Optimal Operation of Fast-SAGD Process Considering Steam Channeling among Vapor Chambers

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ABSTRACT

This paper presented the optimal operation strategy of Fast-SAGD (Steam Assisted Gravity Drainage) process considering steam channeling among vapor chambers. To accomplish minimum cSOR (cumulative Steam to Oil Ratio), it was energetically efficient to start CSS (Cyclic Steam Stimulation) using the wedge well after the steam chambers of SAGD crossed over each other. The early start-up of CSS operation caused steam intrusion into the SAGD chamber that imposed the minimum operation of SAGD. When the SAGD’s chambers expanded sufficiently, the mature pattern of steam chambers decreased the production efficiency dramatically. High injection pressure of CSS can make more efficient production by blocking unnecessary steam injection from SAGD and pushing latent bitumen to the SAGD well pair. After steam chamber of wedge well grows enough, it had better to maintain the low steam injection pressure of the wedge well to use the latent heat of the reservoir.

KEY WORDS: Fast-SAGD, SAGD, CSS, Steam Channeling

INTRODUCTION

The Steam Assisted Gravity Drainage (SAGD) has been implemented as one of the commercialized production scheme to recover oil sands in Canada. However, the undiluted bitumen between SAGD well pairs could result out the production inefficiency if only SAGD process was applied. The Fast-SAGD (Steam Assisted Gravity Drainage) installed wedge-well at the typical SAGD system and carried out CSS (Cyclic Steam Stimulation) to accelerate the growth of SAGD steam chamber in early stage (Arthur, 2009; Cyr 2001; Gates and Wang, 2011). Polikar and Cyr (2000) showed that the Fast-SAGD made the lateral expansion of steam chamber and reduced the steam required.

The typical SAGD scheme of developing oil sands has used the well pad system consisted of several well pairs and thereby the inevitable were steam channeling and interference between well pairs. Previous works have been concentrated on the chamber growth of single SAGD well-pair in 2D homogeneous reservoirs and thereby overlooked the negative effect of steam channeling in typical wellpad system with several wellpairs (Polikar and Cyr, 2000; Shin and Polikar, 2006; Shin and Polikar, 2007).

This paper presented the optimal operation strategy of Fast-SAGD process considering steam channeling and vapor interference among steam chambers, which optimized the energetic efficiency of Fast-SAGD based on ANN (Artificial Neural Network). Start-up time and periodic injection pressures of wedge-well were considered as control parameters.

SIMULATION MODEL

The Fast-SAGD process assumed multiple SAGD well pairs and one wedge well. The 3D reservoir model emulated a real oil-sands deposit in the Athabasca, Canada (Fig. 1). Two SAGD wellpair and one wedge well were located in a three-dimensional model having permeability heterogeneity. The total grid number of the simulation model is 14x101x34 (i x j x k). For SAGD process, the injector is located at 5 m above the producer. Steam injection pressure at SAGD injector was fixed as 2900 kPa a little higher than average reservoir pressure (2700 kPa) and steam trap control is assumed (Elliott and Kovscek, 1999; Gates, 2006). Reservoir properties of the simulation model have been set up as summarized in Table 1 (McElman and Deutsch, 2006).

The wedge-well installed in the middle of two SAGD produced as shown in Fig. 1(b). The installed position would affect the recovery efficiency but before simulating the whole process, it is difficult to determine the optimal placement of the wedge-well.