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INFORMATION RETRIEVAL*

Key Words: A. Extraction-8, Liquid-, Spontaneous-2, Convection-2, Interfacial-8, Patterns-8, Acetic Acid-1, Ethylene Glycol-1, Ethyl Acetate-1, Photography-10, Schlieren-, Motion Pictures-10, Concentration-6, Time-6. B. Size-7, Velocity-7, Stationary-, Propagating-, Polygons-2, Cells-2, Clusters-2, Stripes-2, Ripples-2.

Abstract: Spontaneous interfacial cellular convection accompanying the extraction of acetic acid out of ethylene glycol with ethyl acetate was studied photographically with a Schlieren technique. A flat liquid-liquid interface at room temperature was photographed straight down with motion picture and still cameras. The interface exhibited a dominant pattern of stationary and propagating polygonal cells, accompanied by stripes, cell cluster boundaries, and confined or unconfined ripples. The time dependence of the average wave length (size) of the different patterns, their average speed of propagation, and their frequency was determined with initial acetic acid concentration range of 0.1 to 10%, over a time span of 72 hours.

Reference: Orell, Aluf, and I. W. Westwater, **A.I.Ch.E. Journal, 8,** No. 3, p. 350 (July, 1962).

Key Words: Vapor Pressure-8, Properties (Characteristics)-8, Physical Properties-8, Relationships-8, Equations-8, Paraffins-9, Olefins-9, Aromatics-9, Hydrocarbons-9, Predictions-9, Critical-9, Constants-, Temperature-9, Pressure-9.

Abstract: A vapor pressure equation is presented which involves the reduced pressure, the reduced temperature, and a charactistic constant for each pure substance. The relationship has been applied to fifty-four hydrocarbons including normal paraffins, isoparaffins, olefins, diolefins, acetylenes, naphthenes, and aromatics. The equation can be used to predict vapor pressures of pure hydrocarbons up to the critical point, or, if reliable vapor pressure data are available, to predict the critical constants.

Reference: Reynes, Enrique G., and George Thodos, **A.I.Ch.E. Journal, 8,** No. 3, p. 357 (July, 1962).

Key Words: Porosity-8, Voids-8, Properties (Characteristics)-8, Physical Properties-8, Beds-9, Packed-, Spheres-9, Balls-9, Diameter-6, Boundaries-6, Concave-, Convex-, Porosity-7, Voids-7, Properties (Characteristics)-7, Physical Properties-7, Variations-7, Radial-.

Abstract: The radial variation of void fraction in a packed bed of uniform spheres has been studied. Results are presented for various D/d ratios, and for concave and convex boundary walls. An improved experimental technique is described in detail.

Reference: Benenati, R. F., and C. B. Brosilow, **A.I.Ch.E. Journal, 8,** No. 3, p. 359 (July, 1962).

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J_0 = quantity defined in Equation (6)
L = axial distance over which $(\mathcal{P}_0 - \mathcal{P}_L)$ is measured
m = $(\mathcal{P}_0 - \mathcal{P}_L)/L$
$\mathcal{P}$ = static pressure referred to a constant elevation = $p + \rho\Phi$
Q = volumetric flow rate through duct
S_0 = cross section of the duct
v_z = local fluid velocity in the z-direction
x,y,z = rectangular coordinates

Greek Letters

δ = variation operator
μ = viscosity
ρ = density
τ_{xz},τ_{yz} = components of the viscous stress tensor
Φ = potential energy per unit mass of fluid

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Immiscibility of Hydrocarbons and Liquid Methane

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J. P. Kohn (3) has recently reported a study of the phase equilibria of the system methane + *n*-heptane. He observed that the system separated into two liquid phases and reported the temperature and pressure of the quadruple point [solid heptane + liquid I + liquid II + gas]. It is very rare for two hydrocarbons to be partially immiscible, and the purpose of this paper is first to confirm Kohn's results and secondly to report some similar obser-

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TABLE 1. QUADRUPLE POINT OF METHANE + *n*-HEPTANE

	Temperature, °K.	Pressure, atm.	Weight fraction of CH_4 in liquid phases	
Kohn	169.6	23.0	0.227	~1
D, *F*, and *R*	169.6	—	0.17	>0.93

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INFORMATION RETRIEVAL*

Key Words: Predicting-8, Estimating-8, Force Constants-8, Lennard-Jones-, Viscosity-9, Critical Constants-9, Critical Temperature-9, Critical Volume-9, Physical Properties-9, Properties (Characteristics)-9, Transport Properties-9, Correlations-10.

Abstract: Lennard-Jones force constants calculated from viscosity values at normal pressures for nearly forty nonpolar organic and inorganic substances have been used to develop relationships for the estimation of these constants from the critical temperature and critical volume of the substance. Log-log plots were used to determine the relationships between the collision diameter and the critical volume, and between the temperature force constant, and the critical temperature. The product of the critical temperature and critical volume was found to correlate linearly with the force constant modulus.

Reference: Flynn, Lawrence N., and George Thodos, **A.I.Ch.E. Journal, 8,** No. 3, p. 362 (July, 1962).

Key Words: Stills-8, Equilibrium-, Fractionation-8, Equipment-8, Distillation-9, Separation-9, Vapor-Liquid Equilibrium-9, Phase Equilibrium-9, Theoretical Plates-9, Stainless Steel-10, Stills-10.

Abstract: A stainless steel six-stage vapor-liquid equilibrium unit has been developed for operation at pressures ranging from atmospheric to 400 lbs./sq. in. and at temperatures between 25° and 400°F. Efficiency tests were carried out at atmospheric pressure and 341 lb./sq. in. over a temperature range of 90° to 357°F, with four test mixtures.

Reference: McCormick, Robert H., Paul Barton, and M. R. Fenske, **A. I. Ch. E. Journal, 8,** No. 3, p. 365 (July, 1962).

Key Words: Entrainment-8, Carry-over (Entrainment)-8, Suspending-8, Sieve Plates-9, Perforations-9, Spacing-9, Holes-9, Bubbles-9, Mists-9, Magnitude-9, Size-9, Liquid Phase-9, Coalescing-9, Spacing-6, Holes-6, Size-7, Distribution-7, Magnitude-7, Sieve Plates-10, Photography-10.

Abstract: The magnitude and size distribution of entrainment have been studied as functions of hole spacing in a sieve tray with high-speed photography. Entrainment appears to be related to the degree of bubble coalescence in the liquid continuous phase and increases rapidly with decrease in hole spacing; it is not affected significantly by bubble bursts.

Reference: Teller, A. J., and R. E. Rood, **A. I. Ch. E. Journal, 8,** No. 3, p. 369 (July, 1962).

Key Words: Stationary Particles-1, Sliding Particles-1, Bouncing Particles-2, Suspended Particles-2, Water-5, Air-5, Settling Rate-6, Particle Density-6, Fluid Density-6, Particle Diameter-6, Pipe Diameter-6, Fluid Viscosity-6, Minimum Transport Friction Velocity-6, Pneumatic Transport-8, Hydraulic Transport-8, Spherical Particles-9, Bernoulli Forces-10, Turbulent Fluctuations-10, Velocity Difference-10.

Abstract: Data for the minium transport velocity of 78- and 310 μ particles flowing in a horizontal pipe were combined with prior pneumatic- and hydraulic-transport data to give a unique minimum-transport relation, valid for particles larger than the thickness of the laminar sublayer. The transport mechanism was consistent with Bernoulli forces due to instantaneous velocity differences accompanying turbulent fluctuations and largely confined to the buffer layer.

Reference: Thomas, David G., **A.I.Ch.E. Journal, 8,** No. 3, p. 373 (July, 1962).

Key Words: Flow-8, Fluid Flow-8, Laminar Flow-8, Liquids-9, Non-Newtonian-, Oldroyd-, Fluids-9, Viscoelasticity-9, Physical Properties-9, Properties (Characteristics)-9, Rheology-9, Conduits-10, Circular-, Pipes-10, Slits-10, Velocity-9, Transport-9, Rates-6, Pressure Drop-7, Predicting-8, Estimating-8.

Abstract: Velocity distribution and flow rate-pressure drop relations for the circular tube and the plane slit are calculated for Oldroyd models. The results are used to fit steady state experimental tube flow data on several viscoelastic liquids. The models describe the fluid behavior well only for low rates of flow, but can be used to approximate flow curves over wide ranges of flow rates.

Reference: Williams, Michael C., and R. Byron Bird, **A.I.Ch.E. Journal, 8,** No. 3, p. 378 (July, 1962).

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vations on other solutions in liquid methane.

We observed the immiscibility of methane and *n*-heptane some years ago (*1*) and, more recently, have measured the temperature and approximate limits of composition of the coexisting phases at the quadruple point. These unpublished results agree moderately well with those of Kohn, Table 1.

It appears that this system is one of those where unusually large differences of intermolecular energies and/or sizes can produce lower critical solution temperatures (L.C.S.T.), although here the heptane solidifies before the L.C.S.T. is reached. There are several similar systems in which ethane, ethylene, *n*-butane, or carbon dioxide is the solvent but in which the solute is not a hydrocarbon (*4*). However we have recently reported L.C.S.T. in several systems containing only hydrocarbons (*5*) or hydrocarbon polymers (*2*), and we have found more recently several in which liquid methane is one of the components.

Liquid methane appears to mix in all proportions and at all temperatures with paraffins containing five or fewer carbon atoms. It is incompletely miscible with *n*-hexane above 182.5°K., with 2-methyl pentane above 194.7°K., and with 3-methyl pentane above 188.5°K. The other two isomers of hexane, 2,2-dimethyl butane and 2,3-dimethyl butane, are miscible at all temperatures. Thus the miscibility appears to increase as the hydrocarbon chain becomes branched. We have still to study many of the heptanes, but it appears again that the branched isomers are the more readily miscible. The L.C.S.T. for 2,4-dimethyl pentane is at about 183°K., while that of *n*-heptane must be below 169°K. As the chain lengthens, the critical temperatures move further from the gas-liquid critical temperature of pure methane.

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