Eqs. 49 and 51 enable calculation of the well's J once e average fluid saturations, p_{wf}, and $\bar{p}_R$ are known. By combining Eqs. 45 and 50, Standing eliminated $)_{max}$ and obtained Eq. 52, which is a general relation- p for IPR curves at various average reservoir pressures.

$$q_o = \frac{J^* \bar{p}_R}{1.8}\left[1 - 0.2\left(\frac{p_{wf}}{\bar{p}_R}\right) - 0.8\left(\frac{p_{wf}}{\bar{p}_R}\right)^2\right]. \qquad (52)$$

Thus, Standing has shown how production rate in a ution-gas-drive performance model can be calculated use of Vogel's IPR information. Because a value of can be calculated with Eq. 49, all terms in Eq. 52 can evaluated.

Later, Al-Saadoon[28] suggested that a different expres- n should be used for J. However, Rosbaco[29] clarified situation by noting that although Standing[26] and Al- doon[28] used different formulas for J and for J/J^*, yield the same results for q_o vs. p_{wf}. Consequenly, workable and acceptable to use Standing's equations. tanding[25] discussed application of the IPR approach amaged wells and Dias-Couto and Golan[30] developed eneral IPR for wells in solution-gas-drive reservoirs is applicable to wells with any drainage area shape, completion flow efficiency, and at any stage of reser- depletion.

e Required for Oil Production

is point, oil recovery vs. reservoir pressure is known the material-balance calculations. The oil produc- rate per well, q_o, corresponding to a specified mini- p_{wf} can be calculated by use of either the uctivity index approach (Eq. 42) or the IPR approach 49 and 52). This q_o is the calculated rate that the is capable of producing. The well also may be sub- to a scheduling constraint, such as an allowable pro- on rate. Consequently, the well's oil production rate pressure p_n is the smaller of these two rates:

$$=(q_o)_{min}, \qquad (53)$$

e $(q_o)_{min}$ = minimum value of calculated and sched- oil rate, STB/D.

e average oil production rate $\bar{q}_o$ during the pressure ment from p_{n-1} to p_n is given by Eq. 54.

$$=0.5(q_n + q_{n-1}). \qquad (54)$$

s average rate is used in Eq. 55 to calculate the time quired for the incremental oil production $(\Delta N_p)_n$ p_{n-1} to p_n.

$$=\frac{(\Delta N_p)_n}{\bar{q}_o n_w}. \qquad (55)$$

cumulative time, t_n, to reach pressure p_n is given 56, with initial time $t_o = 0$.

$$_{n-1} + \Delta t_n. \qquad (56)$$

Insights from Simulator Studies

Because reservoir simulation is the topic of Chap. 48, we will not discuss it in detail here. For solution-gas-drive reservoirs, several comparisons have been made of gridded simulator results vs. simpler approaches, such as tank-type material balances. These comparisons help to confirm the range of applicability of the simpler approaches. The key questions addressed by these studies are the same questions Vogel[24] considered in getting the computed results on which he based the IPR method for well rate calculations. These questions are (1) to what extent is the saturation distribution nonuniform, and (2) how much does this influence performance.

The most informative study was by Ridings *et al.*,[14] who compared laboratory vs. computed solution-gas-drive results for linear systems and obtained close agreement. Also, they used a gridded radial simulator to study the effect of rate and spacing on performance of solution-gas-drive reservoirs. Their conclusions concerning thin, homogeneous, horizontal solution-gas-drive reservoirs included the following.

1. "Ultimate recovery essentially is independent of rate and spacing, and agrees closely with recovery predicted by the conventional Muskat method."

2. "GOR depends somewhat on rate and spacing. For high rates or close spacings, GOR's initially are higher, but later become lower than a Muskat prediction would indicate. At low rates or wide spacings, GOR behavior approaches the Muskat prediction."

3. Computed depletion time agreed closely with conventional analysis (productivity index method) at low pressure drawdowns, but differed more for high drawdowns. This is in qualitative agreement with the results obtained by Vogel.[24]

4. "Intermittent operation greatly affects instantaneous GOR behavior, but the cumulative GOR is not affected significantly. Also, oil recovery apparently is not affected." This refers to the cumulative oil recovery, not the amount of oil recovered in a given time period.

Note that Conclusions 1 and 2 support the use of tank-type models for predictions of recovery and of GOR (at least for low rates) for solution-gas-drive reservoirs. Although Muskat's method is mentioned, other tank-type approaches, such as Tracy's method, would be equally suitable.

Stone and Garder[17] compared one-dimensional (1D) gridded simulator results vs. pressure and production data measured on a laboratory model produced by solution-gas drive. Computed and measured pressures vs. percent oil recovery were in close agreement.

In 1961, Levine and P... of solution-g... radial gridde... The approxi... semisteady st... stock-tank-oi... at any instan... which actually meant uniform GOR (i.e., the total GOR is the same at all points at any instant). Levine and Prats showed close agreement between results of the simulator and the approximate method. These results, for various stages of depletion, were pressure and saturation vs. radius and the corresponding values of producing GOR and of percent