EASTOFLEX

amorphous polyolefin

Bulk Handling and Storage of Molten *Eastoflex* Amorphous Polyolefins

eastman

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Introduction

This publication contains information on bulk storage and handling of *Eastoflex* amorphous polyolefins (APOs), including tank components and materials as well as unloading tank cars and tank trucks. This information must be considered solely as a general guide in establishing procedures and facilities for handling these materials. Customers must determine for themselves the appropriate procedures and facilities for their particular operations.

This publication, pertinent Material Safety Data Sheets (MSDS), and other applicable safe handling information should be thoroughly reviewed prior to the handling of *Eastoflex* APOs. It is the customer's responsibility to direct and control the unloading of any chemical or material into or from bulk storage and handling facilities. Title to all chemicals or materials shipped pursuant to a destination contract shall vest in a customer upon arrival at customer's premises while on board common carrier. Otherwise, title passes to customer at shipping point.

Local and state regulations regarding the handling and storage of chemicals may vary widely. The Federal Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), National Fire Protection Association (NFPA), and a user's insurance company also impose safety standards. In addition, the U.S. Department of Transportation (DOT) prescribes rules and regulations for unloading hazardous materials from tank cars and tank trucks (see 49 CFR 100.199). Knowledge of these and other appropriate federal and state laws and regulations, as well as consultation with the proper authority, should provide guidance for developing adequate handling procedures and constructing appropriate storage facilities.

Benefits of Molten Amorphous Polyolefins

Eastoflex APO users who have switched from solid to molten form have done so for good reason. While specific operations will vary, volume users may be able to realize benefits including:

- Molten handling and storage reduces production cycle times and requires less energy.
- Significant labor savings compared with handling solid forms.
- No packaging scrap to manage, handle, and dispose of.
- Frees up needed warehouse space.
- Quicker delivery time for tank trucks versus freight trucks.

Thermal Characteristics of *Eastoflex* APOs

Thermal characteristics play an important role in how a material handles in molten form. At room temperature, *Eastoflex* APOs are noncrystalline, waxlike, slightly tacky solids. With increasing temperature, APOs soften

and become more tacky. *Eastoflex* APOs do not have a sharp melting point but rather are heavy, viscous liquids at 150° to 160°C (302° to 320°F). They can be pumped readily at temperatures from 175° to 200°C (350° to 390°F).

For uniformity, the data in this publication is based on a 190°C (375°F) melt temperature, the preferred temperature for bulk handling. Curves based on the data should not be viewed as specification values but rather as averages representing performance that may be considered typical.

Eastoflex APOs are stable at room temperature. In addition, they are sufficiently stable for many open-air applications. For example, they can usually be exposed to air for several hours in the reservoir of a coater / laminator without serious degradation. However, when the coater / laminator is not in use, the reservoir heat should be reduced or turned off to minimize polymer degradation. In addition, the reservoir should be emptied and cleaned periodically.

When exposed to oxygen at elevated temperatures for more than several hours, the viscosity of *Eastoflex* APOs is reduced and color darkens. For optimum stability under such conditions, the molten material should be handled entirely in closed systems blanketed with an inert gas, such as nitrogen. Molten material can be stored satisfactorily under nitrogen in a steel tank at 175° to 200°C (350° to 390°F) and remains stable when standing in a closed, heated line.

For safe, efficient handling in bulk quantities, *Eastoflex* APOs should be kept molten; they should be stored in heated, insulated tanks under an inert, gaseous blanket; and they should be pumped through heated, insulated lines using heated, insulated pumps. Lines and tanks can be heated using hot oil, electric heaters, or steam at 250 to 350 psig.

If an *Eastoflex* APO solidifies in the tank, considerable time may be required to remelt it. Remelt time can be reduced by circulating the material with a pump as it melts. A heated, insulated circulating line should be used between the pump and the tank. Circulating a molten APO during storage keeps it at a nearly uniform temperature in the tank.

When handling molten *Eastoflex* APOs, safety precautions normally followed for shipping hot liquids should be observed. These should include the use of protective clothing and equipment to avoid thermal burns.

If molten material is spilled on storage tank or transfer line insulation where it is subjected to high temperatures from the heating medium within, it may oxidize rapidly enough to burn. The customer is responsible for cleaning up such spills immediately and replacing damaged insulation.

The following pages are general guidelines only. The comprehensive Department of Transportation (DOT) regulations should be consulted and observed. It is the user's responsibility to comply with all laws and regulations governing the unloading of tank cars and tank trucks.

Bulk Equipment

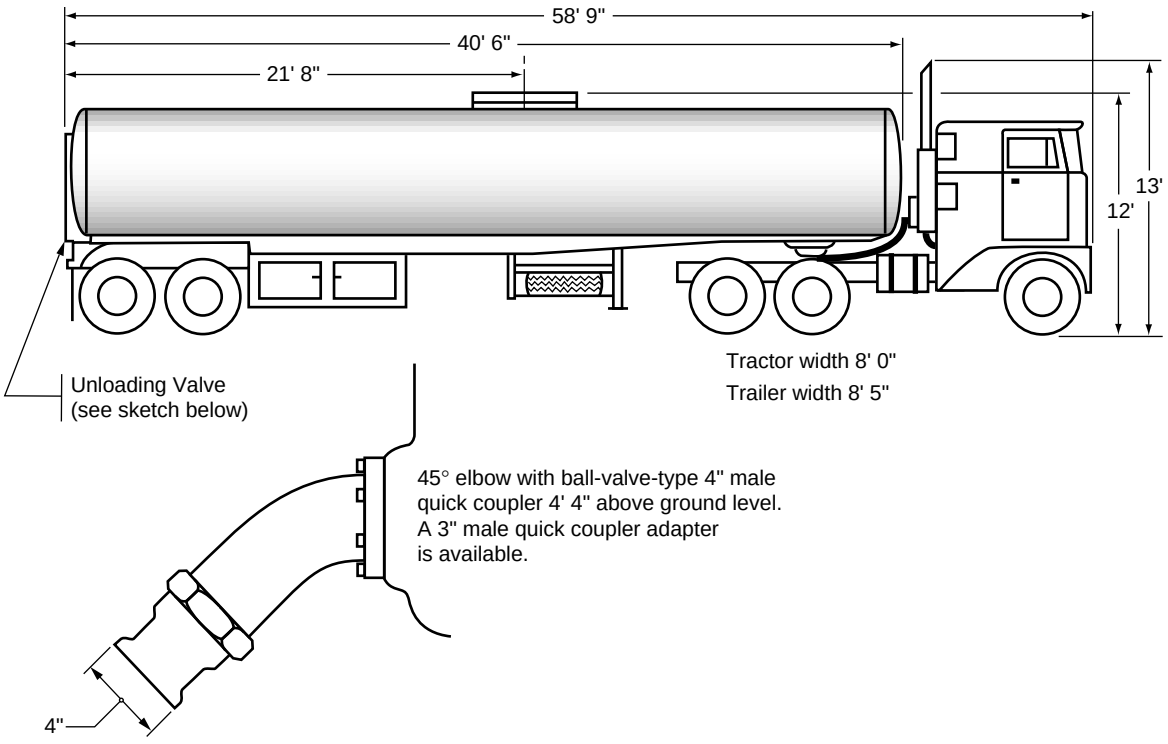
Tank Truck

Eastoflex APOs are shipped in 6,800–7,200 gallon (42,000–44,000 pound) insulated tank trucks. Figure 1 shows the pertinent outside dimensions of the truck.

Each tank truck is equipped with electric heaters powered by a diesel generator. These maintain the temperature of the material around 175° to 200°C (350° to 390°F) to keep it molten and pumpable during transit. An external 240-volt power source may also be connected to the heaters. The truck is not equipped with an unloading hose.

Figure 1

Typical Tank Truck Configuration
6,800–7,200 gal (42,000–44,000 lb)

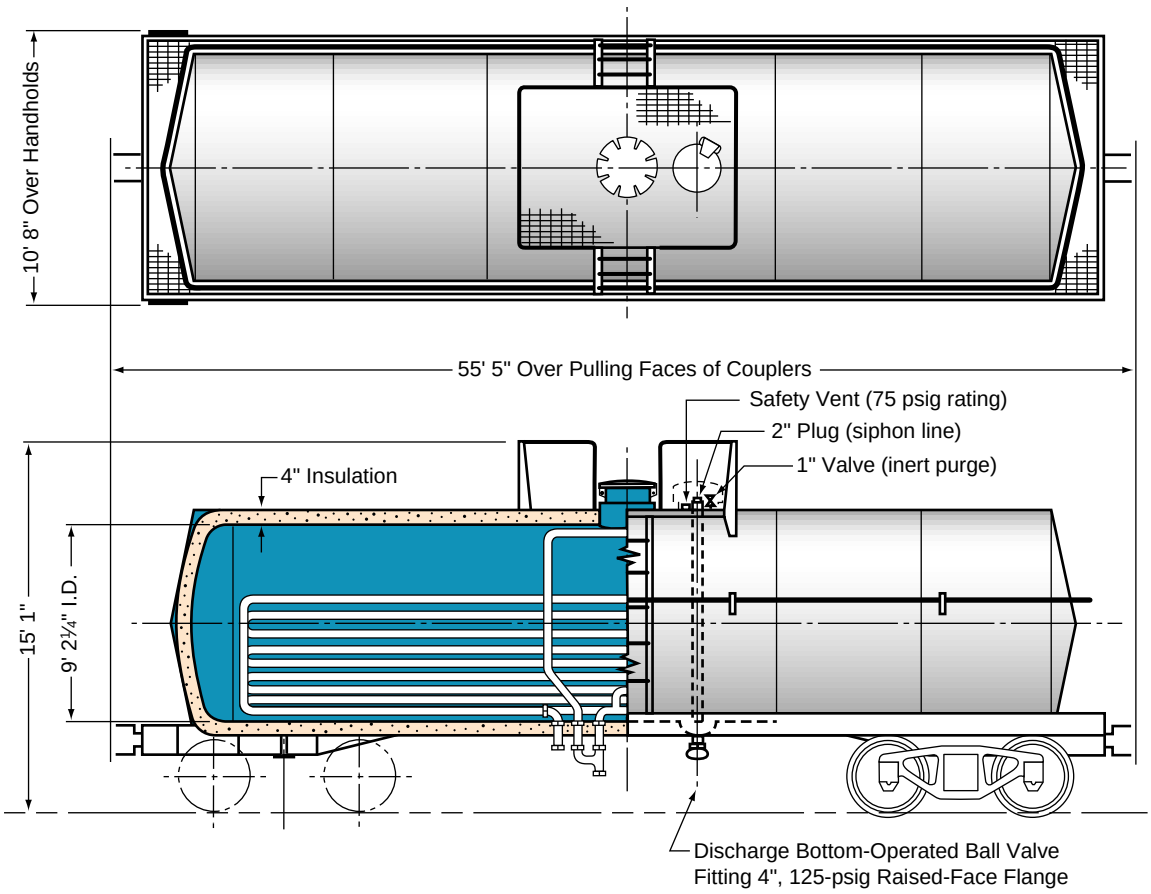


Tank Car

For customers with railroad facilities, *Eastoflex* APOs are shipped in 23,500-gallon (140,000-pound) insulated rail tank cars. No provision is made to heat the tank car en route. However, there are 20 runs of 6-inch, half-oval pipe welded to the tank. Since the pipe is not rated for steam pressures above 200 psig, hot oil should be used to reheat the material to the minimum off-loading temperature of 175°C (350°F). Tank car details are shown in Figure 2.

Figure 2

Typical Tank Car Configuration
23,500 gal (140,000 lb)



NOTE: 1. Twenty external coils with approximately 440 sq ft surface area. Coil volume approximately 440 gal.

2. Since cooling takes place from the outside inward during transit, the material will normally have a molten core on arrival. To conserve energy, the material should be reliquefied and off-loaded into fixed storage facilities as soon as possible.

Tank Truck

The product discharge connection is at the rear of the truck (Figure 1). It has an unloading discharge fitting below the valve on a 45° elbow 52 inches above ground level.

The unloading (suction) line should be straight and short. It should be heated and, if possible, insulated. If the entire line cannot be heated, it should be thoroughly drained after each unloading operation. Customer is responsible for assuring that chemicals are not drained inappropriately into the environment. A short length of insulated, flexible metal hose on the end of the intake line will simplify joining the fitting to the tank truck discharge fitting. The unloading hose must be free of moisture before unloading is started. A rubber hose is not suggested for this use since it cannot be heated. Heating is required if the material cools and flow is restricted or stopped inside the hose. With a flexible metal hose, flow of the APO can be restored by carefully heating the outside of the hose.

IT IS ESSENTIAL THAT CARE BE TAKEN WHEN HOT OIL IS USED AS A HEATING MEDIUM. HOT OIL AND WATER CREATE A VERY HAZARDOUS SITUATION. Any residual condensate must be blown thoroughly from the internal heating coils with hot, dry, compressed air before the coils are connected to the hot-oil line. Customer is responsible for proper disposal of such condensate.

With the contents at 175°C (350°F), a 3-inch gear pump can unload the tank truck in approximately 2 to 4 hours. The unloading rate depends on diameters and lengths of the pump intake and discharge lines, and viscosity of the molten product. An inert gas pressure of about 25 psi on the contents of the trailer will shorten the unloading time.

Tank Car

The car is not heated during transit; it will be necessary to reheat the car for 24 to 60 hours, depending on the temperature of the APO upon arrival. A heating medium capable of providing 300,000 Btu / h will produce an unloading temperature of at least 175°C (350°F). Hot oil at 218°C (425°F) is suggested.

When heating a tank car for unloading, the dome-lid swing bolts should be loosened and dropped down and the dome lid should be wedged open about 1 inch. When heating is complete, the dome lid should be closed and the bolts tightened so that inert gas pressure can be put on the tank car to accelerate unloading.

An unloading line similar to the one suggested above for tank trucks should be suitable. The unloading nozzle on the rail tank car is fitted with a 4-inch raised-face flange.

Pumps

A jacketed gear or screw pump that can handle materials ranging in temperature from 175° to 200°C (350° to 390°F) is suggested for pumping *Eastoflex* APOs. RECIPROCATING AND CENTRIFUGAL PUMPS ARE NOT RECOMMENDED.

Rotary positive-displacement pumps, such as gear and screw pumps, must be equipped with a discharge pressure-relief valve piped back to the pump intake line. In addition, a bypass line around the pump is suggested for regulating the pump discharge pressure and / or output. There should be a pressure gauge in the pump discharge line. A volumetric pressure gauge is suggested.

To achieve the maximum unloading rate, the pump and receiving storage tank should be as close to the unloading site as practical. When the tank car is nearly empty, the unloading rate should be decreased to permit the viscous material to drain from the walls toward the unloading outlet. This will allow the tank car to empty as completely as possible. A bypass line around the pump can be used to alter the pumping rate. Some pumps are limited to viscosities below 7,000 centipoises. For specific applications, pump manufacturers should be consulted.

Eastoflex APOs can be unloaded without the use of a pump. If unloading lines are large, short, and well-heated, 20 to 25 psi of nitrogen on the tank car or tank truck can readily force the material into the receiving tank.

Nitrogen Blanket—Carrier

In many cases, the viscosity of *Eastoflex* APOs will require that pressure be maintained on the carrier tank to achieve the optimum unloading rate.

A 1-inch threaded pipe is available for connecting the nitrogen supply to the tank truck. Tank cars are equipped with a 1-inch ball valve with standard pipe threads on top of the car for the inert gas inlet.

Approximately 10 cylinders of nitrogen will be required to maintain an inert gas pressure of 25 psi on a 7,200-gallon tank truck during unloading. Fourteen cylinders of nitrogen are needed to maintain pressure on a 13,000-gallon railcar during unloading; 25 cylinders of nitrogen will be required for a 23,500-gallon car.

Each tank car and tank truck is equipped with a relief valve. However, as an added safety factor, it is suggested that the customer provide a relief valve in the nitrogen supply system. A standard pressure regulator should be used on the nitrogen cylinders followed by a standard relief valve set at the maximum desired carrier pressure.

Tank

An insulated, clean, dry steel tank is adequate for storing molten APO. The tank should be sufficiently large to provide ample reserve storage between deliveries. It is suggested that the tank hold at least twice as much product as the carrier. This reserve capacity simplifies the scheduling of deliveries. In some instances, insulated tank cars that are no longer roadworthy have been converted into storage facilities.

The tank must be provided with a heating medium. Maintaining *Eastoflex* APO at 175°C (350°F) will require about 30 square feet of heating surface per 1,000-gallon storage capacity and the use of 204°C (400°F) hot oil or steam at 250 psig. Storage tanks can be heated by various means, including internal and external coils. The tank should be well insulated and protected from the weather. A metal covering will protect the insulation against spills.

The tank should be on a suitable foundation that meets federal, state, and local codes. To minimize static buildup, the tank should be properly grounded. Dikes to contain spills should be considered, depending on proximity to other buildings and equipment.

If any APO is spilled, check local regulations for disposal. Customer is responsible for proper disposal of any spilled material.

Copper acts as a catalyst for oxidizing amorphous polyolefins; its use should be avoided in any system designed to store or handle *Eastoflex* APOs.

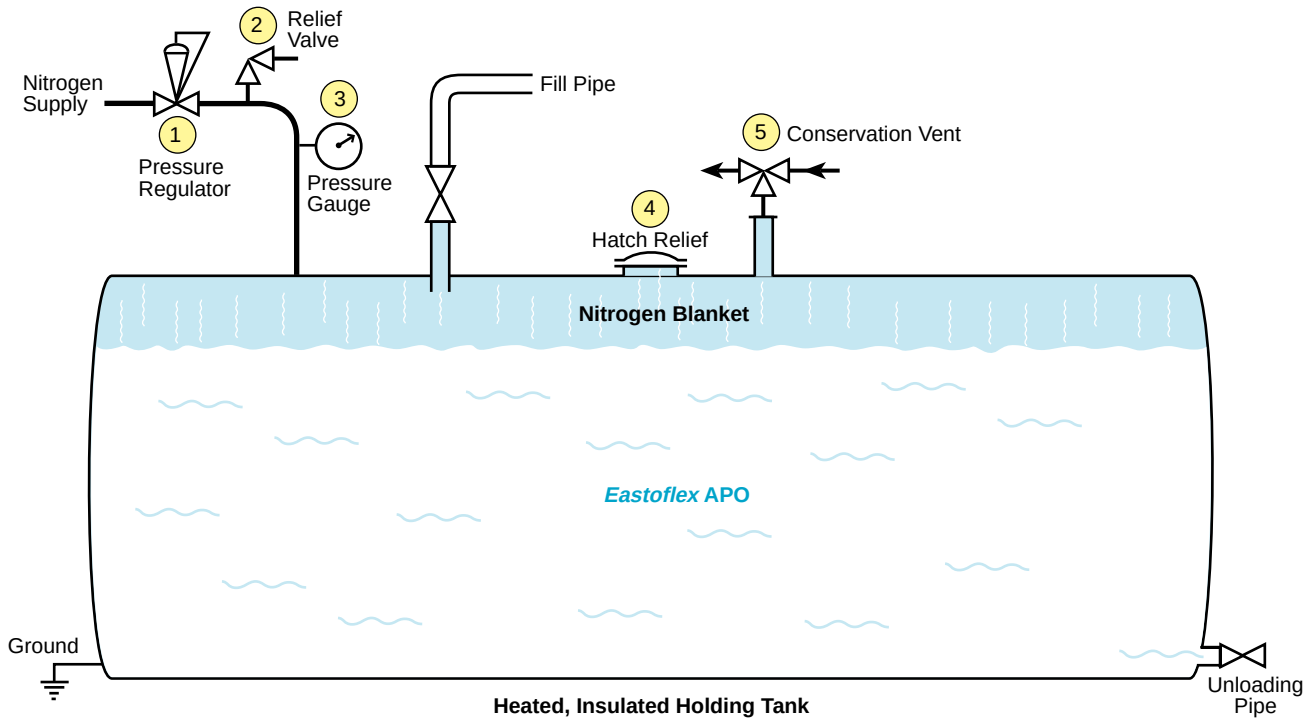
Nitrogen Blanket—Storage Tank

The vapor space between the contents and the top of the storage tank will contain some concentration of volatile organic compounds that will vary over time. Therefore, it is strongly suggested that the vapor space in the storage tank be treated as though it is between the lower and upper explosive limits. A nitrogen gas purge should be used to exclude air from materials that can form explosive mixtures. Blanketing the tank with inert nitrogen can remove oxygen that could otherwise contribute to ignition.

One possible design of the nitrogen system is shown in Figure 3.

Figure 3

Nitrogen Blanketing of Storage Tanks



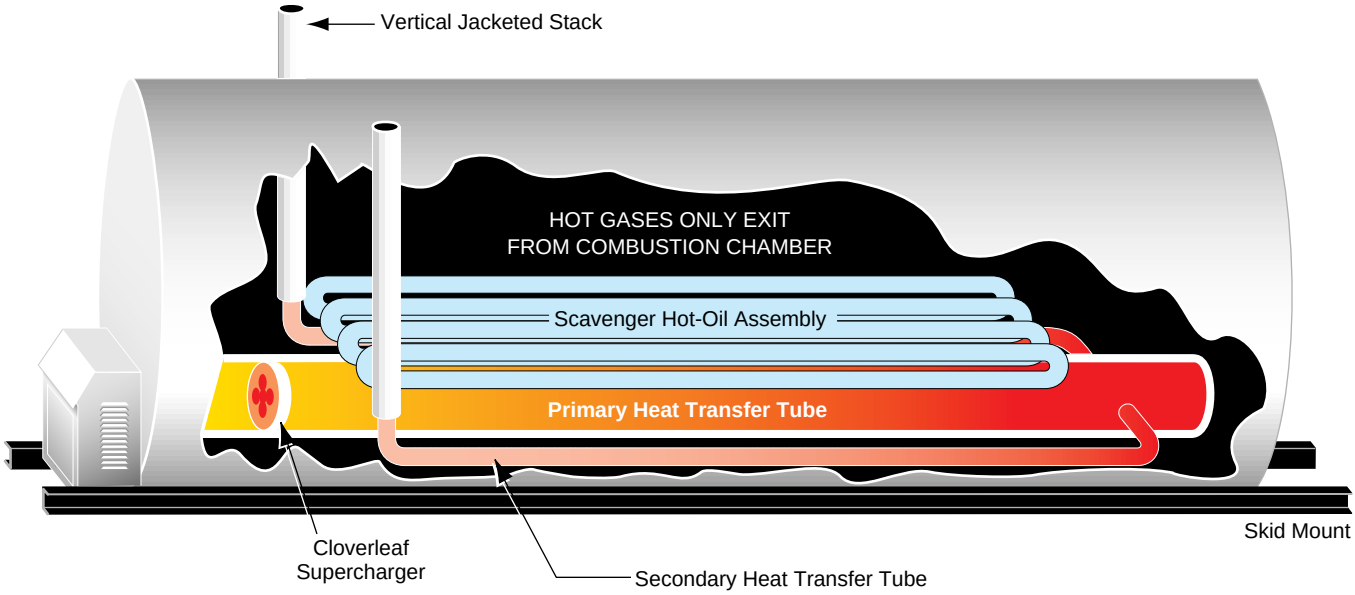
1. Self-contained pressure reducer to maintain tank pressure.
2. Relief valve.
3. Pressure gauge (or manometer if desired).
4. Hatch relief—relieves large surges in liquid or pressure.
5. Conservation vent—relieves excess pressure and vacuum.

Figure 4 illustrates one type of package unit system for storing molten *Eastoflex* amorphous polyolefins. Manufactured by Infern-O-Therm Corporation, Keyport, N.J., the unit is available in capacities of 10,000 to 30,000 gallons. The material is heated with a direct-fire heating tube that burns either natural gas, propane, or oil. The unit is also available with its own hot-oil heating system.

The Infern-O-Therm unit can be supplied skid-mounted and contains the circulating and transfer pump, provisions for nitrogen blanketing, and tank level measurement. These units have been used by customers for many years to handle molten *Eastoflex* APOs.

Figure 4

Infern-O-Therm Heating/Storage Unit



A list of equipment suppliers for handling molten amorphous polyolefins in bulk is given on page 10. These suppliers have been selected from available general literature sources. Their listing does not suggest that Eastman in any way warrants or guarantees the performance of the suppliers' products. Important information concerning the handling characteristics of *Eastoflex* amorphous polyolefins is given on page 11.

For additional information regarding *Eastoflex* APOs, please contact an Eastman representative.

Sources of Equipment for Handling and Storage of *Eastoflex* Amorphous Polyolefins

Complete Systems and Components

Infern-O-Therm Corporation
Foot of Locust Street
Keyport, NJ 07735 U.S.A.
732-264-7700
inferno@gateway.net

Thermoflux, Inc.
6506 South Lewis, Suite 116
Tulsa, OK 74136 U.S.A.
918-747-9394
sales@Thermoflux.com

Tanks

Columbian TecTank
(formerly Peabody TecTank)
2101 S. 21st Street
P.O. Box 996
Parsons, KS 67357 U.S.A.
316-421-0200
www.tanks.com

Pumps

Blackmer, A Dover
Resources Company
1809 Century Avenue, S.W.
Grand Rapids, MI 49509 U.S.A.
616-241-1611
www.blackmer.com

Roper Pump Company
P.O. Box 269
Commerce, GA 30529 U.S.A.
800-876-9160
www.roperpumps.com

IMO Pump
Dept. T, P.O. Box 5020
Monroe, NC 28111-5020 U.S.A.
704-289-6511
www.imo-pump.com

Viking Pump, Inc.
A Unit of IDEX Corp.
406 State Street, P.O. Box 8
Cedar Falls, IA 50613-0008 U.S.A.
319-266-1741
www.vikingpump.com

Maag Pump Systems Textron, Inc.
2915 Whitehall Park Drive
Charlotte, NC 28273 U.S.A.
800-622-4872 or 704-716-9000
www.maag.com

LCI Corporation
P.O. Box 16348
Charlotte, NC 28297-8804 U.S.A.
704-394-8341
info@icicorp.com

Heating

Sta-Warm Electric Company
P.O. Box 150-T
Ravenna, OH 44266 U.S.A.
888-STA-WARM (782-9276)

Nelson Heat Tracing Systems
EGS Electrical Group, LLC
4041-T S. Sheridan Road
Tulsa, OK 74145 U.S.A.
918-627-5530
www.nelsonheaters.net

Repco Heat Transfer, Inc.
2460 Cerritos Avenue
Long Beach, CA 90806 U.S.A.
562-426-2525

Thermon Industries, Inc.
P.O. Box 609
San Marcos, TX 78666 U.S.A.
512-396-5801
www.thermon.com

Nitrogen Supply

Parker Hannifin Corporation
(Balston)
Filtration & Separation Division
100 Ames Pond Drive
P.O. Box 1262
Tewksbury, MA 01876-0962 U.S.A.
800-343-4048
www.parker.com

Nitronics Systems, Inc.
1700 S. 120th Street, Unit B4
Lafayette, CO 80026 U.S.A.
303-604-1187
www.nitronics.com

Handling Characteristics of *Eastoflex* APOs

Solidification Temperature—This property is defined as the temperature at which the molten mass on cooling will not pour from an inverted beaker. For *Eastoflex* APOs, this temperature is 88° to 93°C (190° to 200°F).

Percent Shrinkage—A shrinkage in volume of 4% to 5% occurs when molten *Eastoflex* APOs solidify at room temperature.

Specific Heat—The specific heat of a substance is not a constant; it depends on the temperature range at which it is measured, generally increasing with increasing temperature. The specific heat of *Eastoflex* amorphous polyolefins varies from approximately 0.38 to 0.59 Btu / lb / °F over a temperature range of 20° to 175°C (68° to 350°F), as estimated from DSC data.

Viscosity—Typical viscosity values at various temperatures are given in Figure 5.

Figure 6 shows the density of *Eastoflex* APOs at various temperatures; Figures 7 through 9 show pressure drops in 2-, 3-, and 4-inch-diameter pipe. This information should prove helpful in sizing transfer and storage equipment such as piping, pumps, and tanks.

Figure 5

Eastoflex APOs—Viscosity vs. Temperature

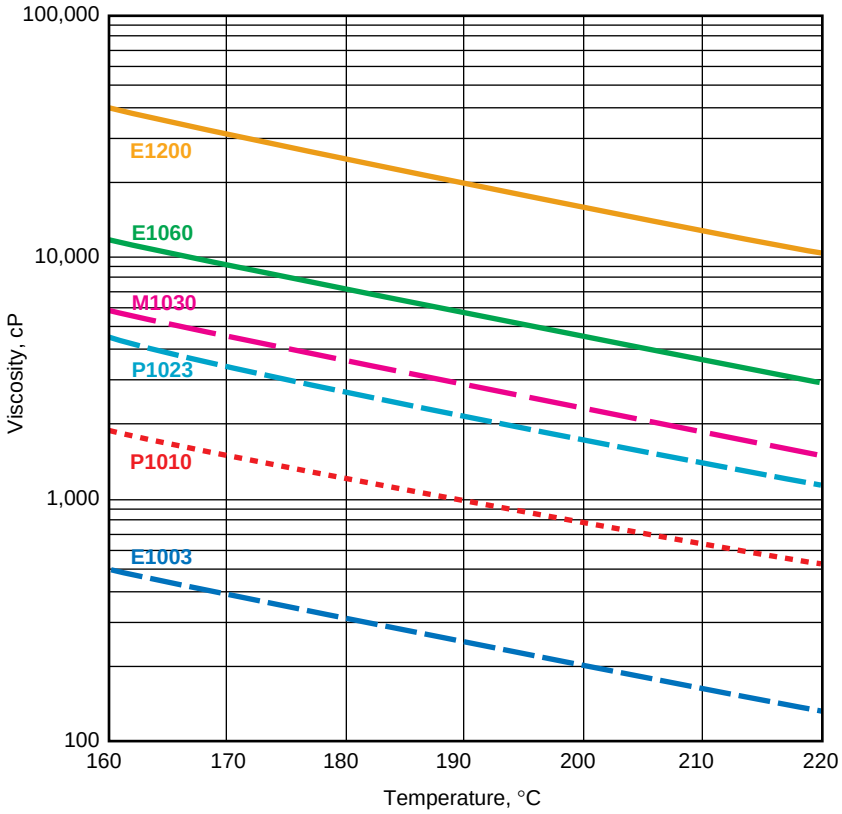


Figure 6

Eastoflex APOs—Density vs. Temperature

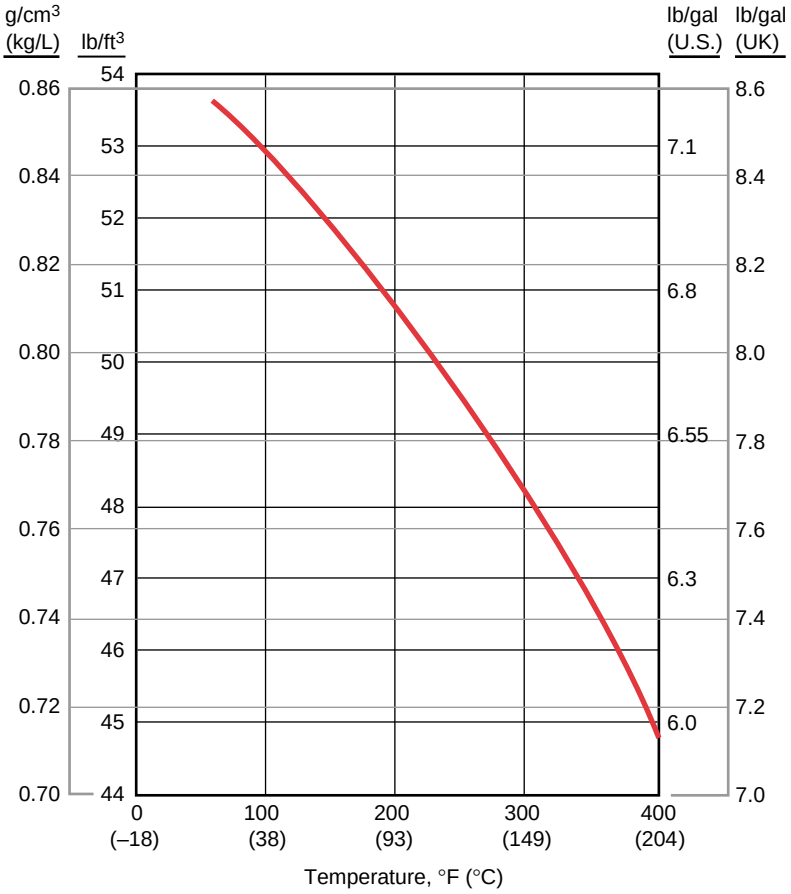


Figure 7

Pressure Drop per 100 ft of 2-in.-Diameter Pipe

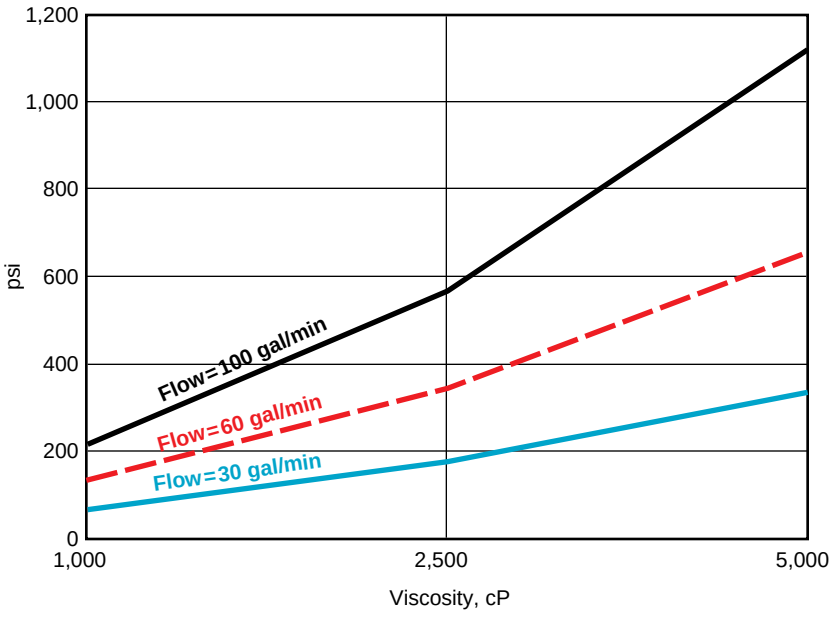


Figure 8

Pressure Drop per 100 ft of 3-in.-Diameter Pipe

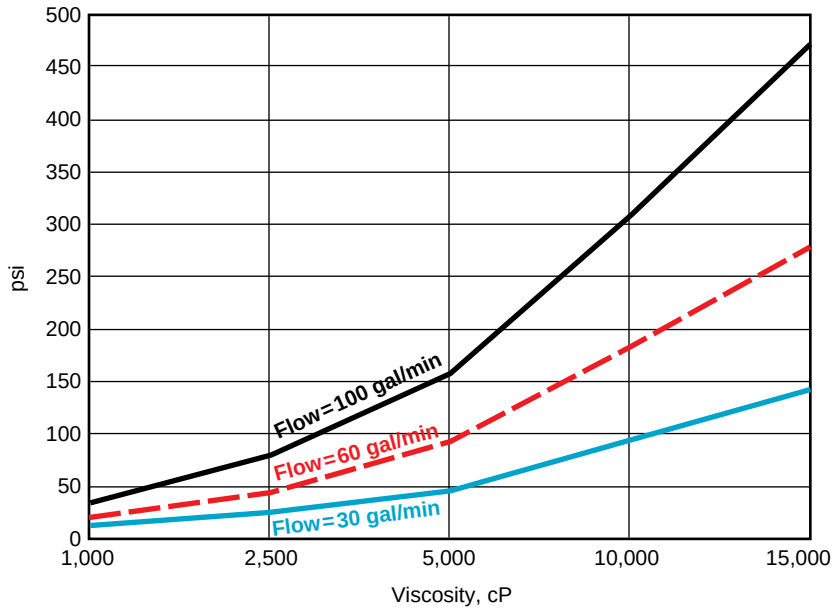
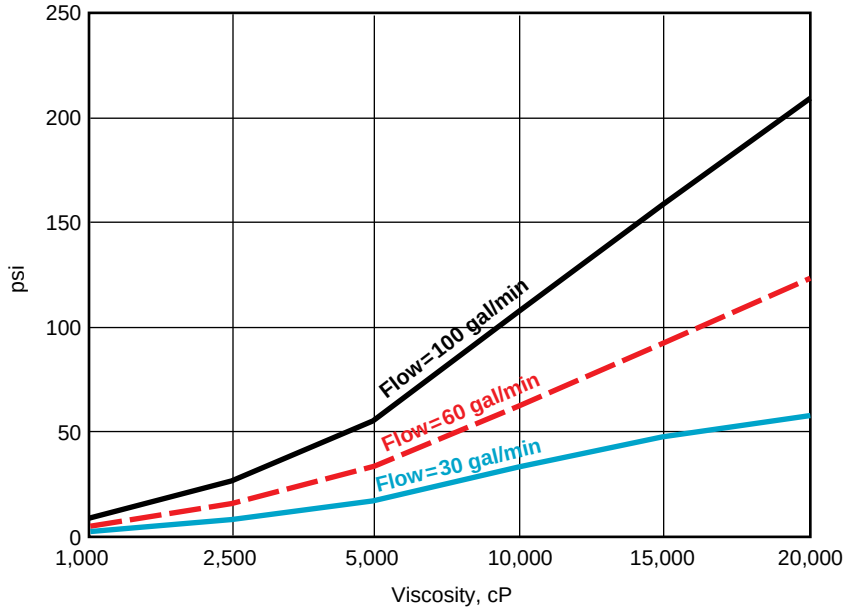


Figure 9

Pressure Drop per 100 ft of 4-in.-Diameter Pipe



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Material Safety Data Sheets providing safety precautions that should be observed in handling and storing Eastman products are available online or on request. You should obtain and review the available material safety information before handling any of these products. If any materials mentioned are not Eastman products, appropriate industrial hygiene and other safety precautions recommended by their manufacturers should be observed.

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