Institute of Refractories Engineers

Training Day 2022

Exercise Answers

Part 1 – Calculate Shell Temp

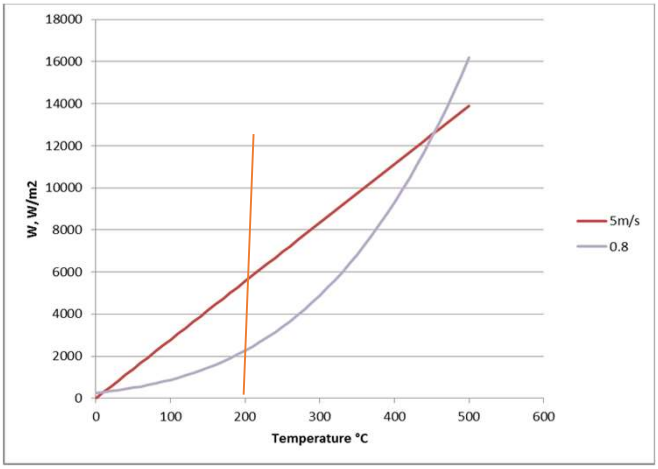
1 Gather Data

- Hot Face 1200°C
- Ambient 0°C
- Thickness 0.125m
- Conductivity 2W/mK
- Emissivity 0.8
- Wind Speed 5m/s

2 First Estimate Shell Temp - 200°C

Part 1 – Calculate Shell Temp

3 Heat transfer
- Radiant 2100W/m2
- Conv 5200W/m2
- TOTAL 7300W/m2



Part 1 – Calculate Shell Temp

4 Calculate temp across lining
- $\Delta T = \frac{W \Delta x}{k A} = 456$

5 Shell temp = 1200-456 = 743℃ HIGHER THAN ESTIMATE AT STEP 2 – increase estimate

Part 1 – Calculate Shell Temp

2 New Shell Est = 300

3 New heat trans = 5000+8000 = 13000

4 $\Delta T = \frac{W \Delta x}{A} = 815$ / 5

5 Shell Temp = 1200-812 = 387

6 HIGHER THAN ESTIMATE AT STEP 2 – increase estimate

Part 1 – Calculate Shell Temp

2 New Shell Est = 330

3 New heat trans = 5400+8400 = 13800 4

4 $\Delta T = \frac{W \Delta x}{k A} = 850$

5 Shell Temp = 1200-812 = 337

6 CLOSE ENOUGH - Shell Temp is ~ 330℃ Heat loss is 13800W/m2 = 13.8kW/m

Part 2 – Reduce Shell Temp

Insulation, but need dense hot face for abrasion.

Min ~75mm for stability of hot face so 50mm for insulation

Fibre board is most efficient if high enough strength.

Microporous is way more expensive so consider 10mm microporous panel + 40mm board + 75mm hot face.

Part 2 – Reduce Shell Temp

HEAT LOSS AT 60°C

Radiant 400W/m2

Convective 1600W/m2

TOTAL 2000W/m2 =2kW/m2
Saving ~12kW/m2.

At say £0.10/kWh, this is a saving of £28/day/m2