Abstract

In modern hydraulic stimulation operations, a key focus for operators and service providers is operational efficiency. While there are many factors that can affect operational efficiency, along with many ways to measure it, most agree that non-productive time (NPT) due to equipment failure is a major barrier to efficiency gains. A key element in delivering hydraulic stimulation is the flow path between the hydraulic pump spread and the wellbore. A failure on this path results in significant impacts to the delivery of the hydraulic stimulation service in terms of cost overruns and increased safety risks.

In recent years, specially designed valves have been incorporated into frac trees. The frac trees are typically connected to the wellhead via a flanged seal connection, and to the pump spread via temporary iron works. While the temporary iron works are a notoriously weak link in the system, they are easily replaced when they fail, resulting in a low incidence of NPT. The frac tree itself is much more complex and it is in this area that significant NPT frequently occurs. Eliminating NPT associated with the frac tree is a complex process that is essential to efficient operations.

This paper describes the mechanisms used to evaluate wear points in the design of these systems, the methodologies used to mitigate and eliminate the causes of NPT in the frac trees and the processes used to validate the programs. Case histories are presented, with a detailed examination of the issues and solutions.

Introduction

With the advent of large-scale fracturing operations, wellhead equipment has undergone an evolution in design as the systems have been tasked to cope with an aggressively corrosive and abrasive service life well beyond the original design parameters. As the shale plays have become more mature in their life cycle, a major drive to reducing cost by increasing efficiency of operations has driven the visibility of every operation that affects the ability of the pump spread to operate.

When looking at the capital expended during fracturing operations, the majority of the cost is incurred with the pump spread. Any downtime associated with that large asset is directly associated with high costs. Typically, on a single well, additional pump units are deployed over and above the needed capacity to mitigate the risk of a single pump failure. As a result, if one pump fails, the fracturing operations continue, often seamlessly. Where there is inherent weakness in the system is between the rear of the pump manifold (missle trailer) and the permanently installed wellhead. This represents opportunity for single-point failure that will shut operations down until appropriate repairs are made. Failure in this flow path, therefore, has a disproportionate cost compared to the cost of the equipment and services that maintain the flow path.

The components that make up the flow path are described below, and as they are all pressure containing, there also is an inherent safety aspect to failure. Secondary controls such as concrete blocks or Kevlar straps are used to restrain flow iron in case of catastrophic failure. The fracturing tree components themselves are not restrained, relying on design integrity to prevent catastrophic failure.