EGL DESIGN IN THE PERMIAN BASIN

Alex Moore

Precise Downhole Solutions

BACKGROUND

Gas lift design involves systematically placing gas lift valves along the tubing string. The placement and characteristics of these valves are based on downhole and surface conditions. As the operating principle of a gas lift valve has remained largely the same for decades, the gas lift design process has been refined over time, to maximize the value and to suit the characteristics of these valves.

Electric gas lift (eGL), a form of surface-controlled gas lift (SCGL), varies from traditional gas lift technology, as the valves can be operated at will by electronic power rather than downhole pressures. Generally, eGL valves have variable orifices, aren't equipped with check valves and are more expensive than their traditional counterparts. When working with eGL systems, the gas lift design process must consider the characteristics of eGL valves to create an optimal design.

There are several unique characteristics of eGL valves. A lack of check valve allows for bidirectional flow, which makes eGL suitable for annular and tubing production. An automated variable orifice adapts to changing surface and well conditions. These characteristics are what makes eGL suitable for unconventional wells in the Permian Basin, where production rates and downhole conditions change rapidly.

The ability to move the injection point deeper using eGL becomes a controlled sequence of automation logic. Using onboard pressure sensors and precisely controlled actuators, the depth of injection is adjusted once specific criteria are met. Traditional injection pressure operated (IPO) valves require a reduction in the injection pressure to lower the point of injection. As eGL valves can maintain the maximum injection pressure, valve spacing can subsequently be increased.

Bidirectional injection across an eGL valve allows every valve to be used while on annular flow, then for a second time when drawing the well down on tubing flow. If the transition to tubing flow occurs before the deepest valves are used, they are unable to provide value until end-of-life tubing flow.

Tubing size plays an important role in eGL design as it dictates when the transition from annular flow to tubing flow occurs. Larger 2-7/8” tubing will allow for a faster transition to tubing flow, where 2-3/8” tubing would prolong annular flow. The production rate that determines the transition from annular to tubing flow is useful in eGL design. Including an eGL valve that can accommodate this rate under annular flow is recommended, while being conscious that valves deeper than this would not be used until end-of-life tubing flow. The designer must justify these deepest valves, while ensuring that gas won't be exiting the end of the tubing string. Larger tubing sizes make it possible to reduce the number of eGL valves on the lower portion of the tubing string, as the larger tubing expedites the transition to tubing flow. The transition to tubing flow raises the point of injection, making it harder to justify a more expensive eGL valve where a conventional or side-pocket mandrel gas lift valve could be used at the end of the tubing string to reduce costs.

DESIGN EXAMPLE

To illustrate this, a Delaware Basin Wolfcamp A well using an 8-valve eGL system, in a 2-3/8” tubing, 5.5” cased well will be analyzed. An analysis of reduced rates and different tubing sizes reveals when valves at increasing depths are used and can produce value.

After one year of production, injection has only reached a depth of ~5,400 feet. eGL pressure data has been matched to current production rates. There is no packer in this well, and the tubing is open ended. The indicated packer depth represents the end of tubing. Water cut and GOR remain constant for this analysis.

In Figure 1, only the top three valves have provided value so far. By plotting expected reduced rates shown in Figure 2, we can determine when deeper valves become useful.

Injection at 8,000’ becomes possible at flow rates of approximately 2,000 to 1,500 barrels of fluid per day (BFPD). Injection at 10,000’ becomes available at approximately 1,500 BFPD, when the injection rate is increased to 1,500 mscfd from 800 mscfd.

This tubing and casing configuration, using 2-3/8” tubing within 5.5” casing, allows the deeper eGL valves to be used while remaining on annular flow. These deeper valves can provide value early in the life of the well and can justify their placement.

In Figure 3, it shows how the same well will respond to reduced rates while on tubing flow. Higher valves can provide value once again, where the deeper valves won’t be used until the production rate is well under 500 BFPD.

By converting the tubing to a larger size of 2-7/8” in Figure 4, the annular volume is subsequently reduced. This causes the reduced production rates under annular flow to have a higher injection depth than the example using 2-3/8” tubing in Figure 2. The higher injection depth delays the use of the deeper valves. A conversion to tubing flow may occur before the deepest valves are uncovered.

In Figure 5, the same well under 2-7/8” tubing flow, the deepest valves are finally uncovered at flow rates less than 750 BFPD. In this circumstance, it may be beneficial to have used a side pocket mandrel with an orifice, rather than multiple eGL valves.

For any artificial lift system to be suitable, it must be economical. While eGL offers production benefits compared to traditional gas lift, the increased cost of each valve makes an efficient design even more critical. Every valve must be able to justify its value.

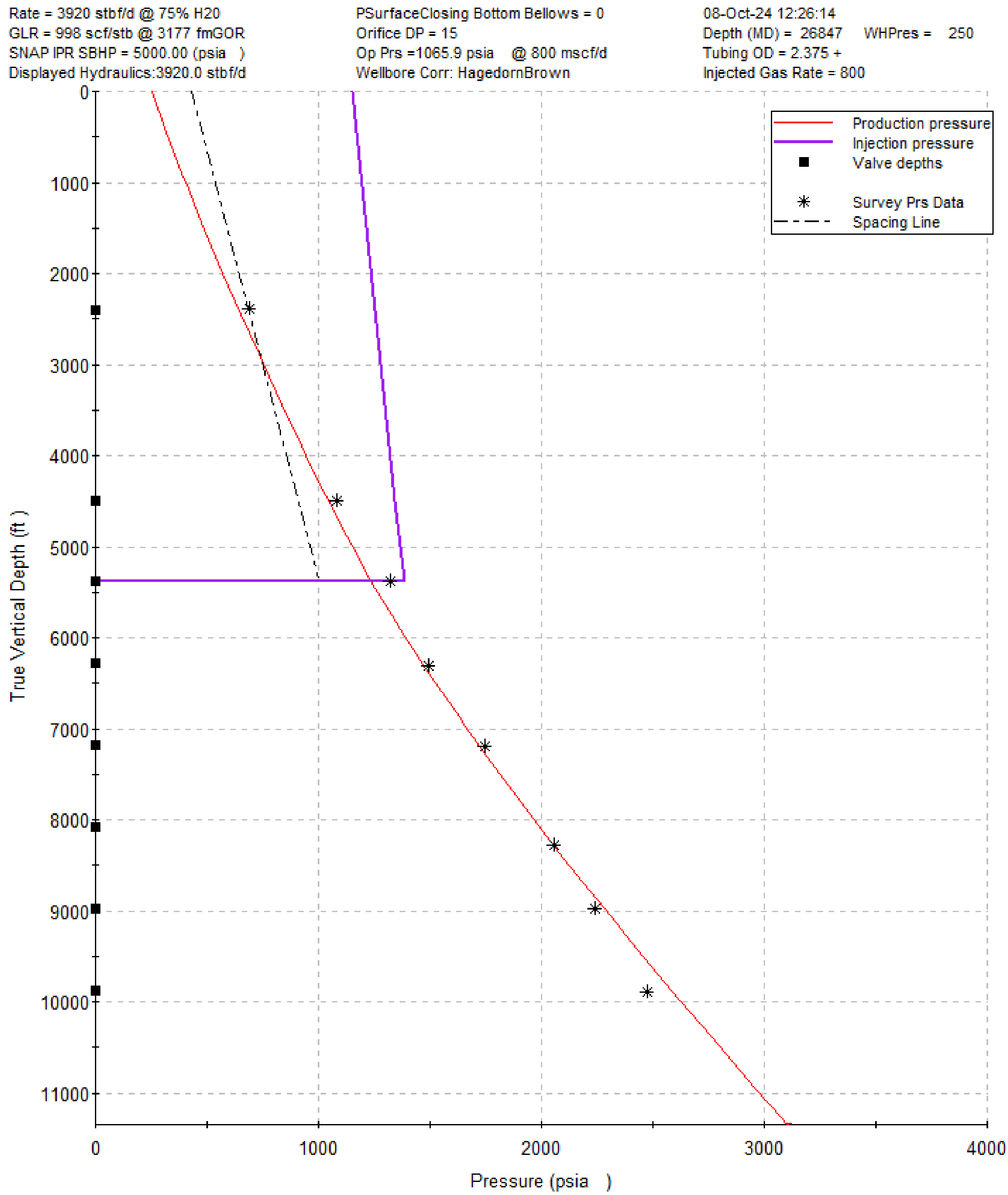

Figure 1. Annular Flow (2-3/8” Tubing / 5.5” Casing)

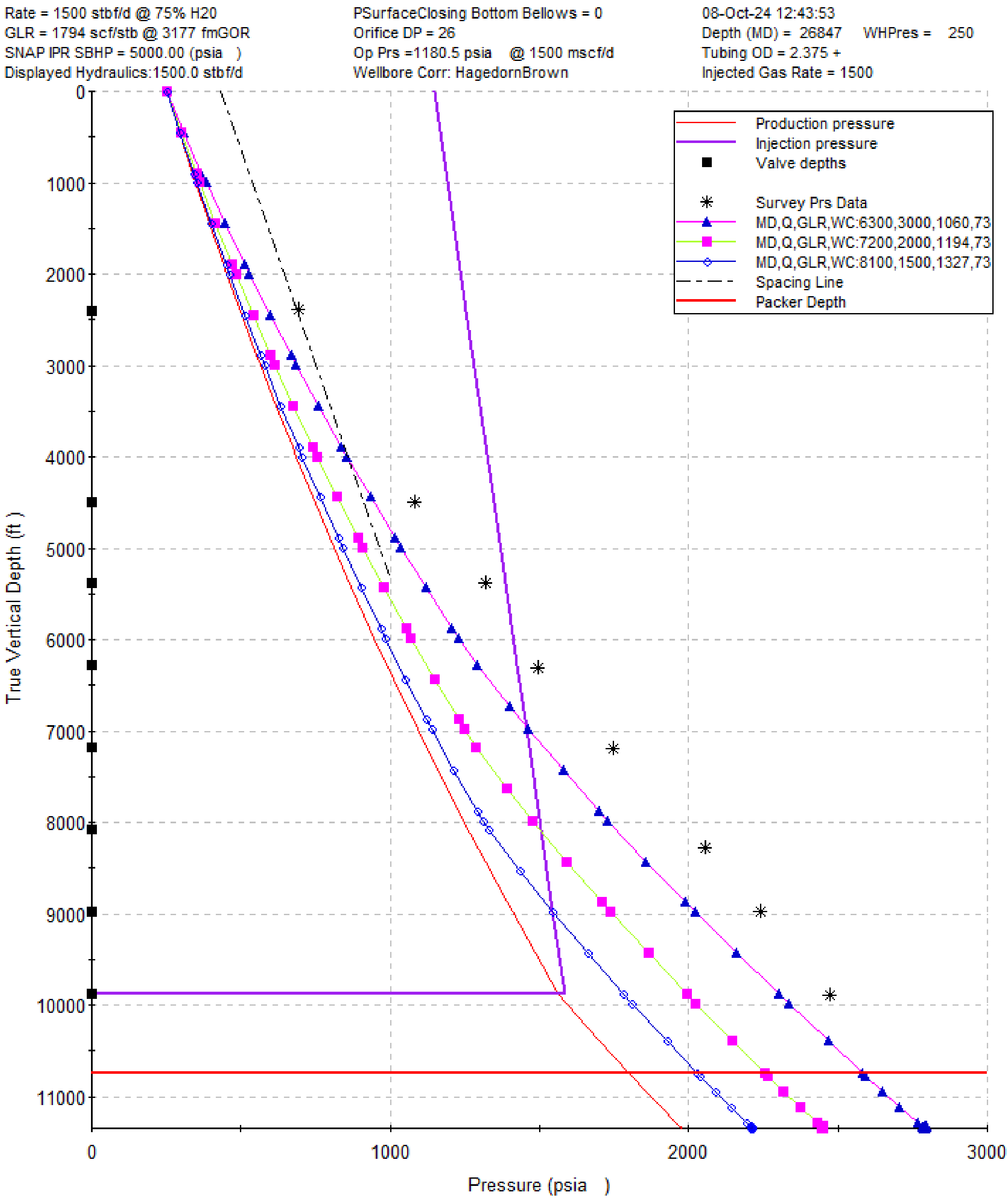

Figure 2. Annular Flow Reduced Rates (2-3/8" Tubing / 5.5" Casing)

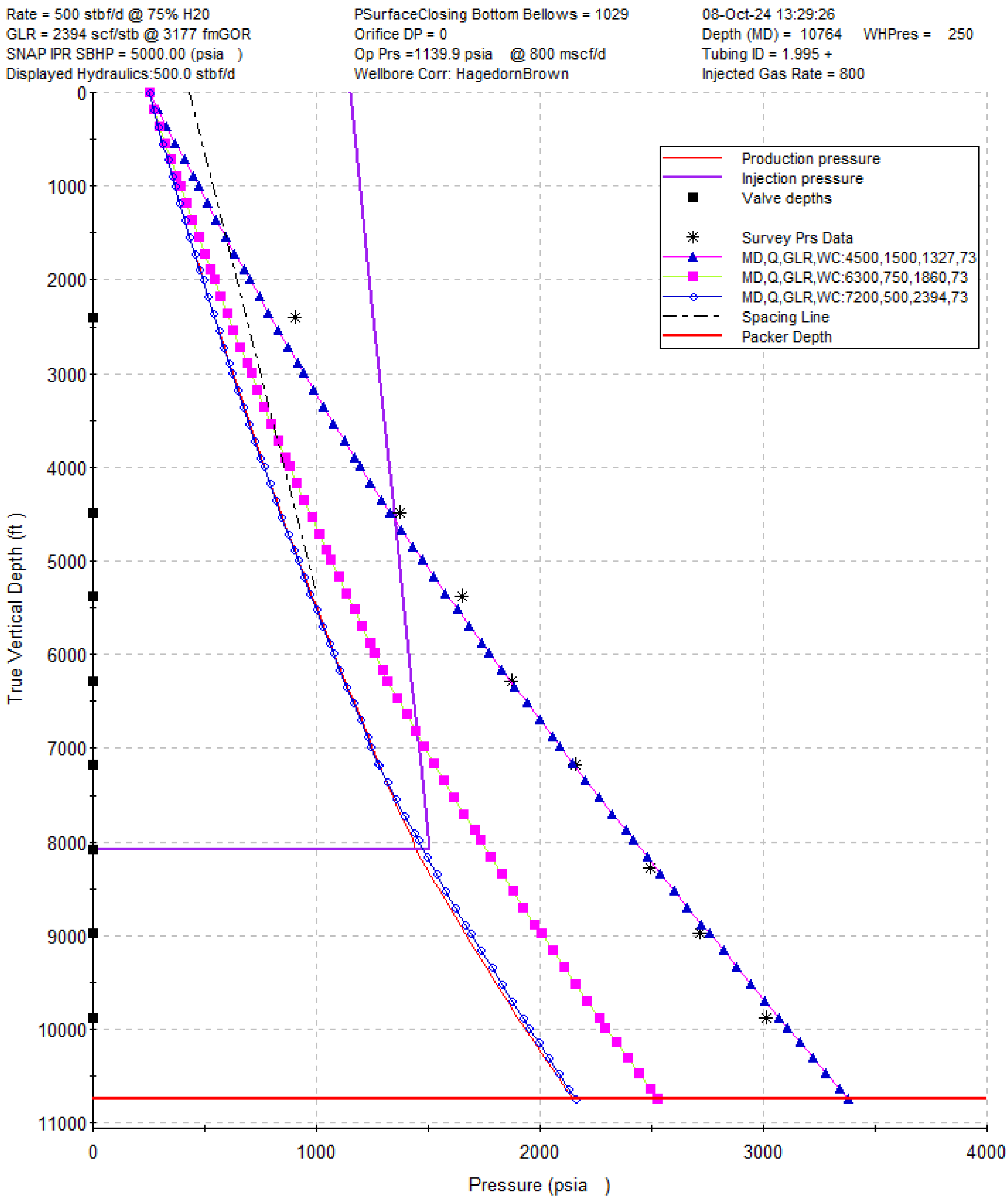

Figure 3. Tubing Flow Reduced Rates (2-3/8" Tubing)

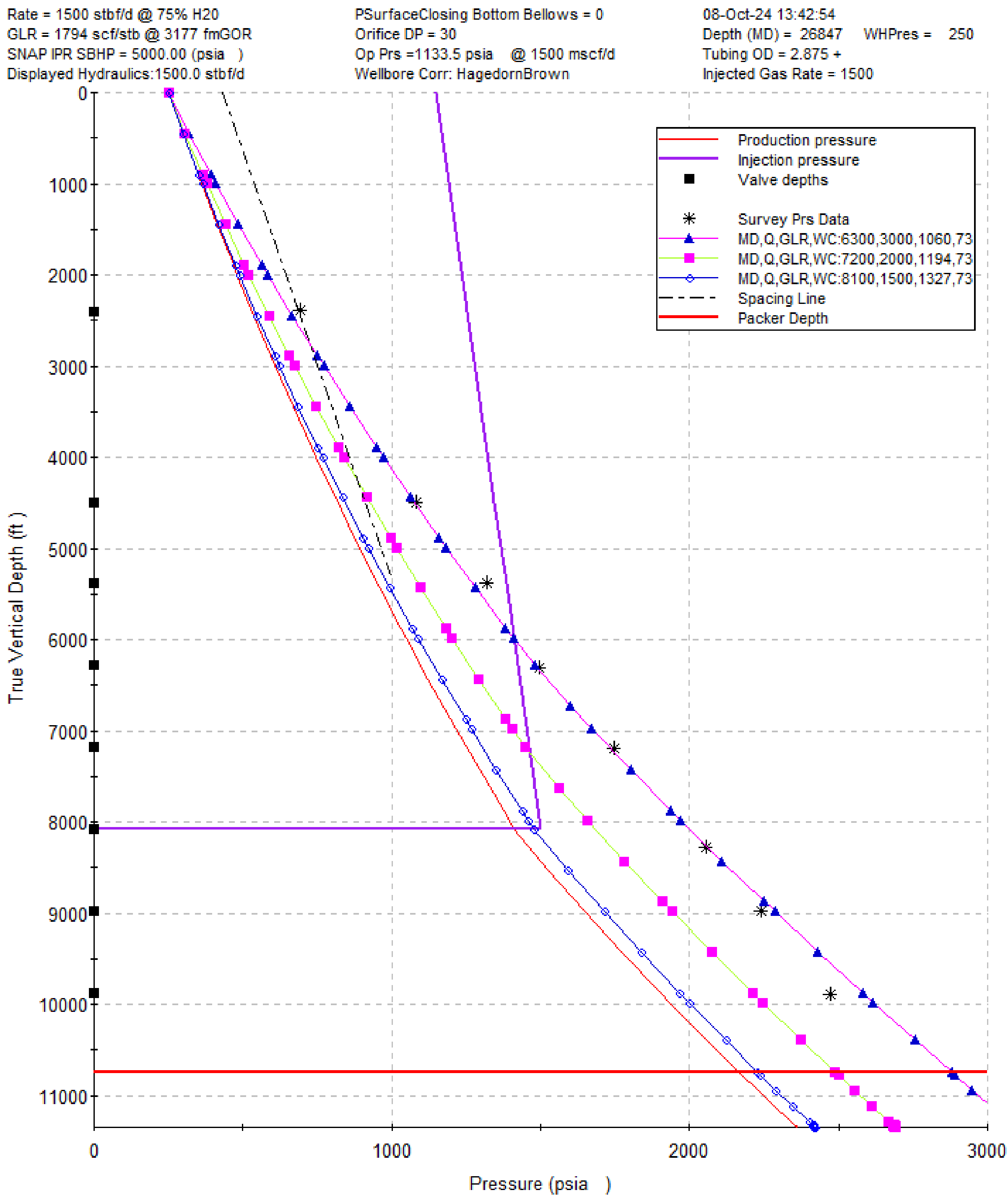

Figure 4. Annular Flow Reduced Rates (2-7/8” Tubing / 5.5” Casing)

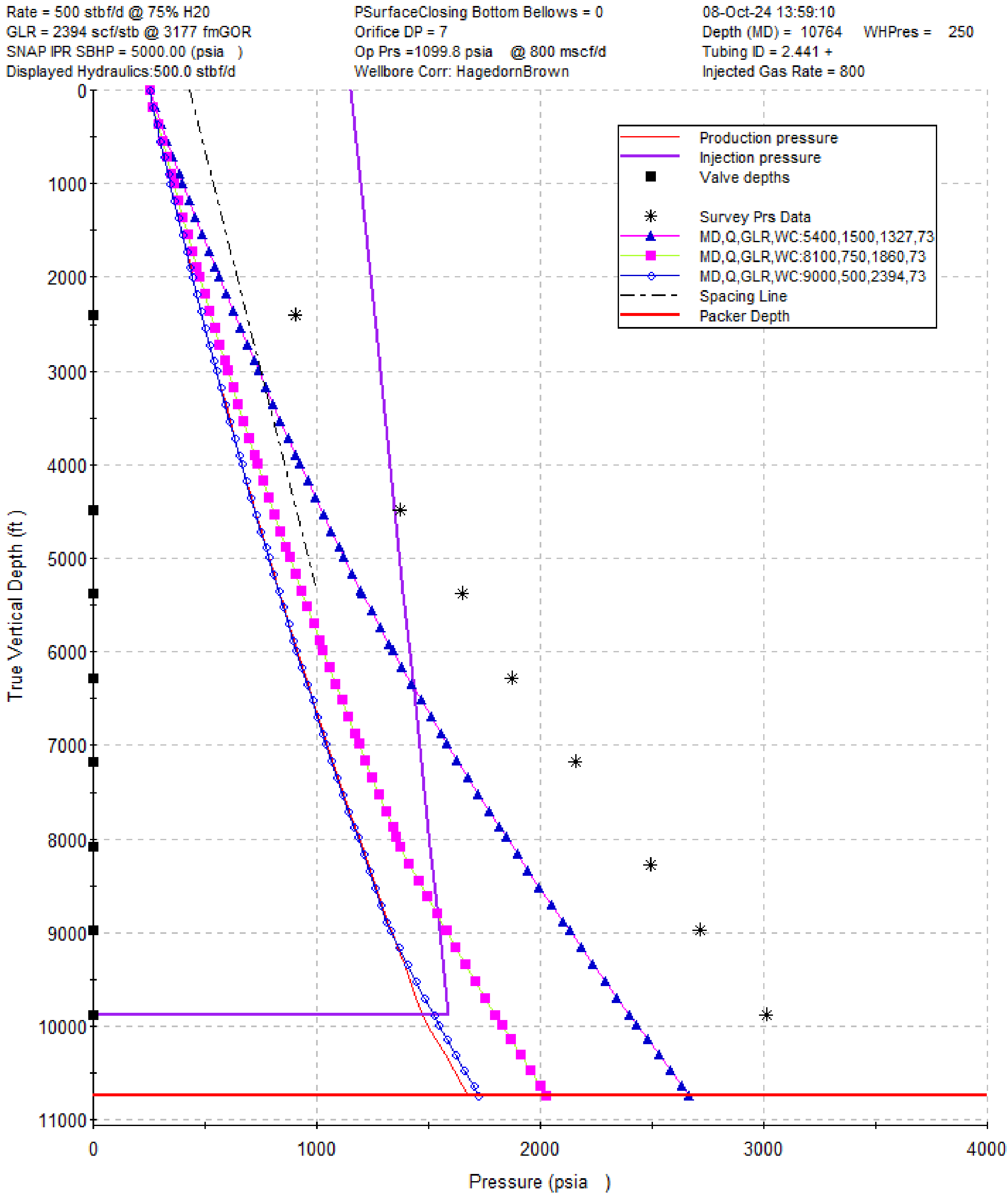

Figure 5. Tubing Flow Reduced Rates (2-7/8" Tubing)