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The Performance of a High Paraffin Reservoir Under Non-isothermal Waterflooding

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This study analyzes the performance of a high paraffin reservoir under cold waterflooding for 17 years using a 3-D finite difference simulator and analytical solution of injection wellbore temperature profile to upgrade reservoir management strategies. The reservoir has been marked by injectivity issues, early injection rate decline by half initial values and low incremental recovery, hence subject to alternate developmental schemes. The influence of cold waterflooding is assessed from simulated temperature maps due to nonisothermal injection and solution of injection well temperature profile.

Keywords: paraffin precipitation, pour point, non-isothermal waterflooding, reservoir simulation, Shen-95

INTRODUCTION

Block Shen-95 of Liaohe oilfield, characterized by high pour point oil (42–67°C, average of 51°C), paraffin content of 37.5%, and 12–20% resin and asphaltene content. The reservoir temperature is just a few degrees above the maximum pour point temperature. These factors make exploitation difficult and marked by low incremental recovery with regards to the peculiarity of formation damage at the vicinity of both production and injection wells. Formation damage is as a result of paraffin deposition from temperature decline at production wells and non-isothermal injection causing decreased production and low sweep efficiency. The reservoir is a heterogeneous sandstone reservoir with poor natural pressure support and has been on production for about 23 years with 17 years of cold waterflooding.

Early production problems attributed to the high pour point temperature had occurred and paraffin precipitation due to non-isothermal waterflooding was anticipated (Dou and Sun, 1995). The influence of non-isothermal flooding has been established by Ramey (1962), Platenkemp (1988), Civan (2000), Cassinat et al. (2002), and Maloney and Osthus (2005), all are related to paraffin crystallization, precipitation, entrainment, and deposition on dynamic and static reservoir properties. Typical investigations are restricted to wellbore and wellbore region. Analysis beyond the wellbore region is on waterflood sweep efficiency (Bedrikovetsky, 1997) and residual oil saturation effect on history matching (Mezzomo and Rabinovitz, 2001).

This study covers reservoir modeling, numerical simulation, and analytical solution of injection wellbore temperature profile. These provide the means of assessing non-isothermal waterflooding

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