



# New correlations for predicting two-phase electrical submersible pump performance under downhole conditions using field data

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## Abstract

Electrical Submersible Pump (ESP) is one of the major Artificial Lift methods that is reliable and effective for pumping high volume of fluids from wellbores. However, ESP is not recommended for applications with high gas liquid ratio. The presence of free gas inside the pump causes pump performance degradation which may lead to problems or even failure during operations. Thus, it is important to investigate effect of free gas on ESP performance under downhole conditions. At present, existing models or correlations are based on/verified with experimental data. This study is one of the first attempts to develop correlations for predicting two-phase gas–liquid pump performance under downhole conditions by using field data and laboratory data. Field data from three oil producing wells provided by Strata Production Company and Perdure Petroleum LLC. as well as experimental data obtained from experimental facility at Production and Drilling Research Project—New Mexico Tech were used in this study. Actual two-phase pump differential pressure per stage is obtained from experiments or estimated from field data and was normalized using pump performance curve. The values are compared to pump performance curve to study the relationships between pump performance and free gas percentage at pump intake. Correlations to predict ESP performance in two-phase flow under downhole and experimental conditions was derived from the results using regression technique. The correlation developed from field data presented in this study can be used to predict two-phase ESP performance under downhole conditions and under high gas fraction. The results from the experimental data confirm the reliability of the developed correlation using field data to predict two-phase ESP performance under downhole conditions. The developed correlation using the laboratory data predicts quite well the two-phase pump performance at the gas fraction of less than 15% while it is no longer reliable when free gas fraction is more than 15%. The findings from this study will help operating companies as well as ESP manufacturers to operate ESPs within the recommended range under downhole conditions. However, it is recommended to use the proposed correlation on reservoirs with conditions similar to those of the three presented wells.

**Keywords** Electrical Submersible Pump · Pump performance · Free gas · Correlation

## Abbreviations

### Variables

n	Pump speed (RPM)
P	Pressure (P)
r	Radius (L)
SG	Specific gravity
TVD	True vertical depth (L)

### Subscript

cal	Calculated
dis	Discharge
elev	Elevation
fric	Friction
g	Gas
int	Intake
mea	Measured
o	Oil
sp	Single-phase
stage	Per pump stage
ti	Inner tubing
tp	Two-phase

### Greek letter

$\Delta$	Differential
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