Poorly Performed Decline Curve Analysis Won’t Be Reliable

Although decline curve analysis is the oldest and most widely used practice for determining reserves, a paper presented at the Society of Petroleum Engineers/International Association for Energy Economics Hydrocarbon Economics and Evaluation Symposium, held May 17-18 in Houston, suggests there is much to be understood about its practice and implementation.

In a paper titled, “The Practice of Decline Curve Analysis” (SPE-179979-MS), author D.C. Purvis discusses decline curve analysis as practiced in the oil industry being an established process. But while decline curve analysis has been used for more than a century, widespread misunderstanding and implementation plague the industry. Purvis contends decline curve analysis should be more than just a “curve-fitting exercise,” but rather is an exercise in “seeing, understanding and predicting reservoir dynamics.”

As defined by IHS in a Fekete publication, decline analysis is a reservoir engineering technique that extrapolates data from oil and gas wells to, hopefully, accurately forecast the future production rates and ultimate recoverable reserves in a particular reservoir. Purvis and IHS look to J.J. Arps, an American geologist who worked during World War II and published a mathematical relationship for the rate of production decline over time.

According to Purvis, decline curve analysis was used widely in the early 1900s, but it was Arps’ paper in 1945 that really advanced the process in a large way. In fact, Arps himself mentions this in his review of the literature of the 40 years prior to his work, in which he referenced the earliest published observation of this process by authors Arnold and Anderson in their 1908 U.S. Geological Survey report, which observed a production drop over time.

Additionally, the IHS site observes that while many papers have attempted to modify Arps’ work, his original method is still used widely. According to Purvis, what made Arps’ work stand out was that he developed a more general hyperbolic equation to incorporate exponential and hyperbolic behaviors.

In his 1945 paper (SPE-945228), J.J. Arps states, “The basic problems in appraisal work are determining a well’s most probable future life and estimating its future production.”

Arps goes on to say that volumetric calculations are good, but may not be as valuable without additional data, and that the easiest and most reliable source of data is a producing well. The most logical approach is to extrapolate production data and plot it against time, then extend the curve until it reaches the economic limit, at which point one can estimate the life of the well. The process attempts to predict future life of a well or future oil recovery, assuming all trends or calculations remain the same over time.

As it turns out, Arps’ assumption about trends and calculations remaining constant is the thing that gets modern analysts into trouble. Purvis asserts that adequate analysis can be accomplished only by drawing on general experience, examining the nearest analog well while understanding operational changes as well as the uncertainty of the production data themselves. In other words, examining as much data as possible seems to be the key, but it is important to understand that not all data are created equal and sometimes things happen that impact the data. These all play into successfully estimating the life of a well.

Purvis says, “Doing the right thing the wrong way is still wrong.”

In other words, even if decline curve analysis is right for a given situation, if it is done incorrectly, it can be unreliable, at best.

Purvis highlights some examples of when decline curve analysis works best. These include things such as using quality graphs and understanding the limitations of the data they show. He discusses the importance of graphs being instantly readable and presenting meaningful data. Purvis recommends using a consistent frame of reference for the benefit of the end-user as well as the analyst.

The author encourages analysts not to compress or expand graphs, or show meaningless data. In addition, Purvis suggests using multiple graphs for each well, and comparing graphs among multiple wells with and extra eye for the older wells. Analysts should consult multiple scales and types of graphs as they conduct their analyses. Sometimes it is tempting to rely on production data only, without regard for how operations have changed. Only through reviewing operational changes can the analysis accurately determine reservoir trends.

Finally, Purvis recommends forming a functional understanding of what the graphs, plus the geologic data, say about production and the reservoir.

Purvis seems to be advocating a more thoughtful and consistent curve analysis, making sure to take note of as much data as possible in an effort to develop forecasts that are more accurate and reliable.

Jeremy Visconi is the director of technology transfer for the University of Kansas Tertiary Oil Recovery Program and the PTTC Midcontinent Region office. He has more than a decade of experience in developing and organizing technical conferences and special events.

---

“Doing the right thing the wrong way is still wrong.”

---

Reproduced for the Petroleum Technology Transfer Council from the June 2016 issue of The American Oil & Gas Reporter