Prediction of Volumetric Sand Production and Stability of Well-bore in a Niger-Delta Formation

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Abstract

Nigeria's Niger-Delta province has been identified as one petroleum system- The tertiary Niger-Delta (Akata-Agbada) petroleum system. Almost all the petroleum resources currently are produced from the sandstone species within the Agbada formation. Also turbidite sand in the upper Akata formation is a potential target in deepwater offshore and currently producing interval onshore. This paper presents a mathematical model to simulate sand production from petroleum reservoir subject to an open-hole completion. A coupled reservoir-geo-mechanical model was used to predict the volumetric sand production and associated wellbore stability. The model is based on mixture theory with erosion. The Representative Elementary Volume (REV) composes of five phases - solid matrix, fluidized solids, oil, water, and gas phase was chosen. The model also incorporates the reservoir drawdown pressure, rock failure criteria, rock types and field condition. Analytical solution of sand displacement processes is also highlighted. Results show that the magnitude of sand production is strongly affected by the flow rate, the confining pressure, the pressure drawdown and the fluid viscosity. The determined ratio of the productivity index to the saturation of the fluidized solid can be correlated to determine reservoir formation type during sand production, and predicting the wellbore stability. The model has a higher degree of

validity for light and medium crude oil flow which possesses moderate lubricating properties, and therefore erosion of sand particles during production highly depends on flow rate.

Introduction

Hydrocarbon production increases if zero sand production criterions is relaxed and sand production is allowed. The benefits of the increased production need not to outweigh the negative consequences of sand production such as the risk of well failure, erosion of pipelines and surface facilities, sand separation and disposal. A proper assessment is thus required where knowledge of the mass and rate of sand production is necessary (Papamichous, 2002). Sand control is vital to reliable production in many sandstone reservoirs where sand can present a major obstacle to well production (Hamby and Richardson 1968, Bratli, and Risnes 1981, Opara and Ichara 1988 and Ugbebor, 1999). Nigeria's Niger-Delta region having been identified as part of Akata-Agbada formation which is predominantly sandstone in nature is currently facing a serious sand production challenges. Sand production in oil wells occurs when the formation disaggregates due to the combination of in-situ stress and fluid flow and is carried into the wellbore (Appah, 1998).

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