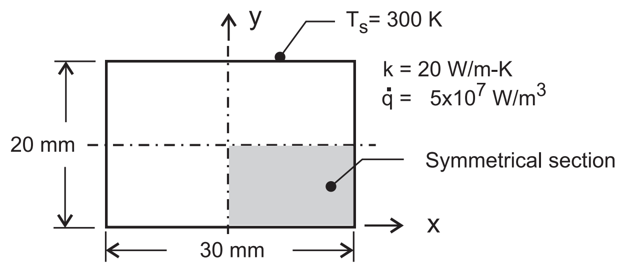
PROBLEM 4.89

KNOWN: Log rod of rectangular cross-section of Problem 4.53 that experiences uniform heat generation while its surfaces are maintained at a fixed temperature. Use the finite-element software FEHT as your analysis tool.

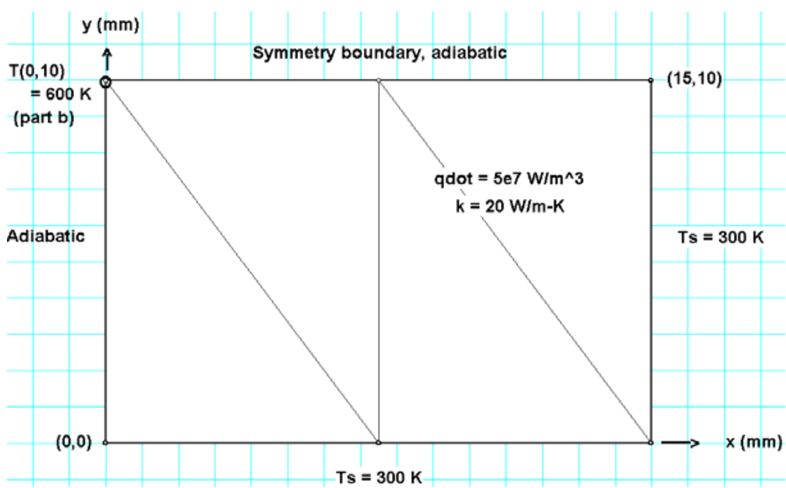
FIND: (a) Represent the temperature distribution with representative isotherms; identify significant features; and (b) Determine what heat generation rate will cause the midpoint to reach 600 K with unchanged boundary conditions.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, and (2) Two-dimensional conduction with constant properties.

ANALYSIS: (a) Using *FEHT*, do the following: in *Setup*, enter an appropriate scale; *Draw* the outline of the symmetrical section shown in the above schematic; *Specify* the *Boundary Conditions* (zero heat flux or adiabatic along the symmetrical lines, and isothermal on the edges). Also *Specify* the *Material Properties* and *Generation* rate. *Draw* three *Element Lines* as shown on the annotated version of the *FEHT* screen below. To reduce the mesh, hit *Draw/Reduce Mesh* until the desired fineness is achieved (256 elements is a good choice).



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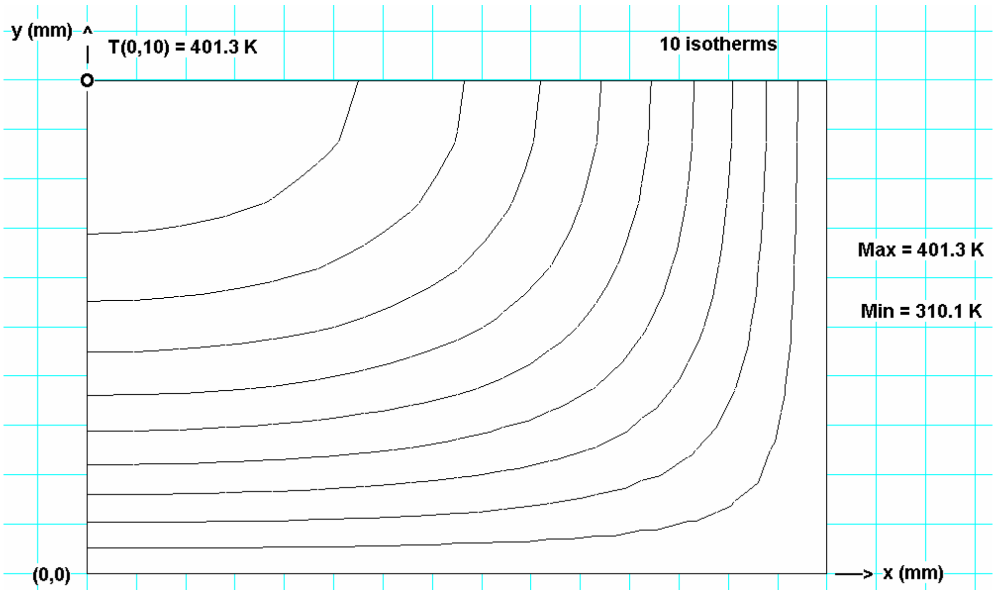
After hitting *Run*, C*heck* and then *Calculate*, use the *View/Temperature Contours* and select the 10-isopotential option to display the isotherms as shown in an annotated copy of the *FEHT* screen below.



The isotherms are normal to the symmetrical lines as expected since those surfaces are adiabatic. The isotherms, especially near the center, have an elliptical shape. Along the x = 0 axis and the y = 10 mm axis, the temperature gradient is nearly linear. The hottest point is of course the center for which the temperature is

(T(0, 10 mm) = 401.3 K. <

The temperature of this point can be read using the *View/Temperatures* or *View|Tabular Output* command.

(b) To determine the required generation rate so that T(0, 10 mm) = 600 K, it is necessary to re-run the model with several guessed values of $\dot{q}$. After a few trials, find

$$\dot{q} = 1.48 \times 10^8 \text{ W/m}^3$$ <