DuPont™ FM-200®
(HFC-227ea)

FIRE EXTINGUISHING AGENT

Properties, Uses, Storage, and Handling

DUPONT

The miracles of science™

DuPont™ FM-200® Fire Extinguishing Agent

Properties, Uses, Storage, and Handling

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Introduction

Chlorofluorocarbons (CFCs) and bromine-containing compounds such as the Halons (Halon 1301, Halon 1211) have many unique properties. They are low in toxicity, nonflammable, noncorrosive, and compatible with other materials. In addition, they offer thermodynamic and physical properties that make them ideal for a variety of uses. CFCs have been used as aerosol propellants, refrigerants, blowing agents for plastic foams, cleaning agents for metal and electronic components, and in many other applications. The Halons have been used as fire extinguishing agents and explosion suppressants for the protection of high-value equipment and assets, and have been employed in hand-held portable extinguishers, total flooding systems, and local application systems.

However, the atmospheric stability of these compounds, coupled with their bromine and/or chlorine content, has linked them to depletion of the earth's protective ozone layer. As a result, DuPont has stopped production of CFCs and Halons and introduced environmentally acceptable alternatives, such as FM-200®. FM-200® contains no bromine or chlorine; as a result, it does not contribute to the destruction of stratospheric ozone, i.e., FM-200® has an ozone depletion potential (ODP) of zero.

Chemical Properties of FM-200®

Chemical Name	1,1,1,2,3,3,3-heptafluoropropane
Molecular Formula	CF_3CHFCF_3
Molecular Weight	170.03
CAS Registry Number	431-89-0
ASHRAE Designation	HFC-227ea

Uses

FM-200® is listed as an acceptable replacement for Halon 1301 and Halon 1211 in the United States Environmental Protection Agency's Significant New Alternatives Policy (SNAP) program. FM-200® is a suitable fire extinguishing agent for total flooding, portable, and local application systems. FM-200® is noncorrosive, electrically nonconductive, free of residue, and characterized by low toxicity. It is ideally suited for protection of high-value assets such as those found in computer rooms, data control centers, telecommunication facilities, and museums.

The fire extinguishing concentrations of FM-200® allow it to be used as a total flooding agent in normally occupied spaces for the protection of Class A (solid), Class B (liquid and gas), and Class C (electrically energized) hazards.

FM-200® is also suitable for use as an inertion agent in explosion suppression applications.

Physical Properties

Physical properties of FM-200® are given in Tables 1 to 3 and Figures 1 and 2.

For complete thermodynamic properties, see DuPont Bulletin T-FM-200.

Table 1
Physical Properties of HFC-227ea

Property	
Chemical name	1,1,1,2,3,3,3-Heptafluoropropane
Chemical formula	CF_3CHFCF_3
Molecular Wt.	170.03
Boiling Point, 1 atm, °C (°F)	–16.34 (2.59)
Freezing Point, °C (°F)	–131 (–204)
Critical Temperature, °C (°F)	101.75 (215.1)
Critical Pressure, kPa (psia)	2925.0 (424.24)
Critical Density, kg/m^3 (lb/ft^3)	594.25 (37.098)
Liquid Density @ 25°C (77°F), kg/m^3 (lb/ft^3)	1387.7 (86.63)
Density, Saturated Vapor at Boiling Point, kg/m^3 (lb/ft^3)	8.4860 (0.52979)
Vapor Density @ 25°C (77°F) and 1 atm	7.1461 (0.4461)
Specific Heat, Liquid (Cp) @ 25°C (77°F), kJ/kg–°C (Btu/lb°F)	1.1816 (0.28242)
Specific Heat, Vapor (Cp) @ 25°C (77°F), kJ/kg–°C (Btu/lb°F) and 1 atm	0.81327 (0.81327)
Vapor Pressure, Saturated @ 25°C (77°F), kPa (psia)	454.73 (65.9)
Heat of Vaporization @ B.P., kJ/kg (Btu/lb)	131.77 (56.7)
Thermal Conductivity, Liquid @ 25°C (77°F), W/m–°C (Btu/hr-ft°F)	0.060491 (0.034975)
Thermal Conductivity, Vapor @ 1 atm, W/m–°C (Btu/hr-ft°F)	0.013336 (0.0077103)
Viscosity, Liquid @ 25°C (77°F), cP (lb/ft-hr)	0.23935 (0.57901)
Viscosity, Vapor @ 1 atm, cP (lb/ft-hr)	0.011590 (0.028038)
Relative dielectric strength @1 atm, 25°C (N_2=1)	2.00
Solubility of Water in HFC-227ea @ 20°C (68°F), ppm	600
Ozone Depletion Potential	0.0 (CFC-11 = 1)
Global Warming Potential, GWP (100 yr ITH. For CO_2, GWP = 1)	3220
Atmospheric Lifetime, years	34.2
TSCA Inventory Status	Reported/Included
European List of New Chemical Substances	EINECS, Listed (207-079-2)
SNAP Status	Listed
Inhalation Exposure Limit (AEL[a])	1000 ppm 8 hr and 12 hr TWA

[a] AEL (acceptable exposure limit) is an airborne exposure limit established by DuPont that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects.

Table 2
Vapor Pressure and Density of FM-200® (SI units)

Temperature °C	Vapor Pressure (kPa)	Liquid Density (kg/m³)	Saturated Vapor Density (kg/m³)	Vapor Density @ 1 atm (kg/m³)
–15	107.33	1539.7	8.961	8.4325
–10	132.23	1522.1	10.921	8.2412
–5	161.41	1504.2	13.205	8.0603
0	195.36	1486.0	15.853	7.8889
5	234.58	1467.3	18.905	7.7260
10	279.57	1448.2	22.411	7.5709
15	330.89	1428.6	26.421	7.4229
20	389.08	1408.4	30.996	7.2815
25	454.73	1387.7	36.202	7.1461
30	528.42	1366.2	42.118	7.0163
35	610.79	1344.0	48.833	6.8918
40	702.45	1320.9	56.454	6.7720
45	804.09	1296.7	65.109	6.6568
50	916.39	1271.4	74.956	6.5459
55	1040.10	1244.8	86.189	6.4389
60	1175.90	1216.5	99.062	6.3356
65	1324.70	1186.2	113.900	6.2359
70	1487.40	1153.6	131.170	6.1395
75	1664.90	1117.9	151.500	6.0462
80	1858.30	1078.2	175.870	5.9559
85	2068.80	1032.8	205.840	5.8684
90	2298.10	978.6	244.310	5.7836
95	2547.90	907.8	298.000	5.7013
100	2821.60	786.8	397.240	5.6215

Table 3
Vapor Pressure and Density of FM-200® (English units)

Temperature °F	Vapor Pressure (psia)	Liquid Density (lbm/ft³)	Saturated Vapor Density (lbm/ft³)	Vapor Density @ 1 atm (lbm/ft³)
10	17.50	95.51	0.63	0.5197
20	21.93	94.28	0.77	0.5069
30	27.18	93.02	0.95	0.4948
40	33.35	91.73	1.16	0.4834
50	40.55	90.41	1.40	0.4726
60	48.88	89.05	1.68	0.4624
70	58.45	87.64	2.00	0.4527
80	69.38	86.19	2.38	0.4434
90	81.79	84.68	2.81	0.4345
100	95.80	83.11	3.31	0.4261
110	111.54	81.46	3.88	0.4179
120	129.15	79.73	4.54	0.4102
130	148.77	77.90	5.30	0.4027
140	170.55	75.94	6.18	0.3955
150	194.65	73.84	7.22	0.3886
160	221.26	71.54	8.45	0.3820
170	250.55	69.00	9.93	0.3756
180	282.77	66.10	11.76	0.3694
190	318.18	62.68	14.10	0.3634
200	357.11	58.32	17.33	0.3576

Figure 1. Vapor Pressure of DuPont™ FM-200® (English Units)

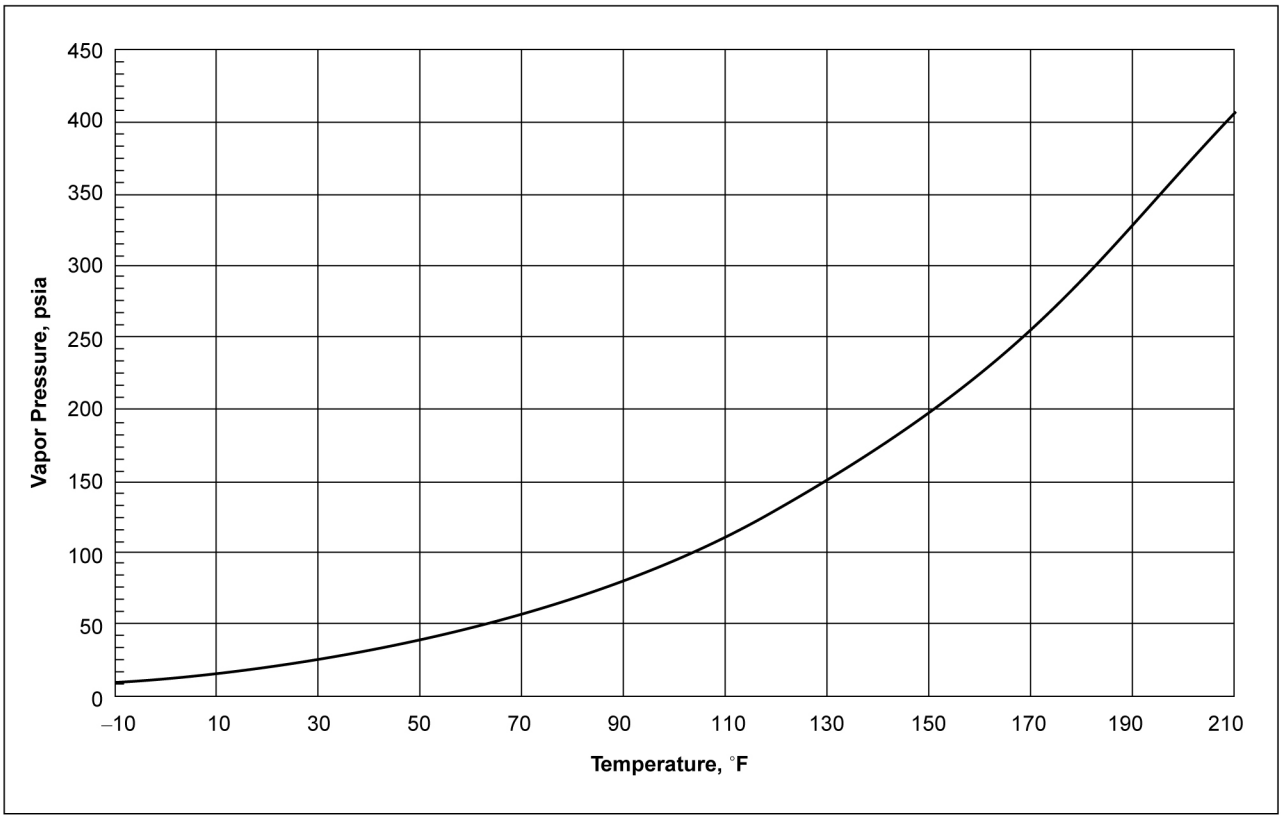
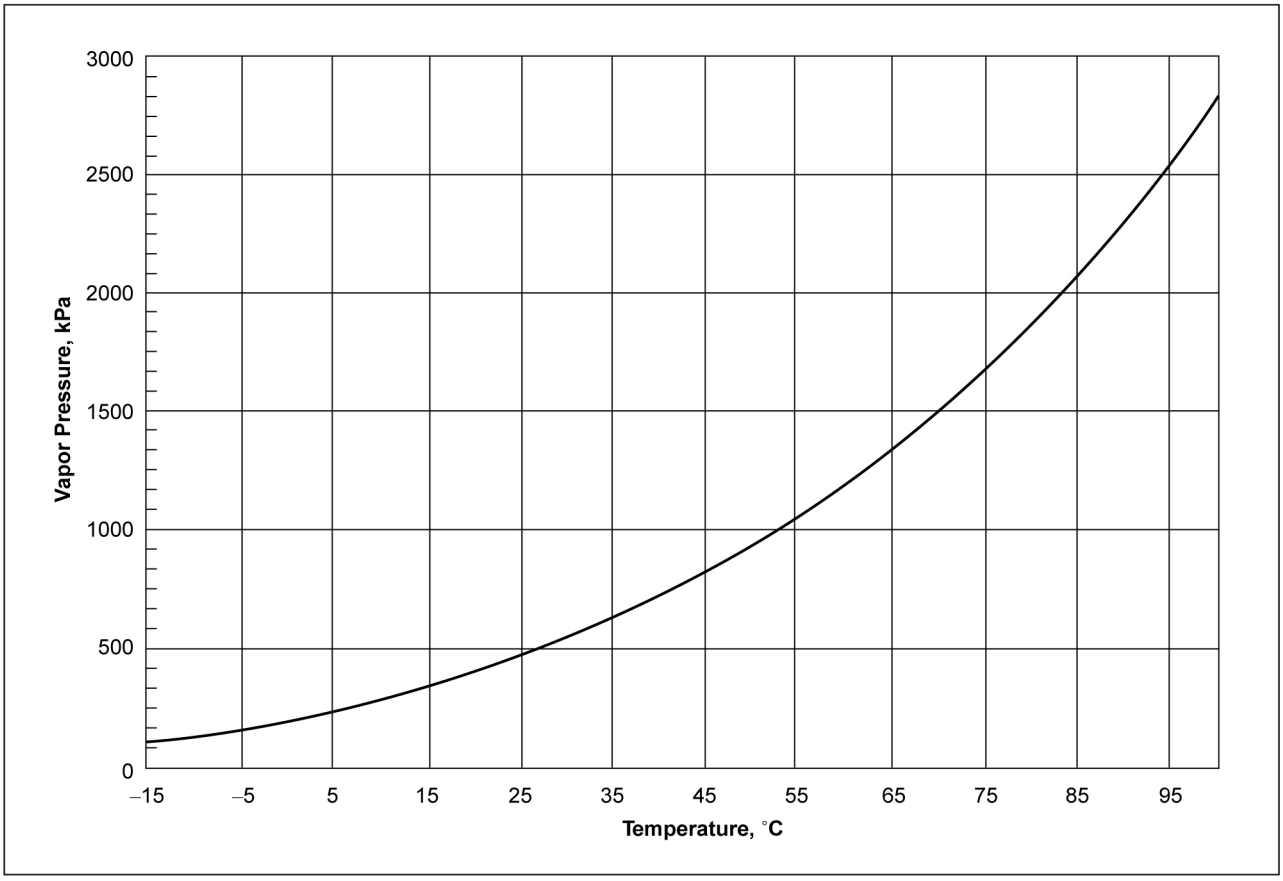


Figure 2. Vapor Pressure of DuPont™ FM-200® (SI Units)



Materials Compatibility

Because FM-200® can be used in a variety of applications, it is important to review the materials of construction for compatibility when designing new equipment, retrofitting existing equipment, or preparing storage and handling facilities. The following are general test results. To determine the compatibility of the specific materials being considered for use in a particular system, additional tests should be conducted with these materials at the conditions of that system.

Stability with Metals

Most of the commonly encountered metals such as steel, cast iron, brass, copper, tin, lead, and aluminum can be employed with FM-200® under normal conditions of use. Testing to ASTM G31 at 130°F for 18 days indicates that the following metals are suitable for use with FM-200®:

Aluminum 1100	Nickel 200	Aluminum 2024
Copper CDA 110	Inconel 600	Cast Iron, grey
Stainless Steel 316	Lead	Stainless Steel 304
Carbon Steel 1020	Yellow Brass	Silver 999+ fine

High temperature stability tests were conducted with FM-200® and commonly used metals at 175°C for two weeks, and FM-200® was found to be very stable. At temperatures above 175°C, depending on specific conditions, some metals may act as catalysts for the breakdown of FM-200®. These conditions include: presence of moisture or other contaminants, type of metal, metal surface area, contact with liquid or vapor agent, as well as time and temperature of contact.

Halocarbons may react violently with highly reactive metals such as the alkali and alkaline earth metals, sodium, potassium, and barium, in their free metallic form. Materials become more reactive when finely ground or powdered, and in this state magnesium and aluminum may react, especially at higher temperatures. Highly reactive materials should not be brought into contact with FM-200® until a careful study is made and appropriate safety precautions are taken.

Compatibility with Elastomers

Compatibility tests were performed with several commonly used elastomers. Elastomer coupons were 50% immersed in liquid FM-200® for two weeks at room temperature. Additional tests were conducted per ASTM D471 at 100°C (212°F). All of the elastomers tested exhibited minimal swell with the exception of urethane and Viton® A. Results are summarized in Table 4.

Table 4
Elastomer Compatibility

Elastomer	Linear swell, %	Weight Gain, %	Hardness Change, units
Exposure at Room temperature, 23°C (72°F) for 14 days			
Butyl	0	0.37	0
Nordel® EPDM	0.20	1.44	1.6
Neoprene W	0.05	0.66	0
NBR	0	1.86	4.0
Hypalon® CSM	0.19	1.41	2.4
Viton® A	9.49	26.83	–44.0
Epichlorohydrin homopolymer	0.15	0.08	5.5
FA polysulfide	0.05	0.06	6.9
Hytrel TPE	1.33	5.71	4.6
Exposure per ASTM D471 at 100°C (212°F)			
Buna N	-3.1		
Butyl	3.6		
EPDM	1.0		
Hypalon®	-2.0		
NR Rubber	1.7		
Neoprene G	0.8		
Neoprene W	-3.6		
SBR	-1.2		
Silicone	2.8		
Urethane	>10		
Viton® A	8.4		

Table 5
Plastic Compatibility

Plastic	Weight Gain, %	Surface Condition
High-density polyethylene (HDPE)	0.11	No Change
Polystyrene (PS)	–0.03	No Change
Polypropylene (PP)	0.06	No Change
Acrylonitrile-butadiene-styrene (ABS)	–0.03	No Change
Polycarbonate (PC)	–0.10	No Change
Nylon 6/6	–0.17	No Change
Polytetrafluoroethylene (PTFE)	5.23	No Change
Polyimide (PI)	-0.11	No Change
Polyethylene terephthalate (PET)	-0.04	No Change
Polybutylene terephthalate (PBT)	-0.06	No Change
Acetyl	-0.04	No Change
Polyvinyl chloride (PVC)	-0.06	No Change
Polyphenylene oxide (PPO)	-0.05	No Change
Polyphenylene sulfide (PPS)	-0.38	No Change

Compatibility with Plastics

Compatibility tests were also performed with several commonly used plastics. Results are summarized in Table 5.

Safety

Users of FM-200® should read and understand the DuPont Material Safety Data Sheet (MSDS). Copies of the FM-200® MSDS can be obtained from DuPont Customer Service or International Offices (see last page of this document for locations, telephone numbers, and Web site).

Inhalation Toxicity

FM-200® poses no acute or chronic hazard when it is handled in accordance with DuPont recommendations and when the exposure is maintained below the recommended exposure limits. DuPont has established the Allowable Exposure Limit (AEL) for FM-200® at 1000 ppm, 8-hr and 12-hr TWA.

However, inhaling high concentrations of FM-200® vapor may cause temporary nervous system depression with anesthetic effects such as dizziness, headache, confusion, loss of coordination, and even loss of consciousness. Higher exposures to the vapors may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation. Intentional misuse or deliberate inhalation may cause death without warning.

If a person is experiencing any of the initial symptoms, they should be moved to fresh air and kept calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical attention.

Cardiac Sensitization

If vapors are inhaled at a concentration of 105,000 ppm and higher, the heart may become sensitized to adrenaline, leading to cardiac irregularities and, possibly, cardiac arrest. Similar effects are observed with many hydrocarbons and halocarbons at high concentrations. The likelihood of these cardiac problems increases if the person is under physical or emotional stress.

Because of possible disturbances of cardiac rhythm, catecholamine drugs, such as epinephrine, should be considered only as a last resort in life-threatening emergencies.

The threshold cardiac sensitization, lowest observed adverse effect level (LOAEL) for FM-200® is 105,000 ppm (10.5%) and the no observed adverse effect level (NOAEL) is 90,000 ppm (9%) as determined in epinephrine-challenged dogs.

Skin and Eye Contact

At room temperature, FM-200® vapors have little or no effect on the skin or eyes. However, in the liquid form, FM-200® can freeze the skin or eyes on contact, causing frostbite. If contact with liquid does occur, soak the exposed area in lukewarm water, not cold or hot. In all cases, seek medical attention as soon as possible.

Always wear protective clothing when there is a risk of exposure to liquid FM-200®. Where splashing of FM-200® may occur, always wear eye protection and a face shield.

Spills or Leaks

If a large release of vapors occurs, such as from a large leak or spill, the vapors may concentrate near the floor or in subfloor areas and displace the oxygen available for breathing, causing suffocation.

Evacuate everyone until the area has been well ventilated. Use blowers or fans to circulate the air at floor level. Do not re-enter the affected area without self-contained breathing apparatus or unless the area has been monitored to indicate that that the concentration of FM-200® vapors in the area is below the AEL of 1000 ppm.

Always use self-contained breathing apparatus or a supplied air mask when entering tanks or other enclosures where vapors might exist. Use the buddy system and a lifeline. Refer to the FM-200® MSDS for more information.

FM-200® vapors have virtually no odor. Therefore, frequent leak checks or the installation of area monitors are necessary in enclosed areas where leaks can occur.

To ensure safety when working with halocarbons in confined areas:

1. Route relief and purge vent piping (if used) outdoors, away from air intakes.
2. Make certain the area is well ventilated, using auxiliary ventilation, if necessary, to move vapors.
3. Make sure the area is clear of vapors prior to beginning work.
4. Utilize monitoring equipment to detect leaks.

Storage and Handling

Shipping Information for the United States

FM-200® is a liquefied compressed gas. According to the U.S. Department of Transportation (DOT), a liquefied compressed gas is a gas, which when packaged under pressure is partially liquid at temperatures above -50° C (49CFR 173.115). The appropriate DOT designation for FM-200® is as follows:

Proper shipping name:	Heptafluoropropane
Hazards class:	2.2
UN No.:	3296
DOT/IMO Labels:	Nonflammable Liquefied Compressed Gas

Containers

Four types of containers are being used globally for shipping FM-200®. Specifications for the containers are provided in Table 6.

The 68 kg (150-lb) size cylinder of FM-200® is a freestanding, upright returnable cylinder, equipped with a nonrefillable liquid/vapor valve. With this two-way valve, FM-200® can be removed from the cylinder as either vapor or liquid through the single or double outlet without inverting the cylinder. The outlet is designed for a CGA-660 connection. The handwheel for discharging liquid is on the side of the valve. A dip tube, which extends to the bottom of the cylinder, is attached to the valve's liquid port. The handwheel for discharging vapor is located on the top of the valve. A diagram of this cylinder is shown in Figure 3. A diagram of the Ceodeux brand liquid/vapor valve used on the 68-kg size cylinder is shown in Figure 4. The 68 kg size cylinders are usually shipped on a pallet, stacked on their side.

The 544 kg (1,200-lb) size FM-200® cylinder is a freestanding, upright returnable cylinder equipped with a forklift lifting attachment incorporated into the foot ring or at the tope of the cylinder. These cylinders are fitted with Ceodeux or Superior brand valves designed for a CGA 660 connection. A diagram of this cylinder is shown in Figure 5.

ISO containers are used for export shipments of FM-200®. The overall ISO container dimensions shown in Table 6 represent the frame in which the container is shipped. The tank itself is approximately 19 feet (5.8 meters) long, and has an outside diameter of approximately 86 inches (2.2 meters). Individual valves for liquid and vapor discharge are provided. Acme 1-3/4" x 1" MNPT valves (part number A2003) are employed for vapor removal and Acme 3-1/4" x 2" MNPT valves (part number A2063) for liquid removal. These valves fittings are on the ISO container; to unload the ISO container, couplings and adaptor fittings are required. Vapor removal requires the use of an Acme 1-3/4 x 1" MNPT adaptor (part number A1131F). Liquid removal requires the use of an Acme 3-1/4" x 2" MNPT adaptor (part number A1157F). A diagram of a typical ISO tank is shown in Figure 6.

FM200® is also shipped in 5000 gallon (8927 L) tank trailers. These tank trailers are equipped with 1-1/4" mail Ever-Tite (vapor) and 2" male Ever-Tite valves (liquid). Required power is either 240 volt or 440 volt.

Bulk Storage Systems

DuPont sells bulk storage systems to its FM-200® customers. The systems are prefabricated, tested, and ready to install onsite. The units are designed to optimize economy, efficiency, and safety in the storage and dispensing of FM-200®. The delivered systems include all components, such as storage tanks, pumps, piping, valves, motors, and gauges, as an integrated unit. All systems are equipped with the DuPont Fluorochemical Emissions Elimination Delivery (FEED) System to prevent emissions during deliveries and with dual pumps to provide an installed spare. The units are skid-mounted and require only placement on a concrete pad and connection to electrical and process systems.

A typical bulk storage system is shown in Figure 7.

Your DuPont Marketing Representative can arrange for guidance on site selection, purchase, installation, startup, and maintenance.

Transfer of FM-200® From Containers

The preferred method for transfer of liquid FM-200® from the cylinder is to use a suitable pump. There are several industrial pumps suitable for the transfer of FM-200®. Contact an industrial pump manufacturer for the recommended pump.

The receiving container should be evacuated to eliminate contamination by air and to facilitate transfer of FM-200®.

If a pump is not available the chilled transfer line method will facilitate transfer of FM-200® to the receiving container. This method chills the FM-200® as it passes through the transfer line, reducing the pressure in the receiver to induce transfer by pressure differential. A coil of compatible metal tubing of sufficient pressure rating is positioned in the transfer line between the supply and the receiver. The coil is placed in a cold bath, such as water ice or dry ice.

Leak Detection

Whenever a system is assembled or serviced, it should be checked for leaks. There are many commercially available leak detectors. These devices are readily available through a refrigeration supply house.

A detailed discussion of leak detection, along with a list of manufacturers of leak detection equipment, is available in DuPont Bulletin ARTD-27 (H-31753-2).

Handling Precautions for FM-200® Shipping Containers

The following rules for handling FM-200® containers are strongly recommended:

- Use personal protective equipment, such as side-shield glasses, gloves, and safety shoes, when handling containers.
- Avoid skin contact with liquid FM-200®; it can cause frostbite.
- Never heat a container to a temperature higher than 52°C (125°F).
- Never refill returnable cylinders without DuPont consent. DOT regulations forbid transportation of returnable cylinders refilled without DuPont's authorization.
- Never use a magnet or sling (rope or chain) to lift containers. Lifting may be accomplished by the use of a safe cradle or platform basket that holds the container.
- Never use containers as rollers, supports, or for any other purpose than to contain FM-200®.
- Protect containers from any objects that will result in a cut or other abrasion in the surface of the metal.
- Never tamper with the safety devices in the valves or container.
- Never attempt to repair or alter containers or valves.
- Never force connections that do not fit. Make sure the threads on the regulator or other auxiliary equipment are the same as those on the valve outlets.
- Keep valves tightly closed, with valve caps and hoods in place when the container is not in use.
- When storing containers outside, store under a roof and protect from weather extremes.
- Use a vapor recovery system to collect FM-200® vapors from lines after unloading.

Table 6
Specifications for FM-200® Shipping Containers

Type	Dimensions	DOT Specification	Net Weight, lb FM-200®	Net Weight, kg FM-200®
68 kg (150 lb)	12″ x 46″	4BW240	150	68
	10″ x 56″	4BW400	150	68
544 kg (1,200 lb)	30″ x 53″	4BW260	1,200	544
	30″ x 56″	4BW240	1,200	544
ISO Container	8′ x 8′ x 20′ (frame	51	37,000	16,784
Tank Trailer	5,000 gallon	MC-330 or -331	37,000	16,784

Figure 3. 68 kg (150 lb) Size Cylinder

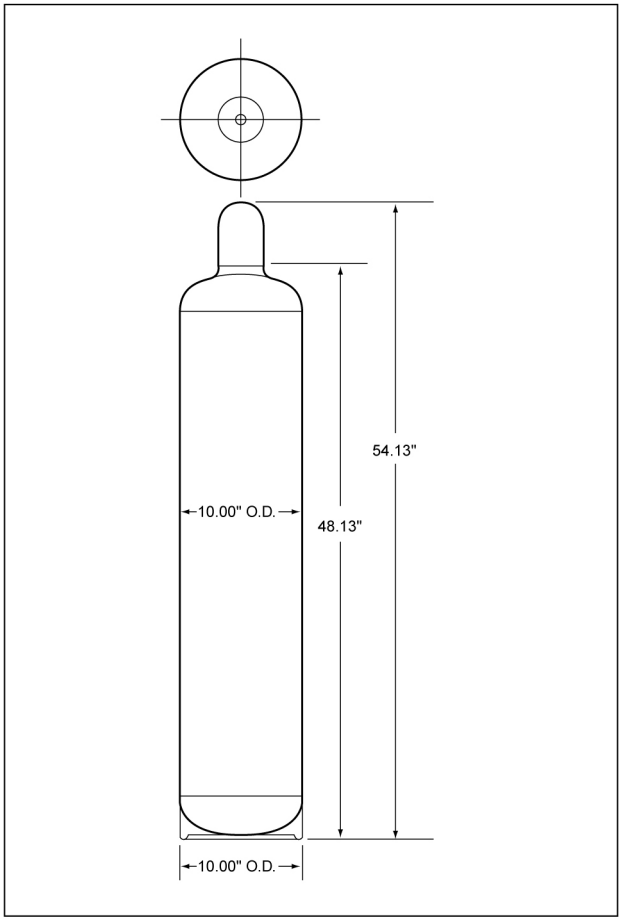


Figure 5. 544 kg (1,200 lb) Size Cylinder

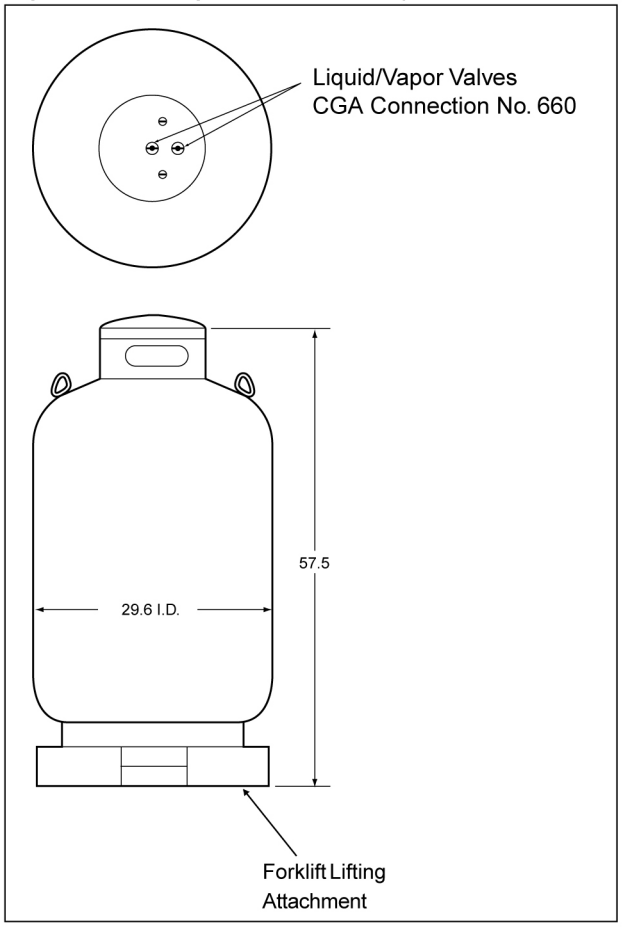


Figure 4. Liquid/Vapor Valve

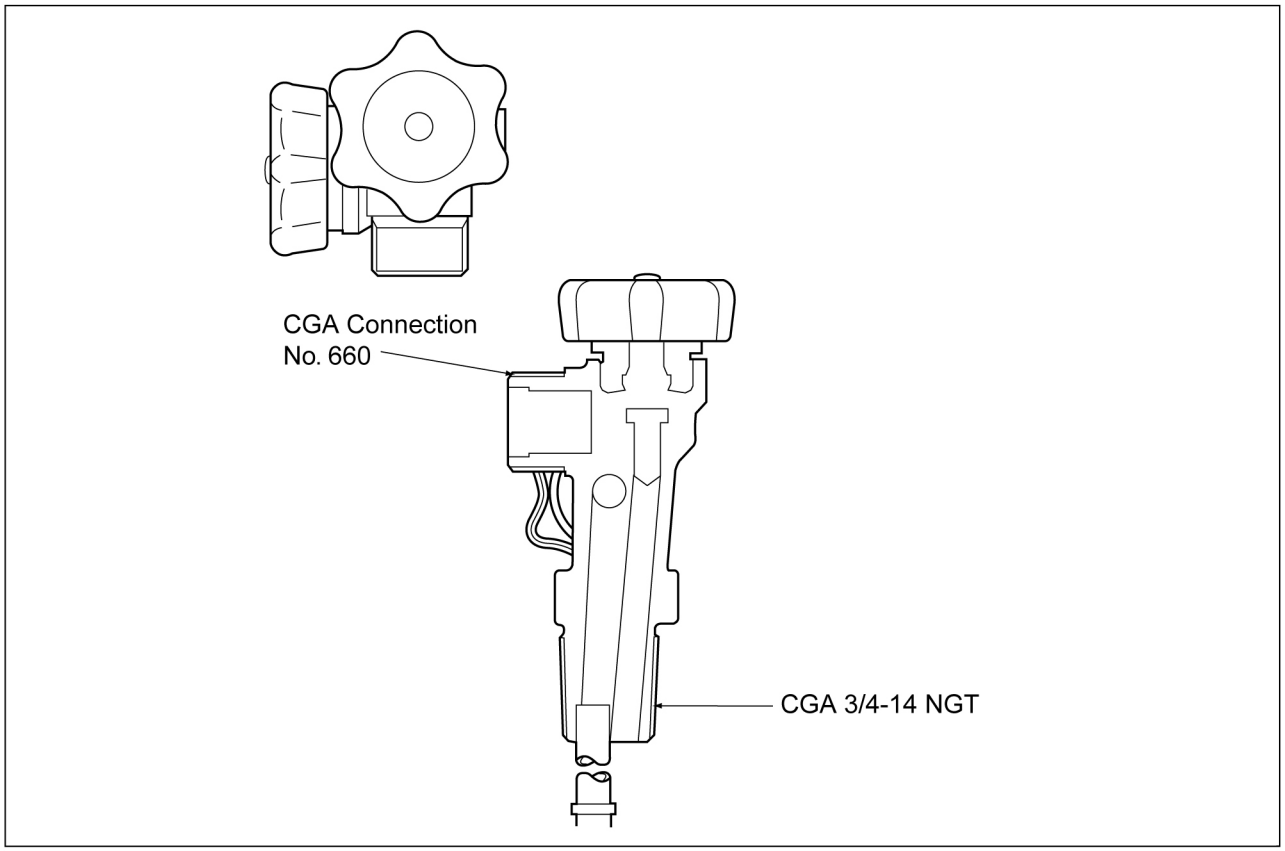


Figure 6. Typical ISO Tank

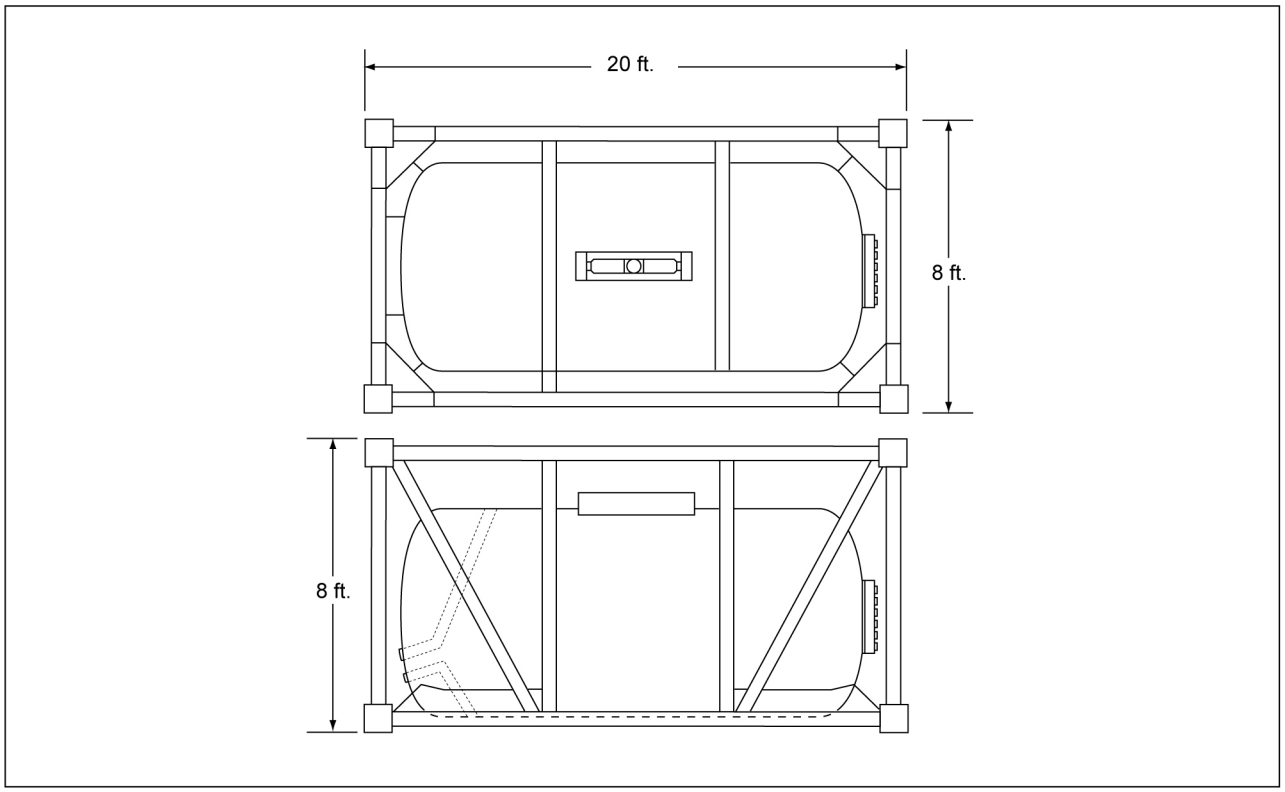
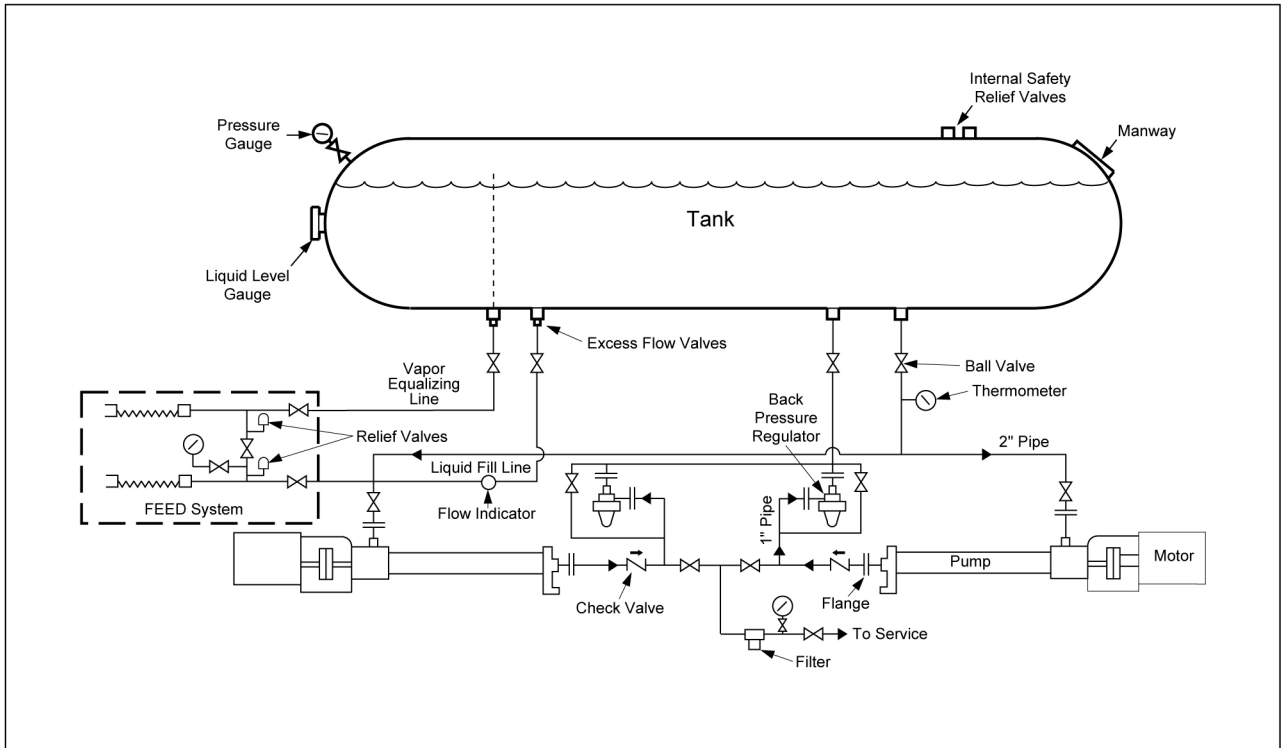


Figure 7. Typical Bulk Storage System



Nitrogen Superpressurization of DuPont™ FM-200®

FM-200® is shipped in cylinders that contain essentially pure FM-200®. These containers are evacuated before filling to remove air, and the FM-200® contains less than 1.5% (vol.) non-condensible gases (air, nitrogen, etc.) in the vapor space. The pressure in these cylinders is therefore due to the vapor pressure of FM-200® alone.

In fire suppression applications it is desirable to increase the available pressure above the vapor pressure of FM-200®. This is accomplished by adding nitrogen to the FM-200® either during or after transfer, and is termed "superpressurization". Superpressurization increases the total pressure available for flow from the container through downstream piping, provides a pressure pad to keep the liquid compressed in the liquid phase during flow, and also serves to stabilize the container pressure over a wide temperature range.

To determine the amount of nitrogen required for superpressurization of FM-200® at various fill densities, it is necessary to understand the solubility relationship of nitrogen and FM-200®. Extensive experimental work was conducted by DuPont's Central Research and Development group to develop this information. The Peng-Robinson Equation of State (PREOS) was then used to calculate the following:

- Weight of nitrogen required for superpressurization
- Isometric diagrams
- Henry's Law Constants

Tables 7 and 8 provide the weight of nitrogen required to pressurize FM-200® to 360 psig (2500 kPa) and 600 psig (4150 kPa). Isometric diagrams for FM-200® are shown in figures 8 through 11.

Henry's Law Constants

PREOS was also used to calculate the Henry's Law Constants as shown in Figure 12 (English units) and Figure 13 (SI units).

Table 7
Weight of Nitrogen Required for Superpressurization of DuPont™ FM-200® (English Units)

Weight of nitrogen per lb of FM-200® at 70°F		
Fill Density lb/ft³	**360 psig**	**600 psig**
	oz	oz
40	0.534	0.944
45	0.463	0.819
50	0.407	0.718
55	0.361	0.636
60	0.323	0.568
65	0.291	0.511
70	0.263	0.461
75	0.239	0.418

Table 8
Weight of Nitrogen Required for Superpressurization of DuPont™ FM-200® (SI Units)

Weight of nitrogen per kg of FM-200® at 21°C		
Fill Density kg/m³	**2500 kPa (gauge)**	**4150 kPa (gauge)**
	g	g
600	36.4	63.8
700	30.3	53.1
800	25.7	45.1
900	22.2	38.8
1000	19.3	33.8
1100	17.0	29.7
1200	15.1	26.3

Figure 8. Isometric Diagram – DuPont™ FM-200® Superpressurized with Nitrogen to 360 psig at 70°F

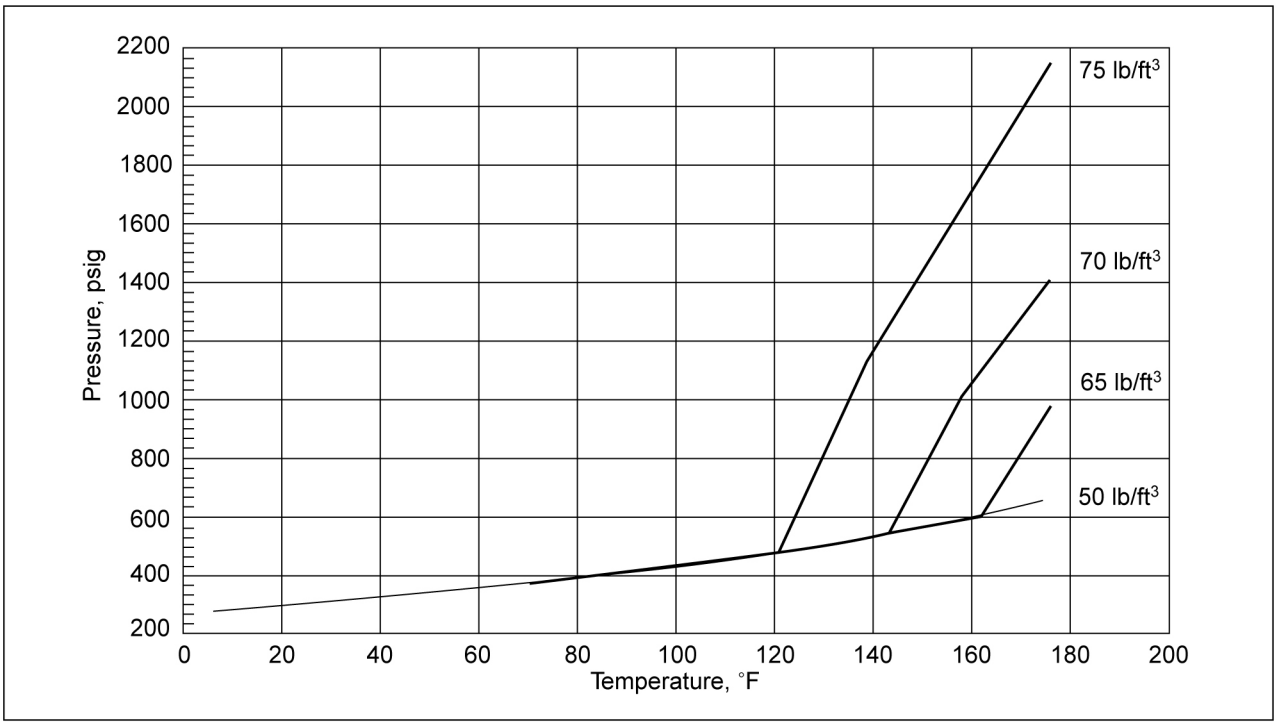


Figure 9. Isometric Diagram – DuPont™ FM-200® Superpressurized with Nitrogen to 600 psig at 70°F

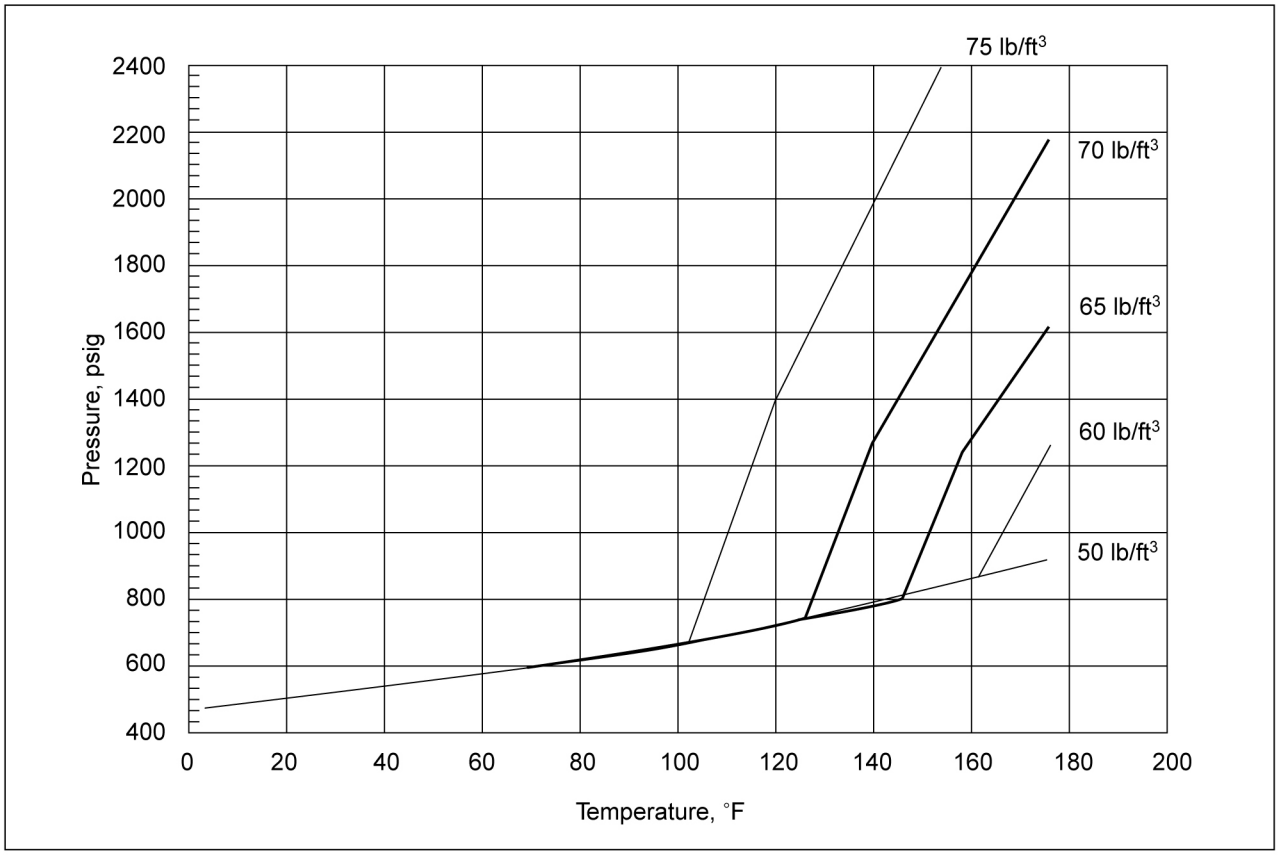


Figure 10. Isometric Diagram for FM-200® Superpressurized with Nitrogen to 2500 kPa at 21°C

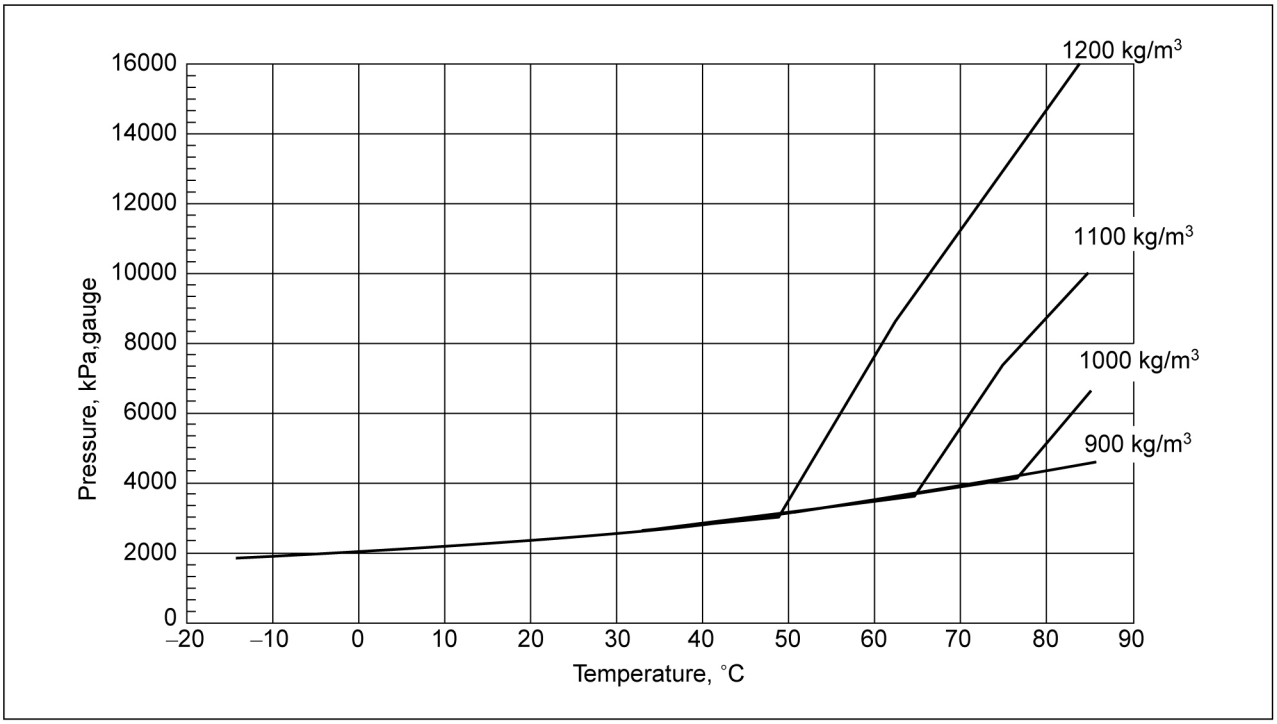


Figure 11. Isometric Diagram for FM-200® Superpressurized with Nitrogen to 4150 kPa at 21°C

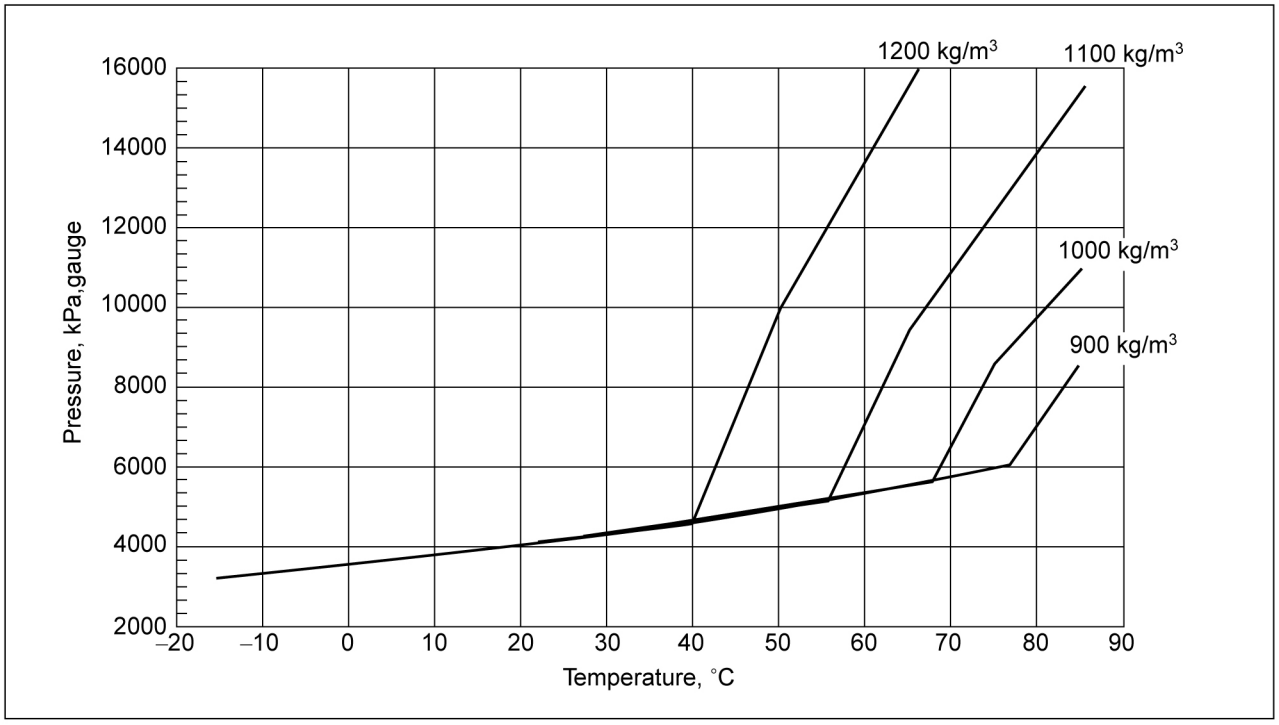


Figure 12. Henry's Law Constant for Nitrogen Solubility in DuPont™ FM-200® (English Units)

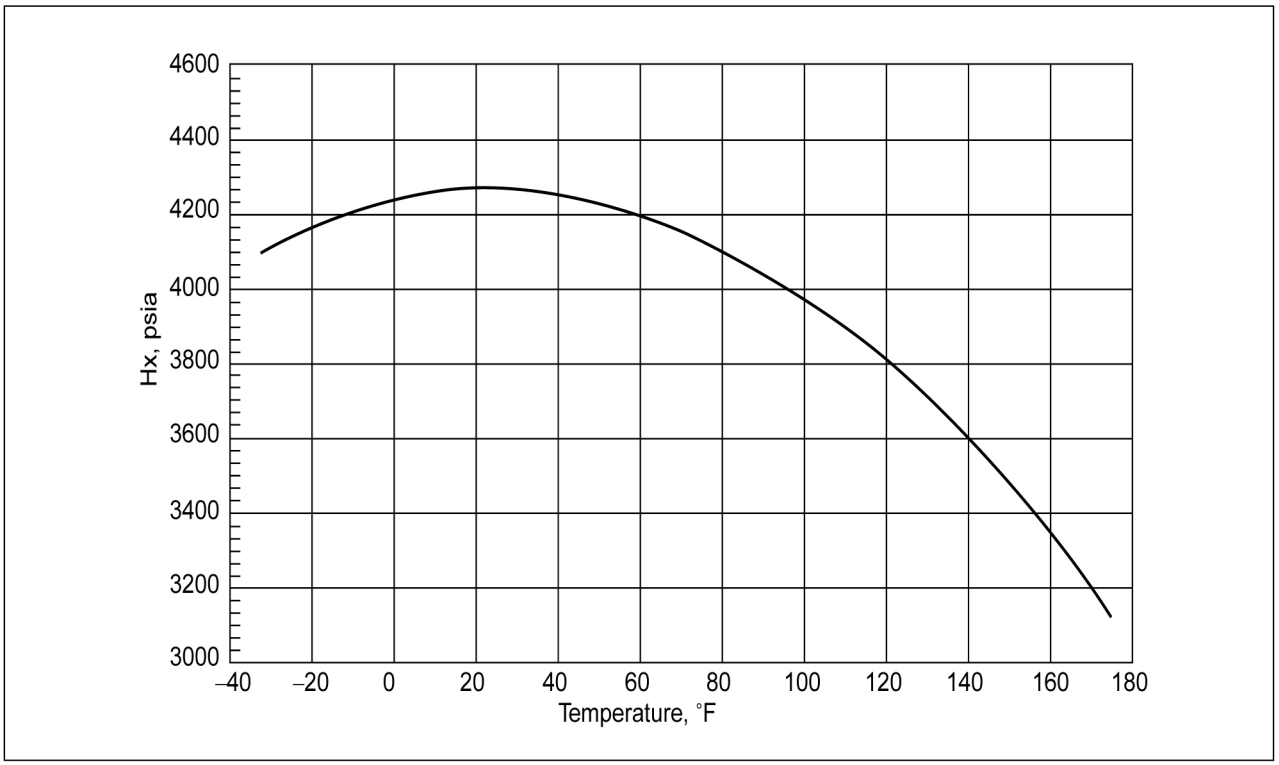
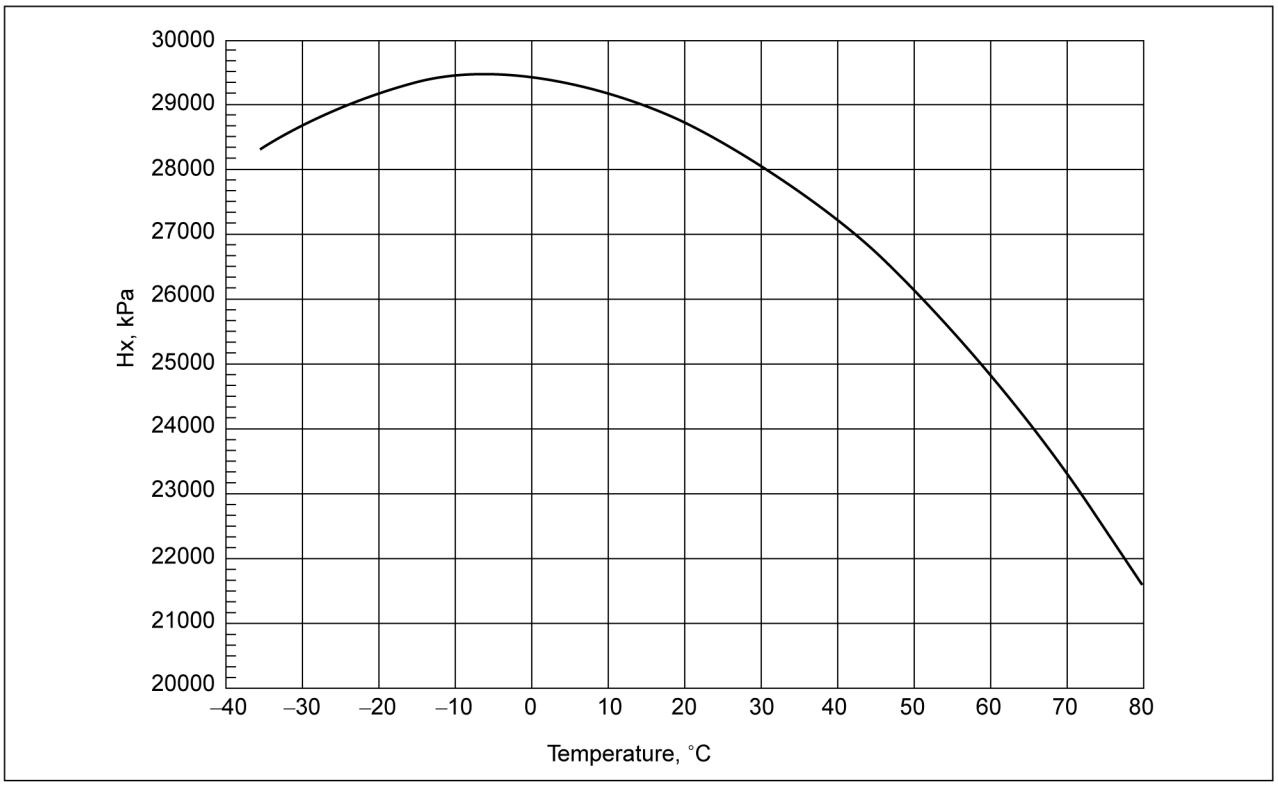


Figure 13. Henry's Law Constant for Nitrogen Solubility in DuPont™ FM-200® (SI Units)



Recovery, Reclamation, and Disposal

Responsible use of FM-200® requires that the product be recovered for reuse or disposal whenever possible.

Recovery

Recovery refers to the removal of FM-200® from equipment and collection in an appropriate container. Recovery does not involve processing or analytical testing. Recovery is normally performed when a system must undergo maintenance and the FM-200® is then returned to the system after completion. There are a number of recovery devices on the market. These devices contain a compressor and an air-cooled condenser, and may be used for liquid and vapor recovery. Before purchasing a specific recovery unit, check with the manufacturer to be sure that it contains the elastomeric seals and compressor oil compatible with FM-200®.

Reclamation

Reclamation refers to the reprocessing of FM-200® recovered from a system to new product specifications. Quality of the reclaimed product is verified by chemical analysis. In the United States FM-200® is included in DuPont's reclamation program. Contact DuPont for further information.

Disposal

Disposal refers to the destruction of used FM-200®. Disposal may be necessary when FM-200® has become contaminated with other materials and no longer meets the acceptable specifications of DuPont or other reclaimer. DuPont does not presently accept severely contaminated FM-200® for disposal; licensed waste disposal firms are available. Be sure to check the qualifications of any firm before sending them used FM-200®.

For further information regarding DuPont Fire Extinguishing Agents, contact: www.cleanagents.dupont.com

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K23261 (09/09)

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