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Downhole measurements of electrokinetic potential for oilfield monitoring

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Permanently installed downhole sensors are increasingly being deployed to provide 'real-time' reservoir data during hydrocarbon production, which helps to reduce uncertainty in the reservoir description and contributes to reservoir management decisions. Where wells are equipped with inflow control valves (so called 'intelligent' wells), it is possible to develop a feedback loop between measurement and control to optimize production.

We suggest that measurements of electrokinetic potential during production, using permanently installed downhole electrodes, could be used to detect water encroachment towards an intelligent oil well. Downhole electrodes mounted at the production well on the outside of insulated casing, have been successfully applied in subsurface resistivity surveys during oil production. Similar technology could be used to measure electrokinetic potential. Moreover, recent and ongoing work has changed our understanding of electrokinetic coupling under two-phase conditions.

We present the results of numerical simulations of fluid movement during hydrocarbon production, using a new formulation which captures both the changing fluid distributions and the resulting electrical potentials. We suggest that encroaching water causes changes in electrokinetic potential at the production well which could be resolved above background electrical noise; indeed, water approaching an oil well could be detected several 10's to 100's of metres away. This contrasts with most other downhole monitoring techniques, which sample only the region immediately adjacent to the wellbore. If the well is equipped with downhole inflow control valves, production may be significantly enhanced if encroaching water is detected before it arrives, and flow into the wellbore properly controlled.