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| **In-class activity 1 (Individual working w/ group): Prepping the Model (due end of class 9/13)** | | | | | | |
| **What properties are needed/not needed for the model? For each property of the food, give reasoning as to why.** | | | | | | |
| Food Property:   * Water activity * Moisture content * Light transmittance * pH * Emissivity * Activation energy * Thermal death time * Z-value | Why Is/Is Not Used:   * Is used: How much water is available for heat transfer * Is used: Related to relative humidity, which * Is not used: not relevant to heat transfer, especially as the food is in a can and no light should theoretically enter * Is used: if the pH of the material is outside that at which the organism thrives, it will kill the organism without requiring heat transfer * Is used: used in radiation heat transfer * Is used: heat needed to degrade components * Is used: time to degrade proteins/food properties which is not desirable * Is used: range of temperatures which degrades the food properties/ proteins faster | | | | | |
| **For each property where a range or raw data is given, how do you intend to address this in the final model? For each property listed please give reasoning as to why you are choosing your current strategy.** | | | | | | |
| Food Property:   * Water activity * Moisture content * pH * Emissivity * Activation energy * Thermal death time * Z-value | How will you use or address? Why?   * A singular raw data value is given, I will assign this exact value to a variable * A range is given, I will use the average value of this range and assign the average to a variable * A singular raw data value is given, I will assign this exact value to a variable * A singular raw data value is given, I will assign this exact value to a variable * A range is given, I will use the highest value given to ensure that the activation energy required is reached * For the food properties, a singular raw data value is given, I will assign this exact value to a variable * A range is given, I will use the highest value given to ensure that the activation energy required is reached | | | | | |
| **Are there any properties of the food that are needed that are not given in the problem statement? If any, please justify why it is needed and what source you will obtain it from.** | | | | | | |
| Food Property Needed:   * Density * Heat capacity * Thermal conductivity | Why is it needed?   * Is used: Used in equation for heat transfer * Is used: Used in equation for heat transfer * Is used: Used in equation for heat transfer | | | Why did you use the source you did?   * USDA Food Database gives material components for food, will use this data along with the Choi-Okos equation to find the density * USDA Food Database gives material components for food, will use this data along with the Choi-Okos equation to find the heat capacity * USDA Food Database gives material components for food, will use this data along with the Choi-Okos equation to find the thermal conductivity | | |
| **What assumptions will you make to solve the problem? For each assumption explain why you made the assumption and what it may limit about your model.** | | | | | | |
| Assumption(s):   * No external gradient in temperature * The can is a closed system: no mass or light enters or exits the can * The metal can’s heat transfer resistance is negligible (the can temperature is the same as the environmental temperature). * The can is filled completely with food material. * Ambient pressure is constant. * Heat only enters the can radially | | | Why did you choose?   * We are only interested in what occurs in the can * Mass movement is undesirable; light energy will not be added * The can material has high thermal conductivity. * Air is not desirable in the can * This would cause a change in temperature * The dominant face for heat transfer is the lateral face of the cylinder | | | What will this limit?   * The model will only look at behavior inside the can * No mass balance between the can and the environment is required; light energy will not be considered * Can’t model can heating before food material heats * No convection term inside the can * No temperature changes due to external pressure changes * Slab-related heat transfer will not be considered |
| **The mathematical equations necessary to solve the problem. For each equation please explain why it was chosen and any assumptions your model will make about the equations. Please list all equations necessary. Feel free to use the course textbook or online materials.** | | | | | | |
| Equation Needed:   * Choi-Okos * Finite difference for temperature changing over time and space * Thermal death time * Growth and death kinetics of microorganisms from Geankoplis Ch. 9 * Arrhenius Equation * Sterilization thermal process time equation | | Why is this needed?   * To calculate all unknown values * To calculate temperature change over time and space * To calculate how long it takes to sterilize the food of a certain organism 10 fold * To model the concentration of microorganisms in the can * To determine reaction rate constant (K) * Time required to sterilize to specification | | | What assumptions does this equation make?   * Constant composition * Step size for time and space * The 10 fold reduction occurs at the Z temperature value * Organism division rate * Reaction rate is only dependent upon temperature of the system and activation energy * Sterilization is different from organism to organism | |
| **What computational technique will you use to solve the system? Explain why this technique was chosen, what the benefits are, and what the limitations are. (For example, implicit finite difference, explicit finite difference, finite element method, Crank-Nicolson method, Monte Carlo method, etc).** | | | | | | |
| Computational technique chosen:   * Explicit finite difference   What are the benefits of this technique?   * Temperature at a time depends explicitly and solely on the temperature at a previous time * Simple and computationally fast   What are the limitations of this technique?   * Stable solutions require m<2; if not met, the solution is unstable and oscillates   Why did you choose this technique over alternatives?   * It is computationally fast and allows for us to meet the needs of our client in a timely manner | | | | | | |
| **Please show how you intend to combine the properties, equations, assumptions, and numerical techniques in your final solution (provide a “roadmap” of how you believe you will solve the problem). Feel free to include diagrams, drawings, or maps.** | | | | | | |
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