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Strategies for Selection of Artificial Lift System for Deviated gas wells

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Abstract: Various artificial lift system is used in inclined gas wells. Almost all the methods were acquired and developed from those employed in oil wells. This study demonstrates a methodology to define the most adequate artificial-lift technique based on technical limitations, a suitability coefficient and economic analysis towards deviated well configuration.
Keywords: Artificial lift, Attribute, Screening, Weighting factor, Economic analysis.

I. INTRODUCTION

The objective of the Artificial Lift System (ALS) in gas wells is to remove liquid from the wellbore, which is named as deliquification. The deliquification technique can be categorized into two types, Active system and Passive system. Active system is used when the reservoir is depleted and it includes Sucker rod pump, Progressive cavity pump, Electrical submersible pump, Jet pump and Wellhead compressors. Passive system is used when the gas velocity is insufficient to carry liquid naturally from the wellbore but sufficient reserve remains in the reservoir and it includes velocity strings, plunger lift and foam lift [1-6].

II. RECOMMENDED GUIDELINES

The development of the recommended guidelines depends on physical limitations of each artificial lift systems, well and field constraints and a quantitative appraisal of the attributes involved. Three main screenings are performed in the decision-making process. The first screening is based on ALS's limitations such as depth, flow-rate changes, requirement of gas and pressure, well-integrity effects and field conditions. The first screening eliminates the inapplicable methods and allows applicable methods. The second screening depends on an attribute table that assigns a score for each attribute considered. In this screening, an average suitability factor is calculated for each feasible artificial-lift operation and the artificial-lift methods are ranked. The third screening is an economic assessment of the methods being evaluated. The Net Present Value (NPV) and other parameters are estimated in this screening.

III. TECHNICAL LIMITATIONS OF METHODS

To execute the main goal of the first screening, various parameters need to be considered, which aids in rule out the unsuitable methods and render a list of remaining methods that can be eligible for implementation. The systematic plan is to define simple rules to carry out the elimination process. These rules include limitations listed in typical-attribute tables, quick calculations, common reasoning when selecting on ALS and typical "rules of thumb" based on experience for specific field conditions.
The working module is based on an aggregation of logic rules in the form of if/then/else statements, such that the "if" part is referred to as the "condition" and the "then" part is referred to as the "feasibility" of an ALS. In this case, it will indicate if the ALS is applicable for the condition being evaluated.

A. Attribute Table

The main process in the second screening is based on an attribute table. The quantitative and qualitative attributes are evaluated by allotting a suitability score to each, based on the effect they have on the ALS performance. This process includes identification of key attributes, building of attribute matrix for technical comparison, defining simple attribute scoring and weighting factors, assigning attribute scoring and ranking the ALSs by calculating a suitability factor.

B. Identification of Attribute

The following are the identified key factors which influence ALS selection for horizontal gas wells.
For well conditions and geometry,
Well depth – shallow (< 7500 ft) or deep (> 7500 ft)
Wellbore deviation angle
Lateral orientation (toe up, toe down, and hybrid or undulations)

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Presence of sump
Maximum dogleg severity
Casing size
Dual completion

For production conditions,
Liquid production – high (> 200 bpd) or low (< 200 bpd)
Bottomhole pressure (BHP)
high (> 3000 psi),
medium (2000 psi < BHP <1000 psi),
low (< 1000 psi)
Gas/liquid ratio (GLR) – high (GLR> 5000 scf/STB) or low (GLR< 5000 scf/STB)
Fluid characteristic – high-viscosity fluid
Fluid characteristic – sour (presence of H_2S)
Production-problem handling – solids
Production-problem handling – corrosion
Production-problem handling – paraffin
Production-problem handling – scale
Intermittent-flow handling
Adaptability to reservoir depletion

For field conditions,
Developed
Remote
Power condition (poor or good)

For cost and performance,
Reliability
Installation cost
Operating cost
Twenty-four attributes were defined in accordance with the most-influential parameters, for an engineer while selecting the ALS.

C. *Defining the Attribute Scoring and Weighting Factors*

A suitability coefficient was assigned to each of the attributes to build the base score. Furthermore, a weighting score was assigned to each attribute. By using both the parameters, weighted geometric mean is calculated. The weighting factors are estimated values, indicating the relative importance or effect of each attribute in the group compared with the other attributes in the group. The intention of using weighting factors is to establish priorities in the most influential factors in the overall performance rating.
Taken in account of the published field data and ALS limitations evaluated through various literature sources, a matrix with scores assigned to each of the attributes has been proposed. By following the guidelines below, the weighting factors are assigned:

1) For all attributes, a value from 1 to 10 is assigned, which gives the significance of the attribute. A rating of 1 indicates "not important in the selection process", 5 represents that is "important" and 10 means it is "very important in the selection process".
2) An attribute should not be considered, if it is rated as 0.
3) Normalization to 100% shows the contribution of the factor in the overall average.

D. *Suitability Factor*

The weighted geometric mean is suggested to calculate the suitability factor. This has not been used before in ALS selection processes. The advantages of using weighted geometric mean are as follows:

1) Increasing or decreasing the relative importance of the attributes introduces flexibility in customizing the selection process according to company strategies and priorities.

2) Increased sensitivity in ranking of the options better reflects the case when one attribute score is equal to a very small value and cannot be compensated for by the other attributes. This gives significance to small score values in the overall rating.

IV. ECONOMIC ANALYSIS

The economic analysis is a systematic way to identify the most profitable ALS by comparing suitable options. Various economic indicators such as monthly value, NPV and payback period are used to calculate the economic performance of a project. The life span of unconventional resources is short, so the annual value analysis is converted to monthly analysis to consider a more appropriate time scale. The cost, production and parameters are necessary input for economic comparison. The evaluation considers uncertainty through range or scenario analysis: pessimistic, most likely and optimistic. Gas price, Natural-gas-liquids price, Oil price, Production data and Cost data are the parameters with uncertainty. The economic analysis is mandatory in any decision-making process, in which the project profitability plays an important role.

By reviewing the feasibility and functionality of the different ALSs, Cost and Profitability needs to be performed before selecting the method.

V. CONCLUSION

The Methodology demonstrated here comprising three stages to get in the final ALS recommendation. The first stage consists of the logical rules that are based on field experience, engineer's expertise and ALS limitations. The second stage consists of attributes affecting the ALS, with the corresponding score and weight in an attribute table. The final stage consists of an economic evaluation.

The suggested methodology offers the following benefits when screening for the different deliquification techniques:

A. A list of suitable ALS options that can be used is created.

B. Tracking and reporting unsuitable options and reasons for elimination allow the engineer to analyse the current constraints in the unsuitable methods and modify the limits if needed.

C. Comparison and ranking among the suitable methods can be achieved through the attribute technical matrix which makes the selection easier.

D. The score assigned indicating the applicability of the method under the specific attribute can be modified according to the experience of the engineers. Also, the relative importance of the attributes can be modified by providing weighting factors.

E. Well productivity is the key factor while selecting the ALS. The economic comparison is performed to provide insights into which method would be economically favourable.

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