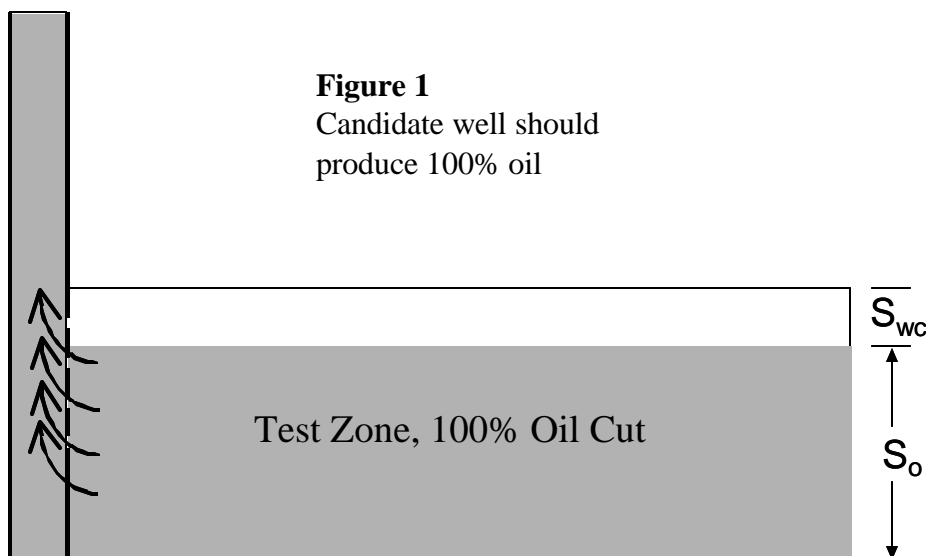


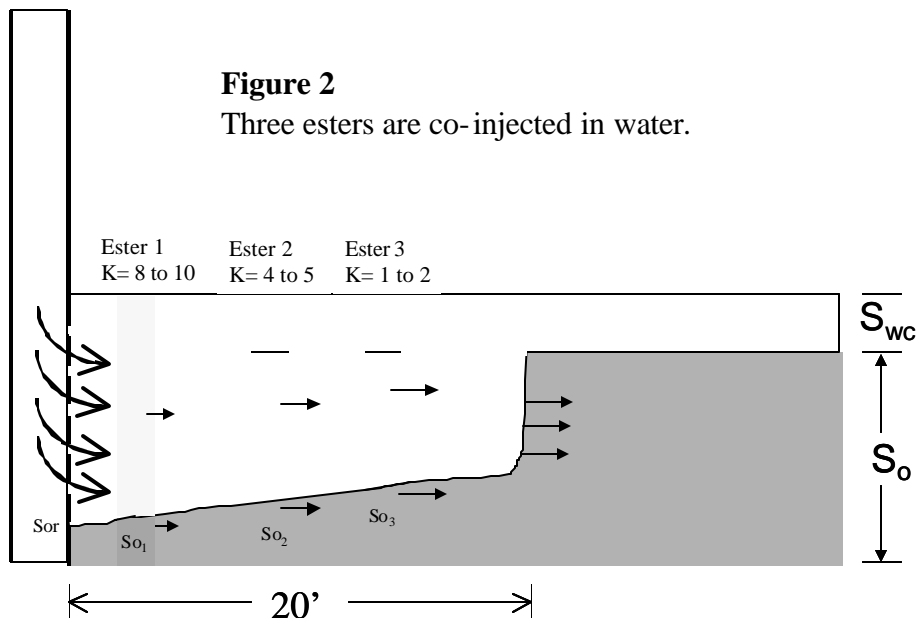
Fractional Flow Testing

Once the connate water testing is completed, the fractional flow test is carried out. The connate water SWCT test is non-destructive; the test well returns to pre-test production status after testing is completed.

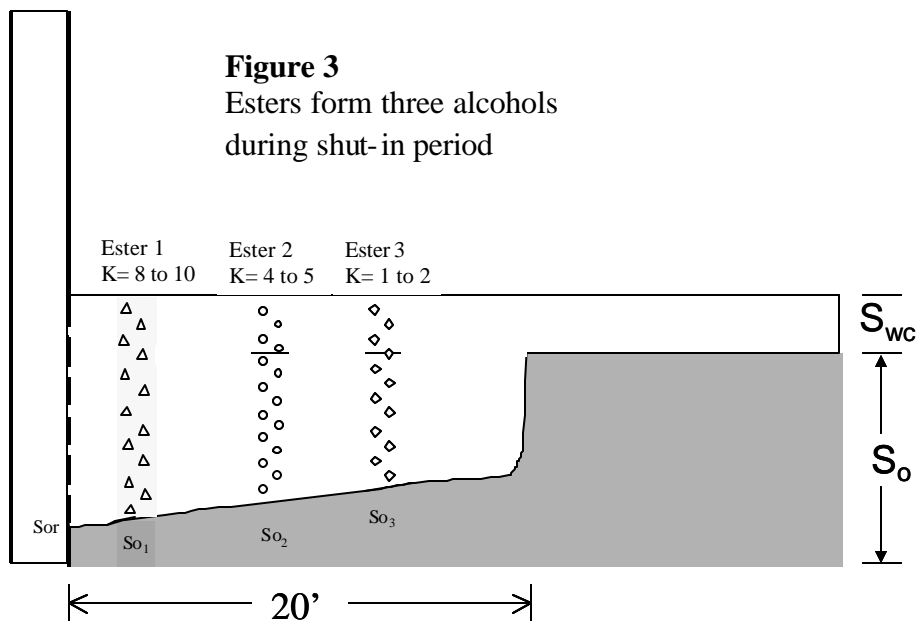
Figure 1 shows a profile of the test well/zone.



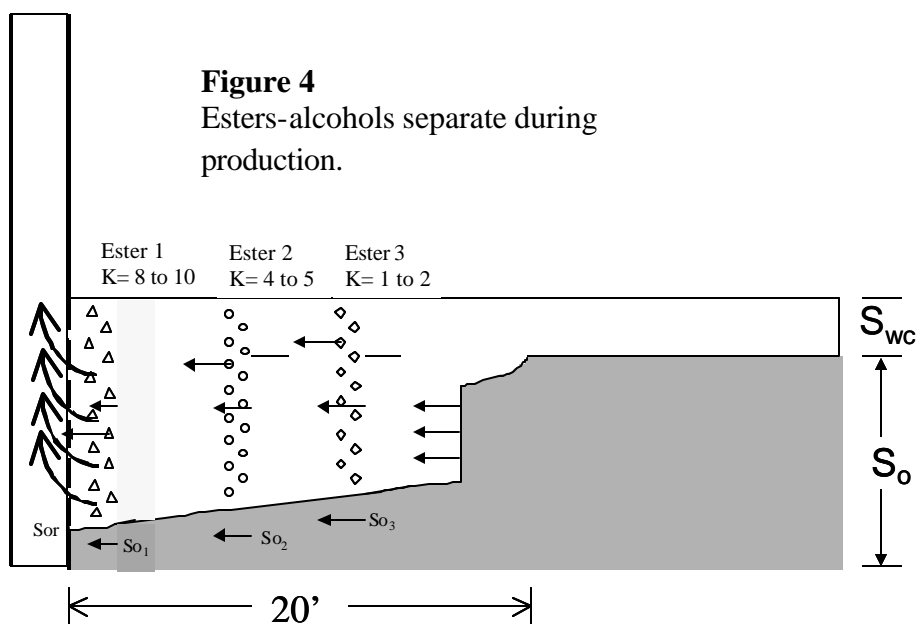
The 100% oil cut allows for a second SWCT test aimed at measuring fractional flow as a function of fluid saturation. The test is implemented by injecting a volume of water carrying three partitioning ester tracers such as methyl acetate, ethyl acetate and iso-propyl acetate. A second volume of water containing no esters push the ester bank away from the well while displacing oil. Figure 2 shows how the three ester tracers and oil saturation are distributed radially from the well during the injection.



During injection, a Buckley-Leverett displacement of oil by water takes place in the test zone. Each ester follows a characteristic oil saturation behind the oil shock front, depending on the ester's oil-water distribution coefficient. The well is then shut in for a three-to ten-day reaction period, to allow production of a unique product tracer from each of the three esters. Figure 3 shows the esters and corresponding hydrolysis product alcohols.



The well is then produced and water samples taken at the well head every fifteen to twenty minutes. The samples are analyzed for the three esters and their corresponding product alcohols. Total produced volume and oil cut is also monitored during production. Figure 4 shows how the esters separate from their corresponding alcohol product tracers during production.



The product tracer peaks return to the well before oil breakthrough occurs.

The ester and alcohol production profiles and the oil cut data are then simulated, and a best-fit model determined. The key unknown parameters in the simulation model are S_{or} , S_{wc} , exponents and pre-factors in the Corey oil and water relative permeability functions,

$$k_{ro} = k_{ro}^0 \left(\frac{S_o - S_{or}}{1 - S_{wc} - S_{or}} \right)^{n_o}$$

$$k_{rw} = k_{rw}^0 \left(\frac{1 - S_{wc} - S_o}{1 - S_{wc} - S_{or}} \right)^{n_w} .$$

The fits to the various tracer profiles and the oil breakthrough plot are quite sensitive to the pre-factors and exponents in the Corey functions. The results, shown by Figures 5 and 6 below show the in-situ measured fractional flow curve and the best-fit relative permeabilities for a hypothetical case.

Figure 5
Typical fractional flow curve

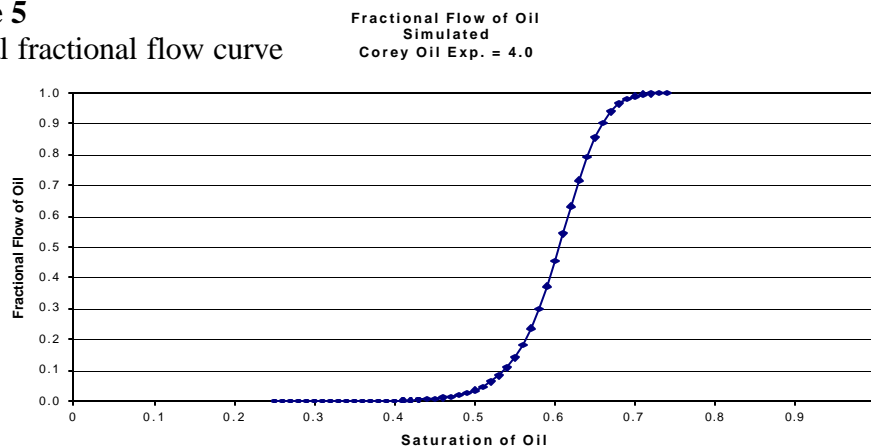
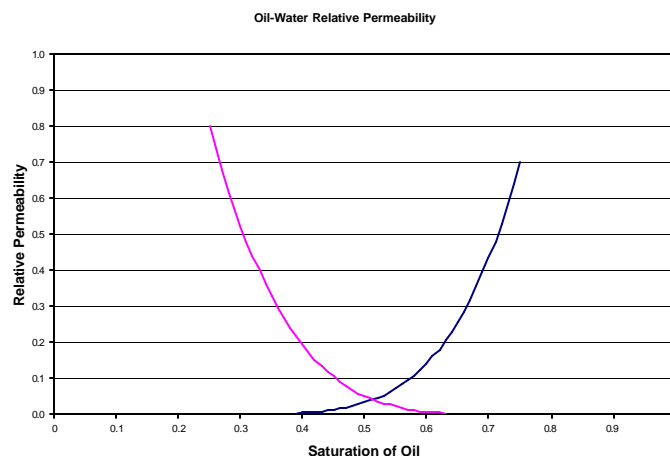


Figure 6
Typical relative permeability curve



Tracer derived fractional flow data allow reservoir engineers to proceed with water flood carrying a much higher degree of confidence in water flood success and performance predictions. Contact Charlie Carlisle at CTI (307) 742-0418, cell (307) 351-3629 or visit our website at www.chemtracers.com for more details on this unique in-situ tool for measuring fractional flow.