NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
DEPARTMENT OF CHEMICAL ENGINEERING

MONSOON SEMESTER 2014

CH3001 CHEMICAL ENGINEERING THERMODYNAMICS II

Time : 1 hour   TEST 1

Max marks : 20

1. Using the Maxwell equation $\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial P}{\partial s}\right)_v$ and $\left(\frac{\partial x}{\partial y}\right)_z \cdot \left(\frac{\partial y}{\partial z}\right)_x \cdot \left(\frac{\partial z}{\partial x}\right)_y = -1$, Derive the remaining Maxwell relations.   (4)

2. The P, v, T relation of a real gas is represented with reasonable accuracy by the relation

$v = \frac{RT}{P} + b - \frac{a}{RT}$ where a and b are constants. For this gas, find the change in enthalpy and entropy along an isothermal path between pressures P_1 and P_2 (3)

3. Using Lee Kesler data, estimate the enthalpy and entropy departures for ethane at 215.5°C and 39.07 bar. (For ethane, $T_c = 305.43$ K and $P_c = 48.84$ bar, $\omega = 0.099$)   (2)

4. Why are the departure functions important in the estimation of thermodynamic properties of a real gas?   (1)

5. What is the change in entropy when 0.7 m³ of CO_2 and 0.3 m³ of N_2, each at 1 bar and 25°C blend to form a homogeneous gas mixture at the same conditions? Assume ideal gases.   (2)

6. At 303 K and 1 bar, the volumetric data for liquid mixtures of benzene (1) and cyclohexane (2) are represented by the simple quadratic expression V= 109.4 – 16.8x_1 – 2.64x_1^2, where x_1 is the mole fraction of benzene and V has units of cm³/mol. Find expressions for $\bar{V}_1$ and $\bar{V}_2$ at 303 K and 1 bar.   (2)

7. Determine the fugacity (MPa) of acetylene at

a) 250 K and 10 bar   (2)

b) 250 K and 20 bar.   (4)

Use the virial equation. Data: $T_c = 308.3$ K, $P_c = 6.139$, $\omega = 0.187$, $Z_c = 0.271$, $P^{sat} = 1.387$ MPa

Satd Liquid volume $V^{sat,L} = V_c Z_c^{(1-Tr)^{0.2857}}$

$$B^o = 0.083 - \frac{0.422}{T_r^{1.6}}$$

$$B^1 = 0.139 - \frac{0.172}{T_r^{4.2}}$$

$$\left(\frac{h^0-h}{RT_c}\right)'$$
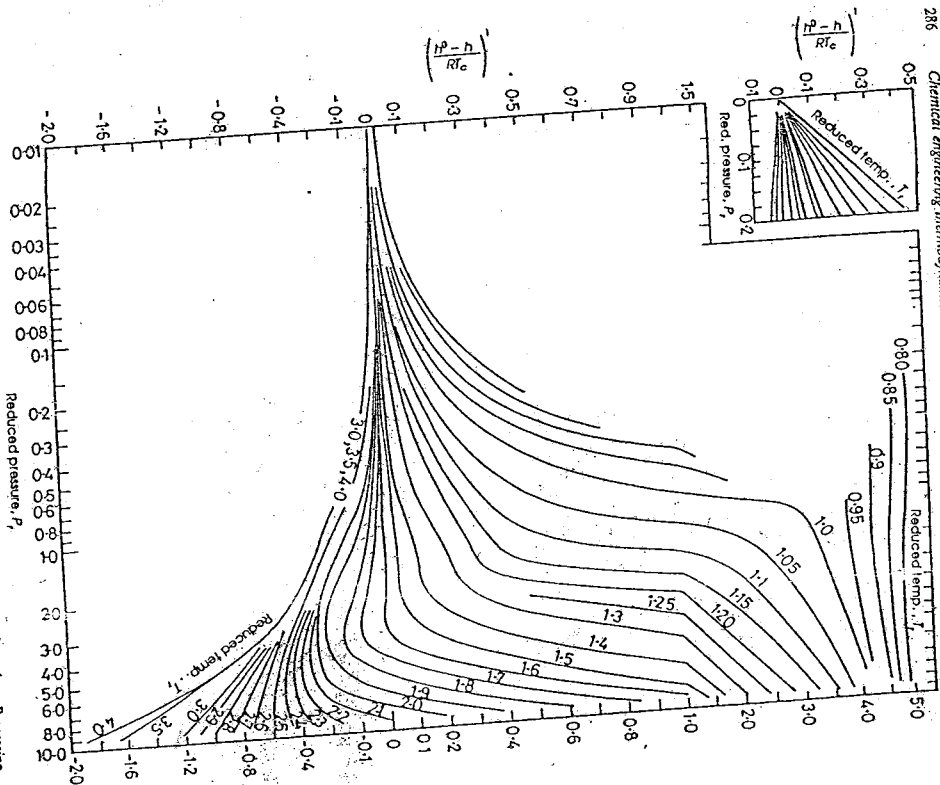
$$\left(\frac{h^0-h}{RT_c}\right)'$$

Fig. 8.3   *Second order enthalpy departure function. Reprinted by permission from Hydrocarbon Processing (April) 1967, copyright 1967 by Gulf Publishing Co., all rights reserved.*
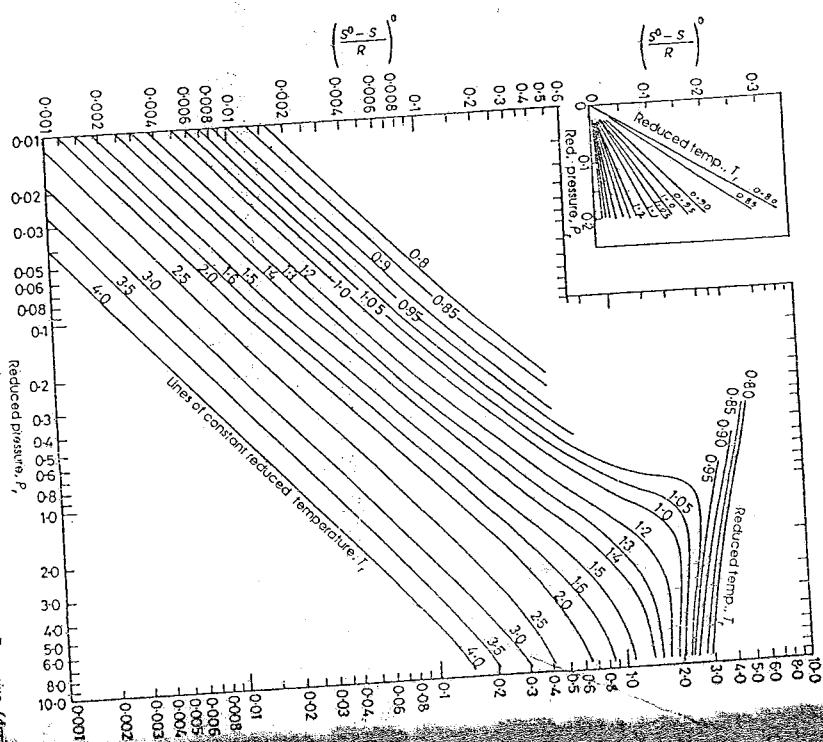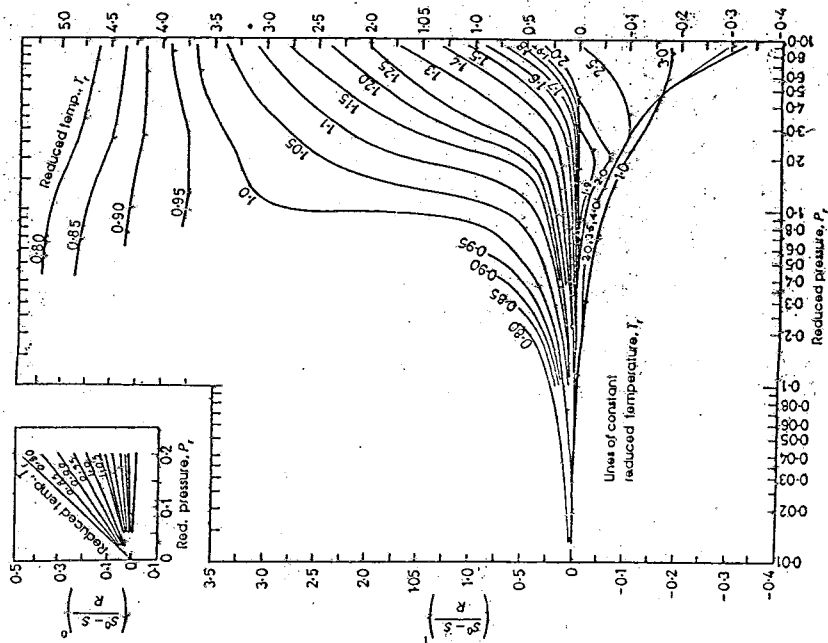
$$\left(\frac{S^0-S}{R}\right)^0$$

$$\left(\frac{S^0-S}{R}\right)^0$$

Lines of constant reduced temperature, T_r

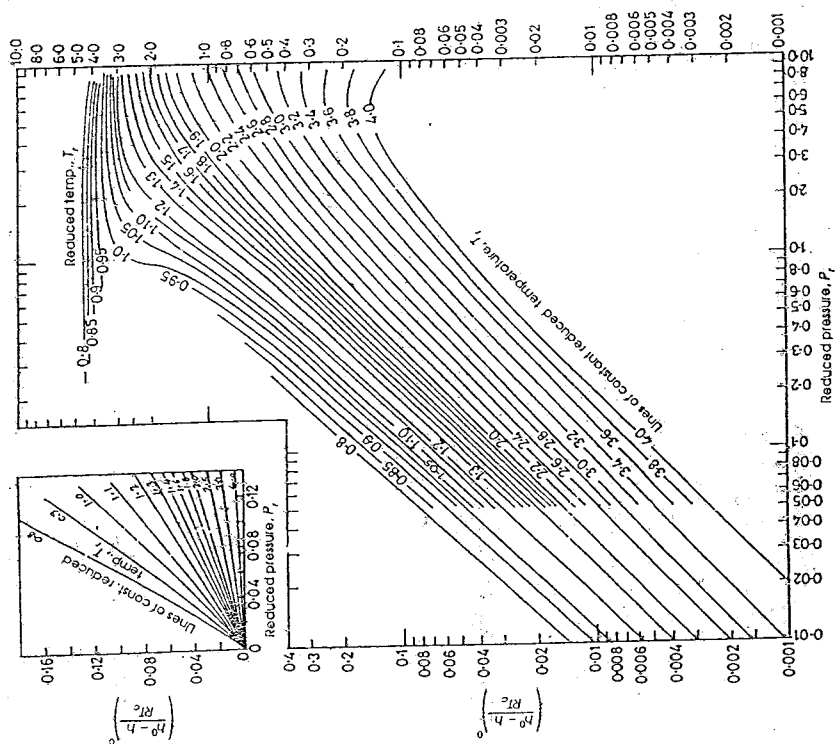Fig. 8.4   *First order entropy departure function. Reprinted by permission from Hydrocarbon Processing (April) 1967, copyright 1967 by Gulf Publishing Co., all rights reserved.*