



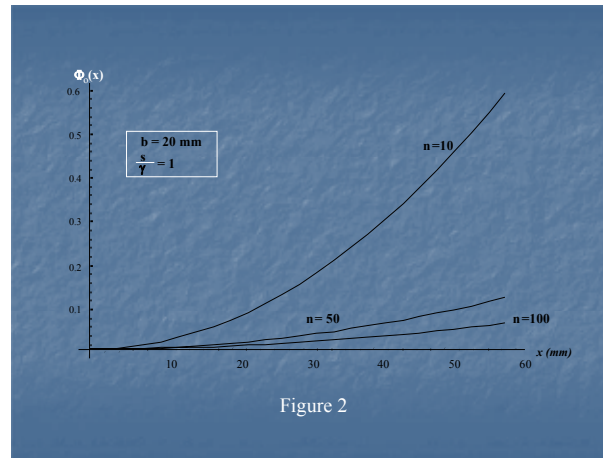
$$\Phi_o(x) = nb\left(\frac{S}{\gamma} + 1\right) \cosh\left(\frac{x}{nb\left(\frac{S}{\gamma} + 1\right)}\right) - nb\left(\frac{S}{\gamma} + 1\right) \quad 0 \leq x \leq \infty \quad (1)$$

Table 1. Description of the symbols in the equation

symbol	$x$	$S/\gamma$	$n$	$b$	$\Phi_o(x)$
unit	mm			mm	mm
name	liquid height	spreading ratio $S = \gamma_{SO} - \gamma_{SL} - \gamma$	fiber number	fiber radius	liquid thickness at $x$

where  $\gamma_{SO}$ ,  $\gamma_{SL}$  and  $\gamma$  represent the surface tensions of the solid fiber, the solid/liquid interface, and the liquid (or liquid/air), respectively, and can be found in handbook or determined experimentally.

- Conducting a parametric study using the theoretical model to examine the effects of important factors. That is, the shape of the absorbed liquid body  $\Phi_o(x)$  is a function of the height  $x$ , the spreading ratio  $S/\gamma$  of the surface properties of liquid, the fiber, and the liquid/fiber interfacial properties, as well as the fiber parameters  $nb$ . A parametric study can be conducted to examine the effects of important factors. For instance, Figure 2 shows the effect of the bundle size  $n$  (number of fibers in a bundle) on the liquid profile when other variables are given. It is seen that a small bundle results in a greater amplitude of  $\Phi_o(x)$  at a given height  $x$ .




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#### Next Year's Goals:

1) to develop a stochastic model to predict the macroscopic transport behavior in fibrous substrates from the microscopic liquid and solid interactions; 2) to apply the generalized model to various practices, from the planar liquid spreading to spatial multiphase separation/filtration in fibrous substrates; 3) to investigate the relationships between transport properties and model fibrous structures, taking into consideration the liquid characteristics and environmental conditions; and 4) to establish a correlation between the theoretical models with experimental data.

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#### Approach:

We would like to develop a stochastic model, the Ising's model combined with Monte Carlo simulation. In this approach, the transport phenomenon is regarded as a process in which spaces between fibrous substrates change from a liquid dominant state to a gas or solid dominant state. Such a change is driven by the system's energy

differences after and before the change. The energy of the system is composed of a summation of the interaction energy among liquid(s) and solid(s) in a microscopic scale as well as energy contributed to the system by external forces.

The specific steps needed to complete them are to:

1. Set up the stochastic model to study the transport phenomena;
2. Compose computer simulation programs for the model;
3. Conduct experiments to verify the model.

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**Outreach to Industry:**

This research will be a joint effort among industry and academia. Fundamental studies will be performed at U.C. Davis in cooperation with industrial partners such as Albany International Research Co. and the nonwoven industry.

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**New Resources Required:**

A contact angle and surface tension measuring system is needed for experimental validation of the model predictions.