APRIL/MAY 2015 **AM 15103**

AMET UNIVERSITY

B.E. (PE) DEGREE EXAMINATION, APRIL/MAY 2015.

(End Semester Examination)

Fourth Semester

Petroleum Engineering

PE 402 — PETROLEUM THERMODYNAMICS

(Session 2014–2015)

Time : 3 hours Maximum : 100 marks

Instructions :

(1) Before attempting the question paper, be sure that you got the correct question paper.

(2) The missing data, if any may be assumed suitably.

(3) Use the sketches wherever necessary.

PART A — (5 × 2 = 10 marks)

Answer ALL questions
(about two to three sentence per question)

1. What are point and path properties? Explain with examples.
2. Explain Gibb's phase rule.

3. State Raoult's law.

4. What is the difference between dynamic and kinematic viscosity?

5. Explain calorific value with units.

PART B — (5 × 4 = 20 marks)

Answer any FIVE questions
(about half a page to one page per question)

6. The molal heat of vaporization of a hydrocarbon is 5360 calories. The vapour pressure at 7 degree C is 1000 mm of mercury. What is the vapour pressure in psig at 20 degree C?

7. 20 liters of dry air is passed through a pure liquid hydrocarbon (MW =144) at 20 degree F. The loss in weight of the liquid was 1.310 grams. What is the vapour pressure at this temperature?

8. Explain the P-V for a multi component system with a neat sketch.

9. Ten pounds of a hydrocarbon are placed in a one cubic foot vessel at 60 degree F. The densities of the coexisting liquid and vapour are known to be 25 lb/cu ft and 0.05 lb/cu ft respectively at this temperature. Calculate the weights and volumes of the liquid and vapour phases.

10. An ideal solution contains 7 pound moles of n-butane and 3 pound moles of pentane. Calculate the dew point pressure at 180 degree F and the composition of the liquid at the dew point.

Vapor pressure of n- butane is 160 psia and vapour pressure of pentane is 54 psia.

11. Calculate the bubble point pressure and the composition of the vapour for a solution containing 100 lb of propane and 90 lb of n-pentane at 100 degree F. Assume ideal solution behaviour. Vapor pressure of propane is 177 psia and vapour pressure of pentane is 15.5 psia.

12. Given the following gas :

Component	Weight Fraction
C1	0.65
C2	0.15
C3	0.10
n - C4	0.06
n - C5	0.04

Assume real gas and Calculate:

(a) Gas density at 2,000 psia and 150°F

(b) Specific volume at 2,000 psia and 150°F

(c) Gas formation volume factor in scf/ft^3.

13. Define gas solubility with unit. Explain how gas solubility varies with pressure.

PART C — (5 × 14 = 70 marks)

Answer ALL questions.

14. (a) A piston and cylinder machine contains a fluid system which passes through a complete cycle of four processes. During a cycle, the sum of all heat transfers is –170 K.J. The systems completes 100 cycles per min. Complete the following table showing the method for each item, and compute the net rate of work output in KW.

Process	Q(KJ/min)	W(KJ/min)	U(KJ/min)
a-b	0	2,170	–
b-c	21,000	0	–
c-d	-2,100	–	– 36,600
d-a	–	–	–

Or

(b) An ideal gas $\left(C_p = 5 \text{ and } C_v = 3 \text{ cal/gm mole}^\circ K\right)$ is at 1 atm has a volume of $V_1 = 22.4\, m^3$. It is brought to P_2 = 10 atm and V_2 = 2.24 m^3 by the following reversible processes.

(i) Isothermal compression.

(ii) Adiabatic compression followed by cooling at constant pressure.

(iii) Heating at constant volume followed by cooling at constant pressure.

Calculate Q, W, U and H for each step of this overall process.

15. (a) Explain retrograde vaporisation and retrograde condensation with a neat sketch.

Or

(b) Explain in detail about the oil reservoir, dry gas and wet gas with diagram.

16. (a) A system contains 25 mole percent propane, 30 mole percent pentane and 45 mole percent heptanes at 150 degree F. Using the equilibrium constants calculate the composition of the liquid and vapour at 20 psia.

Or

(b) Using the equilibrium constants calculate the dew point pressure at 120 degree F for the hydrocarbon system consisting of 5 lb of propane, 30 lb of butane. 10 lb of pentane. 30 lb of hexane and 25 lb of heptanes.

17. (a) The following experimental PVT data on six different crude oil systems are available. Results are based on two-stage surface separation.

Oil	T	P	RS	BO	DENSITY	API	SP. GRAVITY
1	250	2377	751	1.528	38.13	47.1	0.851
2	220	2620	768	1.474	40.95	40.7	0.855
3	260	2051	693	1.529	37.37	48.6	0.911
4	237	2884	968	1.619	38.92	40.5	0.898
5	218	3045	943	1.57	37.7	44.2	0.781
6	180	4239	807	1.385	46.79	27.3	0.848

Using Standing's correlation, estimate the oil formation volume factor at the bubble point pressure and compare with the experimental value in terms of the absolute average error (AAE).

Or

(b) (i) Explain gas formation volume factor and oil formation volume factor with units.

(ii) A gas well is producing at a rate of 15,000 ft3/day from a gas reservoir at an average pressure of 2,000 psia and a temperature of 120°F. The specific gravity is 0.72. Calculate the gas flow rate in Scf/day.

18. (a) What is the difference between net and gross calorific value? Explain the determination of calorific value of a liquid fuel.

Or

(b) A gas reservoir has the following gas composition: the initial reservoir pressure and temperature are 3000 psia and 180 degree F.

Component	yi	Tc	Pc
CO2	0.02	547.91	1071
N2	0.01	227.49	493.1
C1	0.85	343.33	666.4
C2	0.04	549.92	706.5
C3	0.03	666.06	616.4
i - C4	0.03	734.46	527.9
n - C4	0.02	765.62	550.6

Calculate the gas compressibility factor under initial reservoir conditions.

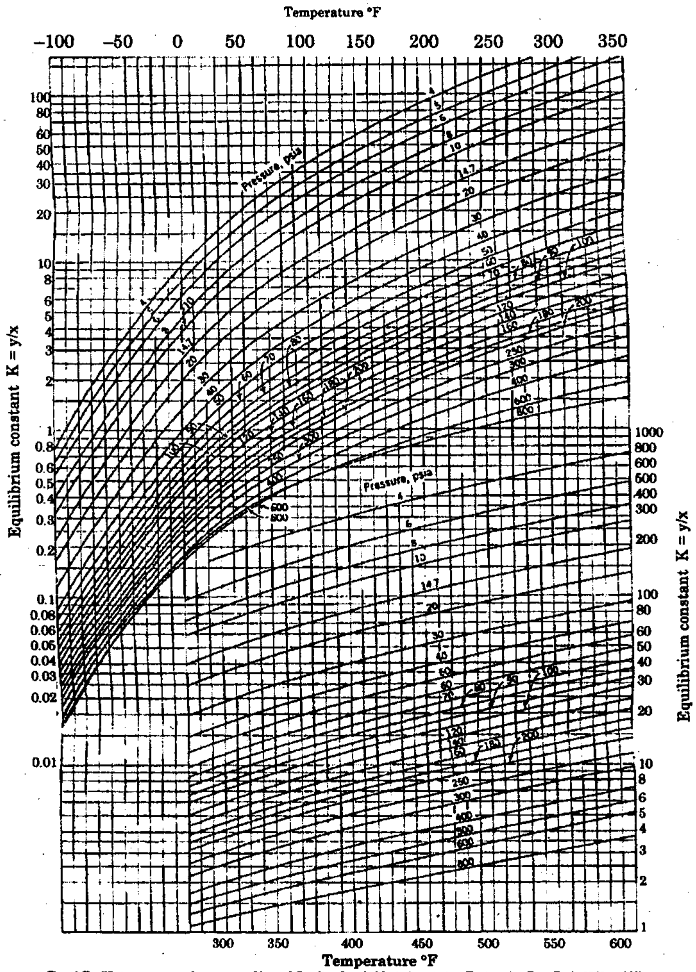

Fig. 43 Equilibrium constants for propane. (Natural Gasoline Supply Man's Association, Engineering Data Book, 1951, p. 108)

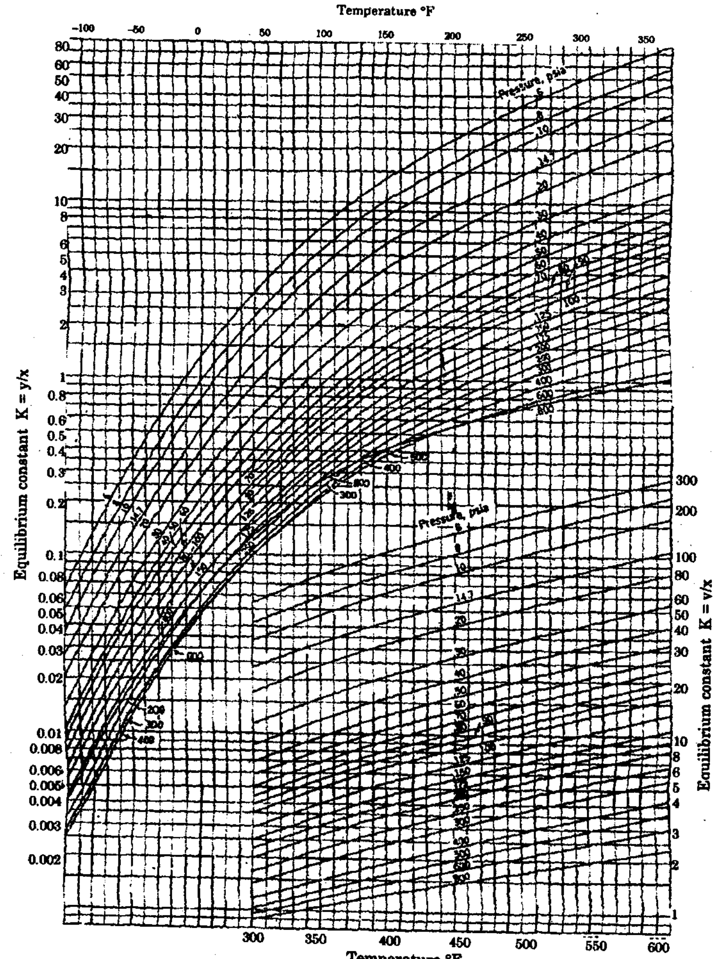

Fig. 45 Equilibrium constants for n-butane. (Natural Gasoline Supply Man's Association, Engineering Data Book, 1951, p. 110)

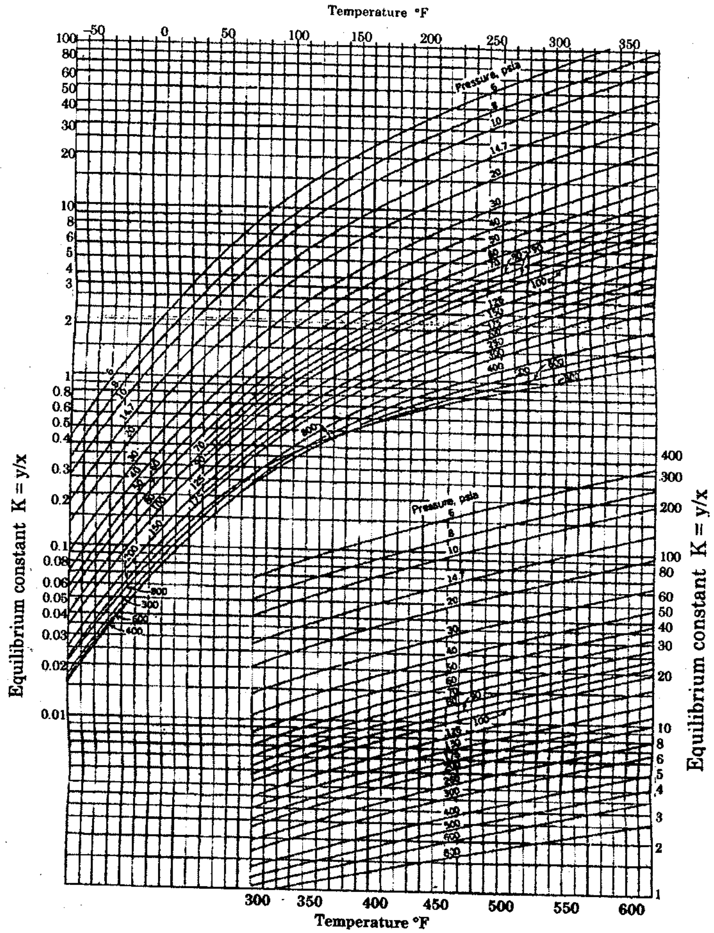

Fig. 44 Equilibrium constants for isobutane. (Natural Gasoline Supply Men's Association, Engineering Data Book, 1951, p. 109)

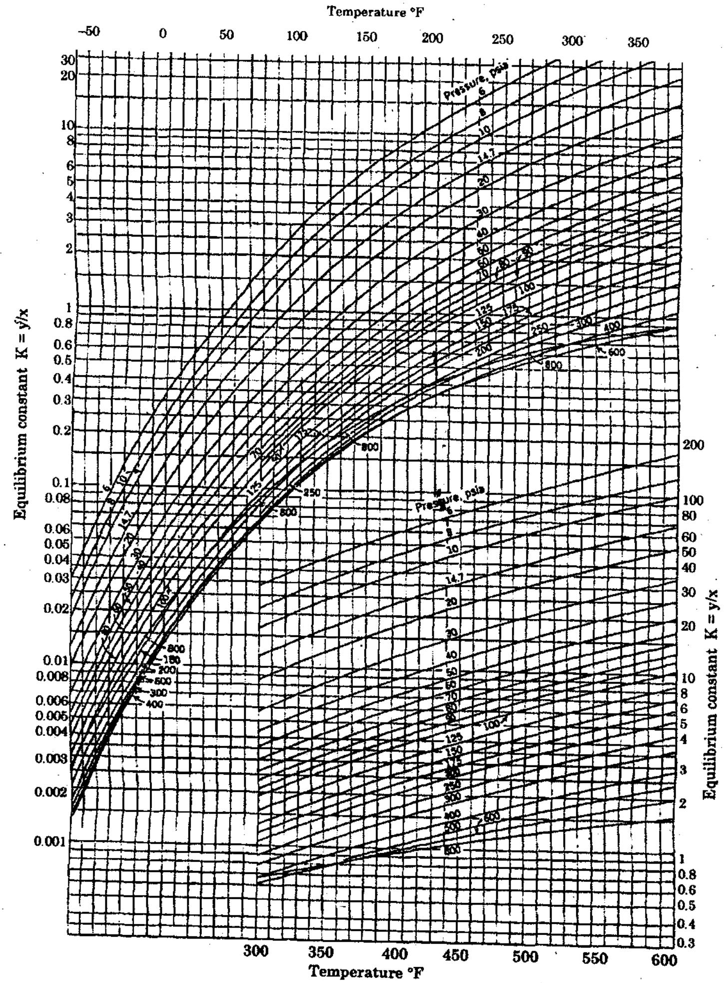

Fig. 47 Equilibrium constants for n-pentane. (Natural Gasoline Supply Men's Association, Engineering Data Book, 1951, p. 112)

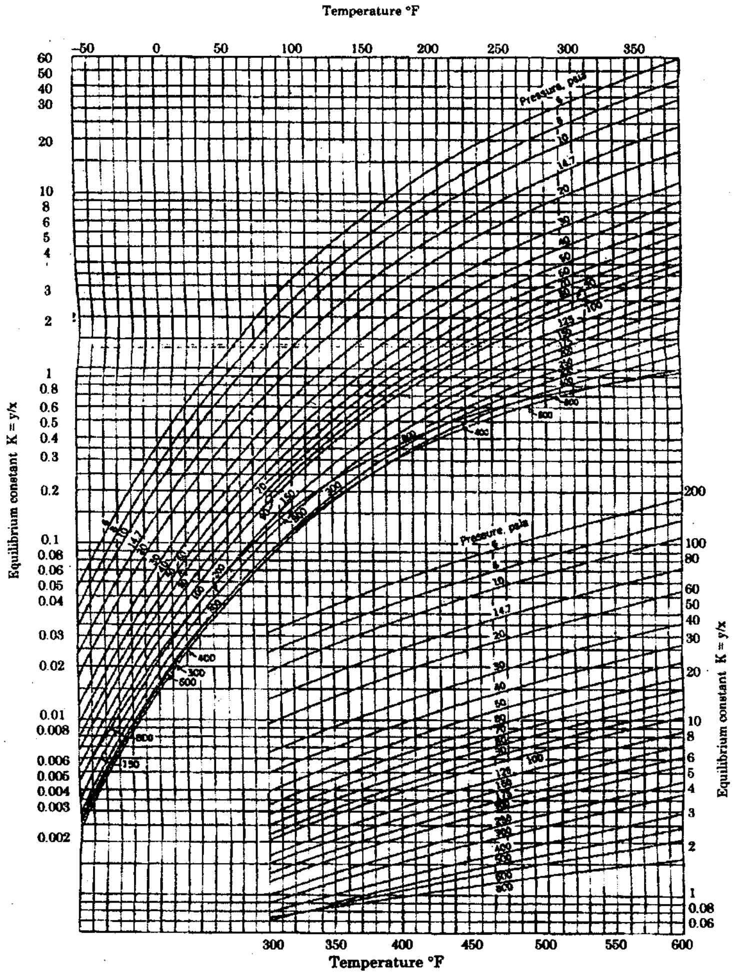

Fig. 46 . Equilibrium constants for isopentane. (Natural Gasoline Supply Men's Association, Engineering Data Book, 1951, p. 111)

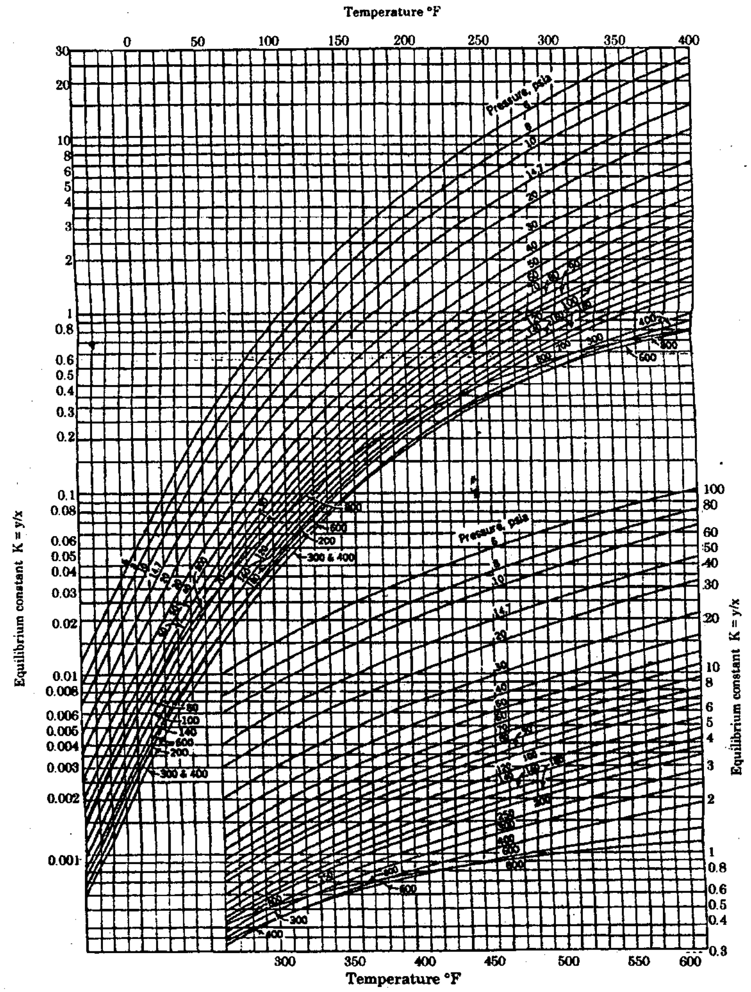

Fig. 48 . Equilibrium constants for n-hexane. (Natural Gasoline Supply Men's Association, Engineering Data Book, 1951, p. 113)

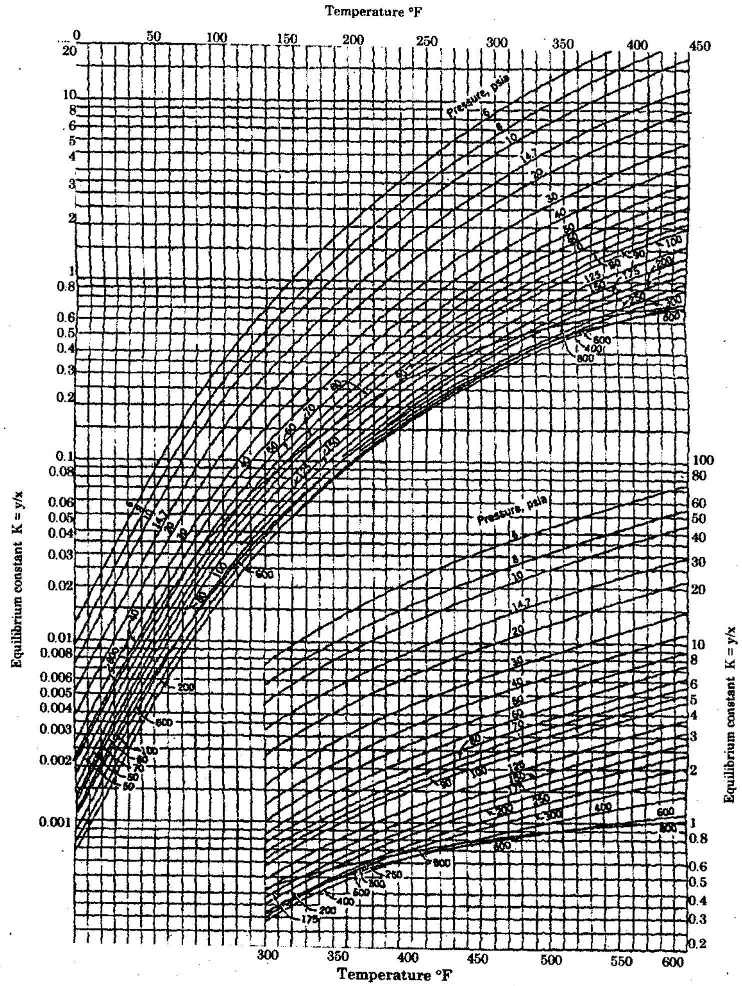

Fig. 49. Equilibrium constants for n-heptane. (Natural Gasoline Supply Men's Association, Engineering Data Book, 1951, p. 114)

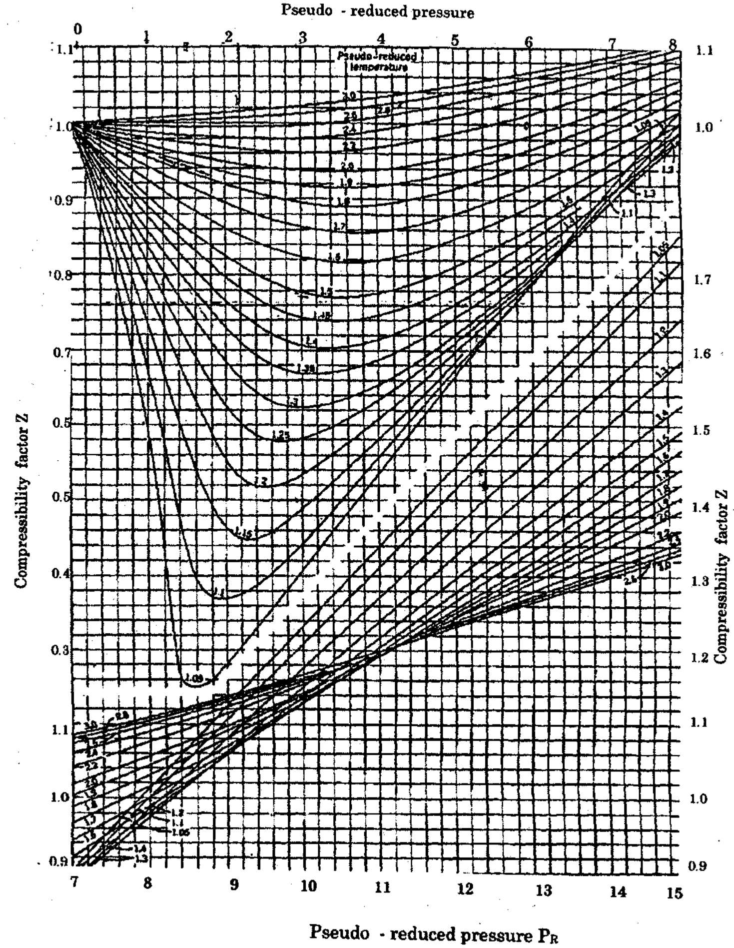

Fig. 10 Z factor for natural gases. (standing and Kntx. ATME Trans, 1942, p. 144