The value of \( n \) for glass is around 1.5 (see Table 23.1), so \( n_1 < n_e < n_2 \), and there is a phase shift in the glass-ethyl alcohol interface as well as ethyl alcohol-air interface. No net phase shift therefore exists between the beams reflected off the top and bottom of the ethyl alcohol layer, and so Eq. (25.11) applies: \( d_m = m \lambda_\omega / 2n_e \), where \( m = 1, 2, 3, \ldots \). For \( d_{\text{min}} \) take \( m = 1 \), along with \( \lambda_\omega = 700 \text{ nm} \), and \( n_e = 1.36 \), to obtain

\[
d_{\text{min}} = \frac{m \lambda_\omega}{2n_e} = \frac{1 \times (700 \text{ nm})}{2 \times 1.36} = 257 \text{ nm}.
\]

In this case \( n_1 < n_e > n_2 \), as \( n_1 = 1.00 \) (air), \( n_e = 1.42 \) (oil), and \( n_2 = 1.333 \) (water). Eq. (25.12) applies: \( d = (m + \frac{1}{2}) \lambda_\omega/2n_e \), where \( m = 0, 1, 2, \ldots \). For minimum value of \( d_m \) take \( m = 0 \), and plug in \( \lambda_\omega = 400 \text{ nm} \), and \( n_e = 1.42 \), to obtain

\[
d_{\text{min}} = \frac{(m + \frac{1}{2}) \lambda_\omega}{2n_e} = \frac{400 \text{ nm}}{4 \times 1.42} = 70.4 \text{ nm}.
\]

Refer to Fig. 60. The wedge-shaped air layer in between the two glass plates provides continuously varying thickness \( d \), from \( d = 0 \) at the apex to \( d = x \tan \alpha \approx x \alpha \) a distance \( x \) from the apex. If \( d \) assumes the value for the \( m \)-th order reflection maximum to occur, then the corresponding value of \( x \) is \( x_m = d_m / \alpha \). Note that there is a \( \pi \)-phase shift due to the difference in the two reflections, one off the top and the other off the bottom of the wedge, so the condition for the \( m \)-th reflection maximum is similar to Eq. (25.12): \( d_m = (m + \frac{1}{2}) \lambda_\omega / n_\omega \) (\( m = 0, 1, 2, \ldots \)) Here we noted that \( \lambda_\omega = \lambda_\omega / n_\omega \). Therefore

\[
x_m \approx \frac{d_m}{\alpha} = \frac{(m + \frac{1}{2}) \lambda_\omega}{2 \alpha} \quad (m = 0, 1, 2, \ldots).
\]

Since by definition \( \gamma = 1 / \sqrt{1 - \beta^2} \),

\[
\frac{\gamma^2 - 1}{\gamma^2} = \frac{(1 / \sqrt{1 - \beta^2})^2 - 1}{(1 / \sqrt{1 - \beta^2})^2} = 1 - \frac{1}{1/(1 - \beta^2)} = 1 - (1 - \beta^2) = \beta^2.
\]