ADVANCED VARIABLE FREQUENCY DRIVE CONRTROL: OPTIMIZATION AGAINST INCOMPLETE FILLAGE

ABSTRACT

Incomplete fillage conditions where the downhole pump does not completely fill up with incompressible liquid has been widely accepted to have detrimental effects on pumping efficiency and moreover the equipment longevity in sucker rod pumping applications. Methods of synchronizing the pump displacement to the wells inflow and thus reducing incomplete fillage has been of keen interest to the industry. During operation, surface sensors are used to monitor polished rod load and position to obtain a surface load vs position graph. Concurrently, a pump load versus position graph is generated by solving the 3-D wave equation for deviated wells in the diagnostic mode. Pump fillage is computationally detected with a mathematical algorithm that accurately estimates the traveling valve close (TVC), standing valve open (SVO), standing valve close (SVC) and traveling valve open (TVO) points in the pump dynamometer card. A sophisticated pump off control (POC) algorithm called Advanced Fillage Mode (AFM) with a continuous feedback mechanism is then implemented to significantly reduce incomplete fillage pumping cycles using a variable frequency drive (VFD) for speed control. AFM accepts the pump fillage set point, maximum SPM, and the minimum SPM as the three operational parameters. AFM continuously monitors the pump fillage, compares the pump fillage on each stroke to the fillage set point and dynamically adjusts the SPM of the well to maintain pump fillage near the fillage setpoint. This synchronizes pump displacement to the inflow of the well. Additionally, various versions of AFM are available depending on the tolerance for incomplete fillage. In pumped-off or near pumped-off situations, the tolerance for incomplete fillage is very low. Whereas, in cases with fluid level above the pump where incomplete fillage manifests itself as gas interference, one may have a higher tolerance for incomplete fillage to pump the fluid to the surface. A calculated “Fluid Level Above Pump” (FLAP) parameter is available where a user may select the FLAP threshold for controller bias. AFM is an intelligent algorithm that determines its key pump off control parameters such as the rate of SPM increments, rate of SPM decrements, observation cycles and stoppage time automatically. Additionally, AFM uses a continuous feedback strategy to continuously optimize the operational variables based on the well’s performance. We will present several before and after case studies to demonstrate the advantages of using AFM.