CHAPTER V
CONCLUSIONS

The experiments were carried out on the two-phase upward flows consisting gas and liquid in a vertical tube with an inner diameter 0.019 m and 3 m in length for air-water and air-SDS solution (1 CMC) systems in order to investigate the influence of surfactant addition on the flow regimes, the corresponding pressure gradients, the bubble size and the bubble velocity.

The boundaries of the bubble, the bubble-slug and the slug flow regimes in SDS solution (1CMC) shifted to the left or smaller values relative to those of pure water. But the boundaries for the churn, the annular and the mist flow regimes remained nearly the same. In the bubble, the bubble-slug and the slug flows, the critical Reynolds numbers of air, $(Re_{air})_{critical}$ were relatively low and the flow was laminar. The effect of surface tension was more pronounced in these regimes. For the churn, the annular and the mist flows, the critical Reynolds numbers of air, $(Re_{air})_{critical}$ were relatively high and the flow was turbulent. So, the effect of viscosity and surface tension in these regimes were relatively less.

Fluctuations of pressure gradients, $(dp/dz)_{exp}$, were less sever in the SDS solution (1CMC) than those in pure water because of the viscosity effect. The highest fluctuations occurred in the slug and the slug-churn regimes of both pure water and the SDS solutions.

At the same liquid Reynolds numbers, the pressure gradients, $(dp/dz)_{exp}$, of the SDS solution (1 CMC) seemed to be equal to the pressure gradients, $(dp/dz)_{exp}$, of the pure water in the bubble and the bubble-slug flow regimes. The pressure gradients, $(dp/dz)_{exp}$, of the SDS solution (1 CMC) were lower than the pressure gradients, $(dp/dz)_{exp}$, of the pure water in the slug to the slug-churn regime because the flows were turbulent and the effect of surface tension was more pronounced in these regimes. The pressure gradients were nearly equal to each other again from the churn flow to the mist flow regime because Re_{air} were high and the flows were turbulent.

At same Re_{liquid}, the pressure gradients, $(dp/dz)_{exp}$, of the SDS solution at 0.5, 1 and 2 CMC were nearly equal to each others but lower than the pressure gradient (dp/dz) of pure water from the slug to the slug-churn flow regimes because the surface tension and viscosity of all SDS solutions were nearly equal to each other. The pressure gradients of water and the SDS solution became equal to each other again in the churn flow regime because Re_{air} were high and flow was turbulent.

The proposed theories for the pressure gradient by Nicklin, Wilkes, and Davidson (1962) for the bubble and the slug flow regimes, Sylvester (1987) for the slug flow regime and by Wallis (1969) for the annular and the mist flow regimes are in moderately good agreement with the measured values.

When we fixed Re_{liquid} with increasing Re_{air}, the bubble width seemed to be constant for pure water but slightly increased for SDS solution (1 CMC). At low Re_{air}, the bubble height of the SDS solution was lower than those of pure water because of the viscosity played more pronounced role than that the surface tension. But at higher Re_{air}, the bubble height of SDS solution was higher than those of pure water because of the surface tension played a more pronounced role than that of the viscosity. The increasing rate of the bubble height for the SDS solution (1 CMC) was higher than that of pure water because of the surface tension effect. As fixed Re_{liquid} with increasing Re_{air}, the length of Taylor bubble for the SDS solution (1 CMC) was longer than pure water because of surface tension effect. The pressure gradient (dp/dz) for the SDS solution (1 CMC) was lower than that of pure water in the slug and the slug-churn flow regime.

As we fixed Re_{air}, the bubble velocity increased with increasing Re_{liquid}. At the same liquid Reynolds number, the bubble velocity of SDS solution (1 CMC) was higher than the bubble velocity of pure water because of the surface tension effect.