MISCIBLE DROPLET IN A HELE-SHAW CELL AND THEEFFECTS OF KORTEWEG STRESSES

王儷霖、陳慶耀

E-mail: 9018792@mail.dyu.edu.tw

ABSTRACT

TIME-DEPENDENT NUMERICAL SIMULATIONS OF THE MOTION OF MISCIBLE DROPLETS IN HOMOGENEOUS POROUS MEDIUM ARE PRESENTED. BOTH THE INFLUENCES OF CONVENTIONAL FLOW PARAMETERS, SUCH AS THE MOBILITY RATIOS, DIMENSIONLESS FLOW RATES AND DROPLET SIZE (PECLET NUMBER) AND DYNAMIC KORTEWEG STRESSES ARE ANALYZED SYSTEMATICALLY. VORTICITY-STREAMFUNCTION FORMULATION IS APPLIED TO MAKE THE EFFECTS OF VELOCITY DIVERGENCE CAUSED BY THE CONCENTRATION GRADIENT IMPLICITLY IN THE GOVERNING EQUATIONS. IF THE DROPLET IS LESS VISCOUS THAN THE SURROUNDING FLUIDS, VARIOUS FINGERING PATTERNS, WHICH DEPEND STRONGLY ON THE FLOW CONTROL PARAMETERS, OCCUR ONLY ON THE LEADING FRONT WHERE THE MOBILITY RATIO IS UNFAVORABLE. THE DROPLET ALWAYS MOVES FASTER THAN THE SURROUNDING FLUID. VIGOROUS FINGERINGS ARE OBSERVED AT HIGHER MOBILITY RATIO, PECLET NUMBER. A SLOWER AND STABLE DROPLET WITH A TAIL ON THE LEADING FRONT IS FORMED FOR A MORE VISCOUS DROPLET IN A LESS VISCOUS ENVIRONMENT. IF THE DYNAMIC KORTEWEG STRESSES ARE CONSIDERED, A NEGATIVE KORTEWEG STRESSES CONSTANT STABILIZES THE DROPLET SIGNIFICANTLY, AS PREDICTED BY THE STABILITY ANALYSIS (HU AND JOSEPH, 1992). TAILED DROPLETS, WHICH ARE SIMILAR TO THE EXPERIMENTAL SHAPES BY KOPF-SILL AND HOMSY (1987), ARE FOUND IF THE LEADING FRONTS ARE TOTALLY STABILIZED BY KORTEWEG STRESSES. THE DROPLET SHAPE CAN BE PREDICTED BY THE DISTRIBUTION OF SURFACE TENSION SIMILAR TO IMMISCIBLE BUBBLE. THE MOVING VELOCITIES OF THESE REAR-TAILED DROPLETS ARE WITHIN THE RANGES MEASURED IN EXPERIMENTS.

Keywords : MISCIBLE DROPLETS, PECLET NUMBER , KORTEWEG STRESSES

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