Project Proposal ChEn 533

1. Identification of the paper and a description of the importance of this paper

Flow of a Viscous Liquid on a Rotating Disk (1957, Authors: Elmslie, Bonner and Peck)

Many coating applications call for a thin, uniform layer of a solid material with specific properties. The application of a thin film is most easily performed by spreading the material while in the liquid phase with subsequent solidification. One technique to quickly increase the uniformity of a liquid coating is to place the liquid on a rotating disc to cause spreading. **This work derives equations to predict the fluid "topography" as a function of time for various initial application arrangements.** Therefore, if I know what final coating shape I want, I can use this method to determine if a given initial condition will lead to the desired outcome. Furthermore, the centrifugation speed and duration required to obtain a desired coating profile can be determined and optimized based upon practical operating constraints. This paper employs transport phenomena to provide information with which to make informed decisions regarding the capability of a rotating disc to produce a desired coating.

2. Relevancy to Transport

The result of the publication of interest is to **predict dispersion behavior of a fluid on a rotating disc by means of the application of the force/flux relationship** experienced by a viscous fluid to determine the outcome given initial conditions such as fluid distribution, angular speed of the plate, and fluid viscosity. This derivation is strictly theoretical based on observed behavior of materials as described by transport equations. The model is robust provided that the fluid obeys several key assumptions, as is the case with other transport problems. Key assumptions in this report include: infinite radius of the plate, a radially symmetric liquid layer, Newtonian fluid (viscosity independent of shear rate), radial velocity is small enough to neglect the Coriolis forces. The applicability of this solution therefore depends upon how accurate these assumptions are for a given system, similar to other classic transport solutions.

3. A brief description of the methods that the paper employs

This publication uses transport equations to describe the force/flux relationship of a viscous fluid subject to outside forces. Centrifugal and viscous forces are equated, and then integrated with applied boundary conditions. The continuity equation is used to relate the outward spread of fluid to the decrease in height of the layer as a means of satisfying conservation of mass in the context of the forces acting on the fluid. The boundary conditions are that the plate velocity equals the fluid velocity at the plate surface (authors use the reference frame of a stationary plate and fluid in motion) and that the upper surface in contact with the air experiences no shearing force.

4. Project scope

The scope of my project is to reproduce the general solution for the height of a fluid film as a function of radius and time with a step-by-step derivation clearly outlining when critical assumptions are made. This will allow a reader to determine where greatest model inaccuracies are likely to originate (and be best addressed) in the context of a non-ideal system. I seek to reproduce the change in fluid contour as a function of time and position, with initial fluid distributions described by gaussian and sinusoidal curves. Furthermore, I will try a custom initial distribution of fluid that is subject to the same forces and pertinent equations of motion.

5. Project schedule

I will write out each step of the derivation by Dec. 9, filling in the skipped steps as this represents the bulk of the work. I will then reproduce the plots shown for sinusoidal and gaussian initial distributions by Dec. 11. From Dec. 11 to Dec. 14 I plan to test the equations on at least one initial distribution not included in this work. The final report will be completed by Dec 14.