Foreline Heat Conduction

# Problem

Need to figure out the length of insulation we need on a foreline to make it touch safe.

# Drawing

A diagram of a piece of wood

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Figure : idealized cylindrical fin

A grey pipe with blue letters

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Figure : Foreline with base held at 120C

# Given

# Find

Calculate the length at which the fore line becomes touch safe (<60C). That is, when the temperature at a distance of x is equal to 60C.

# Assumptions

* No heat transfer internal to pipe
* Free (natural) convection
* Thermal system is at steady state.
* Radiation is neglected.
* Room air is quiescent.
* Constant properties
* Infinite fin boundary condition.

# Relevant Equations

* **(1.1)** Area of a circle
* **(1.2)** Excess temperature
* **(1.3)** Fin parameter
* **(1.4)** Excess temperature of an infinite fin
* **(1.5)** Excess temperature at base of fin
* **(1.6)** Perimeter of a circle

# Solution

The step-by-step solution.

## Step 1: Calculate fin parameter.

Per equation **(1.3)**, the fin parameter is:

## Step 2: Derive excess temperature equation.

Per equation(s) **(1.2)**,**(1.4)**, and **(1.5)**, the excess temperature is given by the equation:

## Step 3: Calculate the x value at which excess temperature reaches 30 degrees C.

Keep in mind that excess temperature is the temperature ***above*** ambient.

See figure below for sample values with different materials, taken from (Moran, Munson, Shapiro, & DeWitt, 2003).

A graph of a temperature distribution

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Figure : Temperature distribution along fin with base temperature of 100C

# Works Cited

Moran, M. J., Munson, B. R., Shapiro, H. N., & DeWitt, D. P. (2003). *Introduction to Thermal Systems Engineering.* John Wiley & Sons, Inc.