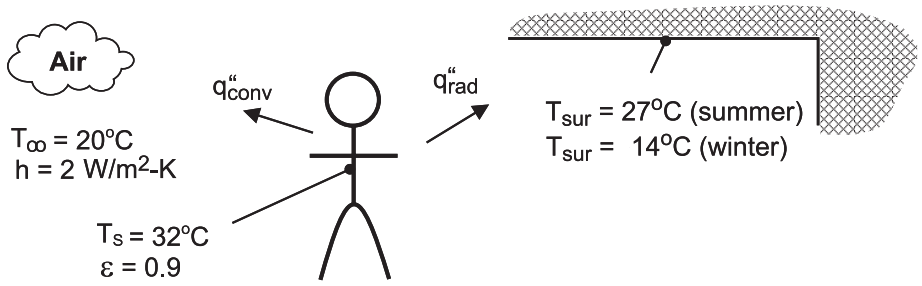
PROBLEM 1.29

KNOWN: Air and wall temperatures of a room. Surface temperature, convection coefficient and emissivity of a person in the room.

FIND: Basis for difference in comfort level between summer and winter.

SCHEMATIC:



ASSUMPTIONS: (1) Person may be approximated as a small object in a large enclosure.

ANALYSIS: Thermal comfort is linked to heat loss from the human body, and a *chilled* feeling is associated with excessive heat loss. Because the temperature of the room air is fixed, the different summer and winter comfort levels cannot be attributed to convection heat transfer from the body. In both cases, the heat flux is

Summer and Winter: $$q''_{conv} = h\left(T_s - T_\infty\right) = 2\ \text{W/m}^2\cdot\text{K}\times 12\ ^\circ\text{C} = 24\ \text{W/m}^2$$

However, the heat flux due to radiation will differ, with values of

Summer: $$q''_{rad} = \varepsilon\sigma\left(T_s^4 - T_{sur}^4\right) = 0.9\times 5.67\times 10^{-8}\,\text{W/m}^2\cdot\text{K}^4\left(305^4 - 300^4\right)\text{K}^4 = 28.3\ \text{W/m}^2$$

Winter: $$q''_{rad} = \varepsilon\sigma\left(T_s^4 - T_{sur}^4\right) = 0.9\times 5.67\times 10^{-8}\,\text{W/m}^2\cdot\text{K}^4\left(305^4 - 287^4\right)\text{K}^4 = 95.4\ \text{W/m}^2$$

There is a significant difference between winter and summer radiation fluxes, and the chilled condition is attributable to the effect of the colder walls on radiation.

COMMENTS: For a representative surface area of A = 1.5 m^2, the heat losses are q_{conv} = 36 W, $q_{rad(summer)}$ = 42.5 W and $q_{rad(winter)}$ = 143.1 W. The winter time radiation loss is significant and if maintained over a 24 h period would amount to 2,950 kcal.