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Technical Service Report No. 32.78
Recommendations for the
Storage and Handling of Liquid Alum

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Recommendations for the Storage and Handling of Liquid Alum

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In case of an Emergency with this product, call:

In US: 800-424-9300 (Chemtrec) In Canada: 866-543-3896

INTRODUCTION

Most aluminum sulfate (alum) customers prefer the liquid product because of its ease and convenience of handling, and its economy of application. Facilities for liquid alum are easily installed. General information follows on the product, and on the equipment and piping required for the bulk storage and handling of liquid alum delivered in either tank cars or tank transports.

Our Technical Service Department is prepared to furnish more specific recommendations as required. Call Customer Service at 800-631-8050 or contact Technical Service at 800-255-7589.

PROPERTIES

Liquid alum, an aqueous solution of aluminum sulfate, $\text{Al}_2(\text{SO}_4)_3 \cdot 14\text{H}_2\text{O}$ (dry alum equivalent - approx.), is a pale green to light yellow liquid. The properties of the product are as follows:

| | | |
|------------------------------------|----------------|-----------|
| Solution Strength, % as Dry Alum | 48.5 | (approx.) |
| % as Total Al_2O_3 | 8.3 | (approx.) |
| Specific Gravity, 60°F (15.6°C) | 1.335 | |
| Degrees Baume, 60°F (15.6°C) | 36.4 | |
| pH 1% solution | 3.5 | (approx.) |
| pH Liquid Alum | 2.3 | (approx.) |
| lbs./gal., U.S. | 11.13 | |
| kg/m ³ | 1333 | |
| lbs. Dry Alum/gal., U.S. | 5.4 | |
| kg. Dry Alum/m ³ | 647 | |
| Viscosity (cps) at 32°F | 52 | |
| at 70°F | 21 | |
| Viscosity (Pa·s) at 0°C | 0.052 | |
| at 21°C | 0.021 | |
| Boiling Point | 214 °F (101°C) | |
| Freezing Point | 5 °F (-15°C) | (approx.) |

SHIPMENTS

Tank Transports

Liquid alum is shipped in stainless steel tank transports of up to 5,000-gallons (18.9m³) capacity (typically, approximately 4,400 gallons (16.7m³)). Minimum recommended storage tank capacity for tank transport delivery is 7,500 gallons (28.4m³), although many low volume consumers find 6,000 gallons (22.7m³) storage tanks adequate. Usually the storage tanks are sized so that approximately ten days' of inventory are provided. Municipal potable water and wastewater treatment plants may require 30 days' inventory. Liquid alum transports are usually self-unloading by means of a pump or air compressor mounted on the tractor and, when operated as described below, are capable of delivering to 30 - 40 foot (9.1 -12.2 meter) elevations without loss of unloading efficiency.

Customers' storage fill line should have a 2" male quick disconnect coupling with dust cap. Ever-Tite part F adapter or equivalent (stainless steel or brass) is recommended. Storage tank fill line connection should be no more than 15 - 20 feet (4.6 - 6.1 meter) from transport unloading area. Unloading area should accommodate the weight and turning requirements of transports. General Chemical's Sales or Technical Service offices upon request will furnish specific details for tank transport or tank car unloading requirements. Typical unloading arrangement is shown on drawing, **Alternate Configurations for Storage & Handling of Liquid Alum: Typical Tank (Truck) Transport Unloading Arrangement**.

Alum is frequently delivered at temperatures as high as 125°F (52°C).

Tank Cars

The customer must provide adequate facilities for handling tank cars including a rail siding, suitable access, platforms, unloading hoses, and a source of compressed air not to exceed 30 psig. Liquid alum is shipped in rubber-lined tank cars of 10,000 and 20,000 gallons (37.9 and 75.5 m³) capacity. Minimum recommended storage tank capacity for tank car delivery is 15,000 gallons (56.8m³), or sized so that a minimum of ten days' inventory is provided (potable water and wastewater treatment plants may require 30 days' inventory).

The air connection is a ¾ in. or 1 in. standard quick-disconnect coupling with a dust plug. The customer's alum hose should have a 2 in. standard quick disconnect coupling with a dust plug. Details are shown as one option on drawing, **Alternate Configurations for Storage & Handling of Liquid Alum: Typical Tank (Rail) Car Unloading Arrangement.**

STORAGE CONSIDERATIONS

Gravity Systems

Where gravity flow to process or feed equipment is practical and desirable, a saving in pump capital and maintenance costs is possible.

Pump Systems

If a gravity system is not possible, centrifugal or metering pumps, sized for head and flow requirements, may be used to transfer alum to the process.

Pressurized System

Pressurizing a storage tank with air or nitrogen is **not recommended** as a means of transferring liquid alum. In addition FRP (fiberglass reinforced plastic) storage tanks, frequently used for alum, **cannot** be pressurized.

Storage Temperature

Liquid alum freezes at about 5°F (-15°C) and, under certain conditions such as surface evaporation, long-term storage, etc., crystallization may occur near 30°F (-1.1°C). Storage tanks should be installed indoors or in a heated enclosure. Storage tanks and equipment located outdoors should be heated with electric heating cable or coils and insulated to maintain a temperature between 45 and 60°F (7.2 and 15.6°C).

Lines exposed to low temperatures should be insulated. Good engineering practice provides flush-out connections at strategic points in the piping, particularly in the area of pumps and metering equipment.

These connections can then be used to purge the pipelines to an environmentally acceptable container with a minimum of effort should crystallization occur. Water lines used for flushing should be disconnected after use to prevent contamination of water supply.

Storage Tanks

The liquid alum storage tank, fabricated of fiberglass reinforced polyester, may be either of vertical or horizontal configuration and should be sized as outlined in the section titled "SHIPMENTS." The tank should be designed for contents of specific gravity of 1.34 at 60°F (15.6°C), with features illustrated on drawing, **Alternate Configurations for Storage & Handling of Liquid Alum: Typical Tank (Rail) Car Unloading Arrangement**, and as dictated by good engineering practice and local conditions.

Typical tanks are available from PolyProcessing Company (<http://www.polyprocessing.com>); Plas-Tanks Industries, Inc. (<http://www.plastanks.com>); and others.

Greater physical strength for high traffic areas or other special requirements may be provided by rubber-lined steel, Type 316 stainless steel, and PVC (polyvinyl chloride) bag liners in steel or wood stave tanks. Details of a rubber-lined storage tank are available upon request.

Spill Protection

Where regulations require that protection be provided to eliminate contamination of the environment from accidental spills or leaks, storage tanks should be installed in a suitably diked area having a capacity of 125% of the volume of the storage tank. Since dikes are normally installed to provide emergency containment, they can be of sealed earthen construction or of lined or unlined concrete block. Suitable linings or coatings include asphalt, PVC, epoxy, and polyester.

Storage Tank Level Indicators

FRP tanks are usually sufficiently translucent to provide a visible indication of the liquid level. However, when these tanks must be insulated, or where other type storage tanks are utilized, manometer-type or pneumatic bubbler gauges, which measure the air pressure equal to the static head of alum in the tank are recommended.

Pneumatic bubbler gauges are available Meriam Process Technologies, a Div. of Scott & Fetzer Co. (<http://www.meriam.com>); Uehling Instrument Co. (<http://www.uehling.com>); and others.

PUMPS AND METERING EQUIPMENT

Transfer Pumps

Centrifugal pumps with wetted parts of Alloy 20 or Type 316 stainless steel, sized for the total head and required flow, are recommended for transferring liquid alum from storage to process. Motor speeds over 1800 rpm should be avoided. Pumps operating at high speeds will have short life and will require more maintenance.

Typical pumps are available from Flowserve Corp., (<http://www.flowserve.com>); Gould Pumps, Inc (<http://www.goulds.com>); Wilfley, A.R. Wilfley & Sons Inc. (<http://www.wilfley.com>); and others.

Metering Pumps

A diaphragm pump, with all wetted parts of Alloy 20 or Type 316 stainless steel and TFE diaphragms, is recommended. Typical pumps are available from Neptune Chemical Pump Co. (<http://www.neptune1.com>); Milton Roy (<http://www.miltonroy.com>); Wallace & Tiernan (<http://www.wallace-tiernan.com>); and others.

Pump Packing

Graphited, lubricated asbestos and TFE impregnated asbestos packings are recommended for centrifugal pumps.

Rotameters

PVC or 316 stainless steel rotameters with Hastelloy C floats are recommended. Suppliers include: Brooks Instrument (<http://www.emersonprocess.com/brooks>); Schutte and Koerting (<http://www.s-k.com>); ABB (<http://www.abb.com>); Wallace & Tiernan (<http://www.wallace-tiernan.com>); and others.

Inline Strainers

Inline strainers can be either "Y" or basket configuration. Hole diameter of 1/64-1/16 inch is suggested (approx. equivalent mesh 42 and 12, respectively). Available from Hayward Industrial Products, Inc. (<http://haywardindustrial.com>); and others.

Head, Measuring or Day Tank

The same materials of construction as outlined for storage tanks are recommended. Head tanks are elevated with an overflow back to the storage tank, and are used to maintain constant head pressure on rotameters or other similar measuring instruments. Measuring tanks are usually sized for a certain batch and are equipped with a calibrated, visible sight gauge for accurately regulating delivery. Placing on scales or load cells to provide precise weight loss and usage is suggested.

VALVES

Ball Valves

PVC valves with TFE retaining rings are recommended. Suppliers include Nibco, Inc., (<http://www.nibco.com>); Hayward Industrial Products, Inc. (<http://haywardindustrial.com>); & Plast-O-Matic Valves, Inc. (<http://www.plastomatic.com>).

Gate, Globe and Y Valves

Alloy 20 or Type 316 stainless steel valves, 150 lb. ASA flanged, OS&Y with TFE packing are recommended. Suppliers include Hayward Industrial Products, Inc. (<http://haywardindustrial.com>); Flowserve Corp., (<http://www.flowserve.com>); and others.

Needle Valves

Alloy 20, 316 stainless steel or PVC are recommended. Suppliers include Hayward Industrial Products, Inc. (<http://haywardindustrial.com>); and others.

Back Pressure Valves

Back-pressure valves are available from Neptune Chemical Pump Co. (<http://www.neptune1.com>); Milton Roy (<http://www.miltonroy.com>), and others. Some metering pumps have back-pressure valves built in.

Pressure Relief Valves

Available from Neptune Chemical Pump Co. (<http://www.neptune1.com>); Milton Roy (<http://www.miltonroy.com>); and others.

Plug Valves

Alloy 20 or Type 316 stainless steel plug valves 150 lb. ASA flanged with TFE sleeves are recommended. Suppliers include Xomox Corporation (<http://www.xomox.com>); Flowserve Corp., (<http://www.flowserve.com>); and others.

Installation Note

Valves should be installed with the stems positioned vertically upward or horizontally, but not downward.

PIPING

Plastic Pipe

Schedule 80 PVC normal impact, or CPVC (chlorinated polyvinyl chloride) pipe with solvent weld socket fittings is recommended over threaded connections. The unloading line to the storage tank may be constructed of CPVC or stainless steel as a safeguard where the unloading temperature of the liquid alum may exceed 120°F (49°C). PVC and CPVC, due to their high coefficient of expansion with temperature changes, should not be anchored at both ends of a piping run, and are best supported continuously such as in a channel or angle iron support.

Stainless Steel Pipe

Schedule 10 or Schedule 40 Type 316 stainless steel pipe with all welded fittings is recommended.

Heat Tracing

Electrical heat tracing with temperature controls are available from storage tank suppliers and piping contractors. Engineering recommendations and specifications would be available from the supplier.

Drawdown Tubing & Calibration Cylinders

Various manufacturers provide graduated cylinders with valve assemblies so that the pump flow rates can be verified. These can be constructed by the user or purchased

from many metering pump vendors. Available from Milton Roy ([http:// www.miltonroy.com](http://www.miltonroy.com)), and others.

Hoses

Natural gum rubber hose and semi-flexible polyethylene pipe with PVC or Type 316 stainless steel inserts can be used if they are suitable for the pressures involved. Suppliers include: Gates Corporation (<http://www.gates.com>); Goodyear Industrial Products Div., (<http://www.goodyearindustrialproducts.com>); and others.

Quick Connects

Suppliers of quick disconnect fittings include: Morris Coupling Company, (<http://www.morriscoupling.com>); and others.

Miscellaneous

Red rubber gaskets, 1/16 in. thick, are recommended.

Exterior surfaces of lined-steel equipment, if used, should be prepared by sandblasting or mechanical brushing and then painted with a suitable PVC base paint, such as available from Valspar Corp. (<http://www.valspar.com>); and others.

SAFETY AND PRECAUTIONS

All personnel involved in the use of liquid alum should be fully acquainted with the safe handling of Liquid Aluminum Sulfate (Alum) as discussed in the product **Material Safety Data Sheet (MSDS)**. Though aluminum sulfate is not considered a particularly hazardous material, its buffered acidic action is in some instances irritating when alum is in contact with eyes, skin or mucous membranes. This can be avoided by the use of protective clothing and equipment

Protective Equipment

Normal precautions should be employed to prevent spraying or splashing liquid alum, particularly when it is hot. Face shields or eye goggles should be worn to protect the eyes; outer covering such as rubber aprons and waterproof sleeves may be used to protect clothing from liquid alum.

Deluge type showers and eyewash stations should be installed and operable in the vicinity of the chemical storage and handling station.

First Aid

CAUTION! Aluminum sulfate may be irritating to the eyes and should be flushed from the eyes using copious amounts of water. If irritation persists, a physician should be consulted promptly. Aluminum sulfate may also be irritating to the skin and should be washed from the skin with water.

Pollution Control Considerations

Accidental discharges of alum in substantial quantities can be harmful to the environment. It is recommended that outdoor storage tanks be suitably diked or otherwise provided with an adequate means of secondary containment.

Appropriate secondary containment measures should also be taken to prevent spills or leaks from indoor storage tanks and tank car or tank truck unloading stations from entering sewers or other channels that discharge directly to a water body or a municipal sewage system.

It is suggested that planned containment measures be reviewed with appropriate water pollution control Regulatory Agencies to assure that the proposed installation will comply with applicable laws and regulations.

Maintenance of the Alum Storage and Handling System

Scheduled preventive maintenance is important to assure trouble-free operation of any system. For the liquid alum system we recommend water flushing of pumps and associated piping on a monthly basis; storage tanks every 12 - 18 months. These measures will prevent the build-ups of alum crystals formed by evaporation.

Under certain circumstances crystal formation can "seed out" additional dissolved aluminum sulfate and create serious plugging problems.

ENGINEERING STANDARD

FIBERGLASS-REINFORCED POLYESTER (FRP) TANKS & EQUIPMENT

FABRICATION & PROCUREMENT

1. SCOPE

This standard covers material specification, fabrication details, procurement, dimensional tolerances, methods of testing and inspection, and shipping information for contact-molded, glass-fiber reinforced polyester, stationary, non-pressure tanks and equipment for chemical service.

2. REFERENCES

2.1 Unless otherwise indicated, the plastics terminology used in this standard shall be in accordance with the definitions given in ASTM D-883, "Nomenclature Relating to Plastics."

2.2 ASTM D-529. Random Chopped-Glass Fiber Mats.

2.3 ASTM D-638. Tensile Properties of Plastics.

2.4 ASTM D-790. Flexural Properties of Plastics.

3. MATERIAL SPECIFICATION

3.1 Polyester resin shall be Atlac 382 or an approved equal.

3.2 The resin shall be free from any pigments, fillers or colorants unless agreed upon in writing between the vendor and buyer. Antimony compounds or other fire retardant agents may be added as required to reduce flame spread classification.

3.3 Chemical surfacing mat shall be Type C (chemical) glass, 10 to 20-mil thick with a coupling agent which will provide a compatible bond between the glass reinforcement and the resin such as a Silane finish and a styrene soluble binder.

3.4 Chopped strand mat shall be Type F fiberglass, 1 1/2 ounce per square yard with a coupling agent which will provide a compatible bond between the glass reinforcement and the resin such as a Silane finish and a styrene soluble binder.

3.5 Type E woven cloth or woven roving (60 cnd max.) having a coupling agent such as "Volan" methacrylate chromic chloride or Silane-type finish can be used as outlined in ¶ 5.7 and 5.8.

3.6 In environments that attack glass (such as fluorides), special non-glass surfacing mats must be used. Glass chemical surfacing mat in ¶ 3.3 and 5.4 shall be omitted on the surfaces exposed to this environment and replaced with non-glass surfacing mats as specified on the purchase order.

4. VENDOR INFORMATION

4.1 At the time of quotation, the vendor shall submit an identified 6 in. x 6 in. x final-wall thickness, finished sample for approval and a letter stating that the complete unit will be satisfactory for all service conditions listed on the "Request for Quotation." The sample, when approved, will be used by the buyer's inspector as a quality check and as a basis for acceptance or rejection.

4.2 General arrangements and over-all dimensions shall be in accordance with the purchase order and accompanying drawings.

4.3 Vendor shall furnish two sets of shop drawings for review by buyer's engineering department prior to start of fabrication.

4.4 All drawings shall be complete, including location of all field joints, informative, and include enough detail to ascertain that all design details as outlined in this specification have been met.

4.5 After approval, vendor shall furnish five sets of shop drawings marked "Certified."

4.6 Tanks with physical loadings, such as agitators or stacks, must be given special design considerations.

4.7 Tanks intended for service above 180°F (82°C) must be given special design considerations.

4.8 Minimum shell and head acceptable thickness shall be 1/4 inch.

5. FABRICATION

5.1 Laminates shall be dense, without voids or dry spots, have uniform thickness and glass-to-resin ratio. The laminate shall not have foreign inclusions, delamination, pin-holes, pimples, cracks or crazes; and air bubbles shall be kept to a minimum in size and number per reference sample (4.1).

5.2 Laminate shall have a minimum Barcol Hardness of 90% of the resin manufacturer's minimum specified hardness for cured, non-reinforced resin. Minimum hardness for Atlac 382 laminate shall be 40. This applies to both interior and exterior surfaces. The Barcol Impressor (Model GYZS 934-1) shall be used for determining hardness.

5.3 All fabricated laminate structures must meet the physical requirements of Table IV.

5.4 All surfaces exposed to the corrosive environment shall be resin-rich and reinforced with a 10-to-20-mil thick, Type C glass surfacing mat.

5.5 A separately cured, unreinforced gel coat shall not be used.

5.6 Over the inner surface, the next 0.100 inch minimum of the laminate shall be reinforced with not less than 20% nor more than 30% by weight of non-continuous glass strands. No other glass product is permitted between these layers. Glass content is determined as per ¶ 7 (f) of ASTM D-1529 specification.

5.7 Follow with additional layers of mat, cloth or woven roving as may be needed to meet all requirements of this specification and any special requirements of the purchase order.

5.8 When woven roving is used, it shall have a ply of 1 1/2 ounce minimum mat on each side. Plies of woven roving or cloth may not be placed one on the other.

5.9 All joint edges of reinforcement shall be lapped a minimum of one inch. Lap joints of adjacent layers shall be adequately staggered to obtain maximum strength.

5.10 All surfaces including cut edges and bolt holes shall be so coated that no glass fibers are exposed.

6. DIMENSIONAL TOLERANCES

6.1 Tank diameter shall be measured internally. Tolerance on nominal diameter, including out-of-roundness, shall be +/- 1%. Measurement is to be taken with tank in vertical position.

6.2 Tank taper, if any, shall be increasing and shall be added to the nominal diameter. Taper shall not exceed 1/2° per side.

6.3 The radius at the bottom to the wall shall be a minimum of 1 1/2 inch.

6.4 Tolerances on wall thickness shall be plus 20% and minus 0% of nominal.

6.6 Pipe and flange thickness shall have a minimum rating of 50 psig.

6.7 Nozzle neck and pipe thickness shall be per Table I.

TABLE I
THICKNESS OF PIPE WALLS & NOZZLE NECKS

| PIPE (ID) | NOMINAL PRESSURE RATING (PSIG)* | | |
|--------------|---------------------------------|-------|-------|
| | 50 | 75 | 100 |
| 2 | 0.188 | 0.188 | 0.188 |
| 3 | 0.188 | 0.188 | 0.188 |
| 4 | 0.188 | 0.188 | 0.250 |
| 6 | 0.188 | 0.250 | 0.250 |
| 8 | 0.250 | 0.313 | 0.313 |
| 10 | 0.250 | 0.313 | 0.375 |
| 12 | 0.250 | 0.375 | 0.438 |
| 14 | 0.313 | 0.375 | 0.500 |
| 16 | 0.313 | 0.438 | 0.563 |
| 18 | 0.375 | 0.500 | 0.625 |
| 20 | 0.375 | 0.500 | 0.688 |
| 24 | 0.438 | 0.625 | 0.813 |
| 30 | 0.500 | 0.750 | |
| 36 | 0.625 | | |
| 42 | 0.750 | | |

*These ratings are suitable for use up to 170°F (77°C).

6.8 Dimensional Tolerances for Table I

| | | |
|-------------------------|---|---|
| Wall Thickness | - | +20% & -0% |
| I.D. & Out-of-Roundness | - | To 6" +/- 1/16" Over 6": +/- 1/8" or +/- 1% (whichever is greater) |
| On Length | - | +/- 1/8" except as otherwise specified |
| End Squareness | - | To 24" I.D.: +/- 1/8" Over 24" I.D.: +/- 3/16" |

6.9 The minimum flange shear surface shall be four times the flange thickness. The thickness of flange hub reinforcement measured at the top of the fillet radius shall be at least one-half the flange thickness and shall be tapered uniformly the length of the hub reinforcement. The fillet radius, where the back of the flange meets the hub shall be 3/8 inch minimum.

6.10 Flanges

Bolt circles, number and diameters of bolt holes shall be per ANSI B16.5, Class 150 steel for pipe sizes up to 24 in. I.D. and per ANSI B16.1, Class 125 cast iron for pipe sizes over 24 inches, however steel or cast iron materials are not to be used. Outside diameters, flange thicknesses and other dimensions shall be per Table II and Detail "A." Flanged pipe and fittings shall have the bolt holes aligned and straddling center-lines.

6.11 All flanges are to be supported by a minimum of four gussets.

6.12 The location of all openings on the vessels shall be held to +/- 1/8 inch.

6.13 All nozzles shall project 6 inches from the outside surface of the vessel to the face of flanges unless otherwise noted.

TABLE II
FLANGE THICKNESS "t" (IN.) SHOWN IN
DETAIL "A" FOR PRESSURE RATING

| SIZE (ID) | OD (IN.) | 50 | 75 | 100 |
|----------------------|---------------------|-----------|-----------|------------|
| 2 | 6-1/2 | 1/2 | 1/2 | 9/16 |
| 3 | 8 | 1/2 | 5/8 | 11/16 |
| 4 | 9-1/2 | 9/16 | 11/16 | 13/16 |
| 6 | 11-1/2 | 5/16 | 3/4 | 7/8 |
| 8 | 14 | 3/4 | 7/8 | 1 |
| 10 | 16-1/2 | 7/8 | 1-1/16 | 1-3/16 |
| 12 | 19-1/2 | 1 | 1-1/4 | 1-7/16 |
| 14 | 21-1/2 | 1-1/16 | 1-5/16 | 1-1/2 |
| 16 | 24 | 1-3/16 | 1-7/16 | 1-5/8 |
| 18 | 25-1/2 | 1-1/4 | 1-1/2 | 1-3/4 |
| 20 | 28 | 1-5/16 | 1-5/8 | 1-7/8 |
| 24 | 32-1/2 | 1-1/2 | 1-7/8 | |
| 30 | 39-1/2 | 1-7/8 | | |
| 36 | 46-1/2 | | | |
| 42 | 53-1/2 | | | |

*Based on flat-faced flanges with full-face, soft-rubber gaskets of Shore Durometer 45 - 65.

7. JOINTS

7.1 Where tanks are manufactured in sections and joined by use of a laminate bond, the joint shall be fiberglass-reinforced resin at least the thickness of the heaviest section being joined. The reinforcement shall extend on each side of the joint a sufficient distance to make the joint at least as strong as the tank wall. The reinforcement shall be applied both inside and out with the inner reinforcement considered as a corrosion-resistant barrier only and not structural material. The inner reinforcement shall consist of a minimum of three ounces of glass per square foot, followed by a 0.010 inch to 0.020 inch of surfacing material as per 1 5.4. (See Table III.)

TABLE III
MINIMUM JOINT WIDTHS

| TANK WALL THICKNESS (INCHES) | MINIMUM OF OVERLAY WIDTH (INCHES) | INNER REINFORCEMENT TOTAL WIDTH (INCHES) |
|---|--|---|
| 3/16 | 4 | 4 |
| 1/4 | 4 | 4 |
| 5/16 | 5 | 5 |
| 3/8 | 6 | 5 |
| 7/16 | 7 | 6 |
| 1/2 | 8 | 6 |
| 9/16 | 9 | 6 |
| 5/8 | 10 | 6 |
| 11/16 | 11 | 6 |
| 3/4 | 12 | 6 |

7.2 All surfaces to receive strapping must be first roughened. The roughened area shall be wider than the glass cover, but this roughened area must subsequently be completely covered with new resin.

8. INSPECTION

8.1 All products fabricated to this specification shall be inspected by buyer's inspector prior to shipment, unless alternative arrangements have made. Vendor shall notify buyer's purchasing department five days in advance of the inspection dates.

8.2 Buyer's inspector shall have access to the vessel or structure at any stage of fabrication.

8.3 Evidence of poor workmanship shall be cause for rejection.

8.4 At the time of inspection, the vendor must submit a letter of certification stating the name of the polyester and compliance with this specification.

8.5 Drawings or specifications (or both), etc., submitted herewith must be returned to the buyer.

9. MARKING

9.1 Each piece or lot shall be marked or tagged with the purchase order number and bill of material item number.

9.2 The centerline established on the buyer's drawing shall be match-marked on all pieces to be joined in the field. Marks shall be made with waterproof paint 90° apart.

10. SHIPPING

10.1 Tanks shall be mounted on cradles if shipped horizontally or on a suitable skid or pallet if shipped in the vertical position.

10.2 The cradles or skid shall be padded and secured to the bed of the vehicle in a manner that will prevent damage to the tank with normal handling.

10.3 The tank shall be secured to the cradle or skid so that there can be no movement of the tank in relation to the skid or cradle.

10.4 A suitable stiffening member shall be secured at the opening of open-top tanks.

10.5 Tanks shall be loaded with at least 2" clearance between the tank, including fittings, and the bulkheads or bed of the vehicle.

10.6 When two or more tanks are shipped at one time, there shall be sufficient clearance or padding between tanks to prevent contact in transit.

10.7 Upon arrival at the destination, the customer shall be responsible for inspection preferably before unloading for damage in transit. If damage has occurred, a claim should be filed with the carrier by the customer. If no claim is filed, the customer accepts all future responsibility for a damaged tank.

11. HANDLING

11.1 The following normal precautions shall be taken in handling the tank at the destination:

11.2 Proper rigging practices shall be observed at all times. Hoisting equipment operators shall attach a guide line to prevent the tank from swinging without control.

11.3 The tank shall not be dropped or allowed to strike any other object. Damage caused by dropping or striking other objects may result in cracking the inner corrosion resistant liner as well as the exterior of the tank.

11.4 The tank shall not be rolled or slid on rough surfaces and never rolled over a fitting.

11.5 In working around the tank, care should be exercised to prevent tools, scaffolding or other objects from striking the tank or being dropped inside the tank. Workmen entering the tank shall wear Soft-soled shoes. Ladders used inside or outside in contact with the tank shall be wooden or have cushion protection on both ends and shall not be permitted to scratch or point load the surface.

11.6 The use of a crane is recommended both in lifting the tank and in erecting same. The clearance between the head shackle of the crane and the tank shall at least equal the overall length of the tank. If this is not possible, a spreader bar must be used to approximate the same angle in lifting.

11.7 If tanks are not equipped with lifting lugs, it is recommended that these tanks be lifted by use of canvas or rope slings (over 1' diameter) at each end of the tank. Tanks can be moved by positioning forklift trucks on either side of the tank, with forks padded.

11.8 Under no conditions shall chains or cables be put' around the tank. Do not lift by using any fittings other than lifting lugs.

11.9 When storing the tank on the ground prior to installation, it shall be placed on the shipping cradles and ties down so that it cannot roll due to winds or sloping elevation.

12. INSTALLATION

12.1 Horizontal tank permanent support cradles shall conform to the manufacturer's recommended design.

12.2 Bases for vertical tanks shall be continuous bottom supports on bases having sufficient strength to support the weight of the tanks under operating conditions without deflection. Full support of the bottom shall be obtained by one of the following:

12.2.1 If the surface of the pad and the bottom of the tank are flat and have no projections from the plane surface, the tank may be set on a smooth concrete surface.

12.2.2 Other methods may be used as recommended by the manufacturer.

12.3 If the tank has a bottom drain, a hole shall be made in the pad with sufficient clearance so that the drain will not be in contact with the base at any point.

12.4 Tanks shall be handled with a crane, as previously described, utilizing the lifting lugs provided. Do not attempt to lift tank by attaching to other fittings. Prior to hoisting the top end, a suitable protective pad of material shall be placed under the bottom pivot point of tank so that as tank rises, the strain is taken on the pad. The hoist wire shall be connected to one top lifting lug and, the tank shall be raised carefully using guide ropes to prevent sudden swinging. When the tank is vertical, the other top lifting lug (180° apart) shall be hooked up, lifting the tank evenly.

12.4.1 All hold lugs supplied must be utilized to secure the tank to its pad.

12.4.2 Valves and piping attached to the tank nozzles shall be independently supported.

12.4.3 When agitators, mixers, cooling/heating coils are to be used, follow the manufacturers' instructions.

TABLE IV
MINIMUM PHYSICAL PROPERTIES(1) @ 730°F (388°C)

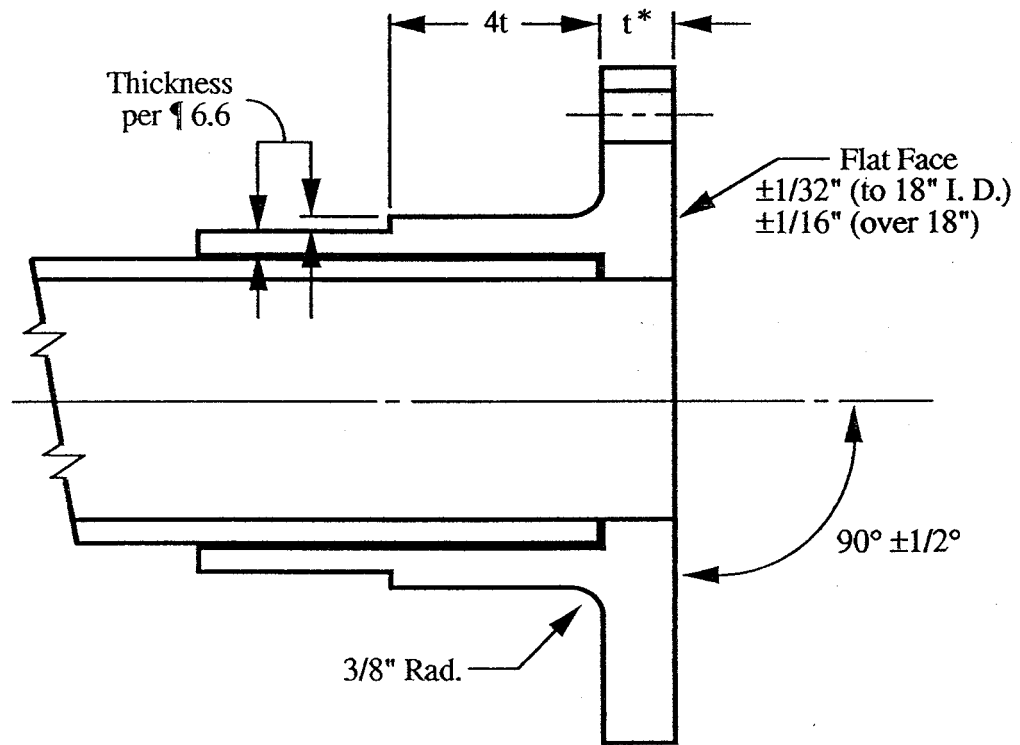
| <u>PROPERTY</u> | <u>TEST METHOD</u> | <u>UNITS</u> | <u>THICKNESS (INCHES)</u> | | | |
|---|---------------------------|---------------------|----------------------------------|-------------------|--------------------|----------------------------|
| | | | <u>1/8 - 3/16</u> | <u>1/4</u> | <u>5/16</u> | <u>3/8 & UP</u> |
| ULTIMATE TENSILE STRENGTH (MINIMUM) | ASTM D-638 ² | 10 ³ PSI | 9 | 12 | 13.5 | 15 |
| FLEXURAL STRENGTH (MINIMUM) | ASTM D-790 ³ | 10 ³ PSI | 16 | 19 | 20 | 22 |
| MODULUS OF ELASTICITY (TANGENT- MINIMUM) | ASTM D-790 ³ | 10 ⁵ PSI | 7 | 8 | 9 | 10 |

(1) Laminates which do not meet these minimum values are considered acceptable provided they are made to afford the same overall strength that would be obtained with a laminate meeting the specified minimum values at the specified thickness.

(2) Tensile strength shall be determined by the ASTM D-638 method, except that the specimens shall be the actual thickness of the fabricated article, and the breaking width shall be one inch.

(3) Flexural strength shall be determined by ASTM method D790, Procedure A and Table I, except that the specimens shall be the actual thickness of the fabricated article, and the width shall be one inch. Other dimensions of specimens shall be as designated by ASTM. specimens shall not be machined on the surface. Test shall be made with the resin-rich side in compression.

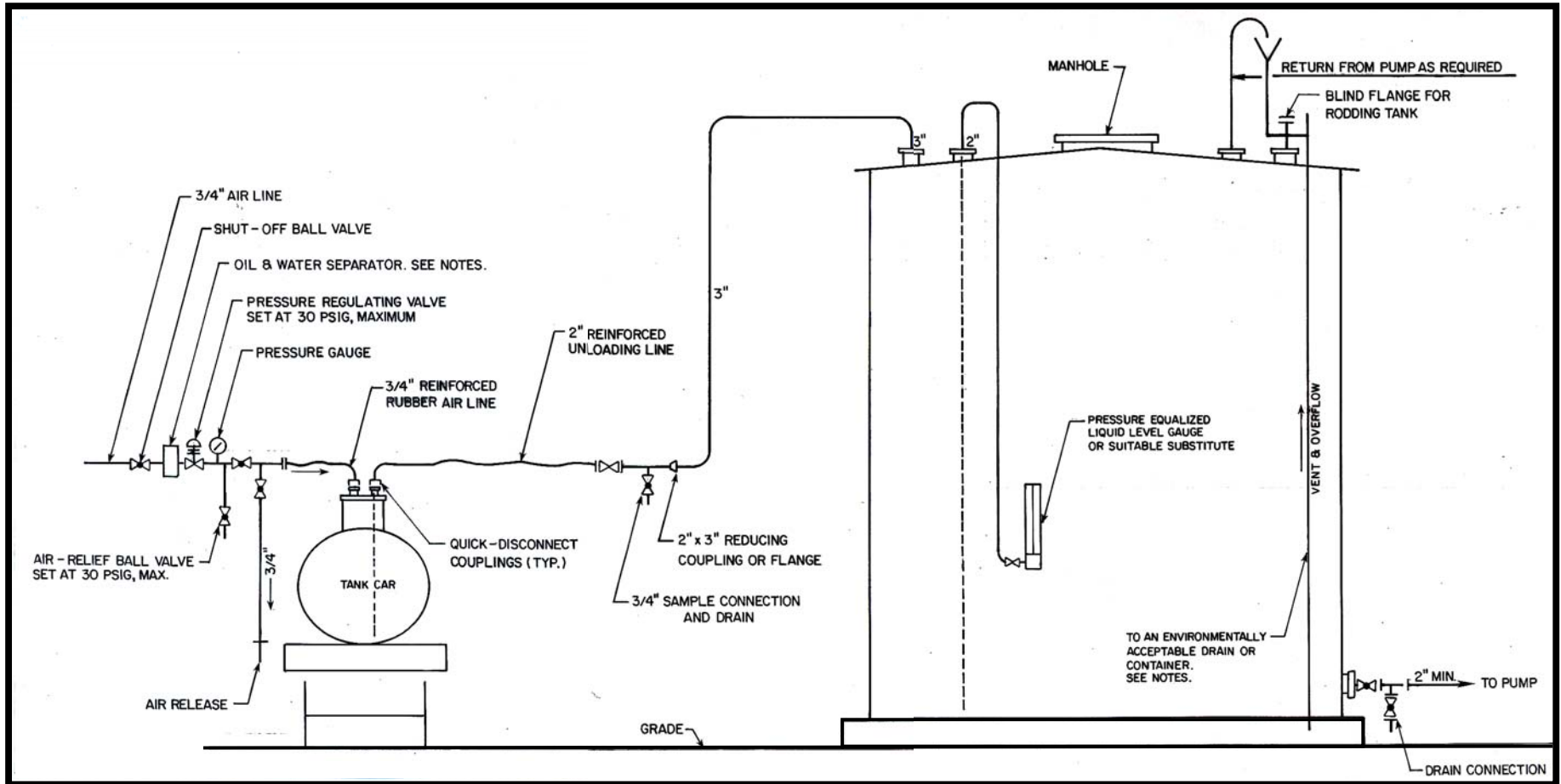
Detail "A"



(* See Table II, page 16

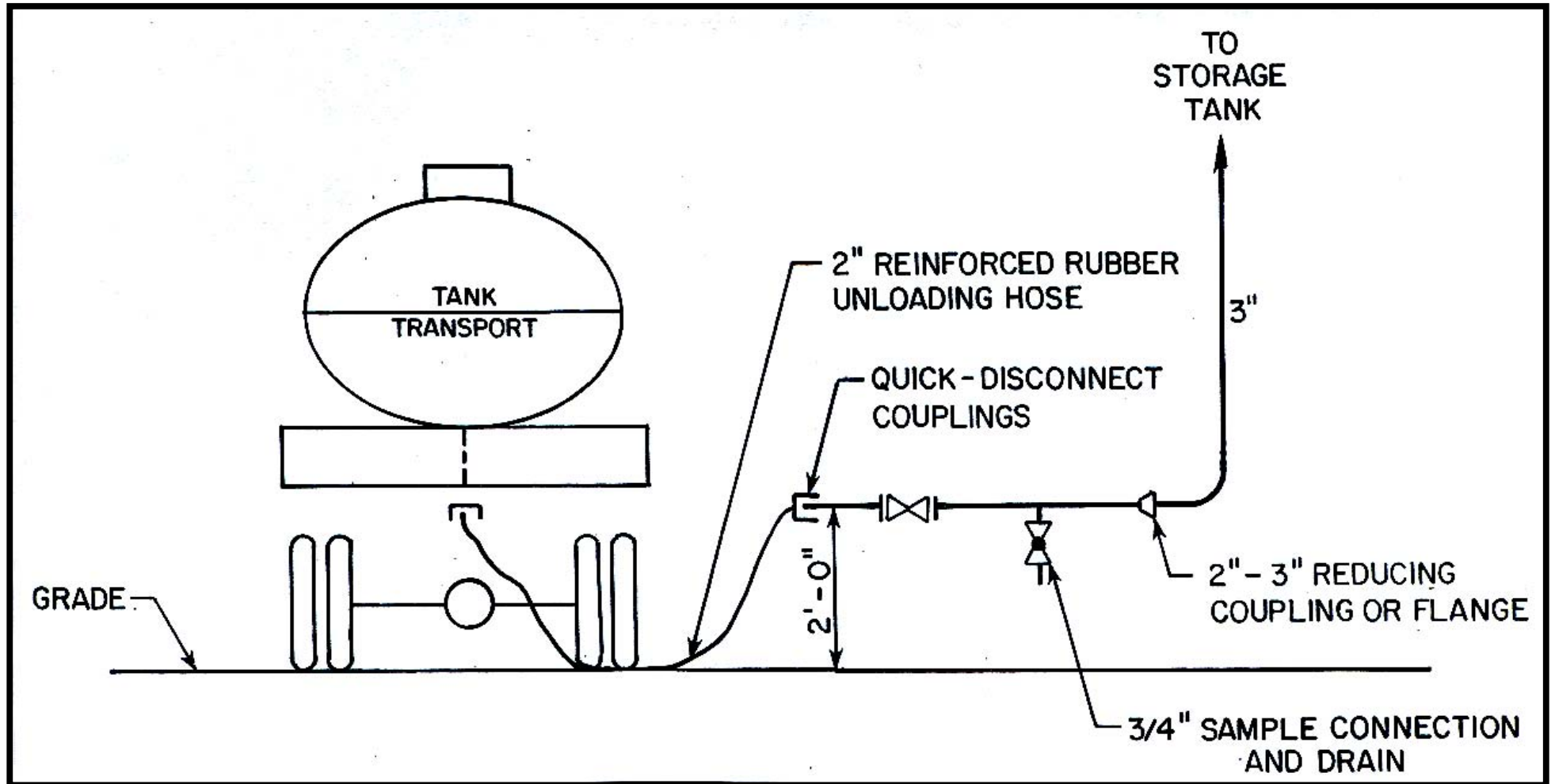
Alternate Configurations for Storage & Handling of Liquid Alum

Typical Tank (Rail) Car Unloading Arrangement

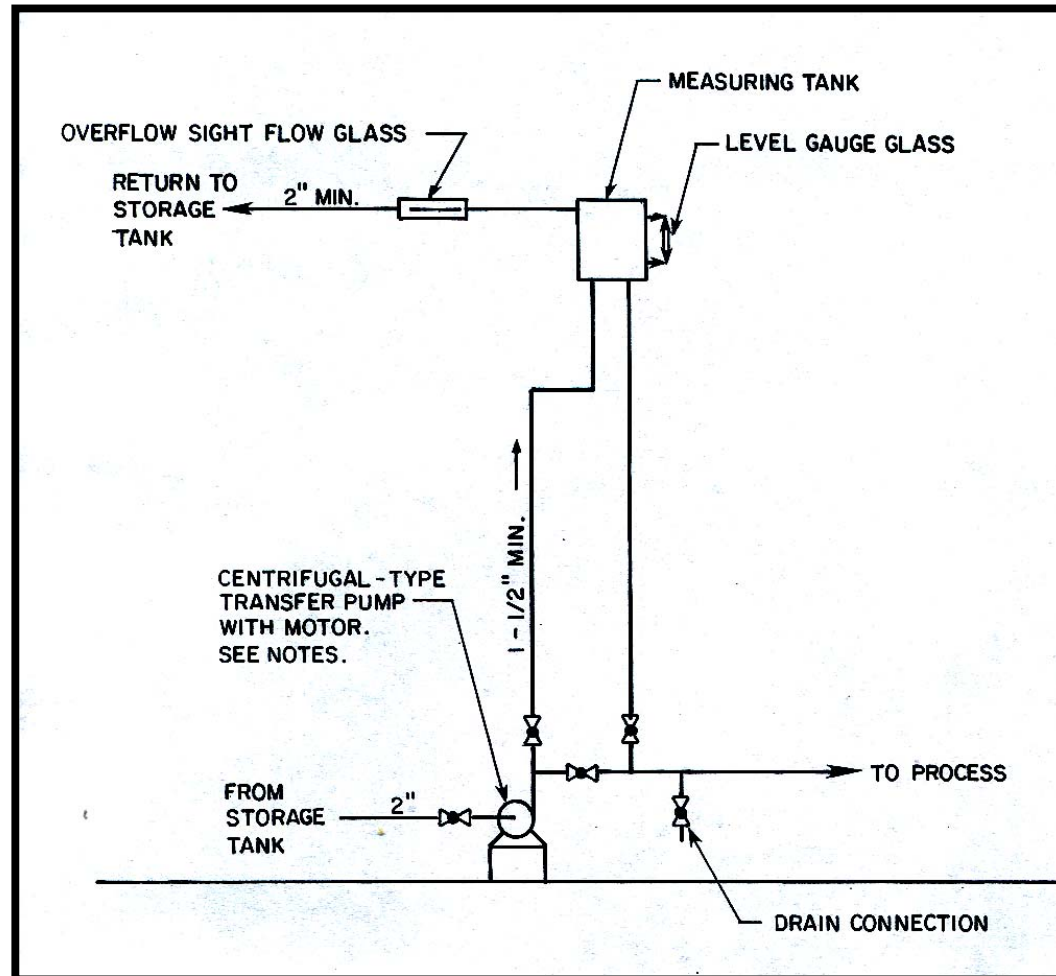


Alternate Configurations for Storage & Handling of Liquid Alum

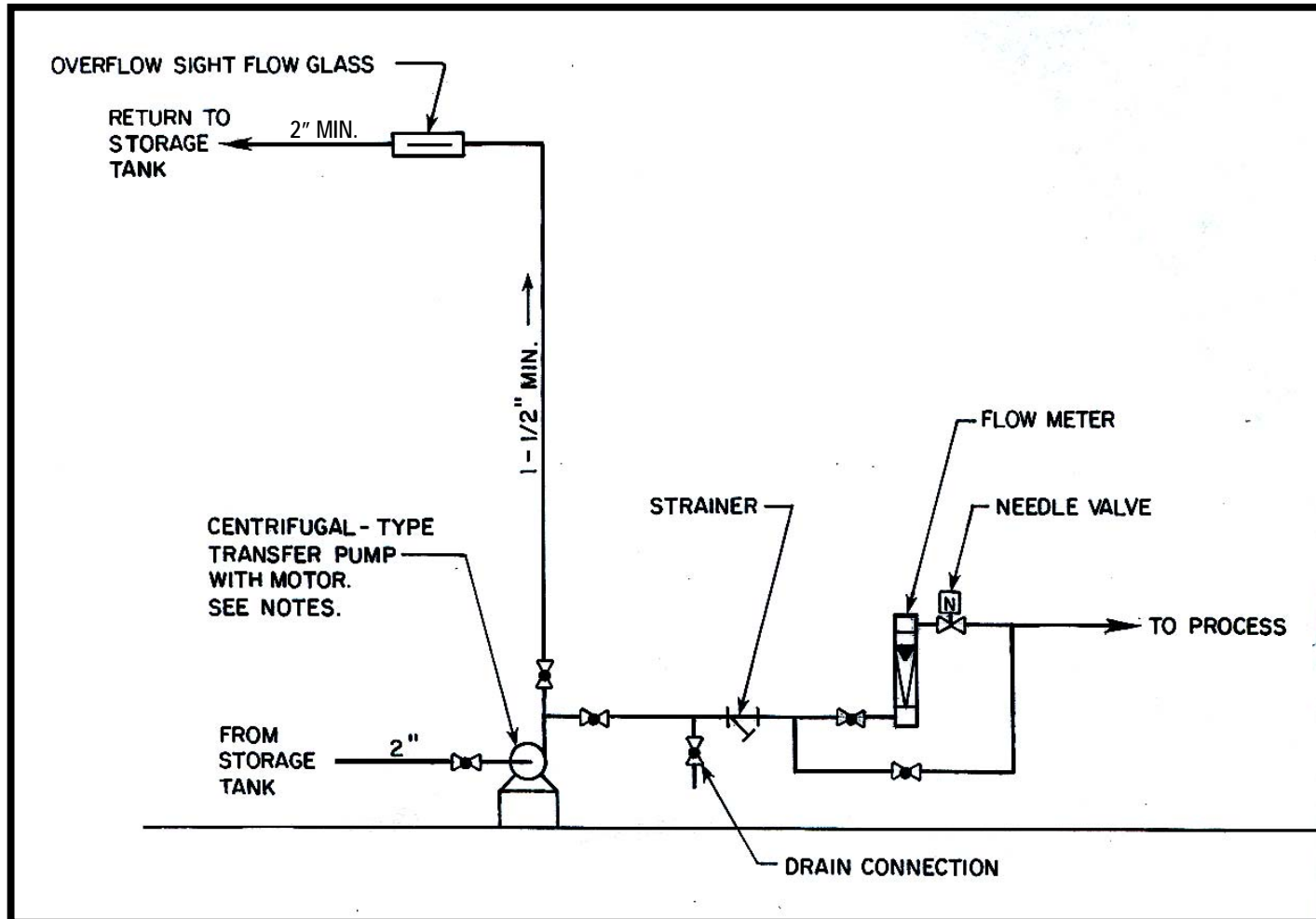
Typical Tank (Truck) Transport Unloading Arrangement



Alternate Configurations for Storage & Handling of Liquid Alum *Feed System "A": Measuring Tank Arrangement*

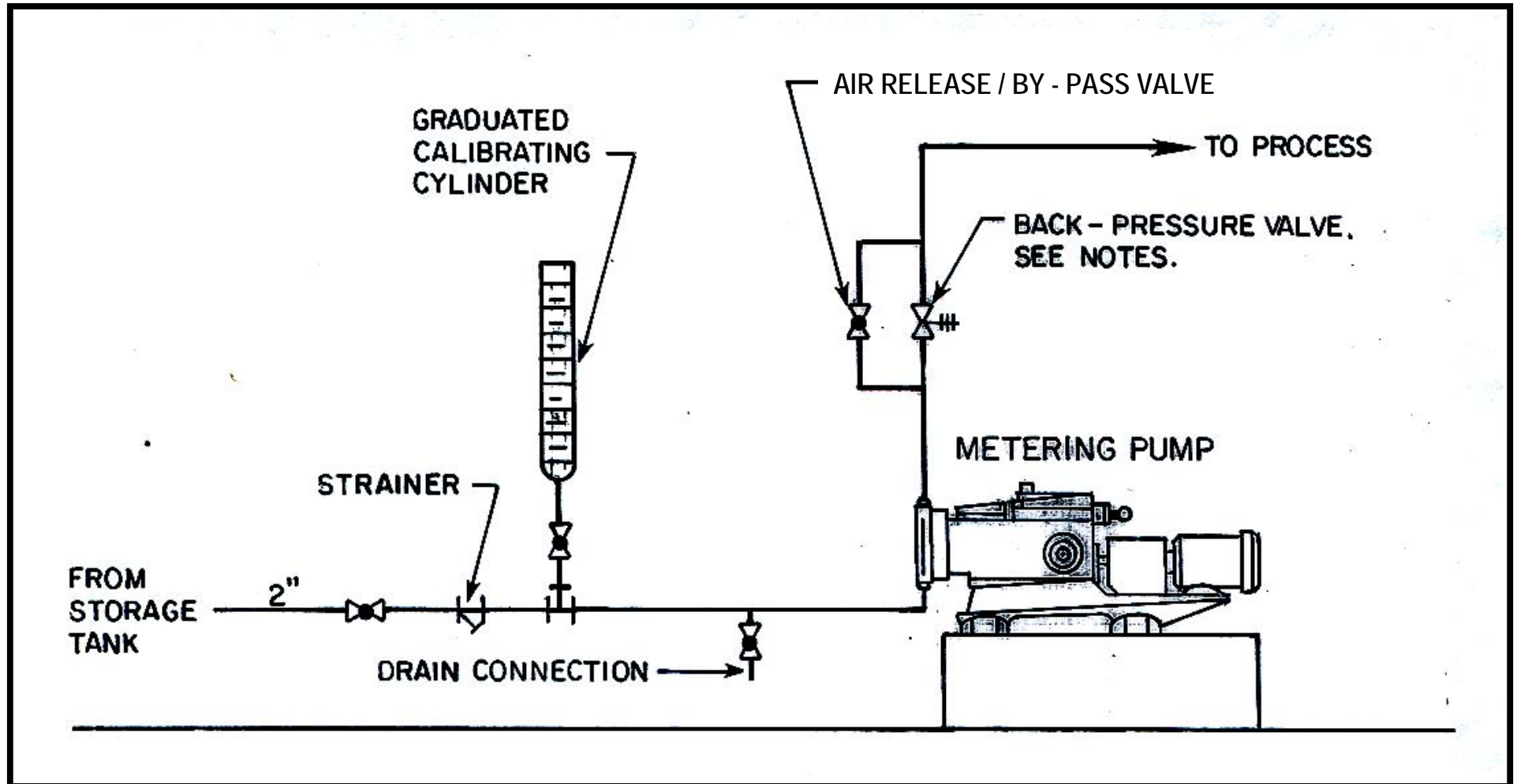


Alternate Configurations for Storage & Handling of Liquid Alum *Feed System "B": Flow Meter Arrangement*



Alternate Configurations for Storage & Handling of Liquid Alum

Feed System "C": Metering Pump Arrangement



Alternate Configurations for Storage & Handling of Liquid Alum

- The pump is to be operated by remote control at measuring tank when **Feed System “A”** is installed and near flow meter or feeder when **Feed System “B”** or **“C”** is installed.
- Back-pressure valve on **Feed System “C”** may be omitted if discharge piping head pressure meets or exceeds metering pump manufacturer’s requirements.
- All vent overflow piping is to be 1” minimum diameter larger than fill piping.
- Containment for storage metering systems and spill control to be provided to suit local, state/provincial, and federal regulations.
- Loose-fitting supports are to be provided for all piping.
- Access platform is to be provided in accordance with local, state/provincial, and federal regulations.
- Oil and water separator must be protected from freezing.

All information, statements, data, advice and/or recommendations, including, without limitation, those relating to storage, loading/unloading, piping and transportation (collectively referred to herein as “information”) are believed to be accurate and reliable. However, no representation or warranty, express or implied, is made as to its completeness, accuracy, fitness or a particular purpose or any other matter, including, without limitation, that the practice or application of any such information is free of patent infringement or other intellectual property misappropriation. General Chemical is not engaged in the business of providing technical, operational, engineering or safety information for a fee, and, therefore, any such information provided herein has been furnished as an accommodation and without charge. All information provided herein is intended for use by persons having requisite knowledge, skill and experience in the chemical industry. General Chemical shall not be responsible or liable for the use, application or implementation of the information provided herein, and all such information is to be used at the risk, and in the sole judgment and discretion, of such persons, their employees, advisors and agents.