CHAPTER V
CONCLUSIONS

High molecular weight paraffins form stable crystals at low temperatures due to the low solubility of these compounds in most of the organic solvents. This crystallization of paraffins leads to the formation of gels with a very complex morphology. The model systems of wax and oil were used to understand the gelation process of these mixtures. The incipient wax-oil gel deposit contains a significant amount of oil trapped in a 3-D network structure of the wax crystals. As a result, the gel behaves as a porous medium in which wax molecules continue to diffuse into the deposit. This phenomenon is called aging of the gel deposit and leads to an increase in the wax content of the deposited gel with time. The aging of the gel deposit hardens the deposit and makes the remediation process challenging.

A cross-polarized light microscope coupled with temperature-control device was used to determine the cloud point temperature of various wax-oil mixtures in order to prepare the model systems of wax and oil used in the cold finger experiments. The results of these cloud point measurements showed that the solubility of wax-oil mixtures was a strong function of temperature.

A series of laboratory cold finger experiments were carried out for various lengths of time to study the physics of aging process of the gel deposits. It was observed that there was a *critical carbon number* (CCN), which wax molecules having carbon number above CCN diffuse into the gel deposit while molecules having carbon number below CCN diffuse out of the gel deposit. Hence, the critical carbon number indicated that the physics of aging process of the wax-oil gel deposit was a counter diffusion phenomenon. It was also found that the operating temperature affected this critical value in the way that the critical carbon number increased with increasing temperature as a step function. The critical carbon number of Model Oil No. 1 increased from C23 at 285.5 K to C24 at 290.5 K and the critical carbon number of Model Oil No. 2 increased from C24 at 285.5 K to C25 at 290.5 K for Model Oil No. 2.

The thermodynamic model was developed to predict the critical carbon numbers as well as the cloud point temperatures of wax-oil mixtures. The heat capacity term was neglected in the solid-liquid equilibrium equation for simplification. The liquid phase non-ideality was described by Flory free-volume equation accounting for the differences in size and free volume of molecules in paraffinic mixtures. The UNIQUAC equation was applied to describe the solid phase non-ideality using volume (r) and surface area (q) parameters of 0.1483 and 0.1852 times the original value developed for liquid phase application.

The values predicted for both the cloud point temperatures and the critical carbon numbers of model oils using the thermodynamic model developed in this study showed a good agreement with the experimental data.