

3. Artificial Lift

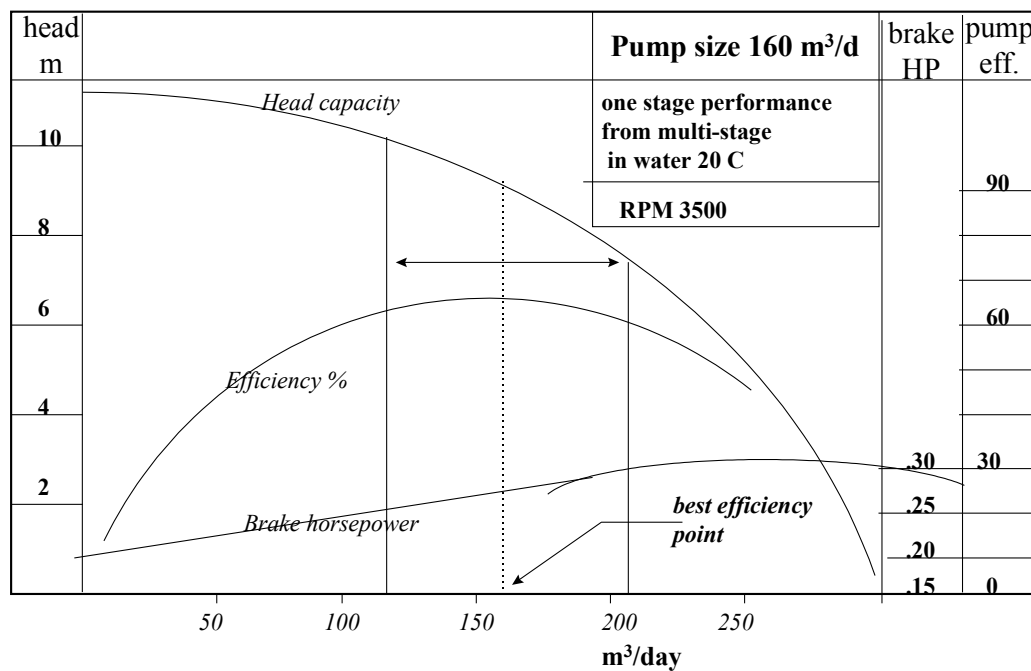
(a) It is planned to install either gas lift or an ESP in the following well, to achieve a production rate of 1000 bbl/day.

Depth	10000 ft
Watercut	0%
Tubing size	4½"
Tubing head pressure	500 psi
Reservoir pressure	2000 psi
Productivity Index PI	2 bbl/day/psi

What are the advantages and disadvantages of these two methods of artificial lift?

(b) If an ESP is installed at the bottom of the well, the required pressure at the outlet of the ESP is 2500 psi, in order to achieve the required tubing head pressure. Calculate the pressure difference that must be supplied by the pump at the planned production rate (1000 bbl/day).

(c) How many stages should the ESP have, based on the following performance curve.



(d) If instead gas lift is installed, the gas injection pressure on surface is 1000 psi. The fluid gradient is 0.4 psi/ft, the gas gradient 0.04 psi/ft and the flowing well gradient approximately 0.15 psi/ft. Determine the deepest point at which gas can be injected (i) without gaslift valves and (ii) with gaslift valves.

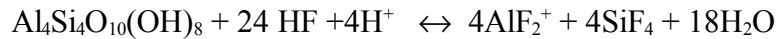
(e) The gaslift valves are adjusted to operate at a pressure 100 psi above the flowing well gradient. Estimate the setting depths and setting pressures of the first two valves.

4. Stimulation

(a) Explain the roles of the pre-flush, the main flush and the post-flush in matrix acidising

of sandstone formations.

(b) In a sandstone acidising treatment, the mud-acid is an HF/HCl acid blend, formed of 1.5% by wt HF and 13.5% HCl. One of the minerals present is kaolinite $\text{Al}_4\text{Si}_4\text{O}_{10}(\text{OH})_8$. Calculate the Volumetric Dissolving Power for HF for the primary reaction given by



The molecular mass of kaolinite is 516.4 and of HF 20. The density of the acid blend is 1070 kg/m^3 and of sodium feldspar 2800 kg/m^3 .

(c) What are the potential problems in pumping a pre-flush into such a long openhole interval. What does this imply about the volume you must pump?

(c) Prior to the mud-acid injection, a preflush of 15% HCl is used. The porosity of the sandstone is 0.25, and it contains 3% [by volume] of dolomite and 7% [by volume] of calcite (CaCO_3). The Volumetric Dissolving Power for 15% HCl with calcite is 0.082 and with dolomite 0.076. The wellbore has diameter 20 cm. The interval to be treated is an openhole interval of length 50 m. The HCl must remove all carbonates to a depth of 30 cm from the wellbore (over the whole of the openhole interval) before the mud-acid enters the formation. What is the minimum preflush volume in m^3 ?

(d) What are thought to be the reasons for failure in using mud-acid with high concentrations.