EFFICIENT GAS WELL DEWATERING WITH JET PUMPS AND DIAPHRAGM SURFACE PUMPS

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DISCUSSION

This discussion will be centered on the following topics:

History of jet pumps as used in the Oil & Gas Industry
Problems associated with early jet pumps and surface equipment
Details of new jet pump
How the new jet pump is being configured to unload liquid loaded gas wells
New types of surface pumps for jet pump power fluid delivery to the down hole pump
Case studies where jet pumps and diaphragm surface pumps were used

BASIC JET PUMP OPERATION

The basis of the theory is Daniel Bernoulli's Principle of using one fluid to move another fluid and using pressure differential to create a venturi.
The power fluid enters the jet pump and is pumped through the jet pump nozzle
As the fluid leaves the nozzle, we change from pressure to velocity.
This resulting venturi creates a suction at the pump intake drawing formation fluid into the jet pump housing and into the mixing tubed or throat.
The power fluid and formation fluid comingle in the mixing tube, The velocity propels the combined fluids out the jet pump diffuser and to the surface.

JET PUMP HISTORY

Jet pumps have been used as an artificial lift device for over 30 years.
Early jet pump systems performance was poor and had lots of problems.
They were larger than today's jet pumps and their use was limited to larger diameter tubulars.
There was no way to quantify how much fluid or horsepower was required to produce the required amount of formation fluid.
Early jet pumps were difficult to optimize as there were few nozzle and throat combinations. So you had to 'settle' for a range of production that could be obtained with these fewer combinations.
With the fewer combinations, it was difficult to eliminate cavitation in the mixing tubes. Cavitation greatly reduced the mixing tube life so steady production from the pump was almost impossible.
The early jet pumps were expensive and difficult to service. Basically, to work on the down hole pump the tubing had to be pulled.
Because of the fewer pumping combinations, the surface pump used to deliver the power fluid to the down hole pump had to be oversized to accommodate the few options. Triplex Plunger pump were required. These plunger pumps have issues of leaking plungers and frequent repair.
Very few people knew how to correctly size a jet pump for an application so there was very poor support from jet pump suppliers.
All of this created a negative view of jet pumps throughout the industry.

NEW JET PUMP

Today's jet pump is a proven gas well dewatering pump system.
They now have a highly scalable output range up to 3000 bbl/day in the smaller gas well dewatering pumps
Jet pumps of today are very efficient and have no moving parts down hole.
New jet pumps can produce moderate amounts of sand and coal fines. In some cases up to 5 gallons per day.
The jet pump has no has locking issues. A slug of gas will make the pump inefficient, but as soon as the slug clears the pump, it picks up and immediately starts producing again.

Due to the wide range of jet pump hosing sizes, down to 1.6' OD, the jet pump can be used in deviated horizontal wells.
Continuous corrosion, scale or paraffin control can be accomplished by injecting chemicals into the power fluid on the surface.
The jet pump features a carrier that holds the nozzle and mixing tube. The carrier can be either pumped out of the well or fished with wire line. This would be done to service the nozzle and mixing tube or change out the combination to optimize production as the well conditions change.
By switching the power fluid from the jet pump inlet to the diffuser side, the carrier is lifted to the surface. This reverse out operation usually takes one man approximately 20 minutes to complete.
The jet pump now comes with windows based software that allows the optimization of the correct nozzles and throats.
With over 115 possible nozzle and throat combinations now available, the jet pump is now much easier to optimize.
Improved metallurgy of the down hole components allow the new jet pump to be installed in a wide range of down hole environments.

NEW SURFACE PUMPS

With the arrival to the market of high pressure diaphragm pumps, high maintenance triplex plunger pumps are no longer required for jet pump service.
These pumps offer diaphragm separation of 'dirty' pump fluid and plungers. No plungers come in contact with process fluids. Plungers operate in a clean oil reservoir.
The oil reservoir is at atmospheric pressure outside the cylinder assembly.
The diaphragm pump has been patented for use in oilfield jet pump applications.
Current sizes for jet pump applications range from 15 to 80 Horsepower.
Hydraulic actuated diaphragms and nickel aluminum bronze fluids ends are standard along with cartridge check valves.
This seal less design makes the unit environmentally safe.

DOWNHOLE JET PUMP CONFIGURATION

For the typical installation for gas well dewatering, 2.375. 2.875, 3.5 or larger production tubing is installed with a seating nipple below the perforations.
The jet pump housing (1.6 OD) is configured with a hold down seal assembly and a strainer nipple on the bottom and is run on coiled tubing or integral joint tubing and stabbed into the seating nipple.
Power fluid is pumped down the small diameter tubing thru the jet pump.
Formation fluid is drawn into the jet pump.
The combined power fluid and produced fluid travel tot eh surface in the annulus created by the small diameter tubing and the production tubing.
Gas is free to travel to the surface via the tubing casing annulus.

CASE STUDY #1 OKLAHOMA GAS WELL

WELL ISSUES

This operator had replaced (4) ESP's in a 12 month period.
ESP's had been failing due to a number of issues including, sand, pump off conditions, high GLR, low pumping bottom hole pressure and well fluid compatibility with the down hole parts.

OPERATOR GOALS FOR THE WELL

The operator wanted to maintain his current production level of 200 bbl/day of formation fluids (oil & water mixture) and maintain gas production of approximately 550 MCFD.
He wanted to reduce downtime due to ESP failures and reduce annual well intervention costs.

SOLUTION

The jet pump analysis software indicated that to produce 200 bbl/day with a pumping bottom hole pressure of 215 psi, would require 56 surface HP.
The jet pump was run inside the 3.5 production tubing on 1.9" OD integral joint tubing.
The jet pump was set in the sump at approximately 7200' from surface.
After 12 months in service all goals for the well were met.

There were no work overs required in the year for the entire 12 months resulting in no well intervention costs.
1 year after the installation an echometer analysis indicated that the jet pump had been producing 200 bbl/day and the well was producing 550 MCFD with a producing bottom hole pressure of 105 psi at the pump intake.

CASE STUDY # 2 FRAC FLOW BACK OPPORTUNITY

This operator had been using rod pumps to recover frac fluids at approximatyely150 bbl/day
The well had been fracced with 15,000 bbls fluid

OPERATOR GOALS FOR THE WELL

The objective was to recover the 15000 bbls of fluid as rapidly as possible and bring production to the market as quickly as possible.

SOLUTION

As there was little previous well data available, several jet pump software analysis were run with the data that was known.
It was determined that the jet pump could recover up to 2500 bbl/day with a Gas Liquid ratio of 20o SCF/bbl and a pumping bottom hole pressure of 1200 psi.
A 2.875 jet pump was run on 2.875 tubing inside 5.5' casing just above a packer.
Power fluid is pumped down the 2.875 thru the jet pump.
Combined power fluid and formation fluid return to the surface via the tubing casing annulus.
After 27 days of jet pumping, 15,200 bbls of frac fluid were recovered (100%). An additional 2100 bbl of oil was produced and sent to market. As there was no pipeline available, all gas was flared.
There were no shut downs of the flow back in the entire 27 days.

SUMMARY

Present day jet pumps are much more efficient and easier to install than previous jet pump technology. Jet pumps are a viable option for dewatering gas wells.
Present day surface equipment is much easier to maintain and easier on the environment.
Jet pumps are great alternative to quickly recover frac fluids.

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