ENGINEERING

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ABSTRACTS

The Wilsak Thodos Equation of State: Its Use and Applicability. WARREN W. BOWDEN, Department of Chemical Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana 47803.——Wilsak and Thodos* invented a new and different equation of state based primarily on experimental PVT data on argon.

The form of this equation is as follows:

$$\pi = \alpha\tau + \beta\,(\psi + \frac{\tau}{\tau+1})\,(\frac{\tau}{\tau+1}) \qquad (1)$$

where $\pi = P_R - P_R^\circ$, $\tau = T_R - T_R^\circ$

P_R° and T_R° are the coordinates of a reference condition. The quantities α, β and ψ are functions of volume only as follows:

$$\alpha = \frac{1}{Z_c} \quad \frac{\rho_R}{\rho_R + 1}\,[1 + \frac{3}{2} \times \frac{\rho_R}{\rho_R + 1}\,(1 + \rho_R + \rho_R^2)] \qquad (2)$$

$$\beta = \rho_R^3$$

$$\psi = \frac{1}{\rho_R^{3/2}} \times \frac{1 + \rho_R^8}{1 + a\rho_R^8}\,(\rho_R - 1)^2[b + c\,(\rho_R - 1)^2] \qquad (3)$$

where $\rho_R = \rho/\rho_C$ = reduced density.

Wilsak and Thodos found that equation(1) represented the PVT behavior of Argon very accurately. In a generalized form it represented the PVT behavior of other compounds well.

This paper a) explains how this equation is used to obtain density (ρ) or volume (V) given P, and T;

b) explains some of the problems encountered when it is used to evaluate fugacity or residual enthalpy; and

c) gives the results of evaluating the residual volume at zero pressure using equation (1).

*R. A. Wilsak and George Thodos, *AICHE J, 31* (#5), 729-790 (1985)

Development of a Microcomputer Based System for On-line Behavioral Experiments. DAVID D. CHESAK, Department of Mathematics and Physics, Saint Joseph's College, Rensselaer, Indiana 47978.——A microprocessor based controller developed by Palya and Walters has been extensively studied for use as a controller and data gathering tool to operate an experimental animal chamber. The low cost of the device permits a unit to be dedicated to each chamber. Each controller is a stand-alone computer in its own right and is programmed in a special subset of BASIC computer programming language to provide ease of program modification. To assure adequate speed of response, the machine simultaneously operates in a background mode as well as a foreground mode so that accurate timing of the experimental parameters is possible.

A number of these controllers, each driving a separate animal chamber, is connected in a satellite network with a central minicomputer controlling the entire network. The system offers greater overall reliability in that the failure of one unit does not immobilize the entire system. Modifying a controller's operating strategy is simply accomplished by down-loading a different program from the central minicomputer storage facility to the controller. This planetary system with "intelligent" controllers allows experimental data to be processed in real time by the controller's microprocessor or the data can be stored in the controller's memory and later transferred to the minicomputer for computation. Overall, the system affords greater flexibility, reliability and economy than has been possible previously.

Correlation of the Volumetric Properties of Compressed Liquids. CHUNG-MING LIN AND WARREN W. BOWDEN, Department of Chemical Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana 47803.——Havward (1967) proposed the Tait equation (below) for predicting the PVT behaviors of compressed liquids. The Tait equation has the form:

$$\bar{K} = \frac{P - Ps}{\dfrac{Vs - V}{Vs}} = f(Tr.Pr,W)$$

Where p	=	pressure	Ps	=	saturated pressure	Pc	=	critical pressure
V	=	volume	Vs	=	saturated volume	Tc	=	critical temperature
Tr	=	T/Tc	Pr	=	P/Pc	W	=	acentric factor

Our objective is to find a form of the function f which fits the experimental data well. We have found that the form

$$\bar{K} = c1 + c2/Tr + c3{*}Tr + c4{*}Tr^2 + c5{*}Pr/Tr + c6{*}Tr{*}Pr + c7{*}Pr^2/Tr + c8{*}Pr^2 + c9{*}Tr^2{*}Pr^2$$

fits the experimental data on CH4 very well. The data on ethane, propane, butane are also being fitted to the same form. The results from these fitting will serve as the basis for the prediction of the PVT behavior of other compressed liquids.

Heat Efficiency of a Passive Solar Greenhouse. ROSALIE J. KRAMER, Indiana University East, Richmond, Indiana 47374.——The purpose of this project was to recyle parts from a conventional greenhouse and use as many of them as possible to construct a passive solar greenhouse that would be used as a demonstration and research unit for the efficiency of passive solar energy.

The original proposal projected 75% efficiency of the passive solar system for this region of the country (central Indiana). It was projected that no supplementary heat would be needed if an outside mean temperature of 30.5° F were maintained. This figure was based on an estimated 70% cloud cover during December-February for our region.

Heat data was to be collected on a chart recorder using termistors placed in a variety of locations. This apparatus recorded outside and two inside temperatures plus indicated when the auxillary heat turned on and off. Data was analyzed by a computerized system.

Auxillary heat was used on an average of 1.82 times per hour during February, 1984. The duration of the heat cycle averaged six minutes at night or approximately 11 minutes per hour.

It was shown that no auxillary heat was needed at night if outside temperatures stayed above 25° F, and if days had been clear and sunny. If days were cloudy, (allowing less heat to be stored), nighttime temperatures (outside) of less than 40° F were sufficient to turn on the auxillary heat system.

Overall, we feel the greenhouse has more than met our expectations in terms of heat efficiency.

Application of Finite Time Thermodynamics to a Simple Power Cycle. S. LEIPZIGER AND B. LEWIS, Rose-Hulman Institute of Technology, Terre Haute, Indiana 47803.——— Finite time thermodynamic analysis uses methods which take into account the irreversibilities necessary to drive a process in real time (i.e. heat exchangers require nonzero temperature differences between fluids) and provides a mechanism for process optimization with respect to particular criteria. It further allows the calculation of traditional efficiencies during that operation.

Results are developed here for the conventional steady-state continuous power cycle with optimization criteria of: 1) maximum power production, 2) maximum thermal efficiency, and 3) minimum entropy production during operation.