

Flow Uncertainty Position

There are many parameters that determine the pressure and temperature distribution within the well.

The pressure and temperature distribution will determine the density, and this determines the elevation head. The flow rates along with the density determine the flowing pressure drop. The frictional flow pressure drops in the various sections of the well geometry (away from the very top and the inlet) are small. There must be extra flowing pressure drops to result in the measured pressure below the BOP. It is well known that there is some pressure drop due to the extraction of fluids from a porous medium. This is often called the well draw down. There is also a pressure drop due to the flow entering the well, which is often referred to as skin. In our case we might assume that skin is large since an intact concrete plug is supposed to exist. However, since the well is flowing, we might assume that this plug has failed.

Two cases are often proposed to obtain a calculated match to the BOP pressure. These are the deep choke (well drawdown and skin) and the shallow choke (flow past a hanger near the top of the well). We have a single pressure measurement, so a variety of resistance pairs can yield the correct BOP pressure.

It is conceded that the deep choke resistance cannot be zero, and one can estimate from the porosity measurements a minimum value for this parameter. Often it is assumed that the shallow choke is zero. This allows for a single value for the deep choke to match the BOP pressure.

The resistance at the top of the annulus flow past the hanger is unknown. It is stated that if the hanger has risen 6 inches, it will not provide much resistance. However, we do not know if it has risen at all.

The geometry of the flow is also unknown. Is it up the annulus, up the well bore, or both. The concrete plug was made in a single pour, and it was supposed to block flow from the reservoir to either path. It is possible that the plug never set up, and there is communication between both paths at the bottom of the well. Often the flow is considered to flow up one path or the other. The combined case just introduces too many more parameters required to determine the flow split.

Current observations have revealed that the drill pipe that was known to exist in the well has slipped from its last known position. We are told that it is at least 900 feet lower. This is not a definitive statement. It could extend down even farther.

We were previously told that the shears have operated and the result is a clean cut with little deformation of the ends allowing an easy exit from the drill pipe. Current observations of the plume out of the cut off riser reveal two distinct colors. This is consistent with the distinct colors out of the kink holes previously. This implies that there are two distinct flow paths through the BOP. Possibly the shears may have not completely sliced the drill pipe, and complete mixing of the drill pipe flow and the BOP annular flow has not occurred.

We have been told that diagnostic tests reveal that there is some flow through the BOP annulus. The visual observations of two color flow indicates that the two paths are nominally the same in magnitude. Again, the split in flow requires a model.