DuPont™ FM-200®

PHYSICAL PROPERTIES
ENGLISH UNITS

FM-200® (1,1,1,2,3,3,3-Heptafluoropropane, CF_3CHFCF_3) is a colorless, non-toxic gas, and a clean and effective fire suppression agent. It is normally shipped and stored as a liquefied compressed gas, and hence is typically handled under saturated conditions, i.e., the liquid and vapor phases coexist in equilibrium. An understanding of the physical properties of FM-200® and the safe and proper techniques for handling liquefied compressed gases allows the agent to be safely transferred from shipping cylinders to the desired end-use container.

Table 1 lists some of the more important physical properties of FM-200®.

Table 1. Physical properties of FM-200®

Molecular weight	170.03
Boiling point at 1 atm	2.55°F
Freezing point	-204°F
Critical temperatue	215°F
Critical pressure	422 psia
Critical volume	0.0258 ft^3/lb
Critical density	38.76 lb/ft^3
Critical compressibility	0.255
Acentric factor	0.356
Dipole moment	1.4309 Debyes
Specific heat, saturated liquid	0.2831 (Cp) at 77°F, BTU/lb per °F
Specific heat, saturated vapor	0.2054 (Cp) at 77°F, BTU/lb per °F
Specific heat, superheated vapor	0.1932 (Cp) at 1 atm, 77°F, BTU/lb per °F
Heat of Vaporization at boiling point	57.0 BTU/lb
Thermal conductivity, liquid	0.040 at 77°F, BTU/h ft °F
Thermal conductivity, vapor	0.0073 at 77°F, BTU/h ft °F
Viscosity, liquid	0.184 centipoise at 77°F
Viscosity, vapor	0.0127 centipoise at 77°F
Surface tension	7.00 dynes/cm at 77°F

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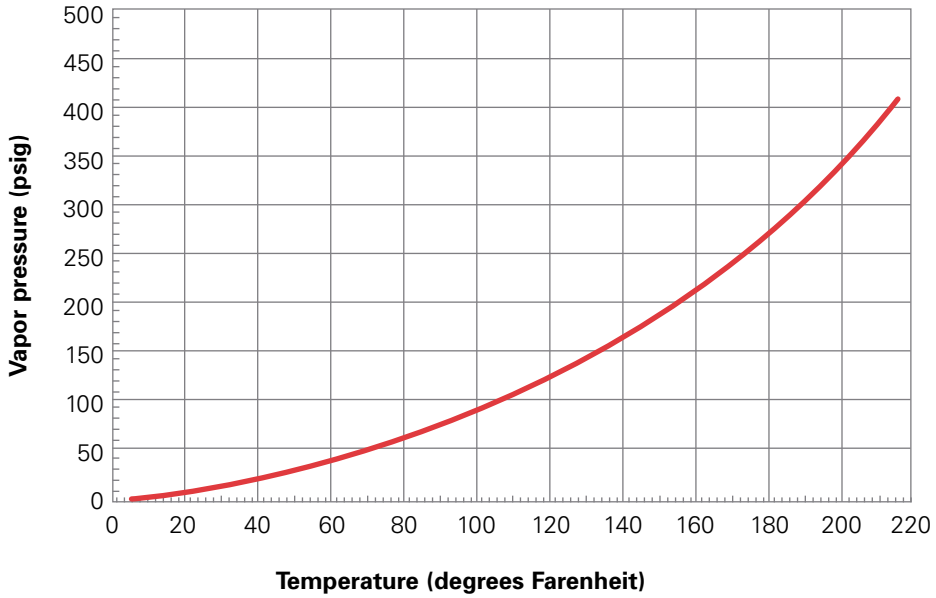
Vapor pressure

The physical property of a liquefied compressed gas that is of primary concern during transfer from one container to another is the vapor pressure. At room temperature and atmosperhic pressure, FM-200® exists as a gas. If this gas is compressed, its pressure will increase; if the pressure is further increased to the vapor pressure of the material, liquefaction will occur. The vapor pressure is the pressure at which liquefaction occurs, and is dependent upon temperature as shown in Figure 1. For a vessel containing liquefied FM-200®, the pressure is determined by the vapor pressure as long as the liquid and vapor phases are in equilibrium ("saturation conditions").

Figure 1. Vapor pressure of FM-200®



Critical properties

The vapor pressure of FM-200® increases with increasing temperature until the critical temperature is reached. At temperatures greater than the critical temperature, FM-200® exists only as a vapor, regardless of the pressure. At temperatures above the critical temperature, FM-200® cannot be liquefied at any pressure. The vapor pressure at the critical temperature is termed the critical pressure, and the mass per unit volume at the critical temperature is termed the critical density.

Liquid and Vapor Densities

The saturated (orthobaric) liquid density of FM-200® is the density of the liquid under saturated conditions, i.e., the liquid and vapor phases coexisting at equilibrium. The saturated liquid density is temperature dependent. With increasing temperature, a unit mass of FM-200® occupies a larger volume (thermal expansion), resulting in a decrease in the saturated liquid density. The saturated vapor density increases with increasing temperature due to the higher vapor pressure of the liquid with which it is in equilibrium. At the critical temperature, the liquid and vapor densities become identical. Above the critical temperature, FM-200® exists only as a vapor.

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The saturated liquid and vapor densities of FM-200® as a function of temperature are shown in Table 2. From this table the temperature at which a cylinder becomes liquid-full can be ascertained. For example, consider a container holding 87.58 pounds of FM-200® per cubic foot of internal volume. At 70°F, the container will be just liquid-full; any further increase in temperature will result in compression of the liquid and the development of tremendous pressures, potentially exceeding the rating of the cylinder. For a container holding 77.69 pounds of FM-200® per cubic foot of internal volume, the container will become just liquid-full at 140°F; at 130°F, the pressure is the vapor pressure of pure FM-200® at 130°F, i.e., 150 psia. Note that these examples are for pure FM-200®; for FM-200® superpressurized with nitrogen, liquid and vapor densities will differ from the values shown in Table 2.

For additional thermodynamic property data, please contact your fire protection equipment manufacturer or DuPont.

Table 2. Vapor pressure and density of FM-200®

		Density (lb/ft³)		
Temperature (°F)	**Vapor Pressure (psia)**	**Liquid**	**Saturated vapor**	**Vapor @ 1 atm**
10	17.5	94.62	0.6237	0.5191
20	21.9	93.50	0.7739	0.5067
30	27.2	92.36	0.9516	0.4948
40	33.5	91.20	1.1603	0.4836
50	40.7	90.02	1.4042	0.4729
60	49.1	88.81	1.6873	0.4627
70	58.8	87.58	2.0157	0.4530
80	69.8	86.31	2.3941	0.4437
90	82.4	85.00	2.8291	0.4349
100	96.5	83.65	3.3279	0.4264
110	112.4	82.25	3.8990	0.4182
120	130.1	80.79	4.5518	0.4104
130	149.8	79.28	5.2975	0.4029
140	171.5	77.69	6.1493	0.3957

DuPont Fire Extinguishants
Chestnut Run Plaza, Building 702
Wilmington DE, 19880-0702
phone: 1.800.473.7790
fax: 1-302-999-4727

cleanagents.dupont.com
FM200.dupont.com

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