Introduction

- When rice is subjected to intense heating (using hot air), it results in rapid evaporation of liquid water inside to form vapor.
- As a consequence, large pressures are generated within the kernel in a span of 15s, resulting in large volume changes of the kernel thereby causing it to puff rapidly.
- Under suitable conditions, the ratio of initial volume to volume after puffing could be as high as 10; a higher expansion ratio indicates a better quality product.
- Rice puffing is a complex interplay of mass, momentum and energy transport along with large volumetric expansion of the solid matrix.
- By treating rice as a porous material, a fundamentals-based model of rice puffing process that can describe heat and moisture transport, rapid evaporation and large deformations of the solid matrix is presented to understand the factors affecting the puffing process.

Modeling Framework

Transport Model
- Conservation of energy – Heat Flow
- Conduction
- Phase change
- Conservation of mass – Water: bulk flow, capillary flow and phase change
- Gas: (air, vapor): bulk flow phase change
- Conservation of momentum – Darcy’s Law

固体 mechanics model
- Linear momentum balance – Lagrangian description
- Pressure gradients
- Constitutive law – Mooney-Rivlin model
- Perfectly Plastic model
- Use Mooney-Rivlin stress criteria for plastic deformation. Rice kernel treated as a porous, elasto-plastic solid

Governing Equations: Transport Model

Conservation of Mass

Conservation of Linear Momentum

Balance of Linear Momentum

Conservation of Energy

Governing Equations: Solid Mechanics Model

Solid mechanics model

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