MONITORING, DIAGNOSING AND OPTIMIZING GAS LIFT OPERATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Non-Provisional U.S. Application Ser. No. 13/711,815, titled "Monitoring, Diagnosing and Optimizing Gas Lift Operations" and filed December 12, 2012 by M. M. Querales, M. Villamizar, G. Carvajal, R. K. Vellanki, G. Moricca, A. S. Cullick and J. Rodriguez, which claims priority to Provisional U.S. Application Ser. No. 61/678,069, titled "Monitoring, Diagnosing and Optimizing Gas Lift Operations" and filed July 31, 2012 by M. M. Querales, M. Villamizar, G. Carvajal, R. K. Vellanki, G. Moricca, A. S. Cullick and J. Rodriguez~~, which is incorporated herein by reference~~.

BACKGROUND

Oil field operators dedicate significant resources to improve the recovery of hydrocarbons from reservoirs while reducing recovery costs. To achieve these goals, production engineers both monitor the current state of the reservoir and attempt to predict future behavior given a set of current and/or postulated conditions. The monitoring of wells by production engineers, sometimes referred to as well surveillance, involves the regular collection and monitoring of measured near-wellbore production data from within and around the wells. Such data may be collected using sensors embedded behind the well casing and/or from measurement devices introduced into the well with the production tubing. The data may include, but is not limited to, water and oil cuts, fluid pressure and fluid flow rates, and is generally collected at a fixed, regular interval (e.g., once per minute) and monitored in real-time by field personnel. As the data is collected, it is generally archived into a database.

In addition to monitoring conditions within the well, the systems used to lift produced fluids to the surface are also monitored. Such monitoring ensures that the systems are functioning as close to their optimal operating point as possible or practical, and that failures are detected and resolved promptly. One such type of system used is a gas lift (GL) system. Mandrels of the GL system are generally mounted along the production tubing and lowered into the well's production casing together with the tubing. Gas is introduced into the annular region between the casing and the tubing under pressure, and valves positioned along and/or

within the mandrel allow the gas to be introduced into the fluid flow within the production tubing. GL systems help lift the product to the surface by reducing the density of the fluid (and thus the downhole pressure), which accelerates the movement of fluids from the formation through the perforations in the casing and up the production tubing.

Downhole sensors, if installed, collect and transmit data to the surface (e.g., via cables to the surface and/or wirelessly). The data may include, but is not limited to, injected gas lift pressure and temperature, and produced fluid pressure and temperature. Although the data provided enables monitoring of the performance of a GL system, determining the underlying cause of a failure or a variation in the performance of GL system is a more complicated task. A given GL system failure or performance variation can have numerous causes and operators strive to identify the cause of such issues quickly to reduce any resulting downtime or reduced production. While experienced petroleum/well surveillance personnel may rely on their personal experience to diagnose and resolve such issues, a more automated approach based on a broader information base offers the possibility of diagnosing issues and providing more optimal solutions in a shorter period of time.

SUMMARY

According to an aspect of the present invention, there is provided a method for monitoring, diagnosing and optimizing operation of a gas lift (GL) system that comprises: collecting measured data representative of a state of a GL system within a well, and further storing the measured data; comparing the measured data to calculated data generated by a model of the well; identifying one or more likely conditions of the GL system based at least in part on mismatches between the measured data and the calculated data; updating the well model to reflect the one or more likely conditions and one or more selected corrections to the one or more likely conditions; generating a plurality of GL system performance curves using the updated well model; and presenting to a user one or more actions recommended to achieve a GL system performance consistent with a GL system operating point on at least one of the plurality of GL system performance curves.

According to another aspect of the present invention, there is provided a gas lift (GL) monitoring, diagnosing and optimizing system that comprises: a memory having GL system monitoring, diagnosing and optimizing software; and one or more processors coupled to the memory, the software causing the one or more processors to:

collect measured data representative of a state of a GL system within a well, and further store the measured data; compare the measured data to calculated data generated by a model of the well; identify one or more likely conditions of the GL system based at least in part on mismatches between the measured data and the calculated data; update the well model to reflect the one or more likely conditions and one or more selected corrections to the one or more likely conditions; generate a plurality of GL system performance curves using the updated well model; and present to a user one or more actions recommended to achieve a GL system performance consistent with a GL system operating point on at least one of the plurality of GL system performance curves.

According to another aspect of the present invention, there is provided a non-transitory information storage medium having gas lift (GL) system monitoring, diagnosing and optimizing software that comprises: a data collection and storage module that collects measured data representative of a state of a GL system within a well, and further stores the measured data; a comparison module that compares the measured data to calculated data generated by a model of the well; a condition identifier module that identifies one or more likely conditions of the GL system based at least in part on mismatches between the measured data and the calculated data; a model update module that updates the well model to reflect the one or more likely conditions and one or more selected corrections to the one or more likely conditions; a performance curve module that generates a plurality of GL system performance curves using the updated well model; and a recommended action module that presents to a user one or more actions recommended to achieve a GL system performance consistent with a GL system operating point on at least one of the plurality of GL system performance curves.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the various disclosed embodiments can be obtained when the following detailed description is considered in conjunction with the attached drawings, in which:

FIG. 1A shows a production well that sources measured well and gas lift (GL) system data.

FIG. 1B shows a simplified diagram of an illustrative GL system.

FIGS. 2A-2D show illustrative user interface displays for monitoring, diagnosing and optimizing GL operations.

FIG. 3 shows an illustrative data acquisition and processing system suitable for implementing software-based embodiments of the systems and methods described herein.

FIG. 4A shows an illustrative GL system monitoring, diagnosing and optimizing method.

FIG. 4B shows an illustrative GL operations task ticketing method that works in conjunction with the illustrative GL system monitoring, diagnosing and optimizing method described.