SATURATED VAPOR PRESSURE CHART FOR REFRIGERANTS

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ABSTRACT

An empirical formula is proposed for the relation between saturated vapor pressure and temperature for refrigerants. A chart has been constructed showing the variation of $\log_{10}$ P against saturation temperature t°C for some refrigerants including new freons R-123 and 134 a. The developed equation introduces a new function F(t) and two constants in order to produce a straight line relationship representation.

Nomenclature

A,B,C,D,E,F and G	Constants in the different expressions of saturated vapor pressure and temp.
ΔH	enthalpy change
P	abs. pressure, kg/cm^2
P_c	critical pressure, kg/cm^2
P_o	sat, vapor pressure at 0°C
T	abs. temperature, deg. K
t	sat. temperature, deg. C
t_c	critical temp. deg. C
ΔV	volume change
$P_r = (P/P_c)$, $T_r = (T/T_c)$	reduced vapor pressure and reduced temp.

INTRODUCTION

There are many vapor pressure equations which fit the actual measurements of saturated vapor pressures and temperatures. These relations are valid only for a limited temperature range (-60°C to 100°C). Most equations are given in the form $\ln P = A - (B/T)$ which can be derived from the integration of Clapeyron-Clausius equation. Other more accurate expressions were developed as $\ln P = A - (B/T) + C \ln T + D T + E T^2$. The constants A, B, C, D and E are to be adjusted to obtain the best fit with the experimental data for a given substance. A generalized correlation for the reduced vapor pressure as a function of reduced temperature is given by $\ln P_r = G (1 - 1/T_r)$. This equation allows reasonable estimates to be made of the properties of gases for which no data is available. The latent heat of vaporization may be calculated by means of Clapeyron equation in the form $(dP/dT) = (\Delta H/T \Delta V)$.

In the present work, a new empirical formula relating the vapor pressure and saturation temperature is proposed by introducing a proposed temperature function which allows the representation of $\log_{10}$ P and t°C as a straight line.

MATERIAL AND RESULTS

In order to obtain a straight line relation between $\log_{10}$ P and t°C for saturation conditions, an arbitrary function such as: t/(305 + 1.25 t) was chosen. The size of the chart was selected in order to cover large ranges for P (0.01 to 100 kg/cm^2 abs.) and for t (-100 to 300°C). The vertical axis of the chart is taken 200 mms and graduated to represent $\log_{10}$ P. The horizontal axis of the chart is 175 mms graduated to represent t according with the proposed function.

Therefore, the new empirical relation is give as:

$$\log_{10} P = A + B\,[t/(305 + 1.25\,t)]$$

The constants A and B can be determined for different refrigerants and water from experimental data at t = 0°C and at the critical state as:

$$A = \log_{10} P_o, \quad B = \log_{10} (P_c/P_o)/[t_c /(305 + 1.25\, t_c)].$$

The following table gives P_o, P_c, t_c, A and B for some refrigerants:

Refrigerant	P_o Kg/cm^2	P_c Kg/cm^2	t_c °C	A	B
R-13	19	39.45	28.83	1.2787	3.7534
R-22	5.2	50.3	96	0.7160	4.3607
R-12	3	40.9	111.5	0.4771	4.5220
R-134a	2.9	40.56	101.3	0.4624	4.8770
R-114	0.87	34.4	145.7	-0.0605	5.3393
R-21	0.67	52.7	178.5	-0.1739	5.6087
R-11	0.38	44.6	198	-0.4202	5.7747
R-123	0.32	36.76	183.9	-0.4948	5.9921
R-113	0.14	34.8	214.1	-0.8539	6.4066
Water	0.006	225.4	374.2	-2.2218	9.4473
Ammonia	4.4	115.2	132.4	0.6434	5.0390

The saturated vapor pressure chart in this work is constructed for ten refrigerants and water. This chart covers large ranges for pressure and temperature and is in good agreement with experimental measurements.

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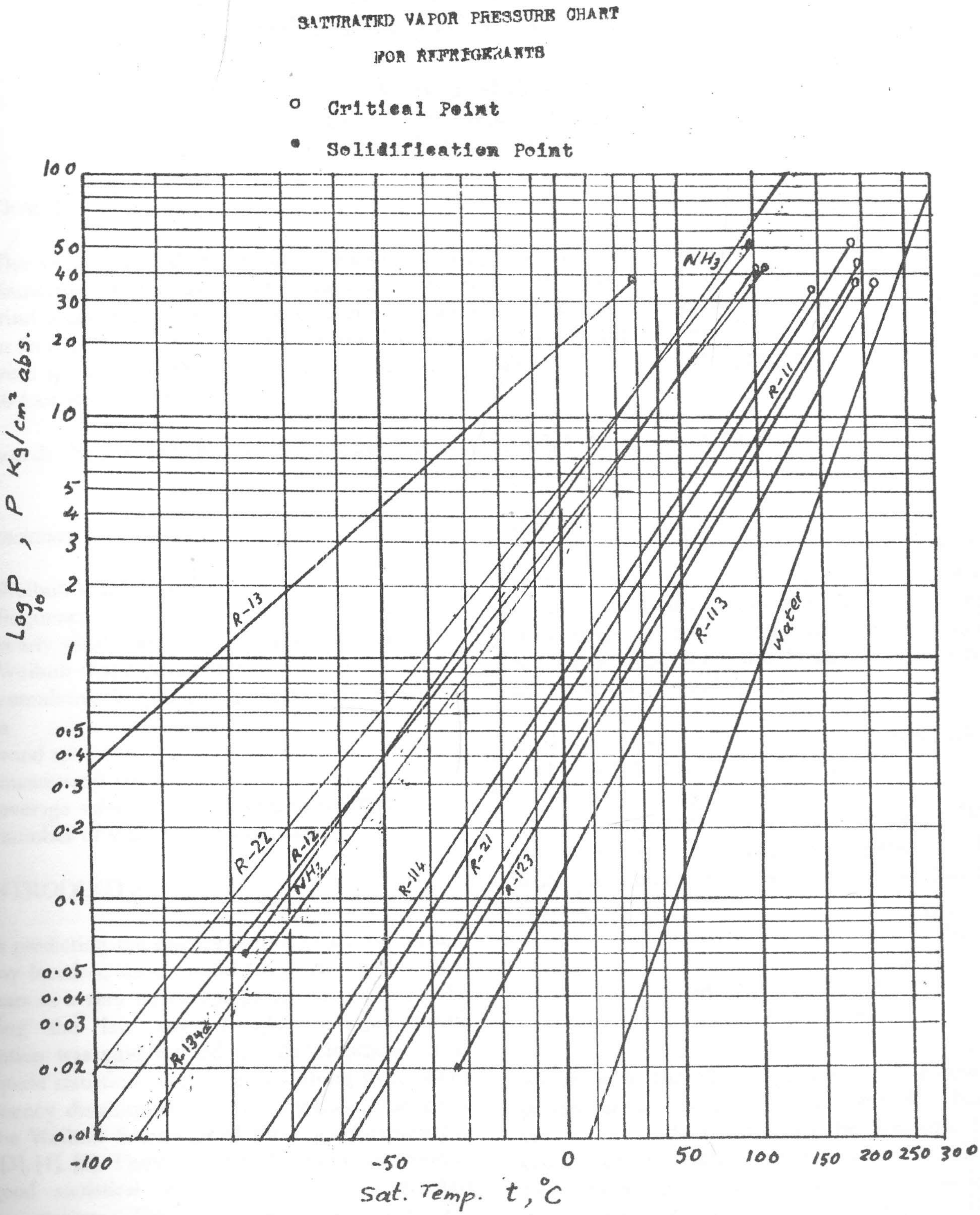
SATURATED VAPOR PRESSURE CHART
FOR REFRIGERANTS
o Critical Point
• Solidification Point
Log10 P , P Kg/cm² abs.
100
50
40
30
20
10
5
4
3
2
1
0.5
0.4
0.3
0.2
0.1
0.05
0.04
0.03
0.02
0.01
-100
-50
0
50
100
150
200
250
300
Sat. Temp. t, °C
NH3
R-11
R-13
R-113
Water
R-22
R-12
NH3
R-114
R-21
R-123
R-134a