

For two liquids to form a stable emulsion, three conditions must exist:

1. The two liquids must be immiscible.
2. There must be sufficient energy of agitation to disperse one phase into the other.
3. There must be the presence of an emulsifying agent.

Some of the common emulsifiers are as follows:

1. Asphaltic material
2. Resinous substances
3. Oil-soluble organic acids
4. Finely dispersed solid materials such as sand, carbon, calcium, silica, iron, zinc, aluminum sulfate, and iron sulfide.

Thermal Properties

(1) Specific Heat c_p :

The specific heat is the amount of heat per unit mass required to raise the temperature by one **degree Celsius**.

It depends on the temperature, where it increases with increasing in temperature and decreasing in density. The following eq. can be used to estimate *Specific Heat c_p* .

$$c_p^L = 4.1868 \left(\frac{0.415}{\sqrt{\rho_L^{15.6}}} + 0.0009 (T - 288.15) \right)$$

c_p in J/g.K , T in K, and $\rho_L^{15.6}$ is the density of oil at 15.6⁰C, g/cm³.

Also, **Figure 7a** below is used to find the Specific heat c_p of Mid liquids oils with a correction factor for other bases of oils.

For **hydrocarbon gasses**, the Figure below is used to find the Specific heat of Mid oil vapours with a correction factor for other bases of oils shown in **Figure 7b**.

To calculate the heat required for the system (KJ or Btu)

$$Q = m c_p \Delta T$$

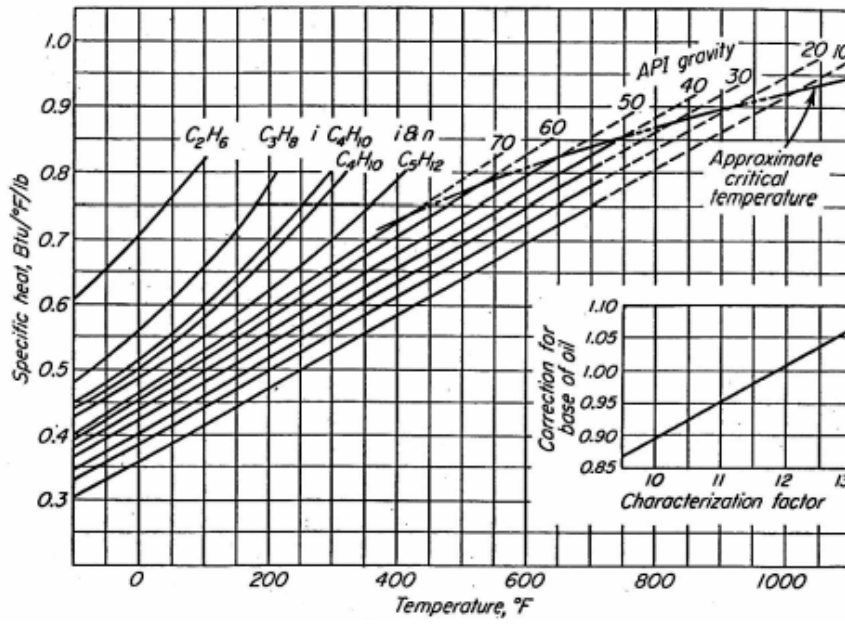


Figure 7a Specific heat of Mid liquids oils with a correction factor

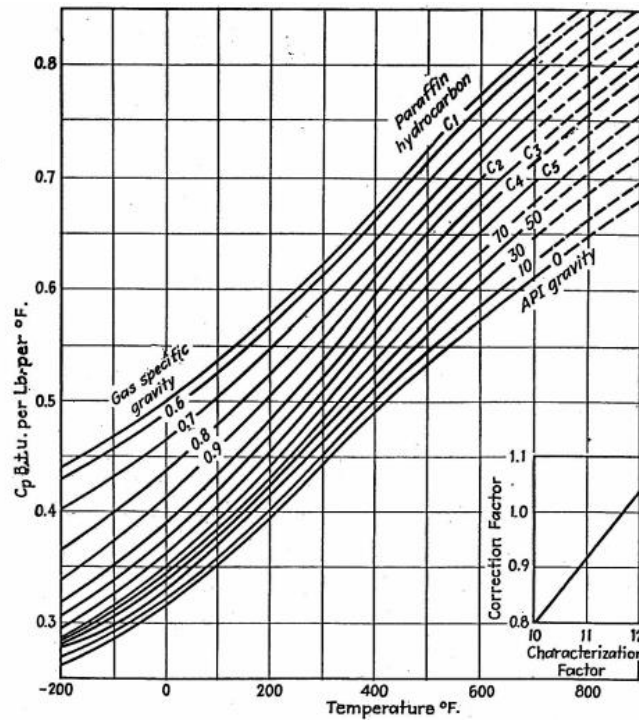


Figure 7a Specific heat of mid oil vapors with a correction factor.

(2) The heat of Combustion:

The amount of heat released per unit mass or unit volume of a substance when the substance is completely burned under standard conditions.

For crude oil or oil fractions, the heat of combustion increases with an increase in temperature, API and hydrogen content, and decreases with an increase in sulfur, ash and water content.

$$\text{Heat of combustion} = 43434 + 93.2(\text{API} - 10)$$

Where Heat of combustion in KJ/Kg

(3) Coefficient of Heat Expansion

1. Is the tendency of matter to change in volume in response to a change in temperature, or the change in the amount in density?
2. It depends on API, which increases with increasing in API .
3. This property is an important issue in designing fuel tanks.

The following equation can be used to estimate the increase in volume:

$$\text{Increasing in volume} = \text{volume} * \Delta T * \text{Coefficient of Expansion}$$

Where: ΔT : is the difference of temperature in °F

The coefficient of Expansion is taken from *Table 1* based on the API of oil

API	Coefficient of Expansion
0 – 14.9	0.00035
15 – 34.9	0.00040
35 – 50.9	0.00050
51 – 63.9	0.00060
64 – 78.9	0.00070
79 – 88.9	0.00080
89 – 93.9	0.00085
94 - 100	0.00090

(4) Latent Heat of Vaporization:

Is the amount of energy in the form of heat released or absorbed by a substance during a change of phase, or is the heat required to complete vaporization under atmospheric pressure?

Figure 8 is used to find the latent heat of vaporization under atmospheric pressure.

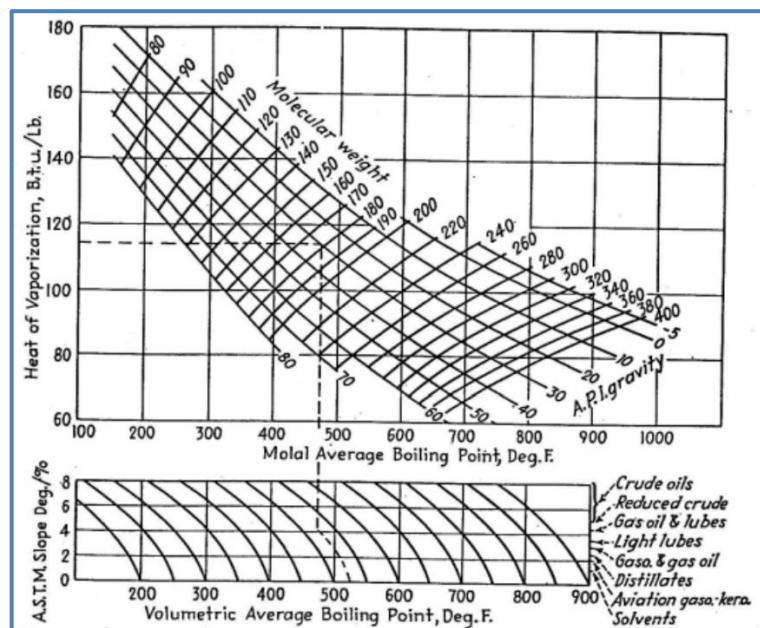


Figure 8 Atmospheric latent heat of vaporization as a function of molecular weight or API gravity

The Latent heat of vaporization can also be calculated at any temperature or pressure from the following equation:

$$L = \gamma L_B \frac{T}{T_B}$$

L = is the latent heat of vaporization at any T or P

L_B = is the latent heat of vaporization at normal B.P

T = any temp. (in °R)

T_B = normal B.P (in °R)

γ = correction factor (from **Figure 9**)

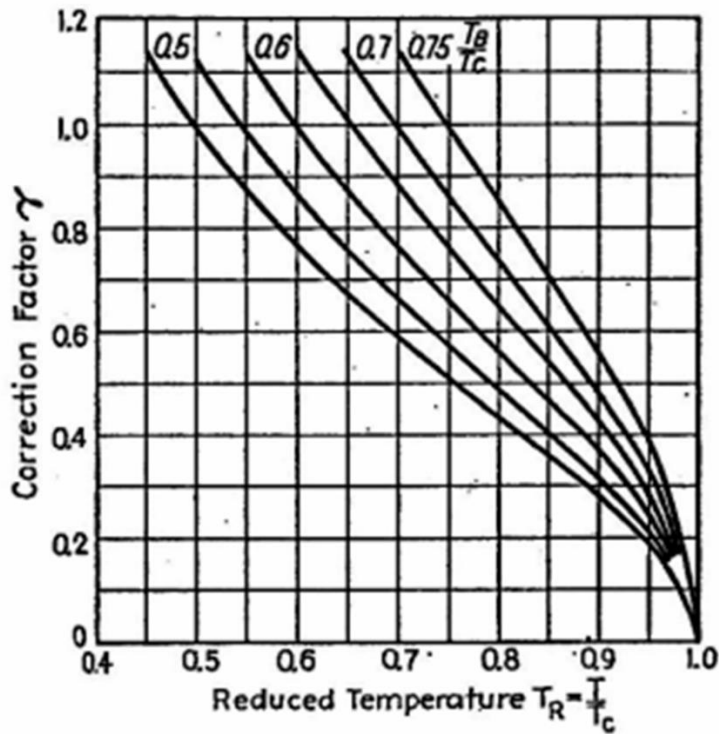


Figure 9 Temperature correction to the heat of vaporization

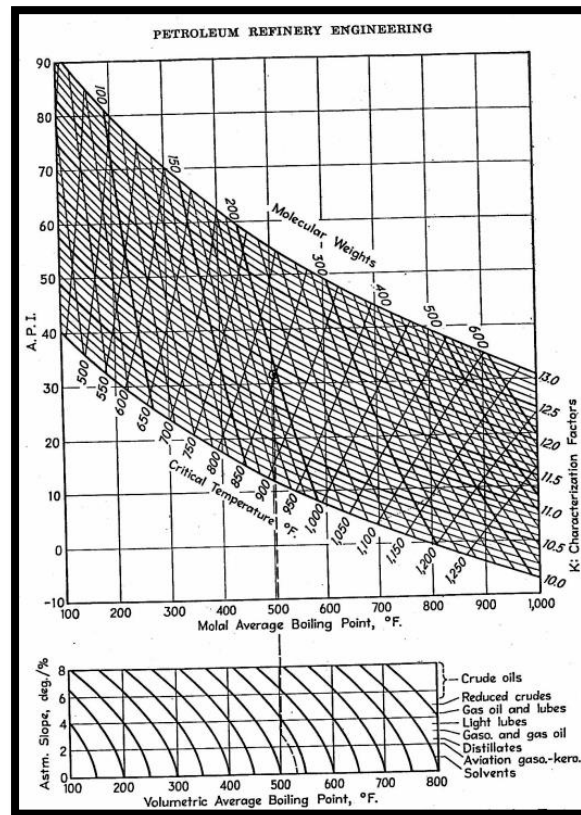


Figure 10 the relationship between (MABP, API, and K)