**24-650 Applied Finite Element Analysis**

**Assignment 2**

submitted by

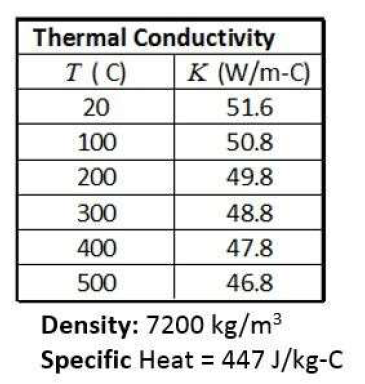
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**Objective**

The goal of this assignment is to explore the steady-state thermal critical radius of the insulation. The main object is a casted iron pipe with a 90-degree bend. The inside and outside diameters are 70 mm and 90 mm, accordingly.

**Assumptions and Conditions**

1. Heat transfer is steady-state in part A, and is transient in part B.
2. The pipe ends are adiabatic.
3. The thermal conductivity, density and specific heat of the pipe is given below:



**Model and Geometry**

The cast iron pipe (see in Fig.1) has inside and outside diameters are 70 mm and 90 mm, accordingly.

|  |  |  |
| --- | --- | --- |
| A white pipe with a hole  Description automatically generated |  |  |
| Figure 1. The curved pipe | Figure 2. The pipe with foam insulation (green) | Mesh Settings |

**Boundary Conditions (Part A)**

The thermal conductivity of the pipe is 52 W/m-C, and the pipe is carrying steam at 155 ℃, with an outside temperature of 20 ℃.

We assume that the pipe ends are adiabatic.

The inside surface has a convention coefficient of 20 W/m2 -C, with an outside surface convention coefficient of 3.8 W/m2 -C.

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**Results (Part A)**

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**A1 –** The maximum outside temperature is **128.5 ℃**

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| --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  | |  |

**A2** – The rate of heat loss off the outside surface of the pipe is **35.4 W.**

**Boundary Conditions (Part B)**

The thermal conductivity of the pipe is 52 W/m-C, and the pipe is carrying steam at 155 ℃, with an outside temperature of 20 ℃.

We assume that the pipe ends are adiabatic.

The foam has a thermal conductivity of 0.20 W/m-C, and the inside surface has a convention coefficient of 20 W/m2 -C, with an combined surface convention coefficient of 3.4 W/m2 -C, calculated by:

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Description automatically generated

|  |  |
| --- | --- |
| A grey pipe with yellow center  Description automatically generated | A yellow tube with white lines  Description automatically generated |
| A screenshot of a computer  Description automatically generated |  |

**Results (Part B)**

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**B1 –** The maximum outside temperature is **130.8 ℃**

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**B2** – The rate of heat loss off the outside surface of the pipe is **32.3 W.**

**B3** – The heat loss is **smaller** than compared to A2, as the heat insulation material prevented some heat loss of that pipe.

**Boundary Conditions (Part C)**

The thermal conductivity of the pipe is 52 W/m-C, and the pipe is carrying steam at 155 ℃, with an outside temperature of 20 ℃.

We assume that the pipe ends are adiabatic.

The foam has a thermal conductivity of 0.20 W/m-C, and the inside surface has a convention coefficient of 20 W/m2 -C, with an outside surface convention coefficient of 3.8 W/m2 -C, calculated by:

|  |  |
| --- | --- |
| A grey pipe with yellow center  Description automatically generated |  |
| A screenshot of a computer  Description automatically generated |  |

**Results (Part C)**

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**C1 –** The maximum outside temperature is **118.7 ℃**

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| --- | --- | --- | --- | --- | --- |
| |  |  | | --- | --- | |  |  | |  |  | |  |

**C2** – The rate of heat loss off the outside surface of the pipe is **35.6 W.**

**C3** – The heat loss comparison is listed below:

|  |  |  |
| --- | --- | --- |
| **A2** | **B2** | **C2** |
| **35.4W** | **32.3W** | **35.6W** |

As one can read from the table above that **Part B** has the **lowest** heat loss, and **Part C** has the **highest** heat loss, one possible reason is due to the increase of surface area (heat insulation material has thickness therefore enlarged the outside surface area), and the influence of surface area overrides the heat insulation effect. Under the situation of outside surface area remain unchanged (Part A and B), the heat insulation does reduce the heat loss.

A computer screen shot of a colorful tube

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A computer screen shot of a green tube

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