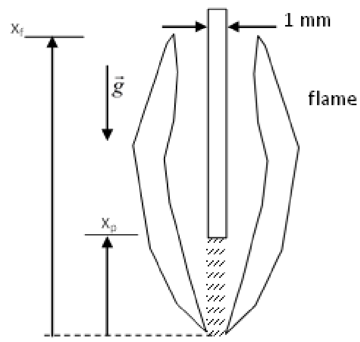
JQ.8.2.Setup

November 16, 2014

8.2 A 1 m high slab of PMMA is ignited at the bottom and spreads upward. Ignition is applied over a length of 5 cm. If the slab is 1 mm thick and ignited on both sides, then how long will it take to be fully involved in pyrolysis? Assume that the flame height is governed by the equation $x_f = 0.01\dot{Q}'$ where x_f is the flame length in meters and $\dot{Q}'$ is in kW/m . The flame heat flux is $25kW/m^2$. Assume that $\dot{m}'' = q''/L$ where $L = 1.6kJ/g$. $T_\infty = 20C$. Obtain data for PMMA from Tables 2.3, 7.5, 7.6, and 8.1.

The picture that you want to use is



The question is asking for the amount of time required for $x_p = 1m$. You will need to solve a differential equation for x_p. see example 8.1 where we expect an equation of form:

$$\frac{dx_p}{dt} = \frac{x_f - x_p}{t_{ig}}$$

We are told that $x_f = 0.01\dot{Q}'$ which has the heat release rate per unit depth $\dot{Q}'$ as a parameter. We need to evaluate this parameter.

$$\dot{Q} = \dot{m}\Delta h_c = \dot{m}'' x_p W \Delta h_c$$

W is the depth dimension. When we divide the heat release rate by W, we get the HRR per unit depth $\dot{Q}' = \dot{Q}/W$.

We see that the flame length is now specified in terms of teh pyrolysis length. We need to specify the mass flux in terms of the heat flux and the latent heat of pyrolysis (L). That is:

$$x_f = 0.01(q''\Delta h_c/L)x_p$$

We expect that $x_p(t)$ will have an exponential variation with time. See example 8.1.

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