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MAGNETIC SUSCEPTIBILITY OF PETROLEUM RESERVOIR MINERAL SCALES: A NOVEL APPROACH FOR THEIR DETECTION, MONITORING AND CLASSIFICATION

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The problem of scale formation occupies one of the leading challenges in the oil and gas industry, and significantly influences costs. Scale formation is encountered in oil and gas production, transportation and processing, causing obstruction of technological operations from the initial stage of hydrocarbon production to the final stage of petrochemical manufacturing. It has been recognised to be a major operational problem in subsurface and surface oil and gas installations and causes damage to hydrocarbon-producing formations. In order to identify ways of combating this problem we propose an initial study of the magnetic susceptibility of mineral scales. This study for the first time comprehensively outlines a systematic magnetic classification of the dominant varieties of petroleum scales existing in the up-stream and down-stream petroleum industry. The results show that the petroleum scales have distinct magnetic differences. They establish three magnetic classes: diamagnetic, paramagnetic and ferrimagnetic scales. The majority of hydrocarbon reservoir scales containing Ca, Sr, Ba, Pb, Na, K, Mg cations and the aluminium-silicon scale group are diamagnetic. The cation scales with sulphate anions (SO_4) are more diamagnetic in comparison to carbonate anions (CO_3). Our theoretically calculated and experimental values of magnetic susceptibility are in close agreement. Any differences between the experimental and theoretical values appear to be due to non-stoichiometric and multiphase scales.

The mass magnetic susceptibility of the diamagnetic scales is less diamagnetic than

crude oil and formation water. Magnetic susceptibility can be used to rapidly distinguish between different diamagnetic scales and reservoir fluids (and between different paramagnetic and ferrimagnetic scales). It can therefore be used for magnetic detection, identification and monitoring of scales. This magnetic characterisation is also likely to help with strategies to combat the build-up of scale minerals.