Heat Transfer in an Eccentric Gas Gap Annulus

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Heat transfer in the annular region between two cylindrical surfaces is widely studied in the context of gas-gap heat switches operating at cryogenic temperatures. At University of Twente, using a similar working principle, a tissue snap freezer is developed where a vial is cooled by a cold reservoir through a gas gap. In this presentation, the question that will be addressed is how the eccentricity of the gas gap annulus influence the overall heat transfer. For small Biot numbers, temperature gradients in the vial may be neglected and a lumped capacitance assumption is valid. The cooling rate increases as the eccentricity between the two cylindrical surfaces increase. However, when the local Biot number of the vial is large this assumption does not hold. An angular dependence heat transfer model is developed to account for the eccentricity. The model predicted temperature gradients in the vial when the eccentricity is large. Experiments were performed to verify this model. The main conclusion from this study is that eccentricity in the gas gap annulus has a significant effect on the overall heat transfer.