Chapter 7
Risk Analysis of Completion and Production Systems

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ABSTRACT

A variety of definitions are available through the literature, but the universal one is in defining the well completion as the optimal path for the reservoir fluids to be produced. That means to achieve a desired production with minimal costs. Wells represent the greatest part of expenditure when developing the reservoir. For a long period of time it was defined to be simple, reliable, and safe with enough flexibility to allow future operations. Nowadays, so called "intelligent completions" appear to give more financial benefits, flexibility, and control. The reliability of system components is essential for long-lasting production. In addition, the differences according to natural flowing well risk and artificial lift are given.

INTRODUCTION

The optimal well completion minimizes initial and overall cost according to production completion, while providing the optimal path for reservoir fluid to reach the surface. When designing the completion of an production well many circumstances should be encountered. The completion must balance the factors related to (Patton & Abbott, 1979) environment, constraints, and resources. The aim of the design is to decide about intervals of the reservoir to be completed, completion method, number of completions in the

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well, casing and tubing configuration and size, perforating considerations etc. So the optimum production (injection) performance include safety by providing the means of production interruption or control restoration in controlled or emergency situations (Peden & Leadbetter, 1986). The integrity of the system and reliability of the components must allow long lasting production with little need for intervention. Because everything is subject of the economic evaluation, the associated costs of initial completion, production costs, and workover and remedial operations and stimulations should be encountered. To obtain optimal completion design there is a need of well performance prediction, than the perforating procedures and equipment are selected, servicing fluid specified and production string and its components as well, and completion sequence and running procedures elaborated. Completion design is influenced by several parameters. They are related to the determined well purpose, dependent on the environment (e.g. land, off-shore), drilled hole diameter, reservoir properties, production characteristics and possibilities and available completion techniques. Much more it is necessary if desired to enable borehole wall stability, selective production from different layers, create minimal pressure drop due the fluid flow, enable the adjustment of flow rate, and allow needed operations and measurements without a need for workover and over all to ensure the well safety. To achieve optimal completion design the prediction of well performance is of interest (now and changes in the future) (Economides, 1998). The well servicing fluid with concern to compatibility with formation rocks and formation fluids is the next factor in the loop. Specification of perforating equipment (retrievable, non-retrievable, tubing conveyed), procedures (underbalanced or overbalanced) and perforations density and spacing impact the inflow performances. Tubing and other down-hole components have to satisfy according the flow optimization, mechanical properties (three-axial stresses) and overall reliability. The specification of the completion sequence and the running procedures are also implemented in the iteration design process, to be in position to consider all eventualities. The design quality depends on the available data. Such data are of two kinds: (1) quantitative data are based on reservoir condition and well parameters and changes can be recalculated and (2) qualitative data are based on the individual or company experience. Data can be grouped according to the scope. Those talking about well objectives and reservoir parameters include well path data, casing program, reservoir depth and thickness, fluid contact zones, reservoir initial pressure and temperature, maximal production rate, well fluids composition and properties and flowing bottom-hole and tubing head pressure. Initial completion and workover data should include the well history, equipment failure records, perforating conditions and servicing fluid characteristics. Completion equipment data specify tubing properties, perforating equipment weight and gun outer diameter and length due the tubing clearance. All other parts of the down-hole equipment should also satisfy material manufacturing requirements, with inner diameters (due to flow restrictions and mandrel seating) and setting position (depth, sequence etc.). Due the change of formation fluids properties when flowing up the tubing, there is also the necessity of determining the depth of wax, hydrate or scale formation if any. Corrosion problems are also strongly related to changes with depth and temperature. Finally clay swelling and wettability changes can appear due the completion or workover works.

From the production point of view, safety is a top concern. Whatever the way of production is applied (naturally flowing well or some

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