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WAG-CO_2 Enhanced Oil Recovery using Proxy Models

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The discovery of new reservoirs in the Pre-Salt layer, located in Santos Basin (Brazil), have brought technological challenges. Among them there is the fact that a lot of these reservoirs have a high concentration of carbon dioxide (CO_2), near 20%. In addition, these reservoirs are located far from the coast, the rigs have a very limited capability to store this gas and the environmental impacts related to its release in the atmosphere are very high. Thus the injection of water alternating gas, as known as WAG, using CO_2 has become a popular method of enhance oil recovery in these reservoirs. The WAG injection, however, is more complex than traditional EOR methods due to the hysteresis effect and also the computational simulation becomes more complex. The development of the proxy models that emulate the output of the simulators are considered the appropriate technical alternative. This work aimed to develop a methodology to perform the optimization of CO_2 -WAG injection in the miscible condition in an efficient and robust way. It proposed the optimization of CO_2 through of injection flow rate that leads to a maximum Net Present Value (NPV), increasing the oil production and at the same time reducing the water production and CO_2, using a proxy model to reduce the computational time required. The-CO_2–WAG EOR in a miscible condition was modeled in heterogeneous and not realistic carbonate reservoir, using a scale of a quarter of five-spot, in which there is a pair of producer and injector. The methodology developed was composed by four steps: physical phenomenon modeling, adjustment of the numerical control, critical parameters selection and, finally, the optimization using proxy models. Three study cases were created in relation to the so called "WAG cycle" that consists in the elapsed time between the beginning of gas injection and the end of water injection. The operational parameters chosen had changed inside a pre determined interval of values and the related NPVs were then evaluated. A traditional optimization method was used as a reference. The results showed that while the NPVs were very close (0,42% of maximum error) the simulation times were quite low (55% of difference in the slowest case) in the proxy models. It was noted also that the NPV increases with the WAG cycle, suggesting that should have a maximum WAG cycle with a higher impact in the NPV of the field.

Biography:

Guilherme A. F. Patrocinio is a bachelor degree student of Petroleum Engineering in the Polytechnic School of the University of São Paulo, Brazil. During the years 2014 and 2015 Guilherme was member of the Society of Petroleum Engineering (SPE) student chapter of the University of São Paulo, helping with the organizations of two workshops related to the oil industry. During the year 2017 he worked in the Laboratory of Simulation and Management of Petroleum Reservoirs (LASG), located in the campus of University of São Paulo in the city of Santos, Brazil. Nowadays he participates of an exchange program in the Politecnico di Torino located in Turin, Italy.