1. This question is a revision question and so is covered in the slides of the video sufficiently





2. Formula for Rth

the maxima and minima are found by differentiation and finding the zero gradients

therefore:

For maxima/minima:

this shows that up to a minimum radius, the insulation makes the heat loss worse.

3. Need to calculate Re first which needs density and viscosity from the tables for air – assume that we can use the dynamic viscosity in the tables as not changed much from the 1 atm pressure air because it is still reasonably low pressure:

calculate density using gas law:

units m3/kg

dynamic viscosity: 2.849×10-5 kg/ms

Prandtl by the formula for Pr, with cp= 1039.8 J/kgK:

Pr: 0.69

Re = (1.307×12×0.05)/ 2.849×10-5 = 27534

Nu = 0.023(27534)0.8(0.69)0.4 = 70

use Nu = hd/k, k = 0.043 W/mK

h = 60.7 W/m2K

Then use the thermal resistance combination of the insulation conduction with the internal and external convection, with internal area 2πrL = 0.34 m2, and area outer 0.94 m2

units K/W

Therefore

units W

U based on ri? use the formula relating U and Rth

units W/m2K

4. look for a solution using the Nu correlation and relationship between h and Nu, start with the Gr:

Find Tfilm (average of surface and far temperature) = (70+15)/2 = 42.5°C or 315 K (approximate to 325 K in tables to save a bit of time in consolidation session, but could interpolate for data)

From tables at 325 K:

ν=1.568×10-5 m2/s, Pr = 0.71, therefore GrPr =

then use Nu = hd/k, with k = 2.816×10-2 W/mK to give:

units are W/m2K

heat transfer is:

units W/m