

JQ.5.2.soln

October 23, 2014

5.2 A cubical stack of natural foam rubber pillows was stored in a basement near a furnace. That part of the basement could achieve 60C. A fire occurs in the furnace area and destroyed the building. The night watchman is held for arson. However, an enterprising investigator suspects spontaneous ignition. The stack was 4 meters on a side. The investigator obtains the following data for the foam.

The point of this problem is to calculate the reduced Damkohler (Da) number for the problem and compare that to the critical Damkohler number for a cubic system. Recall that the Da is the ratio of heat generation rate to heat loss rate. The larger the Da, the more likely the system will show thermal runaway and eventual ignition. The formula to calculate reduced Da is:

$$Da = \left(\frac{E}{RT_{\infty}} \right) \left(\frac{r_0^2 (A \Delta h_c) \exp(-E/RT_{\infty})}{kT_{\infty}} \right)$$

The only major issue with this problem is making sure to use common units for the different parameters.

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In [1]: k=9.6*10**-5; rho=0.108; c=0.5; ADhc=7.48*10**10; E=27.6*10**3; R=8.34/4.2;
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In [2]: T_i=60.+273.; ro=4.*100./2.;
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In [3]: import math;
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In [4]: delta=E/(R*T_i)*(ro**2.)*ADhc*(math.exp(-E/(R*T_i)))/(k*T_i);
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In [5]: delta
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Out[5]: 2.9142336727792406
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