FLOW ANALYSIS FOR A SORGHUM BREWING FERMENTATION PROCESS

Tolani A. Owosina
Simulo Technologies, Lagos, Nigeria

A qualitative flow analysis by numerical simulation of a fermentation process in a sorghum factory in Ota, Ogun State of Nigeria is presented. The simulations were done with the Numerical modeling software, COMSOL MULTIPHYSICS ™.

The simulation is 2 dimensional, steady state and driving inlet flow velocities are such that laminar flow is assumed in all cases. The Industrial process is called steeping and is an intermediate process in brewing beer using the sorghum grain crop which is common in Sub-Saharan Africa. A pre-wetted grain bed of sorghum is aerated by forced air draft in order to induce fermentation. This of course can be done in several ways and the purpose of the flow analysis is to study different possible arrangements in order to save costs while maintaining end-product quality and integrity.

The mathematical model represents the air draft by the Navier-Stokes equations. The actual aeration involves blowing the air through the grain bed. This part of the model is computationally represented as fluid flow through a porous solid medium and is mathematically represented by the Brinkman's equation for relatively fast fluid flow in a saturated porous medium. The governing equations are thus:

The steady state Navier- Stokes equations:

$$\rho \bar{u} \nabla \bar{u} = -\nabla p + \nabla \eta \nabla \bar{u}$$

$$\nabla \bullet \bar{u} = 0$$

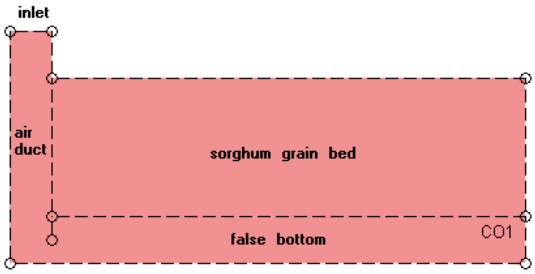
And the Brinkmann's equations for relatively fast fluid flow in a saturated porous medium:

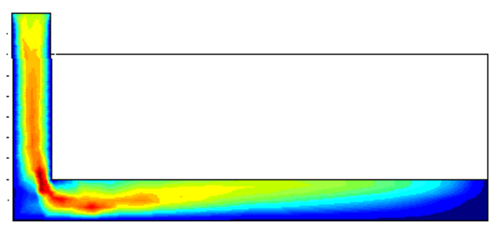
$$\frac{\eta}{\kappa} \bar{u} = -\nabla p + \nabla \eta \nabla \bar{u}$$

$$\nabla \bullet \bar{u} = 0$$

Where ρ is the fluid density, η is the fluid dynamic viscosity, κ is the permeability of the porous medium, u is the fluid velocity and p is the fluid pressure

A 2 dimensional cross sectional depiction of one of the considered flow configurations that make the computational domain is shown as figure1, while the corresponding velocity vector profile of the computed model is shown as figure2.





Several flow arrangements were considered in the study and as a result, optimized flow configurations were evolved.