Boulder Fluid and Thermal Sciences Seminar Series

Tuesday, February 2, 2016
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

Discovery of a “Magenstrasse” and other Gastric Curiosities with a Lattice Boltzmann Model of the Human Stomach

James Brasseur, *University of Colorado, Boulder*

Mechanically, the stomach is a controlled pump that empties viscous heterogeneous liquid content from a bag (the fundus) through a sphincteric valve (the pylorus) by slow squeeze of fundic muscle. In addition, however, periodic peristaltic contraction waves travel towards the pylorus in the lower stomach (antrum), elevating pressure locally, presumably to periodically enhance emptying. My medical collaborators measured antral contractions with concurrent manometry and MRI *in vivo*; we analyzed the data to show that, as each antral contraction wave approaches the pylorus the pylorus momentarily closes, right when an open pylorus would have allowed a surge of fluid flow into the intestines! This is a curiosity. To study in more detail the consequences of the curious phasic relationship between the passage of antral contraction waves and pyloric opening, we applied a lattice Boltzmann computational fluid dynamics model with moving boundary conditions and a stomach geometry model parameterized using time-resolved MRI. Analysis lead to the discovery of a second curiosity: the antral contraction waves produce a narrow path of emptying, or “Magenstrasse” (German for “stomach road”) that directs content from the top of the stomach to the pylorus in relatively short time with little mixing. This discovery might explain a well-known observation in pharmaceutics, that the response time of a drug after ingestion is extremely variable. (If a drug capsule opened in the stomach off the Magenstrasse, it would take over an hour for drug particles to empty into the intestine and drug to enter the circulatory system, while if release occurred on the Magenstrasse, activation time would be quick!) The fluid dynamics underlying this seemingly simple organ turns out to be surprisingly interesting.

Thermal systems modeling of parabolic trough solar power plants

Diego Arias, *Roccor / i2C Solutions*

With over 4 MW of generating capacity installed worldwide, parabolic trough solar power plants are currently the lowest-cost concentrating solar power (CSP) option for electricity production. A parabolic trough plant uses a large field of solar collectors to capture solar radiation and transform it into sensible energy in a high-temperature heat transfer fluid; the thermal energy can be transported to a conventional power plant, or stored in a thermal energy storage system (TES) for later use. This seminar will present an example of the development and use of thermal systems models developed for commercial parabolic troughs plants, in which the effect of individual technical improvements on the overall plant performance were analyzed, and the least cost of energy option was identified. These thermal system models are fundamental for evaluating the overall benefit achieved by technical improvements on commercial applications as well as for guiding R&D decisions. Some of the alternatives studied included solar collectors, heat transfer fluids, thermal energy storage systems and power cycles.