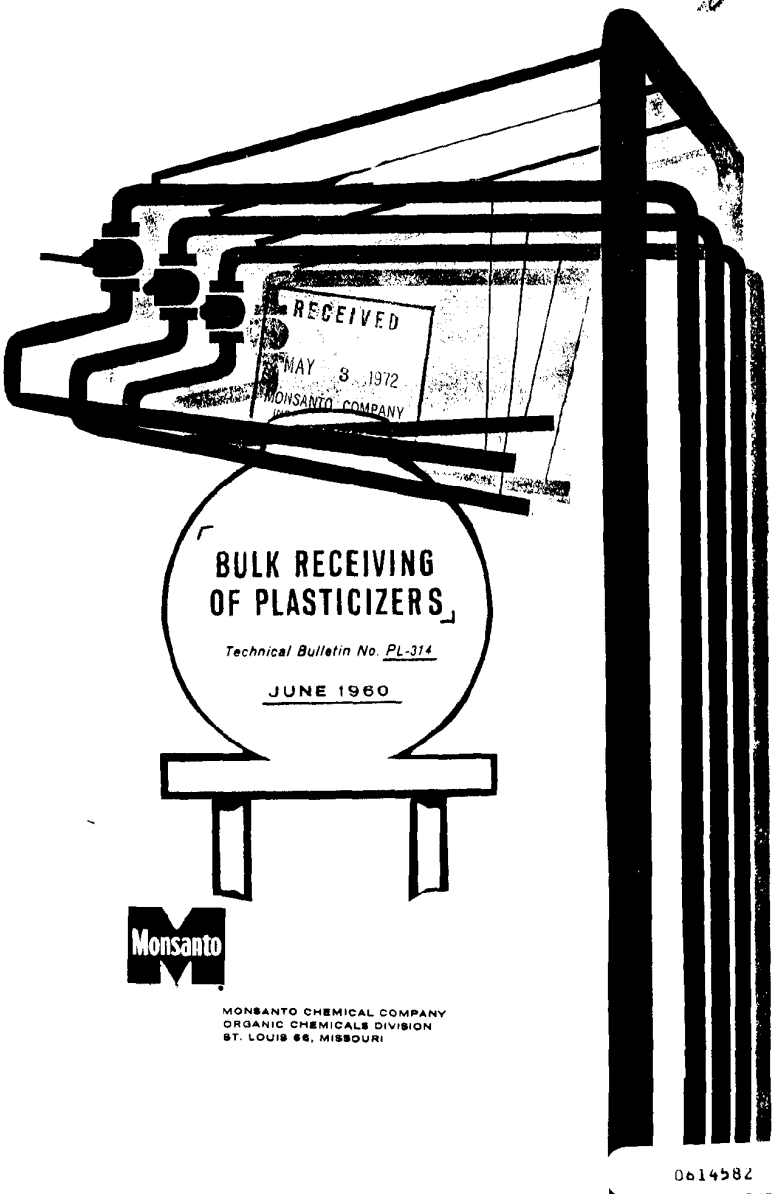
Plasticizers



BULK RECEIVING OF PLASTICIZERS

Technical Bulletin No. PL-314

JUNE 1960

Monsanto

MONSANTO CHEMICAL COMPANY
ORGANIC CHEMICALS DIVISION
ST. LOUIS 66, MISSOURI

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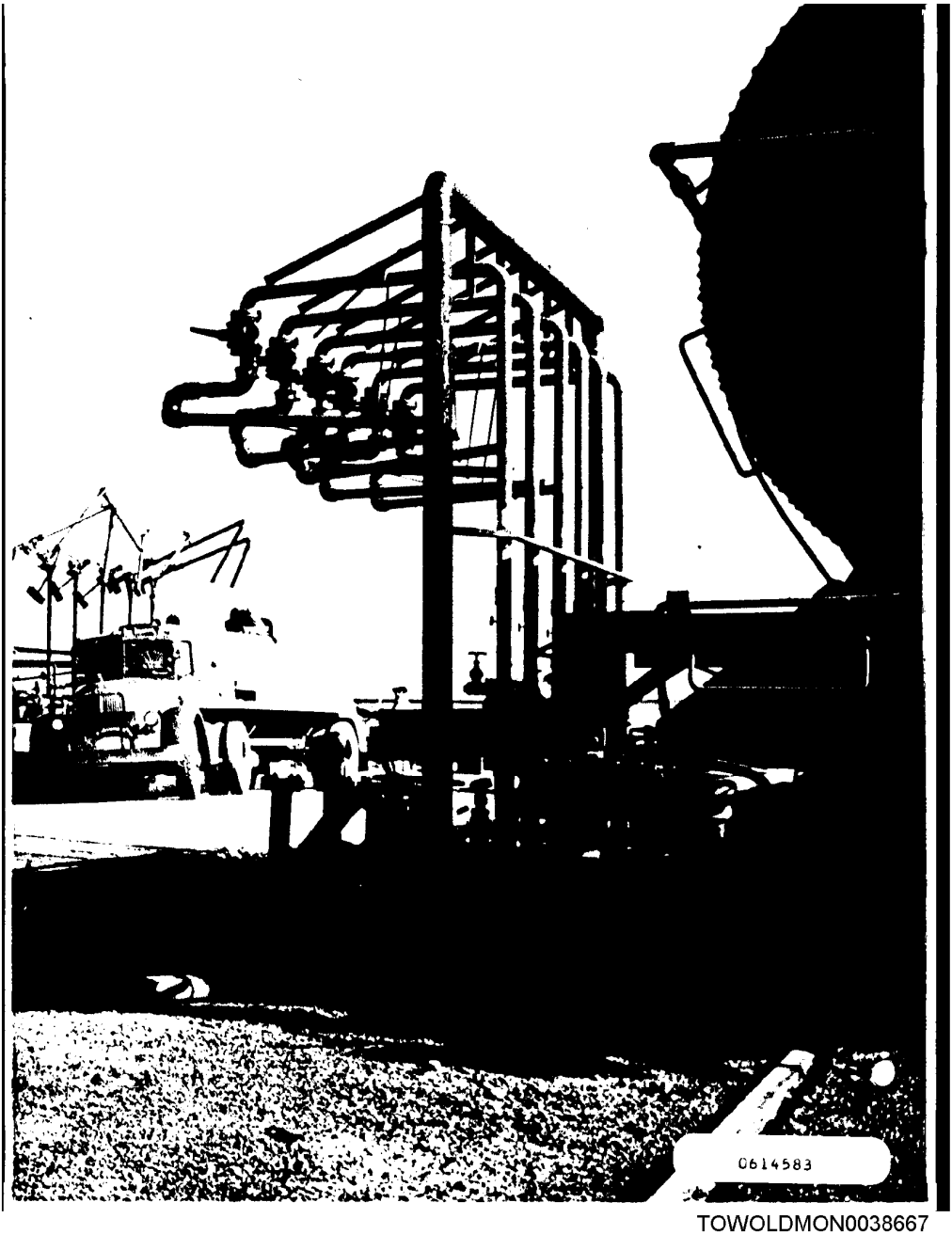

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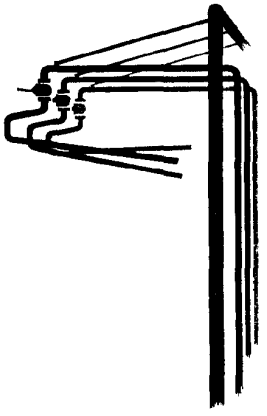

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This bulletin replaces Technical Bulletin No. 0-69, "The Bulk Tank Storage of Plasticizers," revised September 1955.

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RAW-MATERIAL HANDLING

Handling of raw materials is an important part of any manufacturing company's operations. Materials handling accounts for about 25 per cent of labor time for industry as a whole. About 10 per cent of all hourly employees work full time on handling materials. Large-volume usage of chemical raw materials by the rubber and plastics industries provides many opportunities for important savings in bulk buying, receiving, handling, and storage. In this bulletin are outlined several ways by which significant economies can be realized in the purchase and handling of plasticizers.

The contents of this bulletin include sections on Monsanto Chemical Company's delivery service, methods of bulk receipt and their advantages, technical details for a typical bulk-storage system, and properties of several Monsanto plasticizers frequently shipped by bulk methods.

BULK DELIVERY—FOR MAJOR COST CUTTING

Receiving of Monsanto plasticizers by tank car or tank truck contributes to reduction of raw-material costs in three ways. First, bulk selling prices average about ten per cent less than carlot and trucklot prices. Savings are even greater in comparison with less-than-carlot delivery in drums. Lower freight rates add more savings on f.o.b. items. Other significant savings are made possible by reductions in handling labor.

MONSANTO'S BULK-SHIPPING SERVICE

Nine bulk-storage stations, convenient to major plastics-producting centers, are maintained by Monsanto to service plasticizer customers. They are well kept, and care is taken to keep products free from all contaminants. Modern equipment and handling methods expedite shipments for fast delivery service.

Both tank-car and tank-truck service are available from the bulk-storage stations located at the three plasticizer production plants at:

Anniston, Alabama
Everett, Massachusetts
St. Louis, Missouri

The following bulk stations serve customers by tank trucks with Monsanto plasticizers:

Akron, Ohio
Greensboro, North Carolina
Houston, Texas
Long Beach, California
Miami, Florida
Perth Amboy, New Jersey

Monsanto supplies a wide variety of quality plasticizers. Offering more than eighty plasticizers, Monsanto produces the largest selection of plasticizers in the world. The nearest Monsanto bulk station is a one-stop center for all your plasticizer needs.

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MONSANTO'S NINE PLASTICIZER BULK STATIONS
The more frequently used plasticizers are generally stored at most bulk stations. Monsanto gladly works with customers to maintain convenient bulk storage of plasticizers, whenever the volume warrants it, to provide customers with the lowest cost and the most rapid service.

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METHODS OF BULK SHIPMENT

Liquid plasticizers can be delivered in bulk by railroad tank cars (from Anniston, Everett, or St. Louis) or by tank trucks. Various factors determine whether rail or truck delivery is more practical and economical.

Tank trucks are gaining rapid acceptance for bulk deliveries up to about 300 miles. Beyond that distance bulk deliveries are usually made by tank cars. Tank trucks are more versatile and flexible than tank cars. They do not require special railroad spurs. Frequently, faster delivery can be assured because the tank truck is a single unit, not dependent upon the schedules for an entire train of cars. When necessary, smaller quantities can be carried in tank trucks than in tank cars.

Tank cars vary in capacity from a minimum of 4000 gallons to 10,000 gallons. Tank trucks usually carry 3000 to 4000 gallons per shipment depending upon state highway regulations. Minimum tank-truck orders for 2000 gallons qualify for the tank-car price within established delivery zones. Both tank cars and tank trucks are available with two or three compartments for combined shipment of two or three different plasticizers. In compartmented delivery, the Monsanto customer receives the bulk price on each plasticizer—a distinct advantage for small individual usage of several plasticizers.

BULK-STORAGE SYSTEMS

Suitable equipment must be available to permit receiving and storage of bulk plasticizer shipments. The larger the volume of single delivery, the larger is the storage equipment needed, and the larger the capital investment. On the other hand, as volume increases, so do the savings on handling.

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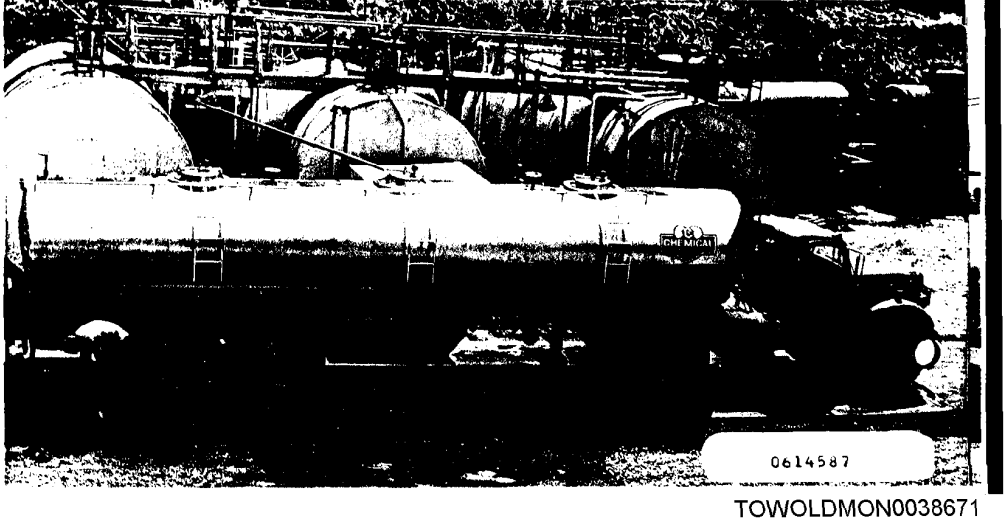

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Basic elements of a bulk-storage-and-handling system are one or more storage tanks, pipe lines, valves, a pump, and a filter. The number and size of the storage tanks depend on the volume of delivery, rate of plasticizer usage, delivery time, and distance from the Monsanto bulk station. Sufficient reserve capacity should be allowed for possible in-transit delivery delays. Details of construction and operation of bulk-storage-and-handling equipment are described in the next sections of this bulletin. The properties of Monsanto plasticizers typically shipped by bulk methods are also listed in detail at the end of the bulletin. These properties are helpful in design of the storage-and-handling facilities.

Storage tanks are not always necessary for receiving liquid plasticizer by bulk shipment. If the bulk shipment can be used within a short time, a customer can supply the plant directly from the tank car, remaining on the siding. Railroads allow two days to unload a tank car but begin to charge demurrage after the second day unless the tank car is "trip-leased." If plasticizer usage is not quite large enough to warrant installation of storage facilities, a customer can also fill drums from the tank car or tank truck and thus realize the price saving from bulk delivery.

MATERIALS OF CONSTRUCTION

Corrosion problems are ordinarily not encountered in the storage and handling of plasticizers. Common steel is generally recommended for new storage facilities because of its lower cost. Existing equipment constructed of stainless steels, nickel, Monel, etc. are also suitable when available for conversion from other service.

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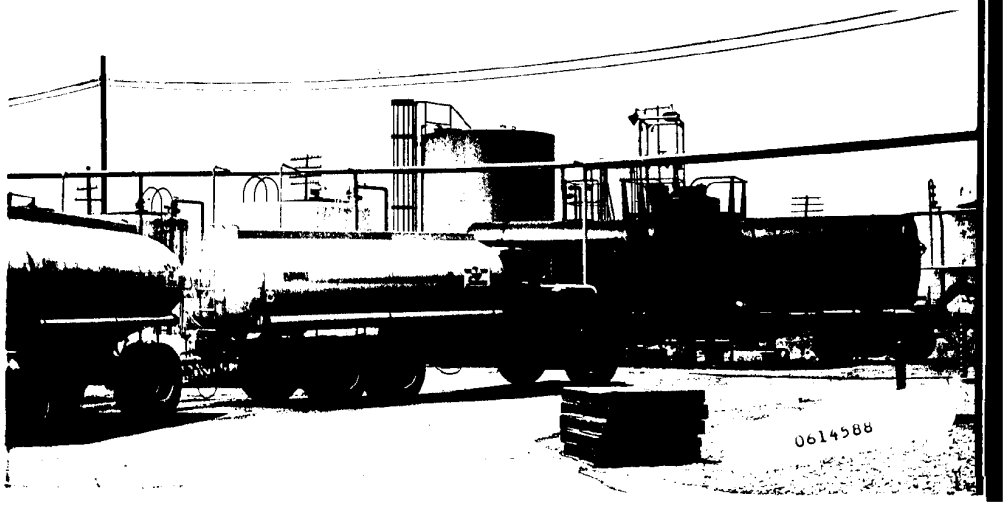

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STORAGE TANKS

Constructon

Vertical steel tanks of from 5000- to 25,000-gallon capacity, depending on storage requirements, are recommended. Construction of a typical storage tank is illustrated by Figure 1. Plasticizer-resistant topping (epoxy, polyester, or furane) is recommended to protect the concrete slab against spilled plasticizer. The top is fitted with a 24-inch flanged manhole for inspection, four 2-inch flanged nozzles, and a 6-inch nozzle. One 2-inch nozzle is fitted with a 2-inch, iron-pipe gooseneck for venting, and another is used as a charging inlet. The 2-inch charging line should be extended from the inlet nozzle to the bottom of the tank to prevent generation of static electricity by free-falling liquid. The other pair of 2-inch nozzles and the 6-inch one remain as spares. A 2-inch flanged nozzle is located at the bottom of the tank for unloading.

The unit is heated when necessary by external steam coils. The coils consist of ½-inch copper or steel tubing installed in two sections. One spiral section on about 18-inch centers is placed directly against the bottom. The other is wrapped on 18-inch centers around the lower third of the unit. The coil area is then shielded and insulated with conducting compound as shown in Figure 1. Steam pressure on the coils can be up to about 110 pounds. (Steam coils may not be necessary where extremely cold weather is unlikely or if rapid pumping during cold weather is not required. Storage tanks for polymeric plasticizers should be fitted with steam coils.)

The tanks are equipped with a guarded, vertical ladder; a working platform with adequate guard rails is installed on the top of the unit (Figure 2). Additional devices, such as liquid-level gauges and temperature regulators, may be added if desirable.

Horizontal, fuel-oil-storage tanks have proved satisfactory for smaller installations. Two 550-gallon tanks, such as the one shown in Figure 3, may be installed either above or below ground with common fill and outlet manifolds to handle a 1000-gallon tank-truck delivery.

To prevent electrolytic deterioration of underground steel storage tanks the following procedure is suggested:

Sandblast outside of tank. Apply coal tar-epoxy coating.

Bolt or clamp a sacrificial zinc or aluminum anode (about 3 feet long and 8 to 10 inches in diameter) to lugs on each side of the tank. Such anodes reportedly last about 10 to 15 years.

Back fill with sand and crushed gravel for good drainage. To prevent flotation of the empty tank, it should either be anchored or else covered by backfill heavy enough to exceed the buoyancy of the empty tank.

Approximate installation costs of various storage systems are as follows:

Capacity (gallons)	Cost Installed ($)	Capacity (gallons)	Cost Installed ($)
1,100 (2—550-gal. tanks)	8,00	15,000	7,000
5,000	3,800	20,000	9,000
10,000	5,500	25,000	11,000

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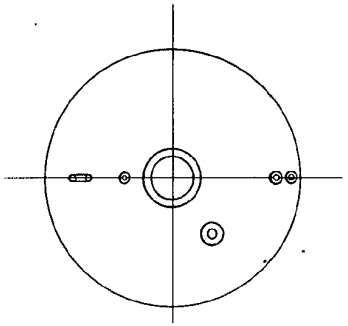
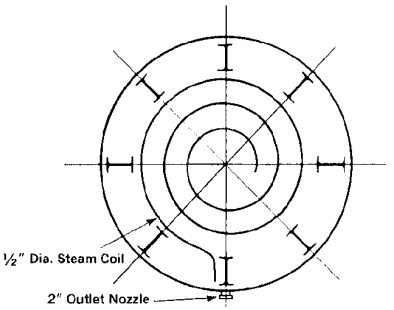
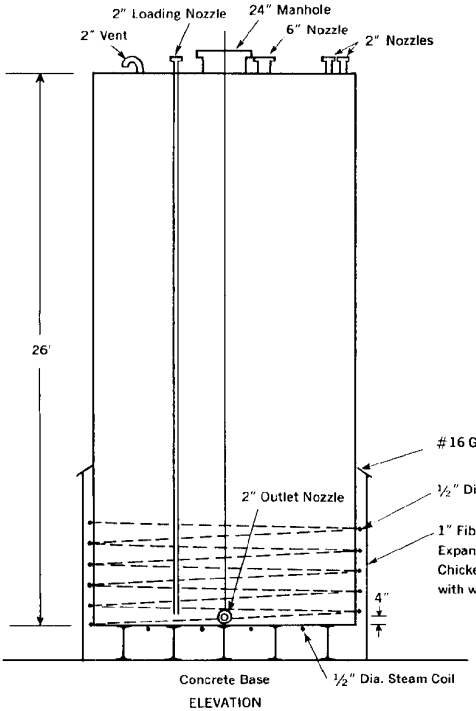


PLAN AT TOP



PLAN AT BOTTOM



ELEVATION

DIAMETER	CAPACITY
10'-0"	15,000 Gals.
11'-0"	19,000 Gals.
12'-0"	23,000 Gals.

Shell Thickness ⅜"

Top Head 7/16"

Bottom Head ½"

FIGURE 1—VERTICAL STORAGE TANK

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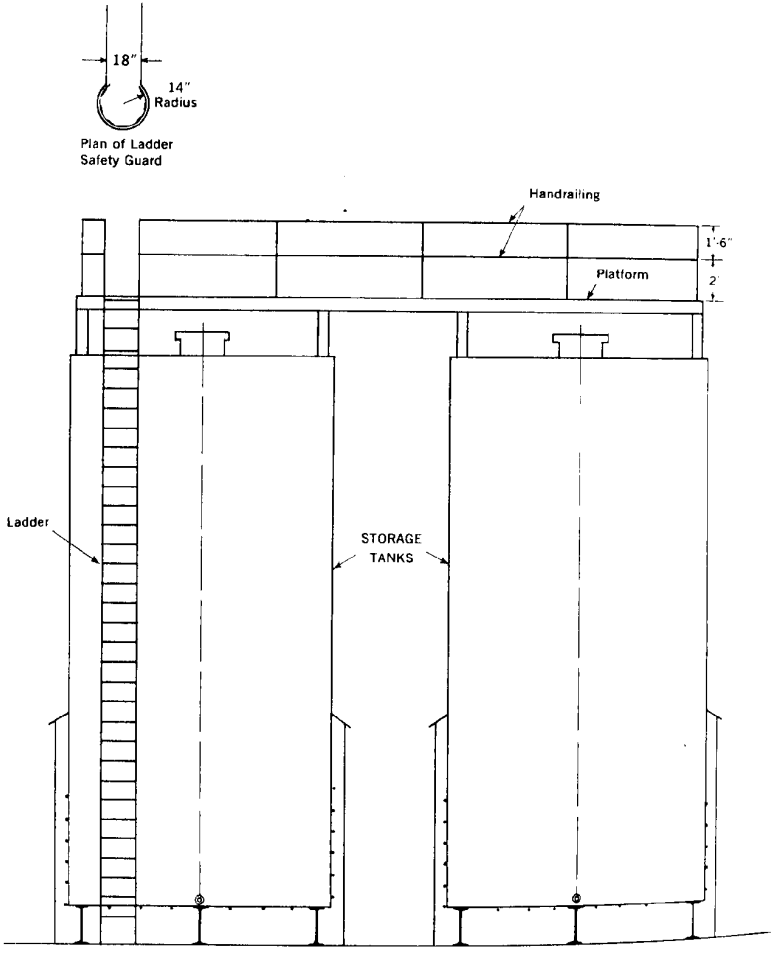

FIGURE 2—STORAGE TANKS WITH LADDER AND PLATFORM

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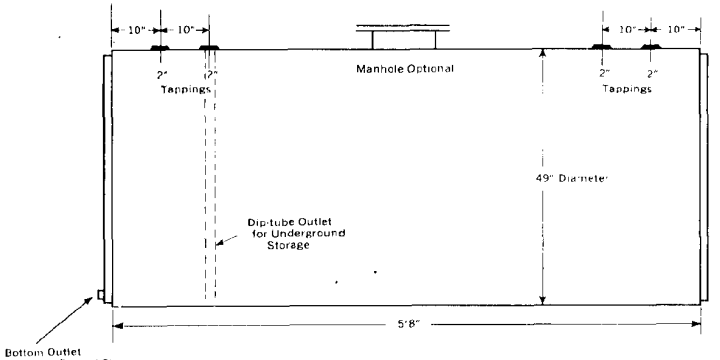
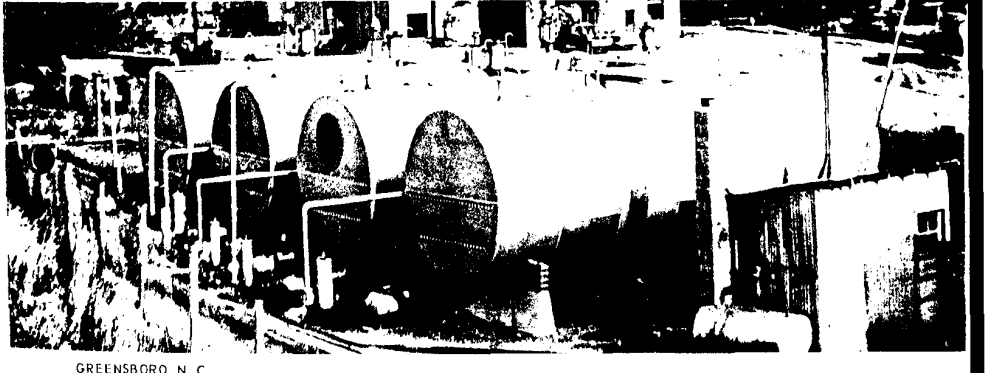


FIGURE 3—550-GALLON, 12-GAGE, FUEL-OIL-STORAGE TANK



GREENSBORO, N. C.

Preparation for Use

Thorough initial cleaning of steel storage units is necessary. The inside is first sandblasted (unless it is essentially rust free) to assure clean and smooth surfaces. When this operation is completed, the sand is removed, and the tank is swabbed or mopped with the plasticizer to be stored. This step should be done as promptly as possible after sandblasting to prevent re-rusting, particularly under conditions of high humidity. After mopping, which removes most of the dirt, a few hundred pounds of the plasticizer is charged to the tank to complete the cleaning. By means of a pump, temporary filter, and hose, the plasticizer is pumped from the tank through the filter and sprayed through the manhole down the walls of the tank until all dirt is removed.

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PIPE LINES

Recommended piping throughout the system is 2-inch steel with screwed unions. A suitable thread sealant is Permatex (trademark of the product manufactured by Permatex, Inc., Brooklyn, N.Y.). Welded pipe may be used instead of screwed connections, if periodic pipe changes are not anticipated. Heating of the lines when necessary is accomplished by tracing with a ⅜-inch or ½-inch paralleled steam line. A typical run of steam-traced pipe is shown in Figure 4. Steel plug valves are used throughout the system.

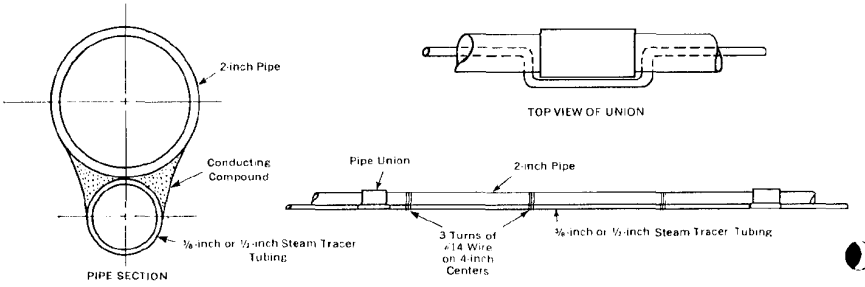

FIGURE 4—TYPICAL RUN OF STEAM-TRACED PIPE

PUMPS AND FILTERS

Self-priming, steel or bronze-lined, centrifugal pumps are recommended, though many types of pumps may be used. Pumps such as Duriron Pump, Dayton, Ohio (Series H) or Worthington Pump, Harrison, New Jersey are satisfactory. The pump should be located and installed so that it can both unload tank cars to the storage tanks and subsequently transfer the plasticizer from storage to production units. A non-self-priming centrifugal pump may be used if the outlet nozzle is as close to the bottom of the tank as piping will permit, and if the pump is not needed for top unloading of tank cars.

Valves should be located on both sides of the pump to provide shut-offs necessary during repairs or repacking of the pump. Asbestos packings (Garlock Inc., Palmyra, N.Y.) have proved satisfactory in most instances. A cartridge filter should be installed on the discharge side of the pump to remove extraneous matter and dirt. A diagrammatic piping arrangement is suggested in Figure 5.

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UNLOADING TANK CARS

It is recommended that tank cars be unloaded by pumping out through a standpipe placed through the dome opening. This method is preferred to bottom unloading to reduce the possibility of plasticizer leakage. Air pressure is not recommended for unloading because of the possibility of car rupture or loss of product by pipe failure.

Care should be exercised to prevent entry of moisture or other foreign matter into the car. The dome opening should be protected when the car is opened for sampling, final unloading, or at any other time.

The following unloading procedure is recommended:

1. Spot the car, set brakes, and block wheels.
2. Open car vent pipe, and check to insure that the lines are not blocked.
3. Provide a protective covering, and then open the dome cover.
4. Place a 2-inch standpipe in the car, and connect to the suction side of the pump.
5. Operate valves to direct the plasticizer to the intended receiver, and pump out contents of car.
6. When car is empty, stop the pump, close all valves necessary, and disconnect and remove standpipe.

In cold weather it may be necessary to warm the car contents before unloading. In such instances (after step 3) steam at 30 to 100 pounds' pressure is passed through the heating coils of the car until the contents are heated to 30° C. The remainder of the above procedure is then followed.

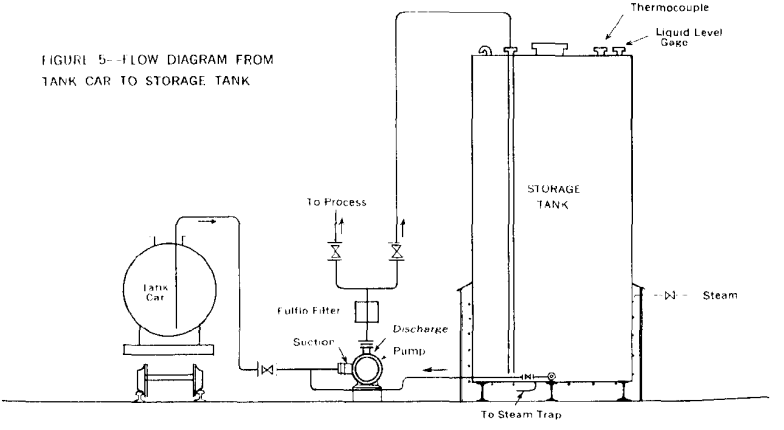

FIGURE 5--FLOW DIAGRAM FROM TANK CAR TO STORAGE TANK

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RETURNING EMPTY CARS

After the standpipe has been removed, close the dome cover and all other connections securely.

If the heating coils were used, remove all steam condensate by draining the coils and then blowing compressed air through them until dry.

Do not permit water or other foreign matter to enter the car.

UNLOADING TANK TRUCKS

Tank trucks are usually unloaded by a gasoline-driven pump, with spark-proof ignition and a flexible hose connection, that is permanently installed on the truck. Care should be taken to prevent entry of moisture or foreign matter in the same manner as for tank cars. The unloading area must be free from flammable solvents that might be ignited by the truck-engine or pump-engine exhaust. The truck driver should follow this recommended procedure:

1. Spot the truck, set brakes, and block wheels.
2. Open dome cover, and check to insure that the lines are completely open.
3. Provide a protective covering while the dome cover is open for product sampling, inspection, and unloading.
4. Connect flexible unloading line to intended receiver.
5. Set valves correctly to direct the plasticizer to the intended receiver, and pump out contents.
6. When truck is empty, stop the pump, close all valves necessary, and disconnect.
7. Properly close dome openings to keep out foreign material on return trip.

Heating of the truck contents is not normally required, since the product is loaded warm and since most trucks are insulated to maintain a sufficient temperature in transit. During cold weather, or when a viscous plasticizer is shipped, steam may be applied to the heating coils of the truck.

SAFETY PRECAUTIONS

Handling of plasticizers generally presents no serious safety hazards. Plasticizers are in general of low toxicity and do not give off appreciable vapors at temperatures ordinarily encountered in handling. However, before a tank that has contained a plasticizer is entered, it is advisable to blow clean, compressed air into the unit for a few hours. Workmen then entering the tank should wear an air mask as an added precaution.

Although flash points of plasticizers are rather high, open flames should be kept away from and out of storage units or tank cars. If welding, for example, must be done in a unit, boil out with water containing about one-percent caustic soda, flush, and reboil with clear water. Air the unit again, and check the safety of the atmosphere inside the unit with an explosion meter before proceeding with welding.

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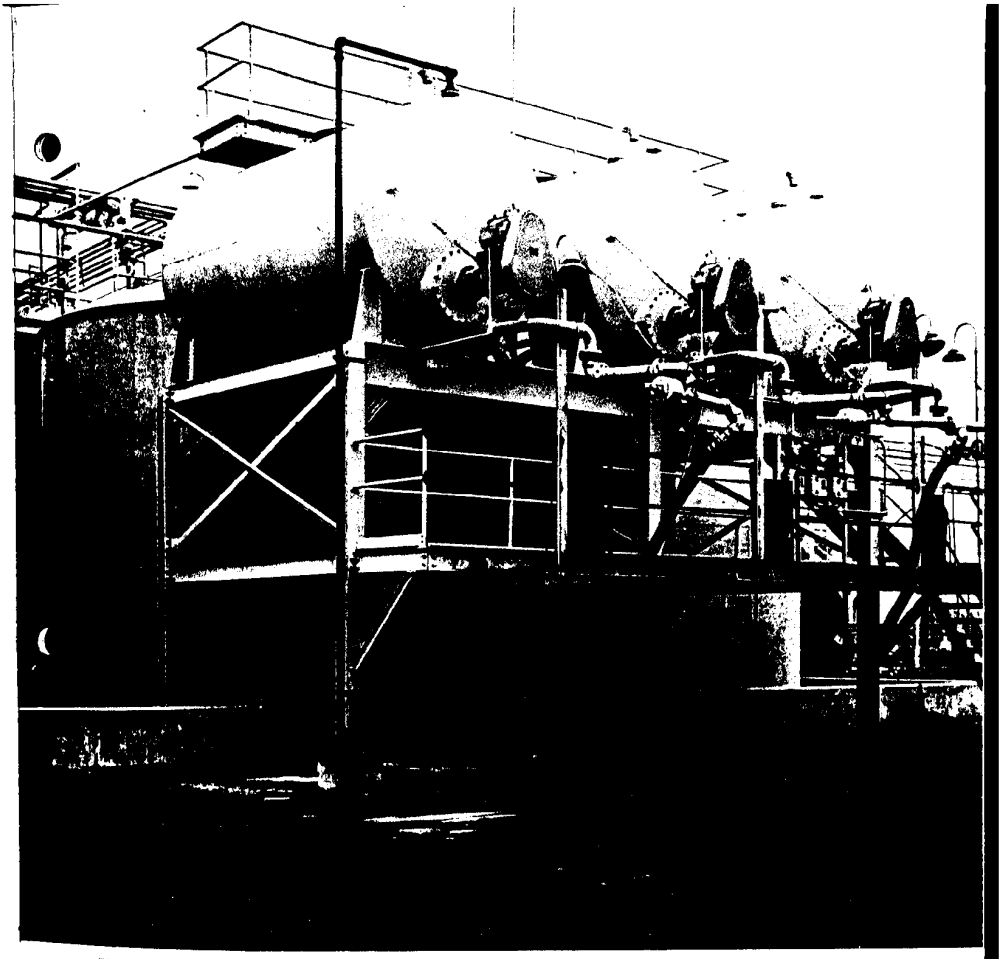

EVERETT, MASS.

Plasticizers splashed into the eyes may be somewhat irritating, but no serious eye injuries have been reported. The standard first-aid treatment is immediate and copious washing with water for at least five minutes. If discomfort persists, a physician should be consulted. Plasticizer that gets on the skin should be washed off with soap and water. They should not, of course, be taken internally.

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DATA ON MONSANTO PLASTICIZERS

Specific Gravity • Crystallizing Point • Flash Point • Viscosity

Plasticizer	Specific Gravity at 25°/25°C	Pour Point (°C)	Crystallizing Point (°C)	Flash Point (Cleveland Open Cup) (°F)	Flash Point (Cleveland Open Cup) (°C)	Viscosity (Centistokes) @100°F	Viscosity (Centistokes) @210°F
PHTHALATES							
Dibutyl	1.045		below —35	340	171	9.9	2.4
Diethyl	1.120		below — 0.3	305	152	6.4	1.8
Diisodecyl (DIDP)	0.965		—53	450	232	14	3.7
Diisooctyl (DIOP)	0.983		—45	430	221	27.4	4.3
Dimethyl	1.189		0	300	149	6.4	1.6
Dioctyl (DOP)	0.983		(gel) —55	425	218	29	4.2
Santicizer 160	1.116		below —35	390	199	18	3.0
Santicizer 165	0.991	—51		390	199	24.4	3.9
Santicizer 213	1.042	—43		305	152	12.9	2.7
Santicizer 214	0.951	—45		325	165	29.6	4.5
Santicizer 602	0.972	—45		412	211	34.5	5.0
Santicizer 603	0.982	—51		395	202	30.4	4.6
Santicizer 630	0.990	—40		370	188	30.5	4.3
Santicizer 631	0.987	—45		385	196	28.9	4.3
Santicizer 636	0.973						
ADIPATES							
Diisodecyl (DIDA)	0.919		below —50	425	218	14.5	3.6
Dioctyl (DOA)	0.927		below —70	377	192	8.2	2.4
Di (n-octyl, n-decyl) (DNODA)	0.916		— 5	401	205	9.5	2.8
Santicizer 644	0.922		below —50	395	202		
PHOSPHATES							
Tricresyl	1.162		below —35	470	245	40	4.0
Santicizer 140	1.208		below —35	450	232	18	2.8
Santicizer 141	1.090	—54		435	224	9.9	2.5
GLYCOLLATES							
Santicizer B-16	1.097		below —35	390	199	24	3.6
Santicizer E-15	1.180		20	386	197	26	2.9
Santicizer M-17	1.220		below —35	380	193	31	2.8
SULFONAMIDES							
Santicizer 8	1.190		0	345	174	120	6
POLYMERICS							
Santicizer 405	1.129	— 1				4800	310
Santicizer 407	1.084	16				2600	180
Santicizer 409	1.082	4		530	277	1294	122
SECONDARY							
HB-20	0.966	—54		320	160	9.5	2.1
HB-40	1.006	—26		345	174	29	3.8
Santicizer 216	0.874			322*	161*		
AROCLOR PLASTICIZERS							
Aroclor 1221	1.187	1		286	141	4.6	
Aroclor 1232	1.275	—35.5		305	152	6.8	
Aroclor 1242	1.386	—19		348	176	17	2.4
Aroclor 1248	1.410	— 7		379	193	42	3.1
Aroclor 1254	1.500	10		none	none	470	6.0

a) Tague Closed Cup

Santicizer, HB-20, HB-40, and Aroclor: Monsanto Chemical Co. trademarks. Registered in U.S. Patent Office

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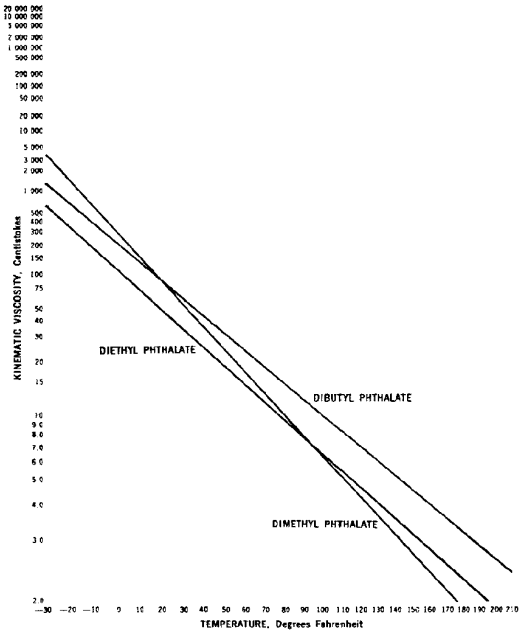

FIG. 6 — PHTHALATES (A) — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

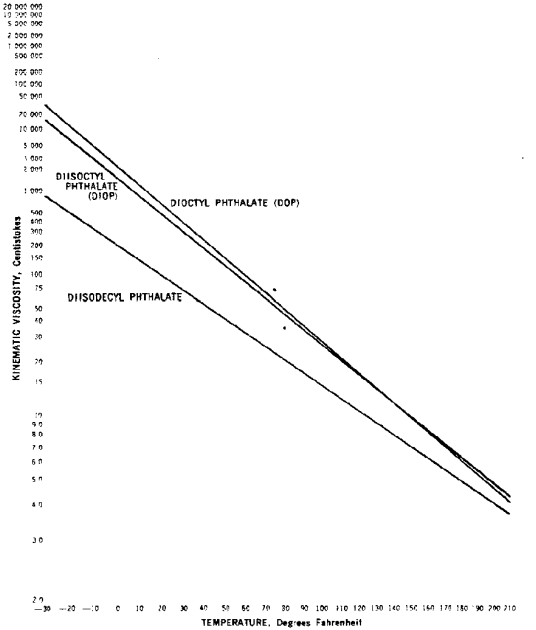

FIG. 7 — PHTHALATES (B) — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

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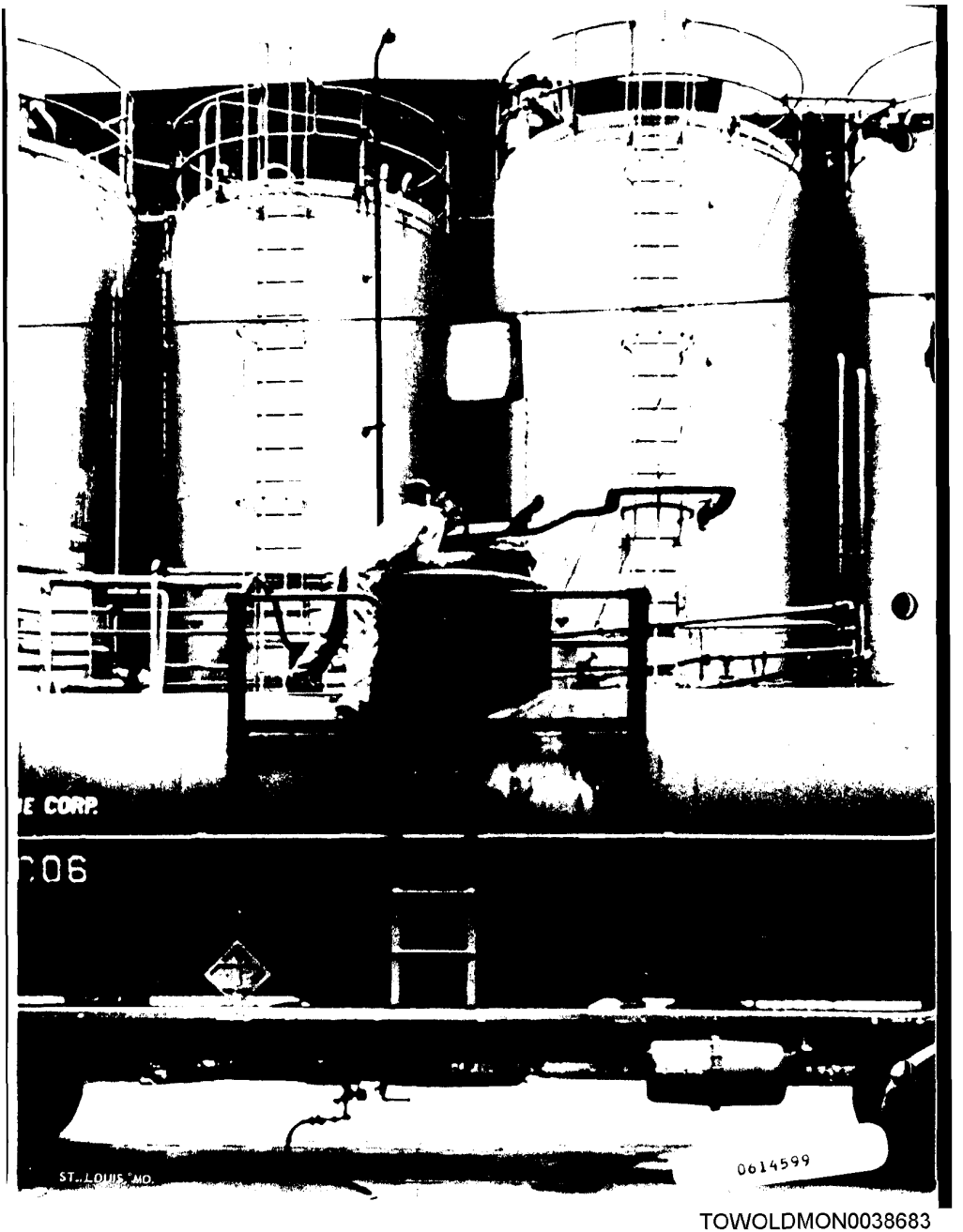

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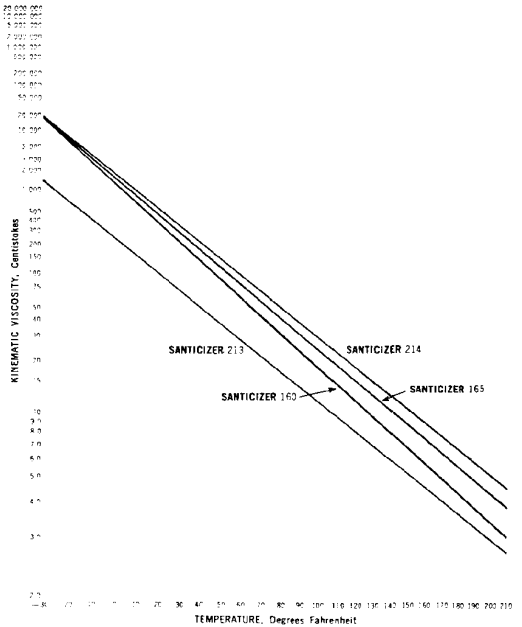

FIG. 8 — PHTHALATES (C) — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

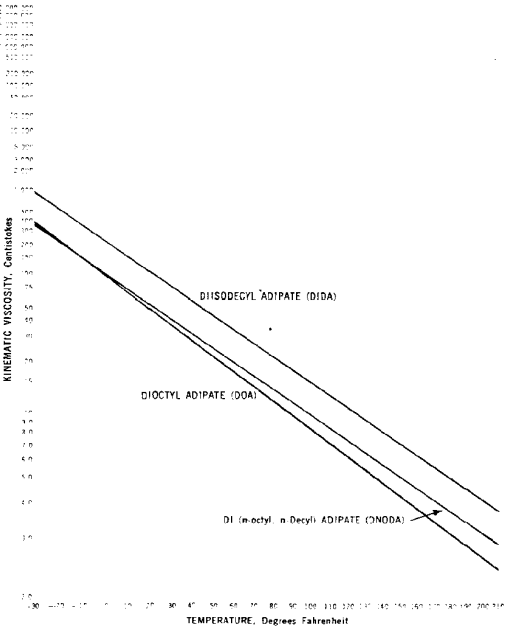

FIG. 9 — ADIPATES — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

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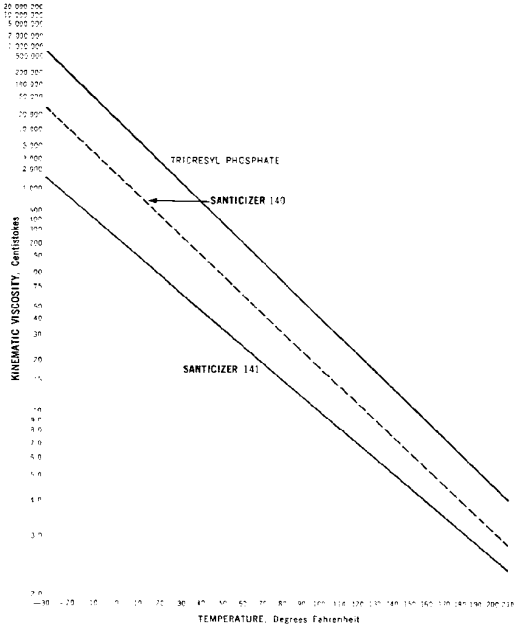

FIG. 10 — PHOSPHATES — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341-39) Modified

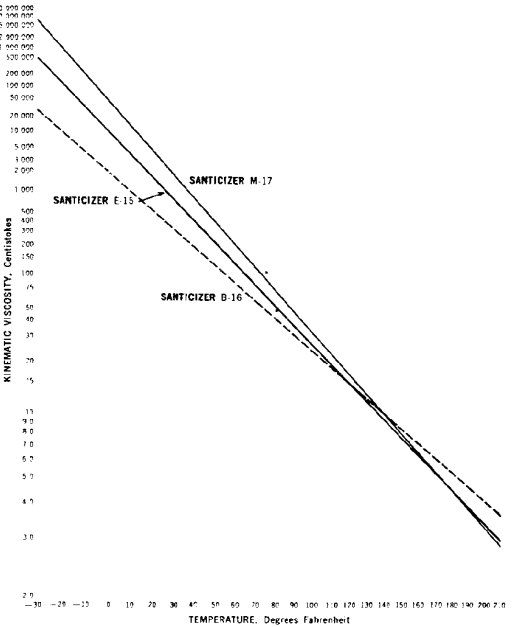

FIG. 11 — GLYCOLLATES — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341-39) Modified

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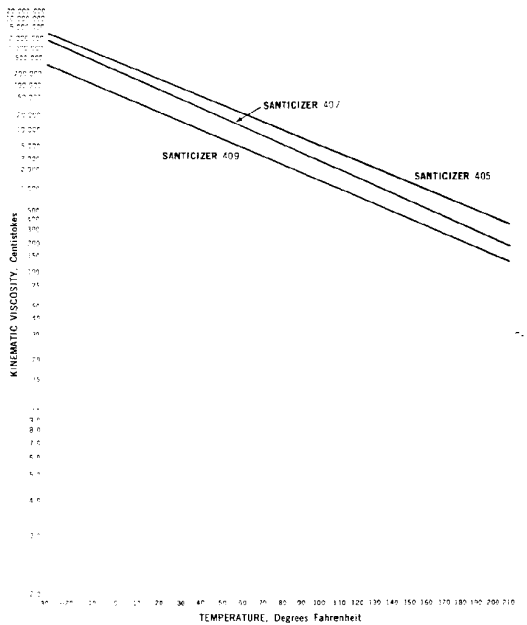

FIG. 12 — POLYMERICS — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

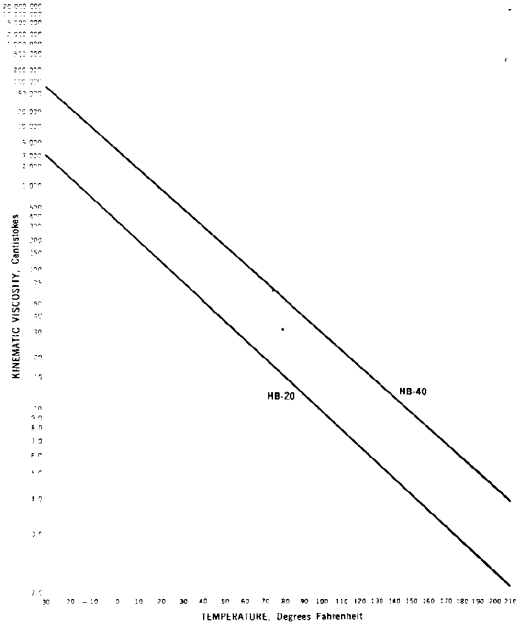

FIG. 13—SECONDARY PLASTICIZERS—VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

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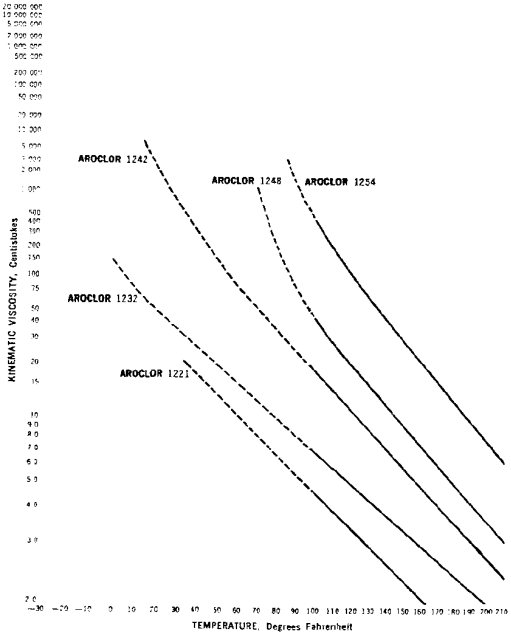

FIG. 14—AROCLOR PLASTICIZERS — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

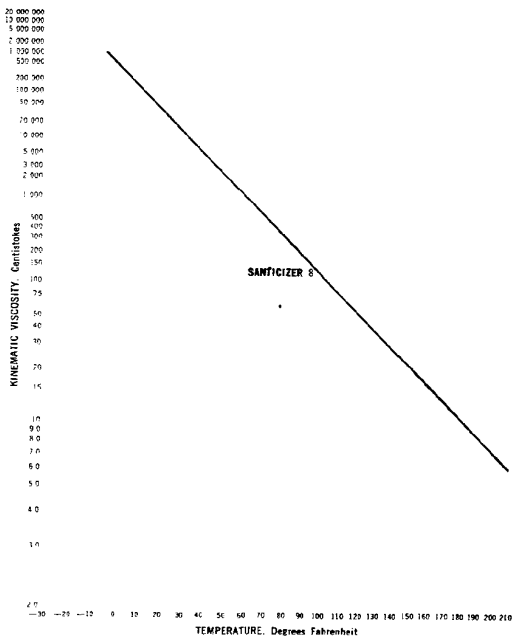

FIG. 15 — SULFONAMIDE — VISCOSITY-TEMPERATURE CHART
A.S.T.M. Standard Viscosity-Temperature Chart (D 341)

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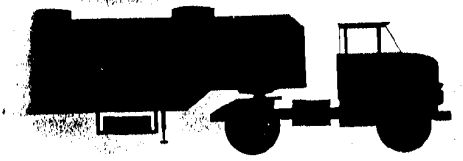

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