W05

You have been hired as a junior food processing engineer at a leading fruit processing company. Your first task is to analyze and optimize the drying process of mango slices to produce high-quality dried mangoes, a favorite snack enjoyed by millions around the world.

The food processing company wants to produce dried mango slices using the semicylindrical dryer. The dryer's long semicylindrical shape allows for a continuous and efficient drying process.
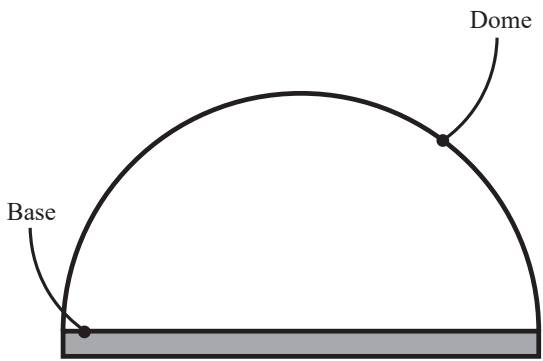

Figure 8: Cross section of the mango dryier

Given parameters:

- The dryer is a long, curved duct with a diameter of 1.5 meters.

- The base temperature is 370 Kelvin.

- The base emissivity is 0.5.

- The base acts as an opaque body.

- The dome temperature is 1000 Kelvin.

- The dome emissivity is 0.8.

- The dome does not reflect any radiation.

- The latent heat of vaporization for water is 2.3 MJ/kg

In this case study, we explore the process of drying organic materials, focusing on the production of dried mango slices. We will examine the application of a semicylindrical dryer designed to efficiently remove moisture from water-soaked mango slices while preserving their natural flavors and nutrients.

  a Determine all four view factors.

  b Give the values of the emissivity, transmissivity, and reflectivity for the base and dome.

From now on, it can be assumed that all bodies act as black bodies. The temperatures and other parameters remain the same.

  c Determine the wavelength that holds the maximum power coming off of the dome.

  d Determine the net rate of heat transfer per unit length from the dome to the base.

  e Determine the drying rate per unit length experienced by the wet mango slices as they pass through the semicylindrical dryer.

  f How long will it take the mango slices to heat up 1 °C?

  g Reflect on your given answer. Is it realistic? If not, what is the implication for the time needed to heat up the mango's one degree if the assumption is not valid?

  h Your boss would like you to improve the drying rate by improving the design. Mention one **design improvement** and explain why this improves the drying rate.