LETTERS TO THE EDITOR

To the Editor:

1974-1979

The year 1974 can be identified either as the death of the years of halcyon energy availability-cost or the beginning of the years of frantic energy shortages and escalating costs. 1974 also begins the period when the United States surrendered the mastery of her fate in convenience fuels.

The year 1974 records the following resolves by our governmental executives and legislators:

A. The United States will be independent of foreign sources of fuels by 1985.

B. Conservation measures will be taken which will reduce the demand for fuels and energy.

C. Utilization of coal will be emphasized so that coal will provide an increasing amount and percentage of our energy needs.

These were our agreed-to-objectives but let us look at what has happened in reality.

1. The United States is importing more and a greater percentage of our energy needs than we did prior to 1974.
2. The energy consumption in the United States has continued to rise at approximately a 4% compounded annual rate.
3. Our resolve to change our sources of energy to use more coal has been similarly unfulfilled. Newly opened mines have either closed or are operating at sharply reduced rates.

All of the above short-falls result from a lack of commitment to face facts. Governmental agencies seem to do more hindering of each other than in deriving compromise solutions (DOE vs. EPA). Legislators devise laws which discourage rather than encourage seeking new supplies domestically. Trying to legislate the laws of supply and demand is always doomed to failure. The final problem is the inability of the governmental agencies to make the enormous number of necessary decisions wisely. This failure is not because of ineptness but primarily because they are being tugged at by all types of pressure and special interest groups.

I am, myself, unable to offer a solution other than the Utopian one: we must work together unselfishly. Lacking a solution we must all face the inescapable fact that energy power is political power. Witness the fact that we are having our noses tweaked ignominiously now. It is not a position we should tolerate now nor can we let it continue. There can be no substitute for universal hard work, intelligent and inspired research, and sacrifice.

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To the Editor:

In a recent paper, Yih and Seagrave [*AIChE J.*, 24, 803 (1978)] presented a study of the hydrodynamic stability of thin liquid films down an inclined plane with heat transfer and interfacial shear. They took into account the influence of the viscosity variation with temperature. With a linear temperature drop across the film, and employing the same assumptions as used by Shair (1971), they found a viscosity variation law of the form:

$$\mu = \mu_0 \, e^{-\alpha\eta} \qquad (1)$$

where η is the dimensionless distance from the wall.

In order to obtain the Orr-Sommerfeld equation, perturbations terms are surimposed to the primary flow. As it was pointed out by the authors, there exist temperature perturbation terms. Yih and Seagrave, as before them Wazzan et al. (1968) and Potter and Graber (1972), used equation (1), which is only true for the primary flow, in the calculation of the perturbation equations. Actually, for the real flow, the temperature drop across the film is no longer linear:

$$\hat{T} = T_0 + (T_1 - T_0)\eta + T' \quad (2)$$

where T' is the perturbation quantity and $\overline{T} = T_0 + (T_1 - T_0)\eta$ the temperature of the primary flow.

The viscosity has first a temperature dependence rather than a film thickness dependence; hence the perturbation quantity T' induces a viscosity perturbation term which has to be taken into account to obtain the Orr-Sommerfeld equation. With the same assumptions as used by Shair (1971), the viscosity term is:

$$\mu = \mu_0 \, e^{-\alpha\eta - \alpha t'} \quad (3)$$

where t' is the dimensionless temperature perturbation term.

Linearization of equation (3) yields

$$\mu = \mu_0 \, e^{-\alpha\eta}(1 - \alpha t') \quad (4)$$

When the viscosity perturbation term is not omitted, the Orr-Sommerfeld equation reads:

$$\begin{aligned} i k R[(\overline{U} - C)(\phi'' - k^2\phi) - \overline{U}''\phi] &= \tilde{\mu}\,[\phi^{IV} - 2k^2\phi'' + k^4\phi] \\ &+ \frac{d\tilde{\mu}}{d\eta}[2(\phi''' - k^2\phi') \\ &+ \overline{U}'(Z'' + k^2 Z) + 2\overline{U}''Z'] \\ &+ \frac{d^2\tilde{\mu}}{d\eta^2}[\phi'' + k^2\phi + 2(\overline{U}'Z' \\ &+ \overline{U}''Z)] + \frac{d^3\tilde{\mu}}{d\eta^3}\overline{U}'Z \quad (5) \end{aligned}$$

where Z is defined as:

$$t' = Z(\eta) \exp[ik(x - c\tau)] \quad (6)$$

This modified Orr-Sommerfeld equation includes supplementary term of function Z, which do not exist in equation (9) of Yih and Seagrave. If the function Z appears in the Orr-Sommerfeld equation, one has to take into account the energy balance equation which yields:

$$i k Pe\,[(\overline{U} - c)Z - \phi] = Z'' - k^2 Z \quad (7)$$

where Pe is the Peclet number defined as

$$Pe \triangleq \frac{\langle U \rangle \rho_1 C_p \Delta}{\lambda} \quad (8)$$

(C_p : heat capacity; λ : heat conductivity).

The additional boundary conditions read:

assuming a constant wall temperature:

$$Z(0) = 0 \quad (9)$$

assuming a constant interfacial temperature:

$$Z(1) + a = 0 \quad (10)$$

The two Orr-Sommerfeld type equations (5 and 7) have now to be solved, with their boundary conditions. The method used by Yih and Seagrave does no longer apply in this case.

However, the method of quadrature by differentiation developed by Solesio (1977) can be used; this method involves development of ϕ and Z at $\eta = 0$ and $\eta = 1$, and the viscosity terms (equation 1) are to be linearized at these same points.

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To the Editor:

The modification of the viscosity-temperature relationship suggested by Spindler to include the effect of perturbations in temperature is an interesting idea about which we would make the following comments:

1. The relation

$$\mu = \mu_0 e^{-\alpha\eta - \alpha t'} \quad (1)$$

is itself an approximation valid only in the case where $T_1 - T_0/T_0^2$ and T'/T_0 are much less than unity. This is easily shown by substituting

$$T = T_0 + (T_1 - T_0)\eta + T' \quad (2)$$

into the viscosity temperature relation

$$\mu = \mu_0 e^{-Ea(1/T_0 - 1/T)} \quad (3)$$

and expanding, to show that $t' = Ea\dfrac{T'}{T_0^2}$. When T'/T_0 is much less than unity, the value of t^2 is correspondingly smaller.

Unquestionably the inclusion of the term $e^{-\alpha t'}$ contributes to additional terms in the Orr-Summerfeld equation. We wrote the energy equation corresponding to Spindlers Equation (7), which in our nomenclature is

$$\hat{F}'' - k^2\hat{F} = i\,k\,Pe[(\overline{U} - c)\hat{F} + \phi]$$

but did not find it necessary to include it in our paper.

3. In our opinion, the simplifications needed to justify Equation (1) do not significantly expand the scope under which the same relationship without the perturbation term is valid. The added mathematical complexity will probably not be warranted by any significant improvement in the results. Our treatment is preferable from an analytical point of view and is consistent with developments by Wazzan et al. (1968) and Potter and Graeber (1972).

We are grateful to B. Spindler for his interest in this problem.

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ERRATUM

In "Equilibrium and Kinetic Studies of Hydrogen Isotope Exchange on Vanadium Hydride," by Y. W. Wong and F. B. Hill [*AIChE J.*, **25**, 592 (1979)], the void fraction • should not appear in Equation (24). Correction of this error leads to an average value of the tortuosity factor of 2.23 ± 0.36. This value is not inconsistent with the notion that axial dispersion is due solely to molecular diffusion. In the Notation list, ***u*** should be defined as the actual linear gas velocity.