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Chapter 1 • Introduction 23

We may tabulate the data and the two curve-fits as follows:

T, °K	300	400	500	600	700	800
$\mu \times 10^6$ , data	2.27	2.85	3.37	3.83	4.25	4.64
$\mu \times 10^6$ , Power-law	2.29	2.83	3.33	3.80	4.24	4.68
$\mu \times 10^6$ , Sutherland	2.27	2.85	3.37	3.83	4.25	4.64

1.42 Some experimental values of  $\mu$  of helium at 1 atm are as follows:

T, °K	200	400	600	800	1000	1200
$\mu$ , kg/m·s	1.50E-5	2.43E-5	3.20E-5	3.88E-5	4.50E-5	5.08E-5

Fit these values to either (a) a Power-law, or (b) a Sutherland law, Eq. (1.30b).

**Solution:** (a) The Power-law is straightforward: put the values of  $\mu$  and T into, say, "Crickit Graph," take logarithms, plot them, and make a linear curve-fit. The result is:

Power-law curve fit:  $\mu_{\text{fit}} = 1.805E-5 \left( \frac{T}{200\text{K}} \right)^{1.68}$  Ans. (a)

The accuracy is less than ±1%. (b) For the Sutherland fit, we can emulate Prob. 1.41 and perform the least-squares summation,  $E = \sum (\mu_i - \mu_i(T_i)) / (200 + S_0 T_i) + S_0^2$  and minimize by setting  $\partial E / \partial S_0 = 0$ . We can try  $\mu_0 = 1.50E-5$  kg/m·s and  $T_0 = 200$  °K for starters, and it works OK. The best-fit value of  $S_0 = 95.1$  °K. Thus the result is:

Sutherland law:  $\mu_{\text{fit}} = \frac{1.50E-5 \text{ kg/m·s} \cdot (T/200)^{1.68} (200 + 95.1\text{K})}{T + 95.1\text{K}}$  Ans. (b)

For the complete range 200–1200°K, the Power-law is a better fit. The Sutherland law improves to ±1% if we drop the data point at 200°K.

1.43 Yaws et al. [Ref. 34] suggest a 4-constant curve-fit formula for liquid viscosity:

$\ln \mu_i = A + B/T + CT + DT^2$ , with T in absolute units.

(a) Can this formula be criticized on dimensional grounds? (b) If we use the formula anyway, how do we evaluate A,B,C,D in the least-squares sense for a set of N data points?

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