Reflux ratio: is defined as the amount of internal reflux divided by the amount to top product.

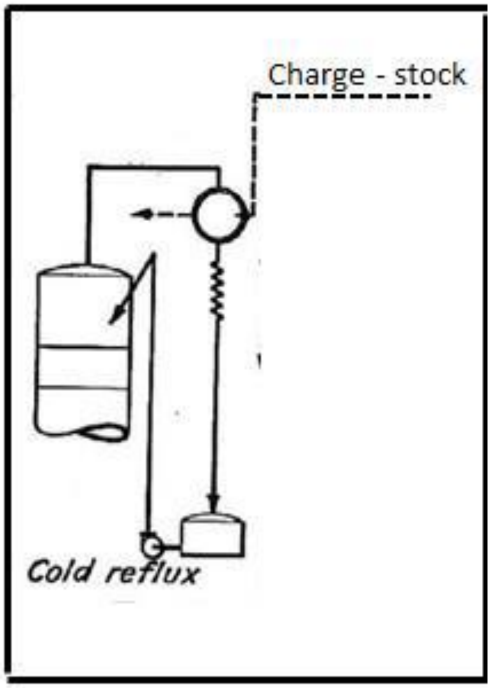
Heat reflux = heat in – heat out = Q in – Q out

Q in = crude oil heat + steam heat

1- **Cold reflux** is defined as reflux that is supplied at some temperature below the temperature at the top of the tower, each pound of this reflux removes a quantity of heat equal to the sum of its latent heat and the sensible heat required to raise its temperature from the storage tank temperature to the temperature at top of tower. It is vaporized and condensed and returns in like quantity to the product storage tank.

$$Q = latent\ heat + sensible\ heat = m\lambda + mCp\Delta T$$

Usually take in this case temperature of reflux =100°F.



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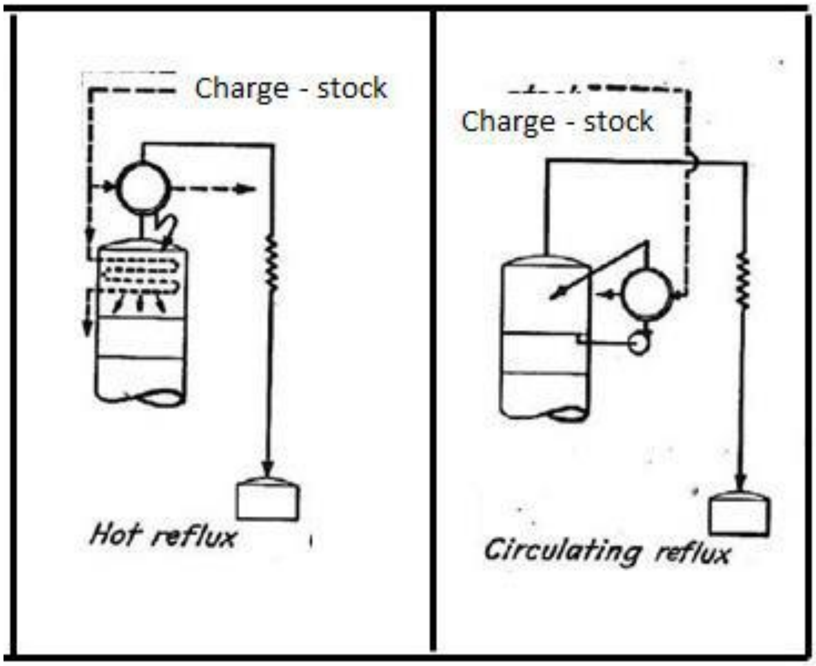
2- **Hot reflux** is reflux that is admitted to the tower at the same as that maintained at top of the tower. Obviously, the reflux or overflow from plate to plate in the tower is essentially hot reflux because it is always substantially at its boiling point.

$$Q = latent\ heat = m\lambda$$

3- **Circulating reflux**, it is able to remove only sensible heat quantity, that is represented by its change in temperature as it circulate, that mean this reflux is withdrawn from the tower as a liquid at high temperature the tower and is returned to the tower after having been cooled.

$$Q = sensible\ heat = mCp\Delta T$$

This reflux withdrawn from the tower as a liquid at high temperature and returned to the tower after having been cooled.



Example: Determine hot, cold, and circulating reflux of gasoline 58 API (6.22 lb/gal), if top temperature is 300ºF and reflux heat is 2,000,000 Btu/lb.

a) $hot\ reflux\ (Q\ ) = m\ \lambda$

$reflux = Q/\lambda$

From fig 5-5; API =58 and T= 300ºF $\longrightarrow \lambda = 123$ Btu /lb

$\therefore\ hot\ reflux = 2 \times 10^{6}/123 = 16250\ lb/\ hr$

$= 16250/\ 6.22 = 2612\ gal/hr$

b) $cold\ reflux\ (Q) = m\lambda + mCp\Delta T$

$\Delta T\ = Ttop - Tr = 300 - 100 = 200°F$

$Tmean = (300 + 100)/2 = 200°F$

From fig 5-1; API =58 and T= 200ºF $\longrightarrow Cp = 0.573$ Btu /lb.^{0}F

$\therefore\ cold\ reflux = 2 \times 106/\ [123 + 0.573\ (300 - 100)] = 8417\ lb/\ hr$

$= 8417/\ 6.22 = 1353\ gal/\ hr$

c) Circulating reflux : assume reflux is cooled from 300 to 200^{0}F

$Tmean = (300 + 200)/2 = 250°F$

From fig 5-1; API =58 and T= 250ºF $\longrightarrow$ Cp = 0.605 Btu /lb.^{0}F

$circulating\ reflux = 2 \times 10^{6}/\ 0.605(300 - 200) = 33100\ lb/hr$

$circulating\ reflux = 33100/\ 6.22 = 5130\ gal/hr$

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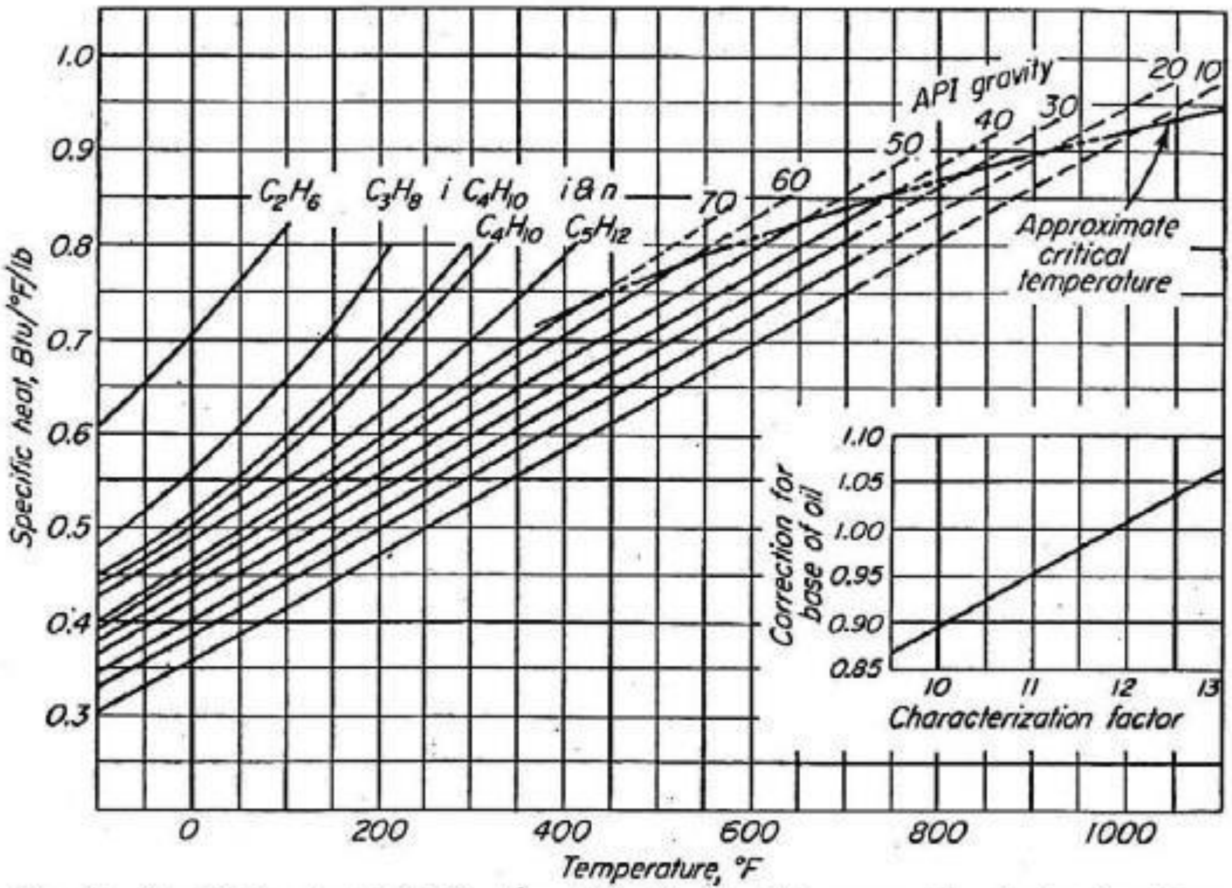

FIG. 5-1. Specific heats of Mid Continent liquid oils with a correction factor for other bases of oils.

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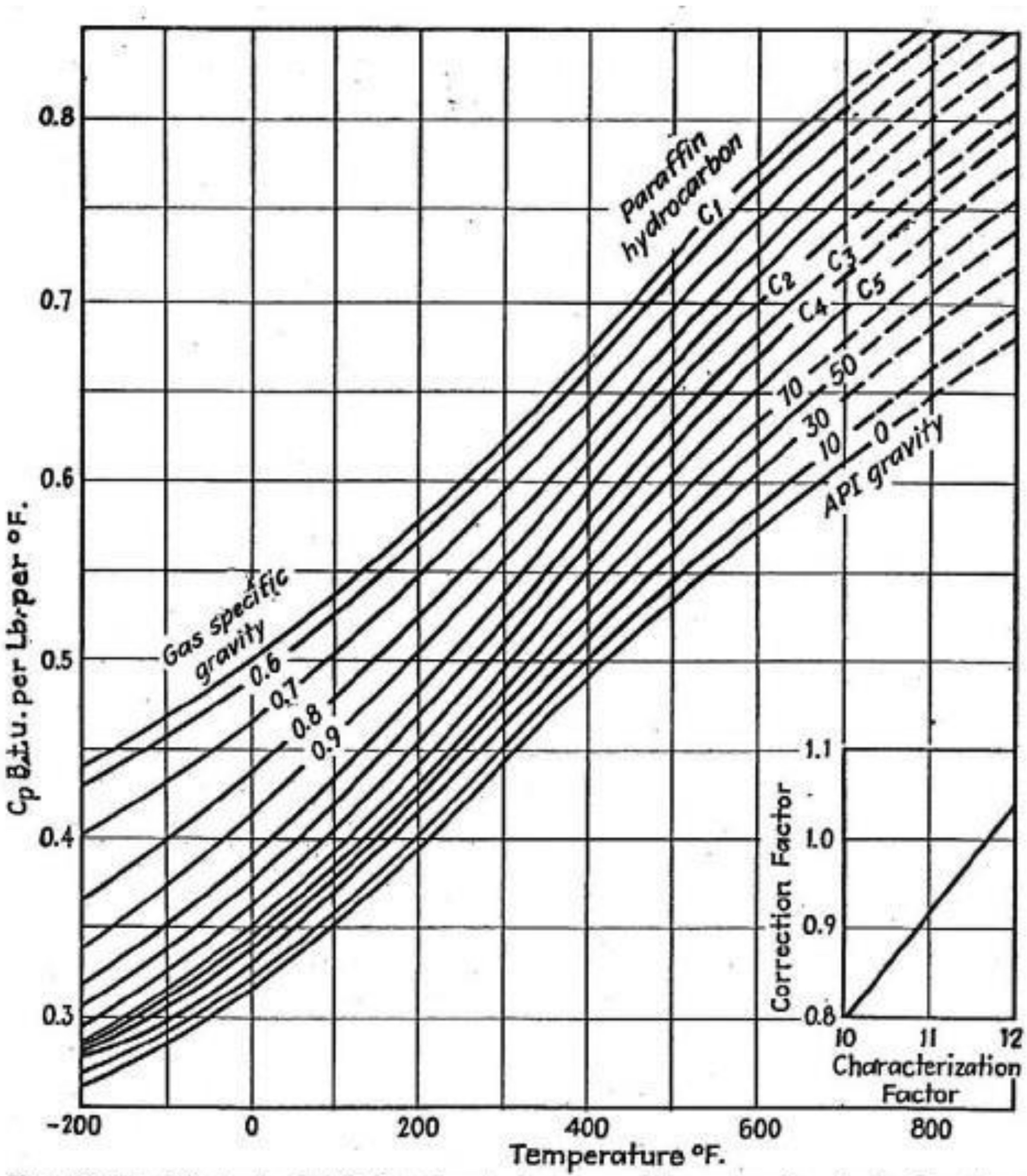

FIG. 5-2. Specific heats of Mid Continent oil vapors with a correction factor for other bases of oils. (*Holcomb and Brown, Ind. Eng. Chem.*)

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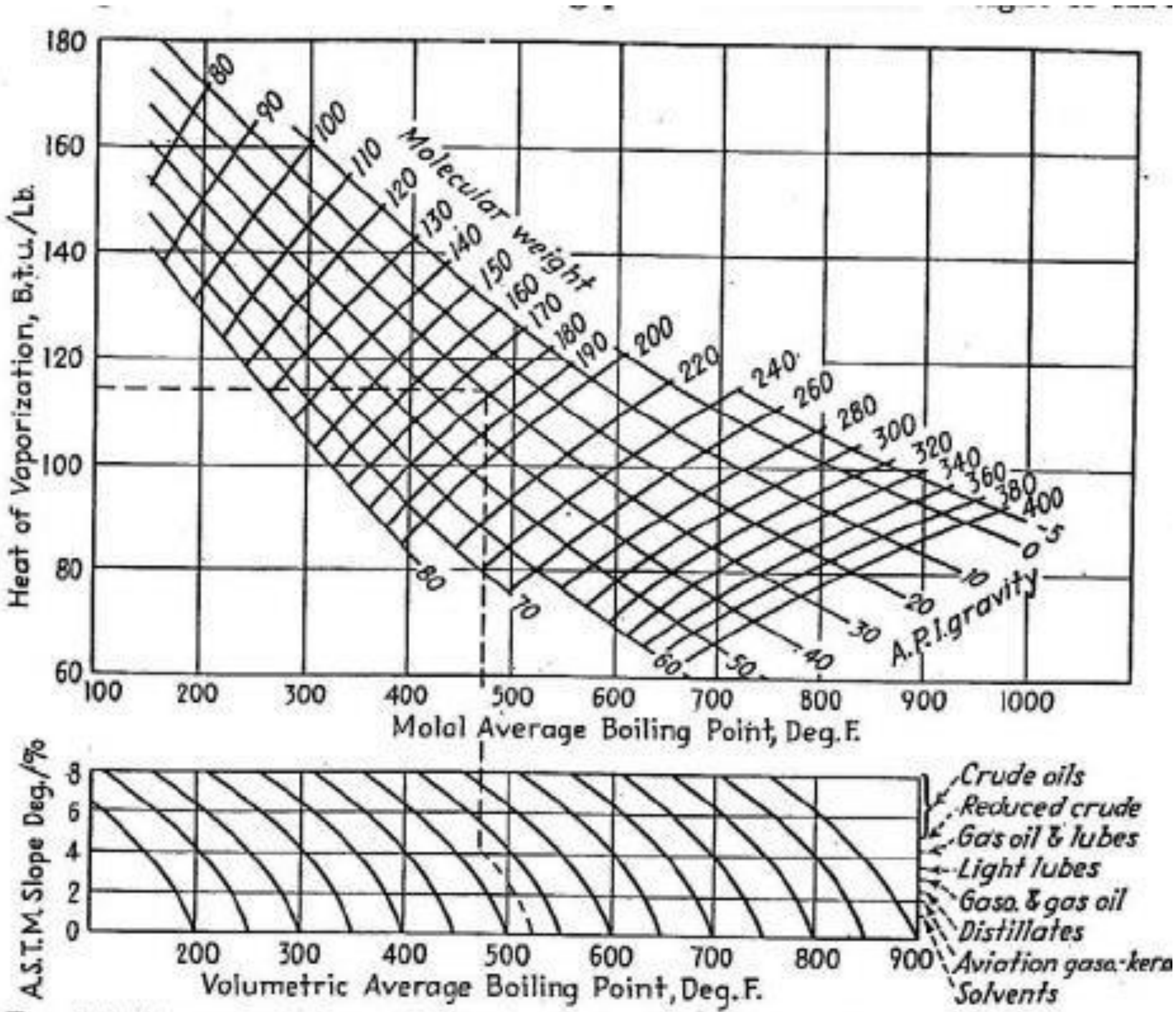

FIG. 5-5. Atmospheric latent heat of vaporization as a function of molecular weight (preferred) or API gravity. (*Courtesy of Hougen and Watson, "Chem. Process Principles," vol. 1, John Wiley & Sons, Inc., New York.*)

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