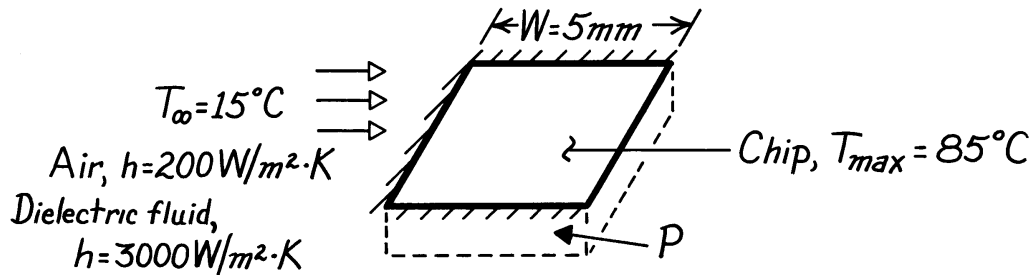


### PROBLEM 1.19

**KNOWN:** Chip width and maximum allowable temperature. Coolant conditions.

**FIND:** Maximum allowable chip power for air and liquid coolants.

**SCHEMATIC:**



**ASSUMPTIONS:** (1) Steady-state conditions, (2) Negligible heat transfer from sides and bottom, (3) Chip is at a uniform temperature (isothermal), (4) Negligible heat transfer by radiation in air.

**ANALYSIS:** All of the electrical power dissipated in the chip is transferred by convection to the coolant. Hence,

$$P = q$$

and from Newton's law of cooling,

$$P = hA(T - T_\infty) = hW^2(T - T_\infty).$$

In *air*,

$$P_{\max} = 200\text{ W/m}^2\cdot\text{K}(0.005\text{ m})^2(85 - 15)^\circ\text{C} = 0.35\text{ W}. \quad <$$

In the *dielectric liquid*

$$P_{\max} = 3000\text{ W/m}^2\cdot\text{K}(0.005\text{ m})^2(85 - 15)^\circ\text{C} = 5.25\text{ W}. \quad <$$

**COMMENTS:** Relative to liquids, air is a poor heat transfer fluid. Hence, in air the chip can dissipate far less energy than in the dielectric liquid.