16.D4   This problem asks us to determine whether or not it is possible to produce a continuous and oriented glass fiber-reinforced polyester having a tensile strength of at least 1250 MPa in the longitudinal direction, and a maximum specific gravity of 1.80. We will first calculate the minimum volume fraction of fibers to give the stipulated tensile strength, and then the maximum volume fraction of fibers possible to yield the maximum permissible specific gravity; if there is an overlap of these two fiber volume fractions then such a composite is possible.

With regard to tensile strength, from Equation 16.17

$$\sigma_{cl}^* = \sigma_m'(1 - V_f) + \sigma_f^* V_f$$

$$1250 \text{ MPa} = (20 \text{ MPa})(1 - V_f) + (3500 \text{ MPa})(V_f)$$

Solving for V_f yields $V_f = 0.353$. Therefore, $V_f > 0.353$ to give the minimum desired tensile strength.

Now, upon consideration of the specific gravity (or density), ρ, we employ the following modified form of Equation 16.10b:

$$\rho_c = \rho_m(1 - V_f) + \rho_f V_f$$

$$1.80 = 1.35(1 - V_f) + 2.50(V_f)$$

And, solving for V_f from this expression gives $V_f = 0.391$. Therefore, it is necessary for $V_f < 0.391$

in order to have a composite specific gravity less than 1.80.

Hence, such a composite *is possible* if $0.353 < V_f < 0.391$.