CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

5.1.1 Batch experiments (The kinetics and growth of silica particles)

Batch experiments were carried out systematically to investigate the reaction kinetics and the growth rate of silica particles synthesized in nonionic W/O microemulsions. The experimental results can be summarized as follows:

The rate of TEOS hydrolysis was approximately first order with respect to the aqueous ammonia concentration. The delay time, $t_{1/2}$, exponentially increased with decreasing ammonia concentration.

The rate of TEOS hydrolysis decreased with increasing the surfactant concentration. This result is due to the fact that surfactant acts as the barrier to transferring of TEOS molecules into microemulsion droplets. As a result, the rate of TEOS hydrolysis decreased.

The water:TEOS molar ratio did not significantly affect the rate of TEOS hydrolysis.

For all co-surfactants used, the rate of TEOS hydrolysis slightly increased with increasing the co-surfactant concentration. The closeness of the specific rate constant, k_h, for all co-surfactants suggested that the chain-length of co-surfactant did not significantly affect the rate of TEOS hydrolysis as well as the delay time.

The final average size of silica particles synthesized in this microemulsion system ranged from 37.4 to 65.7 nm, depending on the type and concentration of co-surfactant. The size of silica particles varied with the

type of co-surfactant by the order: 1-butanol > 1-octanol > 1-dodecanol. The average diameter increased with increasing the concentration of 1-butanol. On the other hand, the average diameter decreased with increasing the concentration of 1-octanol and 1-dodecanol.

5.1.2 The Deposition of Silica Particles in Porous Media (Linear Coreflood Experiment)

The results of linear coreflood experiment indicated a promising prospect of the usage of the in-situ silica particles to reduce the permeability of porous media. The result from this coreflood experiment showed that the silica particles had the delay time equal 30 hours before deposition at the pore walls and the permeability of the core sample was decreased 30 % after the first injection of microemulsion solutions completed. The second injection of microemulsion solutions required longer delay time (i. e., 80 hours) to form multi-layer deposition on the previously deposited particles. The minimum permeability ratio was about 50% reduction.

5. 2 Recommendations

The current study has succeeded in the formation of silica particles in w/o microemulsions from the hydrolysis of tetraethyl orthosilicate (TEOS). Unfortunately, the permeability reduction of core sample due to the deposition of silica particles can not clearly explain. In order to better understand the factors controlling the deposition of silica particles through the porous media, the transport of silica particles through the micro-model should be investigated. This study was carried out by addition of co-surfactant to control the growth rate of silica particles. The results showed that the size of silica particles increased with increasing the concentration of 1-butanol. Therefore,

the increment of 1-butanol or the shorter chain length alcohol is needed for the higher permeability reduction. Moreover, the usage of mix co-surfactants is also suggested to investigate for controlling both the size and the rate of silica particles synthesized in w/o microemulsions.