Failure Identification And Analysis of ESP Motors Used by PDO

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Abstract

Petroleum Development Oman (PDO) LLC has installed many electrical submersible pumps (ESPs) producing a substantial amount of crude oil. The ESPs are preferred compared to other gas lift methods because they are more efficient in managing wells and in producing more oil. In 2002, about 42% of PDO production is achieved by ESPs. ESP wells in PDO are representing about 29% of the all wells in Oman. In the next five years, PDO is planning to increase its ESP production up to 80% of total Oman's production. However, in the last decade, PDO has experienced several problems in ESP wells. The actual run life time of ESPs in PDO is between 2 to 2.5 years while at rated temperature it is expected to reach up to 15 years. Several factors contributed to ESP failures, which are classified as mechanical or electrical failures. These failures have a very high cost. The sources of this high cost can be summarized as follows: ESP's failure results in oil production losses or what is so-called "oil deferment" affecting the oil production revenue. Pulling out the motor from downhole requires mobilization of a rig, which has very high renting cost. This is also called "work over".

During normal switching operation of high voltage grid, transient overvoltages (TOV) are generated in the electric system. These repeated TOVs affect the aging of the winding insulation of the ESP motors causing premature failures. PDO has three capacitor banks which are good sources of TOV in the day-to-day operation. Moreover, starting and stopping operation of large motors in oil fields contributes significantly in the generation of TOVs. Although PDO ESP VI systems are protected against overvoltages by lightning arrester and Transient Voltage Surge Suppressors (TVSSs), it is not certain that these protections are performing well to protect the downhole motor and cabling. A computer model by PSCAD software was developed and used to simulate the effect of different factors for the generation of TOVs in the ESP system. The TOVs computed in this study were calculated at motor terminals. This simulation investigated all possible factors related to the TOVs which can influence the transient behavior of the ESP motor such as cable length, earthling resistance, cable parameters (insulation
permittivity and permeability), opening of the circuit breaker, switching via preinsertion resistance and, finally, the effect of the TVSS rating. A site visit to Jabel Ali’s Workshop and to Yibal Oil fields was also conducted. Historical data (weekly report) from Yibal and Al-Huwaisa field about ESP wells and about the Transient Voltage Surge Suppressors (TVSSs) were gathered and analyzed. Results of the analysis showed that about 34% and 56% of ESPs are without TVSSs at Yibal and Al-Huwaisa, respectively. About 17% and 24% of the TVSS devices in Yibal and Al-Huwaisa respectively, were with improper ratings. Moreover, two TVSSs were tested under impulse voltage in Sultan Qaboos University (SQU). The results showed that they can damp voltage down to of 57% of the transient voltage.