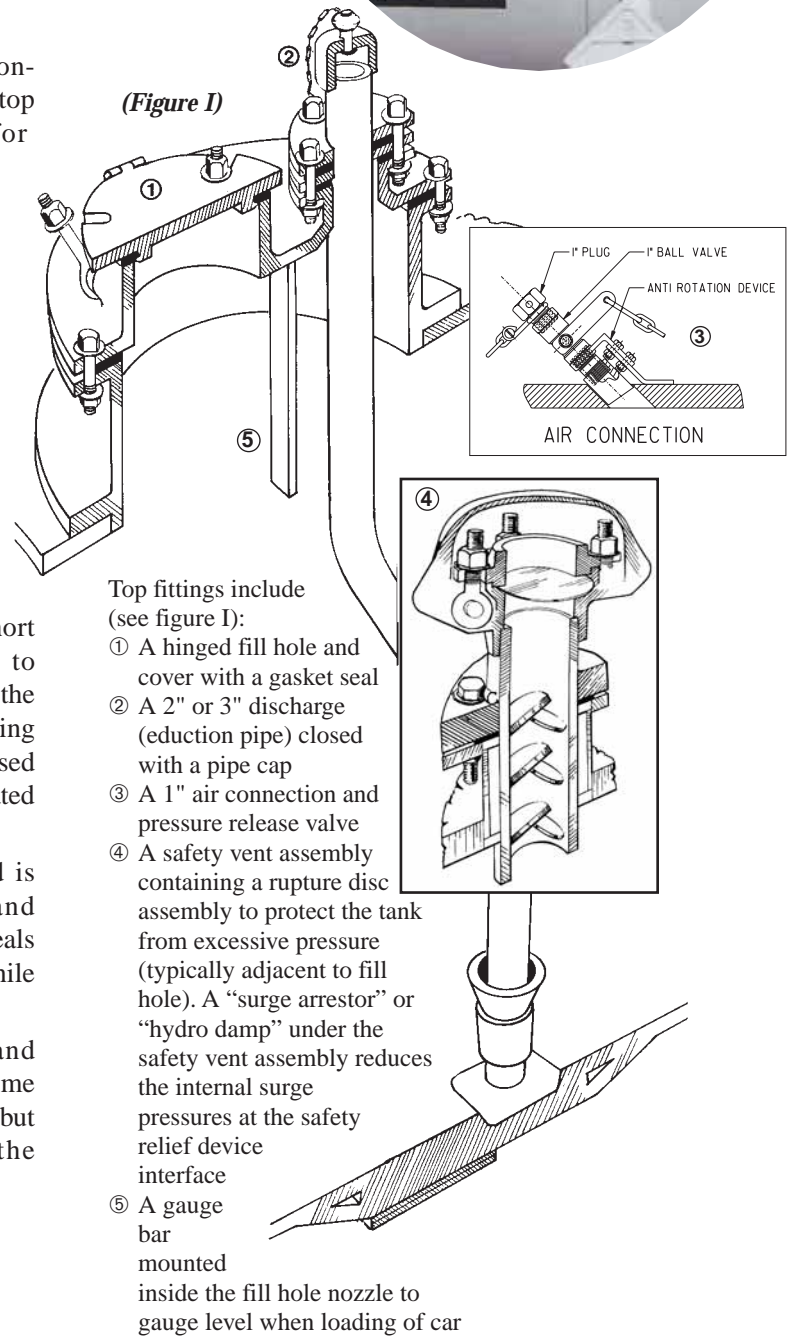
- DOT or TC: Approving authority (Department Of Transportation, US) (Transport Canada)
- 111: General Service or Low Pressure Tank Cars (<165psi)
- A: Separator
- 100: Tank test pressure (note: now tested to 165psi)
- W2: Welded carbon steel, bottom outlet prohibited

Cars used by NorFalco have a capacity of 100 short tons and have a baked phenolic interior coating to maintain product quality and protect the interior of the railcar against corrosion. Tank cars used for shipping 93% acid do not need to be insulated. Tank cars used for shipping 96%, 98%, and 99%, are usually insulated for winter use and may also be steam coiled.

At NorFalco facilities each tank car load of acid is pressure tested with air to check for leaks, and depressurized just prior to shipping. Furthermore, seals are applied to ensure the integrity of the product while being transported to the customer.

Top fittings on tank cars may vary in design and position. In the NorFalco tank car fleet there are some cars with the 'Conventional Acid Cars Top Fittings' but a majority of cars are now equipped with the 'NorFalco Low Profile Top Fittings'.

(Figure I)



TOP FITTINGS ARRANGEMENTS

EDUCATION PIPE: The acid discharge pipe running from the top of the car down inside, to a small sump on the bottom. Sometimes called the “siphon pipe”. The pipe is closed off with a cap, which is attached to the car with a chain. It may be either 2” or 3” in diameter. The NorFalco fleet is currently converting to all 2” diameter to ensure consistency, and soon the entire fleet will be changed to 2”.

AIR INLET/PRESSURE RELEASE VALVE: An air connection to introduce compressed air to pressurize the car for unloading. On Conventional Cars it is situated on the side of the rupture disc assembly while on the NorFalco Low Profile Cars it is installed at a 45° angle on the manway plate. The connection consists of a 1” plug, or a 1” valve with a plug, with the valve handle removed and attached to the car with a chain.

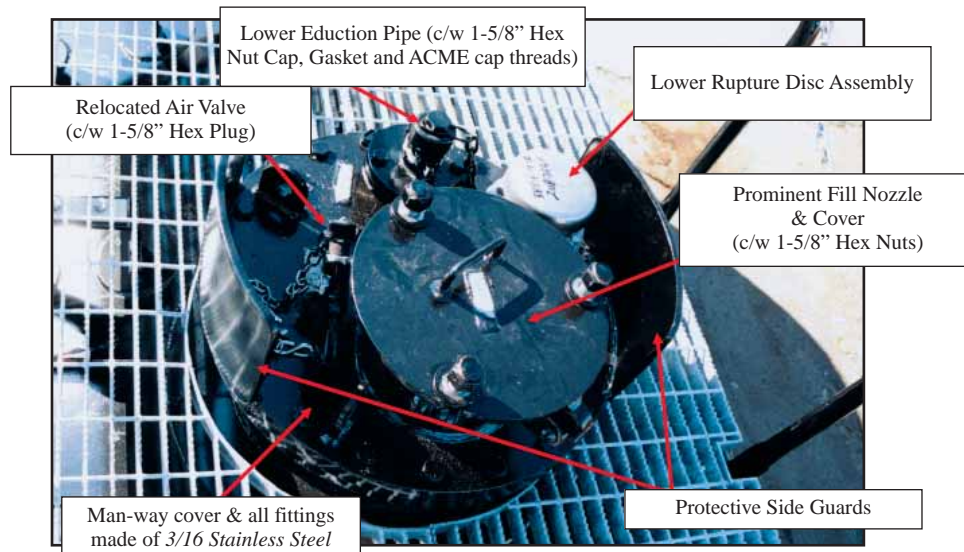
This air connection is also used for depressurizing the car before hooking up hoses for unloading.

BOTTOM WASHOUT: Some tank cars have a blank flange and plug situated on the bottom of the tank car. This fitting is only used when cars are being cleaned at

shops for internal inspection. NorFalco’s fleet is being modified to remove or permanently close these washouts to eliminate any chance of leakage in this area.



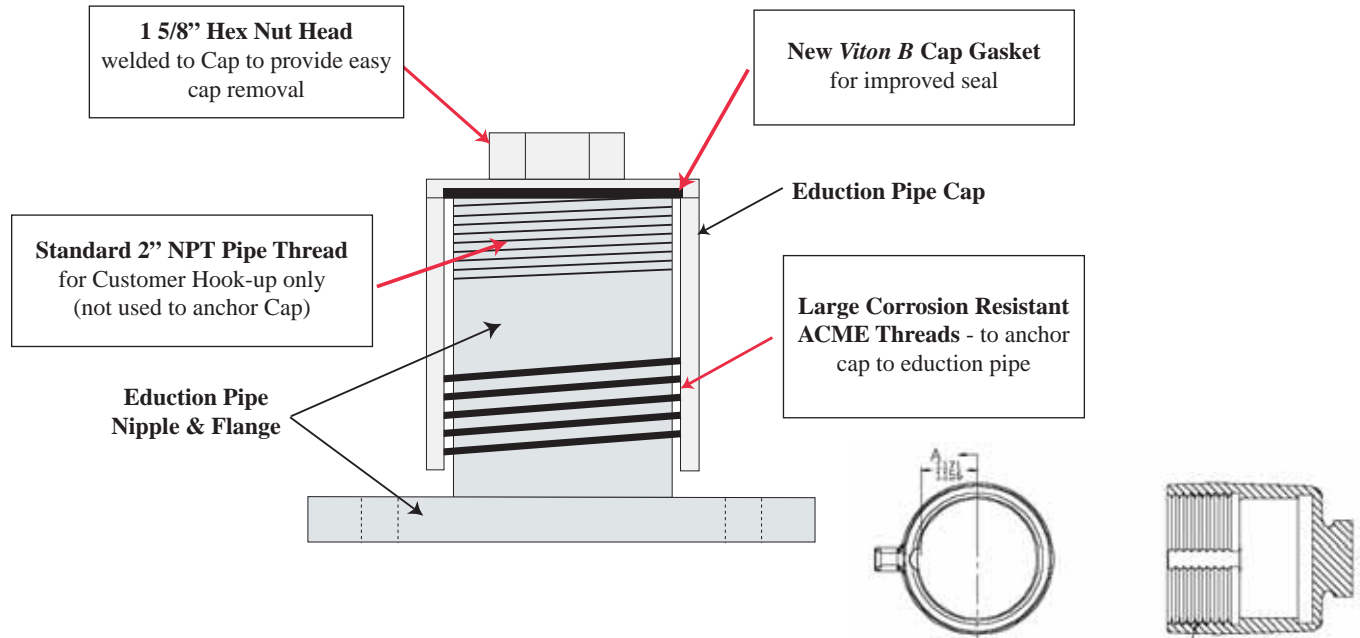
NORFALCO LOW PROFILE FITTINGS TANK CARS



- **Low Profile Fittings and Side Guard Plates:** The top fittings on NorFalco acid cars, such as the rupture disc assembly, air valve and education pipe, are shortened to enable the larger and more prominent fill hole nozzle to provide protection in the event of a derailment rollover. This protection is further enhanced by the addition of two steel side guard plates. Both the fill hole nozzle and side guard plates will absorb forces encountered during rollover, greatly reducing the risk of fittings shearing off and releasing acid to the environment.

- **All Stainless Steel Construction:** The man-way cover and all mounted fittings and nozzles on new NorFalco cars are made of 316 Stainless Steel for improved strength and corrosion protection. This will result in less corrosion, less leakage, reduced maintenance and easier customer hook-up. This design is being applied to all new build tank cars and, where practical, to existing tank cars.

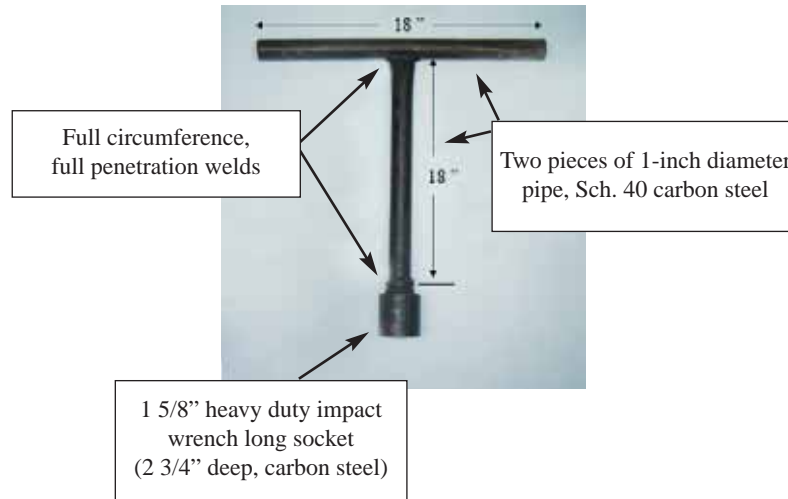
Norfalco Modified Eduction Pipe Cap for Sulfuric Acid Car



- **Eduction Pipe Cap Easier to Remove and Seal:** The eduction pipe cap has been redesigned to enable easier removal and better sealing. The new design uses a separate, coarser set of ACME threads to attach the pipe cap, along with a cap gasket to provide a better in-transit seal. This leaves the finer standard 2" NPT pipe threads untouched by the pipe cap, and will extend the life of these threads for easier hook-up by customer unloaders. To enhance safety the cap is slotted to allow pressure release in a downward direction. This will help warn operators if an attempt is made to remove the cap while there is still pressure in the tank car. The new design also enables much easier removal of the pipe cap, minimizing effort and frustration encountered when trying to loosen caps tightened onto the tapered pipe threads - a common customer complaint. For better operation of this assembly, please note that the coarse threads (ACME) do not need any lubricant, sealant or Teflon tape to ensure the tightness of this assembly. In fact such application will make use and operation of the fitting more difficult.
- **Viton B® Gaskets:** The NorFalco fleet standard for acid tank car gaskets is Viton B®. Though more expensive than other gasket materials, experience has shown this material to be very effective for sulfuric acid tank cars.

- **Center Mount Fittings with Full Platforms:** Top fittings and valves on NorFalco cars are center mounted on or near the main man-way flange and surrounded by a full platform. The central location and full platform provide convenient access for customer operators to safely make all required connections. The central location also helps reduce liquid sloshing impacts on rupture discs and gaskets.
- **Hydro Damps/Surge Protectors:** All NorFalco cars are equipped with surge protectors. Surge protectors are specialized devices mounted inside the tank car just under the rupture disc assembly. Surge protectors baffle the impact of sloshing acid caused by car movement. This baffling effect reduces liquid hammer pressures on the rupture disc, thus preventing premature failure and leaks.
- **Bottom Washout Removed:** To eliminate risk of leakage through the washout flange and plug on the bottom of acid tank cars, we have worked with our suppliers to eliminate the washout assembly on all new NorFalco tank cars. For existing NorFalco cars, the washout cover is being removed and the opening welded shut.
- **One Tool Size:** Fittings and flanges required for offloading can now be disassembled with one tool size. A 1 5/8 inch socket head fits the fill hole cover nuts, the air valve plug, and the newly modified eduction pipe cap on all new and modified cars. A standard ratchet with extension can also be used.

Recommended Tool for *Low Profile Sulfuric Acid Tank Cars*



ENHANCED SECURITY ON SULFURIC ACID TANK CARS



- A single use *fittings* seal to seal the fittings that are used for loading and unloading a tank car. This is a single 1/8" diameter x 80" long cable seal that winds its way through all the four regular-use fittings (air valve plug, fill hole cover, education pipe cap and rupture disc assembly) and must be removed to unload a tank car.

Leaving a cut seal on top of the platform might represent a hazard for the personnel involved in tank car movement and loading. Please ensure that customer unloading personnel remove all severed seal cables before return of the residue tank car.

VESSELS

Vessels equipped to carry sulfuric acid vary in size and versatility up to ships of over 20,000 tons capacity. The equipment required to unload will vary accordingly.



In line with our commitment to Responsible Care[®], NorFalco has embarked on a program of securing and sealing all access points on railcar shipments of sulfuric acid. Our approach to sealing tank cars involves two distinct seal types, both of which meet ISO standards for high security seals:

- Permanent *flange* seals applied to secure flanges and other potential openings that are not involved in loading or offloading of tank cars. These 3/16" thick steel cable seals are not to be removed except when tank cars are in shop receiving maintenance.



Storage and Handling

The properties of sulfuric acid, in large measure, dictate the design, fabrication, and operation of storage facilities, as well as how sulfuric acid is handled. Its corrosive, reactive nature, strong affinity for water and high specific gravity are three major considerations. Before the construction of a storage or handling system, advice must be obtained from a competent engineering department or consultant and codes and regulations must be recognized.



At each point where sulfuric acid is handled, there must be ready access to safety showers and eye wash stations. There must be a minimum of fifteen minutes of warm water at a high enough volume to drench the user, and be equipped with an automatic alarm system designed to summon help from adjacent areas. Safety showers must be supplied with 20 to 30 degree C tempered water to meet OSHA standards (Min. 30 gpm flow), be within a 10 second unobstructed walk (about 50 feet) from the unloading point and be “weatherized” (freeze protected).

STORAGE TANKS

Storage tanks for sulfuric acid in strengths of 93% through 99% are usually fabricated from carbon steel. At normal temperatures there is usually some gradual corrosion on carbon steel that results in the evolution of hydrogen gas and the formation of an iron sulfate

precipitate, most of which settles to the bottom of the tank. Wall thickness should be carefully calculated to provide corrosion allowances and for the high specific gravity of the acid. Smaller storage tanks (under 10,000 gallons) are sometimes constructed from stainless steel or a type of HDPE (High Density Polyethylene) made especially for sulfuric acid service. Such materials reduce or eliminate hydrogen and iron-sulfate generation. Regardless of the material your tank is constructed from, always ensure that it has been designed and manufactured specifically for sulfuric acid.

Many storage tanks use anodic protection systems to minimize corrosion. Storage tank cleaning and inspection procedures are available on request from NorFalco .

HYDROGEN GAS: Hydrogen gas is potentially explosive and special care must be taken when working near tanks or performing maintenance on tanks. A hydrogen meter and spark proof tools and lights should be used, and open flames and welding should be avoided.

CORROSION, INSPECTION AND CLEANING: A program of routine internal inspection should be established to ensure early detection of excessive corrosion. It is necessary to clean out the tanks at regular intervals to allow for inspection. A suggested minimum frequency is every 3 years for tanks containing hot acid and every 5 years for tanks containing cold acid.

FOUNDATION AND SECONDARY CONTAINMENT: It is recommended that storage tanks be enclosed by a secondary containment wall having a capacity no less than 110% of the largest tank volume (local regulations may vary). The containment area should be kept dry and clean. In the event of a leak, the acid should be neutralized and pumped out before it reaches a sewer or watercourse.

HEATING AND INSULATION: Heating and insulation are generally required for 96%, 98%, 99% acid, while 93% acid rarely requires either.

CAPACITY: A good guide for the capacity of the storage tank is 1.5 times the size of the normal delivery or the normal delivery plus two weeks consumption, whichever is greater, although specific production parameters may dictate otherwise.

FILL LINE: Full length dip pipe near the center of the roof with siphon break in dip pipe below roof line. Fill internal dip pipe, type 316 L stainless steel full length to within 24 inches of floor, supported at bottom. Directly underneath, place a carbon wear plate welded to tank.

VENT: Sulfuric acid storage tanks must always have an open vent for normal breathing and to prevent dangerous pressure build-up due to hydrogen. Hydrogen gas may be produced from the action of acid on the steel tank and cause increased pressure and danger of explosion from potential sparks or flames. The vent line should ideally be constructed of acid resistant material such as polyvinyl chloride. If carbon steel is used for a vent line, iron sulfate can build up in

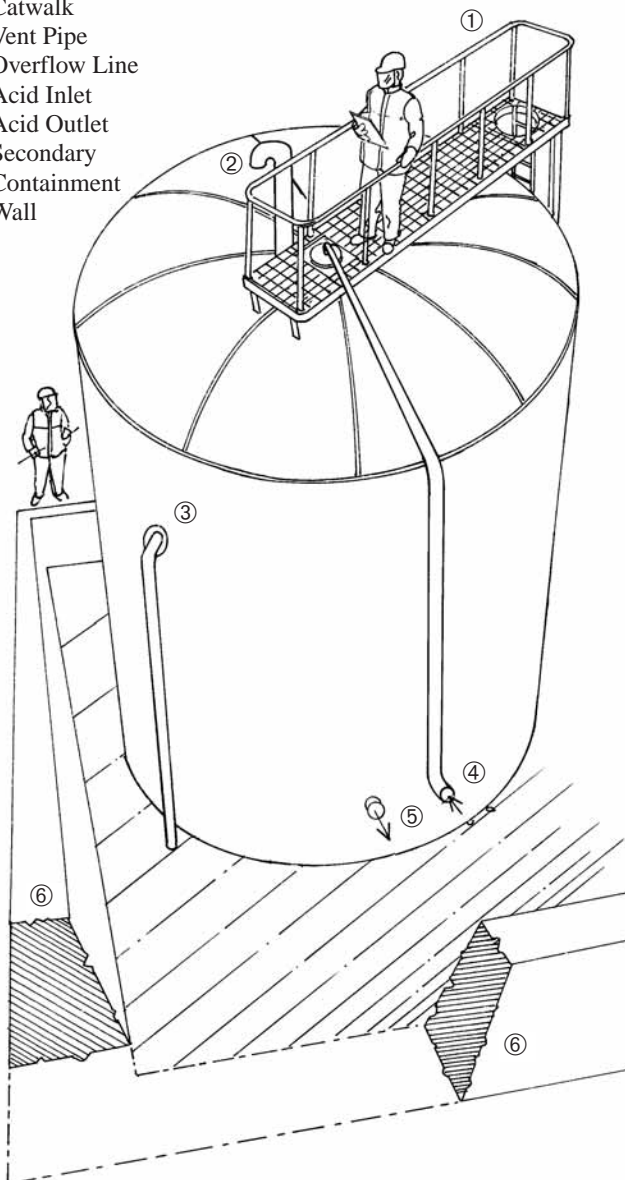
the line over time requiring periodic checks to prevent blockage and possible tank collapse during acid transfer. The vent line should be flush with the inner surface at the highest point of the tank to assure all hydrogen is purged thus minimizing the danger of explosion.

CATWALKS AND OVERHEAD PIPES: Metal catwalks should be provided for working on top of tanks as hidden weak spots may have developed from internal corrosion. One should never walk on the tank skin and should always use the catwalk. If dripping is noticed from a line suspended above, don't look up. Step well away before investigating.

PROXIMITY TO OTHER MATERIALS: Although sulfuric acid is not flammable, it should not be stored near organic materials, nitrates, carbides, chlorates or metal powders. Contact between high concentrations of sulfuric acid and these materials may cause ignition.

PIPING: All lines should be installed so that they drain toward the storage tank, or toward the point of consumption. This will prevent the accumulation of acid in low points, thereby eliminating possible safety hazards when repairs are necessary. The line from the loading point to storage should be equipped with a valve so acid flow may be stopped at any time. The unloading line should also include a drain point that can be checked prior to disconnecting the transfer hose or pipe. Additional information on piping can be obtained by request from NorFalco. NorFalco does not recommend the use of PVC or CPVC for liquid sulfuric acid service, except, possibly, as a liner that has full mechanical support from steel or FRP. This is due to the unpredictable risk of mechanical failure, which can result in acid exposure to personnel, equipment, and/or the environment. Piping at connection points is particularly susceptible to failure.

- ① Catwalk
- ② Vent Pipe
- ③ Overflow Line
- ④ Acid Inlet
- ⑤ Acid Outlet
- ⑥ Secondary Containment Wall



GENERAL HANDLING PRECAUTIONS

Sulfuric acid, like any other corrosive substance, is dangerous if improperly handled. However, if proper handling procedures are followed, large volumes can be handled safely.

The safe handling of sulfuric acid from tank trucks and tank cars by the application of air pressure or by gravity requires careful attention to proper procedures and should be conducted by trained personnel wearing proper protective clothing.

Smoking or other sources of ignition should not be permitted near tank cars or trucks whether full or empty. Tank cars and trucks should be accurately spotted at the unloading line. For safety reasons, it is recommended that at least two persons be present during unloading.

A) Prior to Discharge

The brakes should be set, and the wheels of tank cars or trucks chocked on both sides of the wheel to prevent motion in either direction. Blue warning flags and derailed for tank cars should be placed at least 1.5 car lengths away. Before unloading, contents should be identified and the quantity verified and compared to the available storage capacity. All caution markings on containers should be observed.

Placards must indicate U.N. No.1830 for sulfuric acid, and 1832 for spent acid.

Tank cars and tank trucks when received will frequently be under pressure because of thermal expansion of the acid or slow hydrogen generation. The pressure in the tank car or truck must first be released by carefully and slowly removing the 1" plug from the safety vent or by slowly opening the 1" pressure release valve. Only then can the fill hole cover be opened. However, since sulfates may have blocked the pressure release valve, care should be taken when opening the fill hole cover, since the car may still be pressurized.

It is not recommended to vent through the fill hole.

A hydrogen-enriched atmosphere can develop in the dome of tank cars which have been in transit for long periods, particularly in hot weather. Therefore, it is good practice to vent the gas space with the cover open

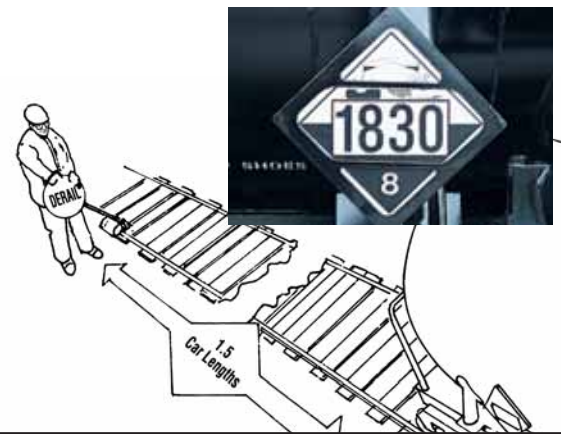
(for 5 minutes) before sampling, to avoid a stray static spark triggering an explosion.

B) Discharge - Top Unloading

After the tank car or truck has been completely depressurized and the fill hole cover opened, the cap on the eduction pipe can be removed. This should be done carefully and slowly since some residual air may be trapped in the pipe.

Under no circumstances should the cap be removed from the eduction pipe before the pressure in the tank car or truck has been released and verified. The acid discharge hose must always be connected before

Product Identification Placard



Air Unloading

The air line should consist of:

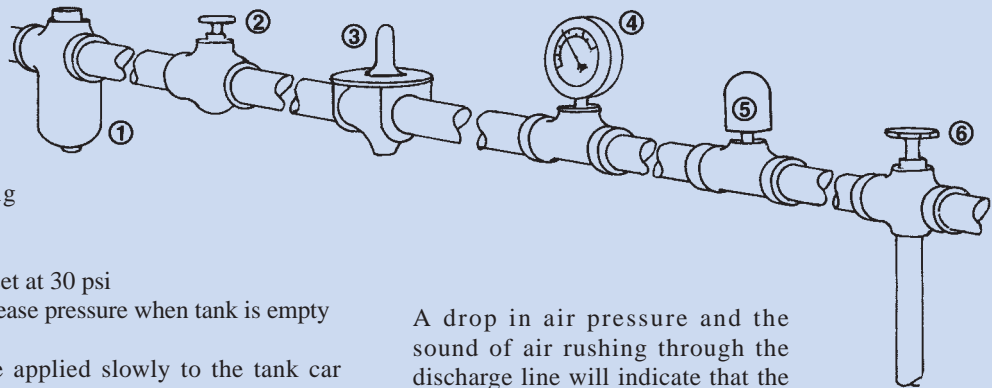
- ① A water/oil separator
- ② A shut-off valve
- ③ A pressure reducing valve set at 25-28 psi
- ④ A pressure gauge
- ⑤ A safety relief valve set at 30 psi
- ⑥ A manual valve to release pressure when tank is empty

Air pressure should be applied slowly to the tank car or truck to establish a flow of acid to the storage tank.

The pressure gauge should be checked to ensure that it does not exceed 30 psi.

The flexible acid line must be supported because of the high specific gravity of sulfuric acid.

If any leaks should develop in the acid lines, the air must be shut off and the air pressure released from the tank before attempting to correct the leaks.



A drop in air pressure and the sound of air rushing through the discharge line will indicate that the tank car or truck is empty.

Sufficient air should be blown through the line to free it of all product.

The air supply should be shut off and the pressure released by opening the release valve.

When the tank is at atmospheric pressure, the air line can be disconnected from the tank.

the air piping is connected to the tank car or truck. Rubber hoses must never be used for acid discharge.

Teflon® lined hoses, with abrasion resistant outer covering are recommended for use with sulfuric acid. Detailed information regarding discharge hose specifications and hose inspection procedures can be obtained on request from NorFalco. Ask for the TechQuip information sheets on this subject.

C) After Discharge

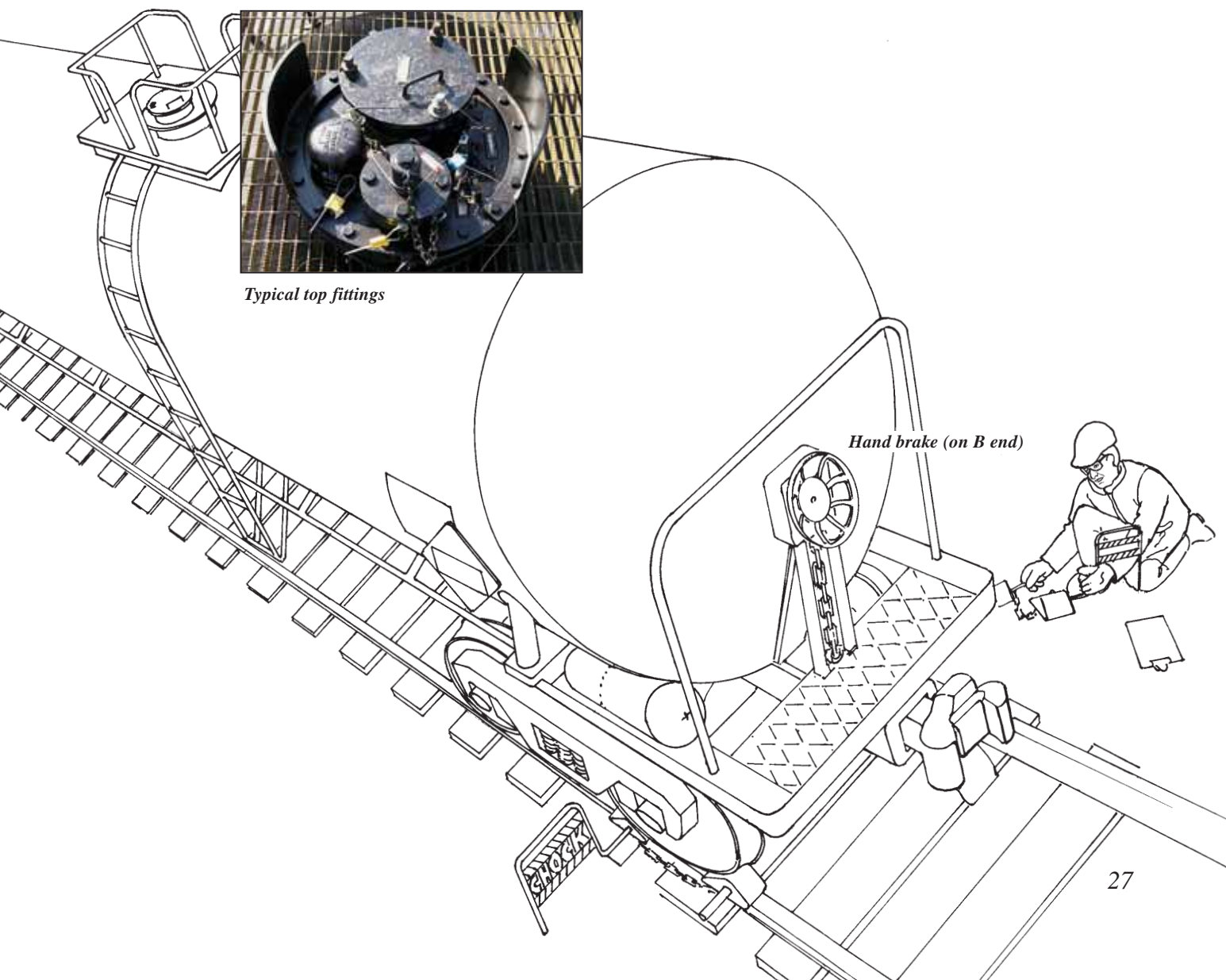
Allow sufficient time for acid to drain from the discharge line. Care should be taken to prevent pools from accumulating in low spots before the discharge line is disconnected. Replace all valves, plugs, and caps and secure the cover.

We recommend use of VITON B gaskets in sulfuric acid service for hoses, tank cars and tank trucks. When using

VITON B gaskets it is important that they meet specific quality standards. A TechQuip sheet on recommended gaskets is available on request from NorFalco.

After discharge, a small amount of residue of the product remains in the tank car/tank truck, therefore 1830 placards will remain displayed for the residue containers returned to NorFalco. If the tank car cannot be completely discharged or if any object has dropped into the tank car, notify NorFalco promptly. Remove wheel chocks, blue flag and derails.

For more comprehensive guidance on the safe unloading of sulfuric acid tank cars and trucks, please refer to the NorFalco Sulfuric Acid Safety Series Video, CD-ROM or DVD, which contains “The Professional Approach to Personal Safety”, “Tank Car Unloading” and “Truck Unloading”.



ACCIDENT PREVENTION



While sulfuric acid's reactive nature makes it a valuable tool in numerous industrial processes, its corrosive nature makes it extremely hazardous when it comes in contact with organic substances, such as the sugars, fats and proteins that make up human tissue.

Prompt emergency measures can help minimize the effects of an accidental burn, but the professional goal is prevention by the consistent adherence to established safe operating procedures.

Dilution:

Acid's reactive and corrosive nature and strong affinity for water create a special hazard when acid is being diluted. Although in daily life it comes naturally to add water to dilute a substance, one should *never add water to sulfuric acid*.

The first drops of water entering the acid will be attacked so ferociously they will boil, spattering undiluted acid out of the vessel.

Instead, when diluting, one should always add the acid to the water, slowly while stirring. The larger volume of water will absorb and dissipate the heat generated by the reaction.

Acid Mist:

Sulfuric acid mist is a human carcinogen and good ventilation must be provided to keep mist concentrations below the exposure limits (currently 0.2 mg/M3 but check MSDS for latest limits). Avoid breathing sulfuric acid mist and wear approved respiratory protection if adequate ventilation cannot be provided.

Hydrogen Gas:

Sulfuric acid, by itself, is not flammable. But, if it comes in contact with metal, such as the steel in storage tanks and lines, hydrogen gas may be produced introducing the danger of explosion. Therefore, strict adherence to no smoking rules and the use of hydrogen detecting meters, spark proof tools and inspection lamps is essential, especially if any activity is planned for the tank which may cause sparking, such as welding, hammering or cutting.

Safety

The Professional Approach

The fundamentals of safety are strongly linked to the development of good work practices by your personnel. The development of a safety program that stresses accident prevention and good work practices must be tailored to a particular operation's needs. At NorFalco, we foster a professional attitude, supporting it with information on the nature of the product, the effective use of personal protective equipment and the promotion of safe work habits. Regular training sessions for new and experienced personnel are supported with ready access to additional information in both print and video form, including the Material Safety Data Sheets.



PERSONAL SAFETY EQUIPMENT

The safe handling of large volumes of sulfuric acid every day is a tribute to the professional attitude of operators and the conscientious use of personal safety equipment. Every operator must be fully trained in the use of personal safety equipment.

Body protection suits come in a variety of forms. The choice is governed by each particular operation.

Prior to suiting up, the suit, and “acid designated” gloves and boots, should be checked for holes. Gloves are checked by immersing them in water.

Gloves should be loose enough to be easily removed in case acid enters them. To help prevent this, sleeves should be worn outside the gloves.

Trouser cuffs should be worn outside the boots to prevent acid from draining into them.

For an acid line break, use of an acid resistant hood is recommended (in place of goggles and face shield).



Hard hats should be worn to protect the scalp.



For eye and face protection, a full face shield with safety goggles must be worn.

Requirement details vary by facility and work being performed. Goggles and a face shield must be worn when working in a “Hot Zone” where splashes can occur unexpectedly.



It is essential that eye protection is provided from all angles because the first reflex if splashed is to turn the head side to side.

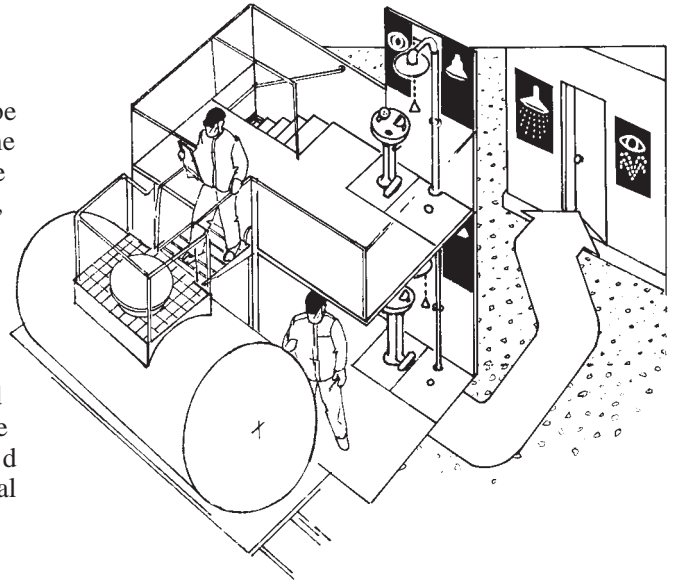


Acid resistant hood

SAFETY SHOWERS AND EYE WASH STATIONS

Safety showers and eye wash stations with alarms must be located within a 10-second unobstructed walk on the same level as the hazard (fifty feet or less is a recommended safe distance) and must be checked daily. For further information, please refer to the most recent ANSI standard.

If the loading or unloading area has two levels, a safety station must be located on each. They must also be located in nearby buildings, so that one is always accessible if a spill makes others unusable. Daily testing ensures correct operation and appropriate water temperature. Water should be lukewarm as an accident victim will have to stay under the shower for at least 15 minutes. The alarm, triggered automatically by the use of the shower or eye wash, is a signal for co-workers to immediately offer assistance.



FIRST AID

A First Aid Manual covering first aid measures specific to sulfuric acid is available on request from NorFalco. Every safety step, properly followed, reduces the chance and effect of even minor accidents, but...

IF SPLASHED, run to the shower, removing clothes while washing and, most importantly, stay in the shower with safety goggles for at least 15 minutes to dilute the corrosive effects of the acid. Cool down small burns with white terry cloth towels, set aside for first aid, dipped in ice water. Co-workers should make sure the victim remains in the shower the full time and, no matter how minor the splash, immediate medical help should be sought. This will help avoid secondary effects that could occur later.



15
min.

IF EYES ARE SPLASHED, immediately flush with water for a minimum of 15 minutes, longer if burning persists, while holding the eyelids open. Co-workers should help to keep victim's eyelids open and get immediate medical help.



15
min.

IF ACID IS INGESTED and the victim is conscious, have him or her **DRINK LOTS OF PLAIN WATER**. Do not use antacids. Then immediately take the person to the hospital. **DO NOT** induce vomiting because it would cause a second round of burning. If the victim is unconscious, get immediate medical attention.



IF ACID MIST IS INHALED and causes irritation, remove the victim to fresh air. If he or she is not breathing, administer artificial respiration. Oxygen may be required, but in either case, get medical help immediately.



SPILLS:

In the event of a spill involving NorFalco produced sulfuric acid, please immediately call the appropriate NorFalco 24-hour emergency response telephone numbers as found on the bill of lading. The Emergency Response number for the United States is CHEMTREC 1-800-424-9300. The Emergency Response number for Canada is 1-877-377-2243. NorFalco has one of North America's largest acid Emergency Response networks in place with trained advisors and 5 in-house emergency response teams plus a network of contractors across North America.

In the event of a small spill, one should contain and neutralize the acid with soda ash, or lime. Then from a safe distance, an experienced operator can dilute it using large quantities of water. Since the area will become slippery, care should be taken.

Larger spills should be contained and appropriate action taken. Clean up and disposal should be carried out by experienced personnel or a qualified contractor.

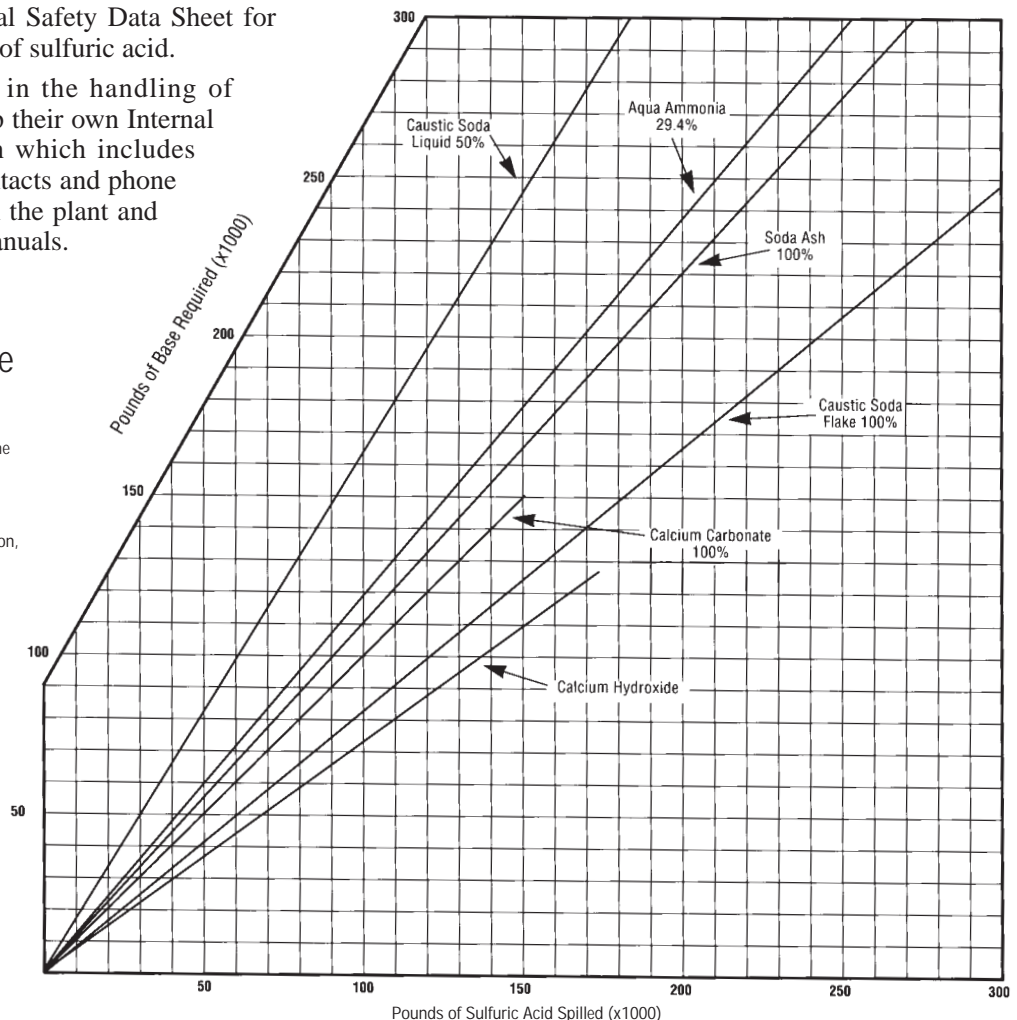
For containment and clean up advice you may phone the NorFalco emergency response phone numbers.

Always refer to the Material Safety Data Sheet for details on the safe handling of sulfuric acid.

Every company involved in the handling of sulfuric acid should develop their own Internal Emergency Measures Plan which includes posting of all important contacts and phone numbers at key locations in the plant and in training and operating manuals.

Pound of Base Required to Neutralize Sulfuric Acid Spill

Reprinted with permission of the National Lime Association, *Lime: Handling, Application and Storage in Treatment Processes*. Fig. 1 (Arlington: National Lime Association, Bulletin 213, Sixth Edition, 1990). Copyright 1949, 1982 National Lime Association, Arlington, VA.



One of NorFalco's Emergency Response Teams

Customer Service

NorFalco's Customer Service Center handles all orders and support requests with a team of representatives assigned to manage your individual needs. For unplanned after hours emergency requirements, NorFalco's After Hours Customer Service Line is available to respond to your needs 24 hours a day, 7 days a week.

With its multiple production facilities, large multimodal transportation network, and centralized marketing expertise, NorFalco takes a highly coordinated, interactive approach to all aspects of its sulfuric acid business. The customer can depend on a single source for sulfuric acid supported by technical and safety advice.



NorFalco acid production sites:

Noranda Income Fund Limited Partnership (CEZinc)
Valleyfield, Quebec
J6T 6L4

Xstrata Copper Horne Smelter
Rouyn-Noranda (Quebec)
J9X 5B6

Xstrata Zinc Brunswick Smelter
Belledune, New Brunswick
E0B 1G0

Xstrata Copper Kidd Creek Division
Timmins, Ontario
P4N 7K1

Xstrata Nickel Sudbury Operations
Falconbridge, Ontario
P0M 1S0



For Further Information or to Place an Order Please Call:

NorFalco LLC.

6050 Oak Tree Blvd., Suite 190
Independence, OH 44131 USA
Tel: (216) 642-7342 Fax: (216) 642-9169

NorFalco Sales Inc.

6755 Mississauga Rd., Suite 304
Mississauga, Ontario L5N 7Y2
Tel: (905) 542-6901 Fax: (905) 542-6914

www.norfalco.com



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