



ASW ENGINEERING MANAGEMENT CONSULTANTS

June 14, 2011

To: Steven Long, Pierre Landry, Rich Pulliam, Cassie Cuaresma
SCE

From: Dennis Rowan, PE
ASW Engineering

Re: Investigations of Energy Efficiency Measures and Industry Standard Practice (ISP)
[Long Stroke (Rotaflex®) Pump Project ISP-0008]

Dear Steve, Pierre, Richard, and Cassie,

ASW recommends that SCE considers that this new construction project is not industry standard practice for the well conditions described in the application.

PROJECT DISCUSSION

The application lists 4 well pumps to be installed as new units with long stroke units that are to produce 350 barrels per day at a depth of 9,000 feet. There are no baseline pumping systems installed so the calculations are based on theoretical baseline units that operate at an assumed efficiency of 45%. The new systems are proposed to operate at 60% efficiency and these two efficiencies are the basis of the savings calculations.

There are benefits to the long stroke unit in addition to energy savings. The long stroke unit reduces wear on the pump components as a result of the longer stroke, which results in a longer interval between well work-over incidents (down-time to overhaul the well/pump components). The increase in production due to the longer interval between well work-over(s) appears to be a driving force in the decision to install this technology.

The project application indicates that the target wells are all 9,000 foot deep and producing 350 barrels of fluid per day. Since the long stroke system is proposed to be installed as new load, in a new well, the projected well conditions are used to determine the best pumping system.

As an industry-wide application, the long stroke unit is not industry standard practice. Rod-beam pumps remain the typically installed pumping system by volume of installations. The long stroke units are typically installed on deeper units with higher flow rates since the conventional units do not perform adequately at substantial depth. There are additional measures that can improve conventional unit performance for cases that may be borderline in terms of depth or flow or both.

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METHODOLOGY

ASW contacted a representative of Weatherford international who manufactures long stroke pumping systems under the Rotaflex[®] trademark. The respondent indicated that the long stroke units produced stroke lengths up to 366 inches while conventional systems were limited to 216 inches. She also stated that these units were higher efficiency and provided lower operating costs. They are ideal for higher capacity wells, greater than 5,000 barrels per day, and deep wells, greater than 2,000 feet deep. The information provided by the respondent indicates that the long stroke units provide more flow than conventional units with greater efficiency and less maintenance when installed in these deeper wells. The respondent also indicated that the industry manufacturers very few long stroke units annually when compared to conventional unit production.

ASW also contacted a representative from Occidental Petroleum Corporation. The respondent stated that his company uses the long stroke units and they are very pleased with the results. Since implementing them into their fields, their rod reversals, periodic maintenance, is significantly reduced. They look at long stroke units in wells where the depth is 5,000 feet or greater, where there is a high capacity well, or where maintenance is high. They are experiencing significant energy efficiencies as a result of these units. Their company has installed approximately 40 long stroke units on wells that produce 800 barrels per day and they have 2,800 conventional systems on lower producing wells that are at depths less than 5,000 feet. The comparable unit would cost around \$140,000 for a conventional and \$250,000 for a long stroke unit. This company also uses 100 electric submersible pumps in wells that are high volume which are up to 3,000 barrels per day, and they also use hydraulic jet pumps in some of their high flow wells.

ASW then contacted a representative from Chevron to inquire about their use and views on long stroke units. The respondent indicated that they use long stroke units on deeper wells or on shallow wells that are higher capacity than the conventional systems produce. The indication was that these units were being installed based on a case by case basis. Each well is evaluated to determine the appropriate pumping system.

ASW also contacted a representative from an evaluator of oil field options that provides the industry with installation options when they are installing new wells or replacement options for their existing wells. The respondent indicated that even the deeper wells with higher wells are candidates for conventional units, and that the long stroke units are only an alternative. The respondent further stated that with proper management of surface and subsurface equipment, the long stroke units do not offer substantial reductions in well failure rates. The respondent also contended that a correctly sized, balanced, and operated conventional beam style unit is extremely efficient. Additionally, for the well in question, 9,000 feet and 350 barrels per day, conventional technology would be suitable to install.

ASW also reviewed a series of studies on artificial lifting systems. One 2007 study define three main types of systems as Progressive Cavity Pumping (PCP), Electric Submersible Pump (ESP), and Rod-beam Pump (SRP). Long stroke and conventional are grouped into the SRP category. These three types represented 98% of the population of the study. The study indicates that the long stroke units are placed alternatively to conventional units in deep wells or high flow conditions. The EPS units are placed in the deeper wells that have even higher flow rates. Another 2007 study looks at the energy efficiency of the various pumping systems and finds that long stroke units can save between 20% and 50% of the energy used by EPS or conventional units. That same study finds that to operate at these efficiencies, the long stroke unit needs to operate near full load. An additional 2001 field study found that well operating costs were reduced by approximately 50% when the well was converted from an ESP to Long-Stroke unit. Finally, ASW reviewed a 1999 study wherein the primary benefits of the long stroke units came from the increased fluid production, lower energy consumption, and higher pump efficiencies which lead to longer pump life and lower maintenance costs. One particular study

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reviewed indicated that the length of the interval between well work-over(s) was increased by a factor of ten (from 60 days to 600 days).

ASW presents the following matrix of factors for your consideration regarding the Long Stroke Pump project:

Table 1: Factors indicating Industry Standard Practice

Factors Indicating Industry Standard Practice	Significance (1 – 3) 1=low, 3=high	Significance Explanation
The decision to install a pumping unit is made based on well conditions, known or projected.	2	The right pump system is chosen for the well. This technology is mature.
Long stroke units are applicable to a limited population of wells.	2	When a candidate well is evaluated, the results of the evaluation determine the unit chosen.
Conventional units are placed in wells where the conditions support the installation of conventional system technology.	2	The industry places conventional units wherever they are functional enough to meet production and maintenance targets.
The project wells are 9,000 feet deep which are typically not good candidates for conventional systems.	2	It is unlikely that conventional will be chosen for this depth, and EPS is used for higher flows.

Table 2: Factors indicating Non-Industry Standard Practice

Factors Indicating Non-Industry Standard Practice	Significance (1 – 3) 1=low, 3=high	Significance Explanation
There are overlapping well conditions that apply to multiple technologies.	2	Deep wells have choices and there are options.
The customer could install ESP units and the energy on-going costs would be significantly higher.	2	Conditions may overlap, but their overlap may be limited.
Energy savings are as much as 50% over EPS or conventional units.	2	If there is an overlap, the energy savings can be a deciding factor.
The customer could install convention units instead of long stroke units for these well conditions.	3	Since there are alternatives for this project, there is evidence that either technology can be used.
Conventional units can be made to operate at higher efficiencies with upgrades to components.	2	Upgrades are options to components within systems. Basic system design is not altered by these changes.

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The factors in Table 1 indicating the project is Industry Standard Practice (ISP) are outweighed by the factors in Table 2 indicating the project is not Industry Standard Practice. The primary consideration being that the customer could install either conventional technology or long stroke units for the proposed well conditions. While the depth tends to lean towards the long stroke units, the flow rates are low enough to include the rod-beam designs in the options for installation. If the flow rates were doubled or more, then the options may be limited to exclude the rod-beam units, but at 350 barrels per day, the option remains.

There are breakpoints where the different technologies apply exclusively, and there are zones where they overlap. If a well is in a discrete zone of non-overlapping conditions, then it may be considered ISP to install the technology designed for the conditions present. If the well is in a zone of overlapping conditions, then the ISP would be more difficult to ascertain and would likely default to the lowest cost alternative that meets the well conditions.

These types of applications may need to be evaluated on a case by case basis to determine the well conditions and whether those conditions fall within a discrete technology zone or within an overlap zone.

CONCLUSIONS

ASW recommends that SCE considers that this project is not industry standard practice for the well conditions described. Either rod-beam or long stroke technology could be installed for the project well conditions.

Dennis Rowan, PE
ASW Engineering