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Study of Barium Sulphate Formation in the Oil Installations – Case of Region STAH

Karima IBELAIDENE[1], Ouardia REBAS[2*], Hamza BOUABDALLAH[2] and Sofiane KACI[2]

[1] CRD Sonatrach, Avenue du 1er November 35000, Algiers, Algeria

[2] Laboratory of valorization of fossil energies, Department of Chemical Engineering. École Nationale Polytechnique, Algiers, Algeria

*Corresponding author's email: ouardia.rebas@g.enp.edu.dz

ABSTRACT

Barium sulphate deposit creates problems in the STAH oil field's (clogging of pipelines, pumping, shutdown of facilities, etc.). The main cause is the use of the injection water mixture from the F3 and F6 tanks to maintain the pressure in the oil wells. These two waters are incompatible in their composition, because, when mixed together, causes solid deposit of barium sulphate. The main goal of this study is to understand the deposition phenomenon of bar-ium sulphate by studying the compatibility of the water of injection in this case the F3 and the F6 with different mixing rates, the influence of the pH and the temperature. To consolidate the work, a mobilization using the "Ellistat" software was carried out, using the various parameters mentioned above. This mathematical model allows us to predict the mass of barium sulphate deposited.

Keywords: Deposition, Barium sulphate, Oil installations, Injection water, pH, Temperature, Model.

1. Introduction

The deposits formed in an oil field reflect the geological composition of the formation from which the crude oil was extracted. A large percentage of oil reservoirs are found in regions rich in carbonates, sulfates and silicates, which provide considerable concentrations of anions, and the abundance of cationic species present in the geological formation's surroundings is responsible for the shape the mineral layers take. Thus, high percentages of silica, calcium and iron provide the ationic species to combine with the available anions. Also, over long geological periods, the processes of biodegradation and aqueous filtration through the various mineral layers have produced saline waters, which are largely responsible for the formation of crystals in the rock pores. During the short time that the fluids contained in the producing formation have been confined to regions of low mobility, the system will have reached an apparent equilibrium. So, in the non-geological context of time, compositional changes have approached a state that appears to be constant, however, when formation fluids find an outlet to flow, such as an oil well, the dynamics of the system change, gases and liquids escape through the well, pressures and temperatures drop and cause a change in shear forces. With these physical changes comes a shift in the pre-established equilibrium, and processes such as deposit formation and corrosion kick in, with negative repercussions on crude oil production.
Our study revolves around this problem, which is mainly encountered in the STAH region. To this end, a field mission was carried out in this region to identify the phenomenon of deposition and the parameters of the oil treatment process. Samples of barium sulfate solid deposits were collected and analyzed by Scanning Electron Microscope and X-ray diffraction. To study the phenomenon in the laboratory, water samples from F3 and F6 were also taken and characterized by physicochemical analysis.

2. Results and Discussion

2.1. Physico-chemical analysis of deposit water

Deposit water F3 is characterized by the presence of barium ions and the absence of sulfate ions, while deposit water F6 is characterized by the presence of sulfate ions and the absence of barium ions, which explains the formation of barium sulfate deposits.

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2.2. Solid deposit characterization

2.2.1. X-Ray diffraction

Mineralogical analysis by X-ray diffractometry revealed that the deposit is composed mainly of barium sulfate (Baryte).

2.2.2. Scanning Electron Microscope

The results clearly illustrate the presence of barium, sulfur, oxygen, chlorine, sodium, strontium, calcium and traces of carbon.

Barium and sulphur are characterized by very high levels in most zones, confirming the results of X-ray diffraction analysis; the main element is barium sulphate. Zone three (03) and zone six (06) are characterized by high chlorine and sodium content, implying the presence of a small layer of sodium chloride.

3. Conclusion

The objective assigned to this work has been achieved. Indeed, the study of the phenomenon of barium sulfate deposit formation at the STAH crude oil production unit revealed that this type of deposit forms particularly as a result of the incompatibility of the two reservoir waters, namely F3 and F6. Added to this are the pH of the medium and the operating temperature. Analyses of the composition of the two waters F3 and F6 show that deposit water F3 is rich in barium ions, and deposit water F6 is rich in sulfate ions. The concentration product of these two ions far exceeds the solubility product of barium sulfate, which explains the deposition of this salt when these two waters (F3 and F6) are mixed. Mixing these two waters at different rates generates barium sulfate precipitation. The maximum precipitation recorded, known as the critical rate, corresponds to a rate of 70% F3 deposit water and 30% F6 deposit water. These two waters are located in an environment where pH and temperature play an important role in the deposition phenomenon. In fact, according to the experiments carried out, the mass of deposits varies proportionally with variations in acid pH, favoring the precipitation of barium sulfate. On the other hand, increasing temperature favors the opposite phenomenon (barium sulfate dissolution). To capture all these parameters, a mathematical model was established on the basis of the experimental data obtained using the "Ellistat" software. This model predicts the mass of barium sulfate deposits as a function of the medium's pH value, temperature and F3/F6 mixing ratio. The model was validated using two approaches: experimental and statistical. Optimization of the model led to the conclusion that at a pH of 4, a F3/F6 volume ratio equal to 80/20 and a temperature of 23°C, barium sulfate deposition is minimal.

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