VACUUM LIMITATIONS ON BLACKMER PUMPS

Intake pressure requirements on centrifugal pumps are determined by the manufacturer and called Net Positive Suction Head Required (NPSHR). This is compared with the NPSH Available to determine the suitability of the intake conditions. For several reasons that procedure does not easily lend itself to use in positive displacement pump applications. What follows is the system for determining the intake requirements for Blackmer Pumps.

There are five principle factors which affect the maximum vacuum:

1. Pump Speed
2. Altitude above sea level
3. Vapor pressure of the liquid
4. Viscosity
5. Entrained and dissolved air or gas in the liquid

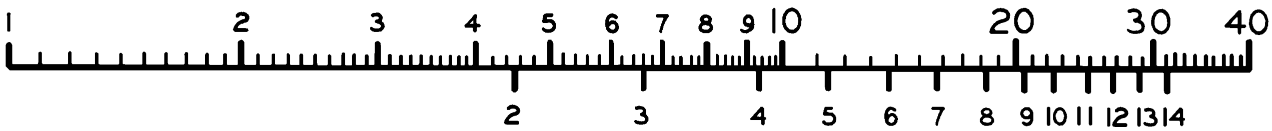
1. The table below shows the maximum desirable vacuum on different sizes of Blackmer pumps, at different speeds, at an altitude of sea level, and at zero vapor pressure.

Blackmer Pump Size	Maximum Desirable Vacuum IN INCHES OF MERCURY at Sea Level at Zero Vapor Pressure								
	1800 RPM	1200 RPM	640 RPM	520 RPM	460 RPM	420 RPM	300 RPM	230 RPM	190 RPM
X1½, 1¼	18	23							
XF1, F1P	15	19							
1, 1¼			22	23	24	24	24	24	24
1½, 2			22	23	24	24	24	24	24
2½			21	22	24	24	24	24	24
3			19	22	24	24	24	24	24
3½			18	21	24	24	24	24	24
4				18	20	22	24	24	24
6							16	19	23
8							14	18	23
10								18	23

2. Subtract from these values 1 inch Hg for every 1,000 feet of elevation.
3. Subtract also the vapor pressure of the liquid at the pumping temperature expressed in inches Hg.

Vapor pressure expressed in inches Hg. is often not readily available. A frequently used measure is Reid Vapor Pressure. The scale below can be used as an approximate conversion of Reid vapor (in PSIA at 100°F.) to vapor pressure in inches Hg.

VAPOR PRESSURE INCHES HG.



REID VAPOR PRESSURE P.S.I.

Another frequently used measure of vapor pressure is millimeters of mercury. This can be converted to inches Hg. by dividing by 25.4.

Millimeters of Mercury / 25.4 = Inches Hg.

The graph on page 50/4 shows vapor pressure for several solvents over a broad temperature range. You will notice that many of the lines have a similar slope. If you have the vapor pressure of a solvent at only one temperature — which is not the pumping temperature — the general slope of the lines on the graph may help you to better estimate the vapor pressure of that solvent at pumping temperature. An example of how this is done is shown at the lower right hand corner of the graph.

On page 5 is a graph that can be used to determine the approximate vapor pressure of automotive gasoline at various temperatures when the Reid vapor pressure is known. For instance — if the gasoline's Reid vapor pressure is 10, the vapor pressure at 70°F. liquid temperature is 13 inches Hg.

For estimating purposes you may assume that automotive gasoline has an average Reid vapor pressure of 9 PSI in the summer, 11 PSI in the spring and fall, and 13 PSI in the winter.

4. The selection data tables for each industrial pump show the speed Limitations for all viscosities. Generally, no other adjustment for viscosity is necessary. However, if you are handling a highly viscous liquid which is also highly volatile, consult with the factory for a recommendation.

5. The amount of entrained and dissolved air in the liquid is indeterminate. However, it does have a definite effect on efficiency and operation of a pump. If the proposed installation is an underground tank, which is filled periodically by draining liquid from a transport truck, the falling of the liquid in the space above the liquid level in the tank will cause air to become mixed with the liquid. Some types of liquid will retain this air in a dissolved condition, invisible to the eye, for much longer times than others. Fuel oils and lube oils are typical examples. The critical vacuum for any pump handling furnace oil or diesel oil is often 2 or 3 inches Hg. less than the table shown because of this factor.

   Pumps operating right at vacuums shown will cavitate to the extent of about a 10% loss of rated capacity but will operate at generally satisfactory noise levels. Pumps operating at less vacuum will operate at capacities proportionately closer to the rated capacity of the pump. Pumps will deliver liquid at higher vacuums but the capacity falls off very rapidly and usually the noise level also increases. The 10% figure is only approximate because vapor pressure is not a true measure of the amount of vapors given off by a liquid at any condition of vacuum or pressure.

In addition to the cavitation caused by vacuum, there will be the normal internal slip and loss of capacity due to differential pressures between intake and discharge.

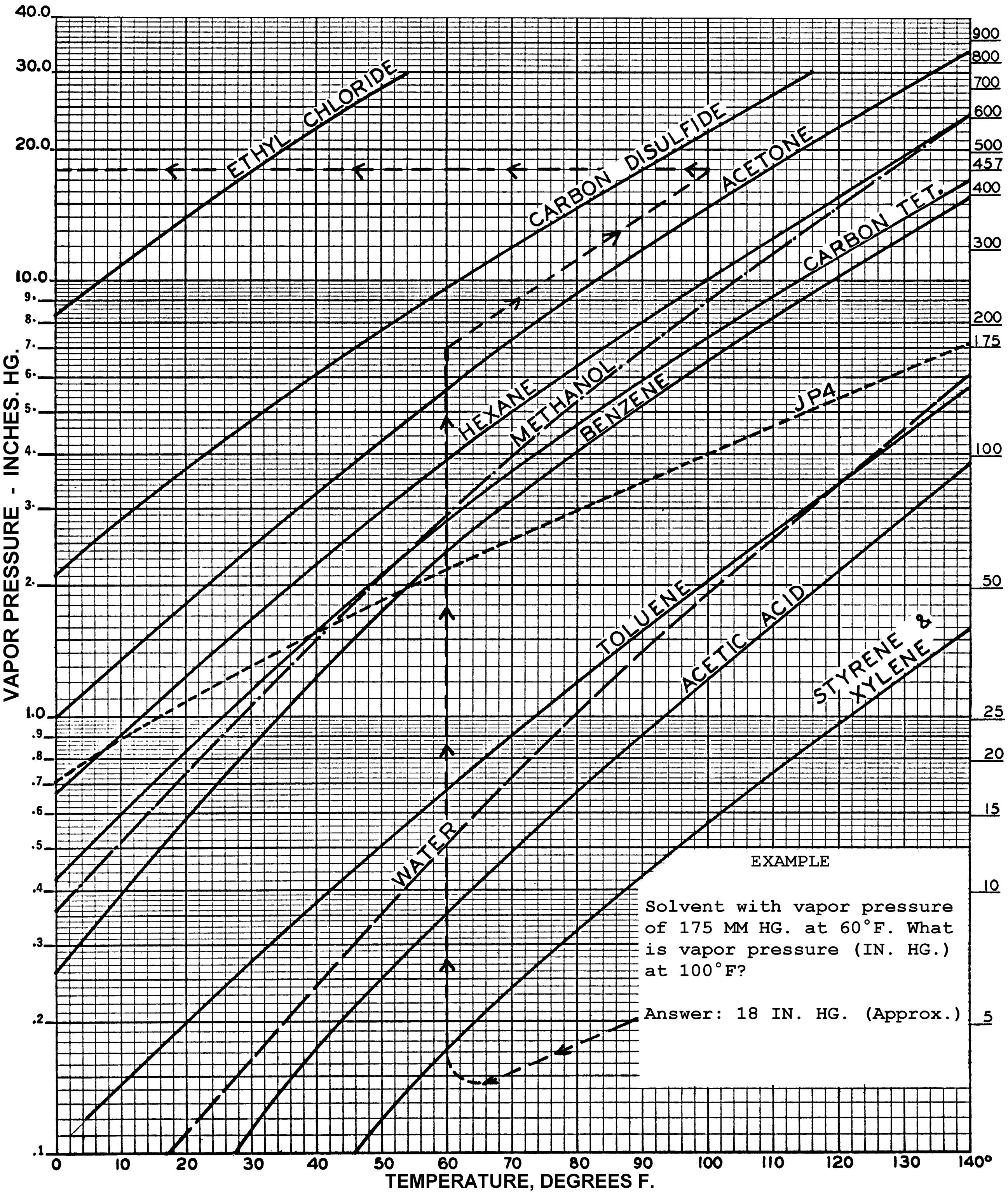
Actual capacities at higher vacuums CANNOT be estimated with any degree of accuracy.

Many times pumps are required to operate at vacuums higher than shown on this table. For example, eight-inch pumps mounted on the deck of river barges operate under very severe conditions. Vacuums often run 4 to 6 inches higher than that shown in the table. There is usually considerable vibration in pumps mounted on the decks of barges but in spite of the severe operating conditions, the pumps do a remarkably good job and are fairly durable. Vanes are replaced in barge pumps much more frequently, however, than when the same pump is used under better conditions.

When computing an installation of a pump lifting liquid from an underground tank, vacuum is computed on the basis of pipe friction plus the actual lift from the bottom of the tank to the center line of the pump. Often this total vacuum at the pump will be equal to or exceed slightly the figures in the table. This does not mean that you should rule out the installation. Logically, an underground tank is usually partially filled. Therefore, most of the time the pump will be operating within the acceptable range. It must be understood, however, that when the liquid level does drop to the minimum point that the pump may make a little extra noise and the pumping rate may fall off slightly.

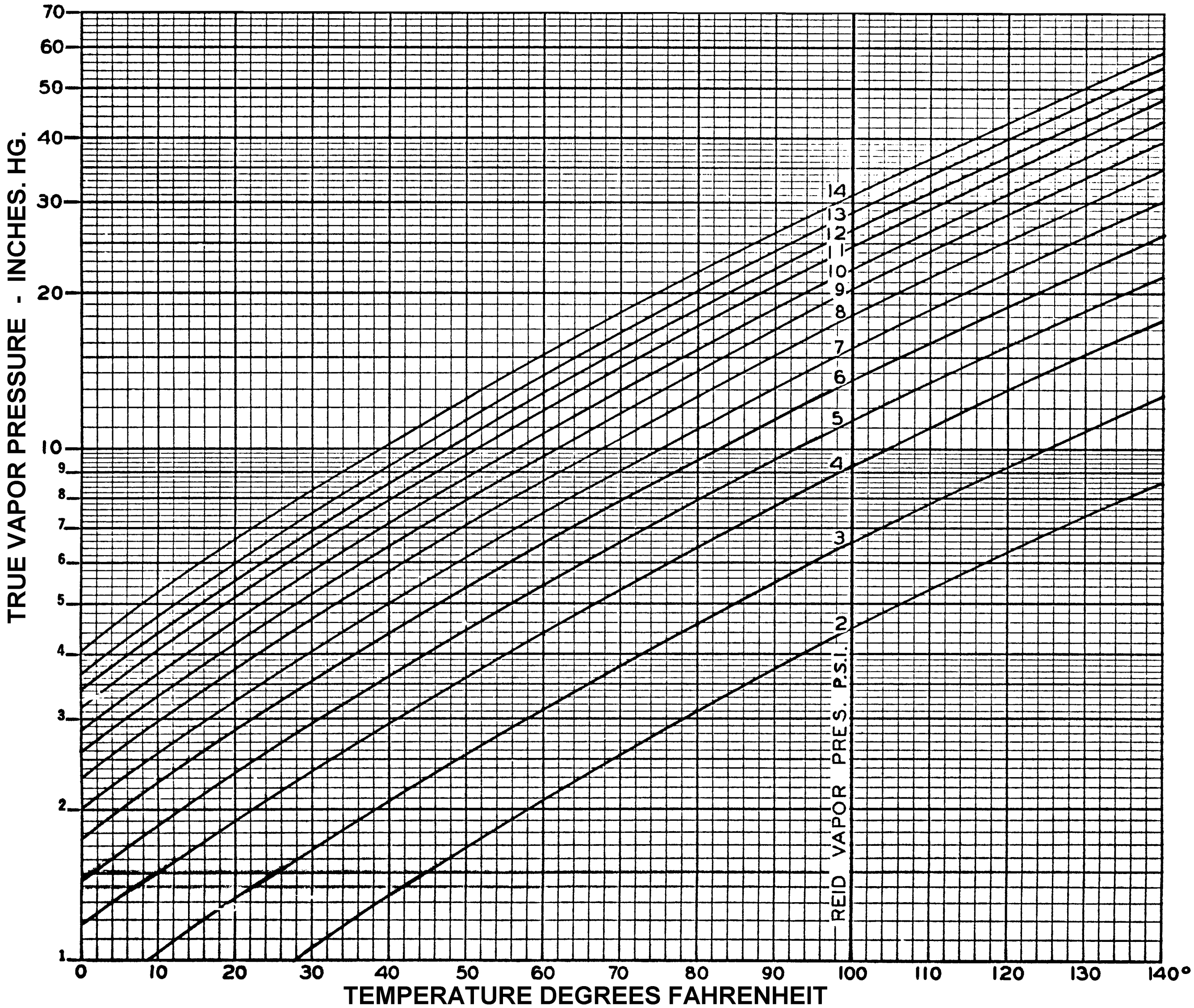
VAPOR PRESSURE GRAPHS — MISCELLANEOUS VAPOR PRESSURES

1 IN. HG. = 25.4 MM



VAPOR PRESSURE GRAPHS of MOTOR GASOLINES

(Approx. Values)



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