D-JAX CORPORATION
MIDLAND, TEXAS

APPLYING PUMP OFF CONTROLLERS TO MARGINAL PRODUCERS

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Abstract

Numerous types of pump off control devices have been available to producers and operators since the late 1960's. Since that time, pump off controllers have proven themselves to be invaluable in reducing lifting costs and increasing pumping system efficiency. This technology has, in general, been applied only in cases where economic justification is assured. Sadly, marginal (or stripper) production does not justify the expense and maintenance of most controllers. Therein lies a paradox - the wells that could economically benefit most from the application of pump off controllers were excluded from consideration due to economic constraints. The need for a simple, inexpensive and reliable POC became abundantly clear.

By taking a unique approach to the detection of pump off, D-JAX corporation of Midland, Texas has been able to reduce the complexity of pump off controllers, making them more reliable and less costly. A large majority of marginally producing wells are now within the economic threshold of pump off controller applications.

This paper discusses the required functions and attributes of a pump off controller, proper selection of wells for successful pump off control application and a low cost, reliable means for the detection of pump off. Case studies will show how pump off control has been successfully applied to marginal (and other) producing wells to lower lifting costs, enhance pumping system efficiency and increase profitability.

The Purpose of Pump-off Controllers (POC'S)

Beam-pumped, sucker rod, artificial lift systems are, by far, the most common means of producing oil. Fully 80% of the world's oil is produced by this method of artificial lift because these systems are relatively inexpensive, very efficient, easily repaired and a vast amount of knowledge exist about them. The major disadvantage of the beam-pumped, sucker rod, artificial lift system is the propensity for over-displacement. In other words, when the system is properly designed for load and stress, it will produce more fluid than the reservoir can yield. This condition is called "fluid pound" and has some extremely negative consequences. Fluid pound can damage subsurface pumps, tubing, rod strings, gear boxes, pumping unit bearings and pumping unit structure. Virtually every component of the pumping system is adversely affected by fluid pound. Furthermore, when a pumping system is pounding fluid, energy is being consumed needlessly.

In the past, pump-off control devices have been used quite effectively to reduce the effects of fluid pound. Pump-off control devices, commonly known as POC's, have been offered in various forms from the simplest to highly sophisticated instruments. Invariably, where POC's are concerned, the level of sophistication is directly proportional to the cost. In any case, the main purpose of a pump-off controller is twofold:

A. To detect the absence of available well fluids and shut the pumping system down when that occurs.

B. To allow adequate time for well fluids to build up and start the pumping system up again.

Detecting Fluid Pound

There are as many methods of detecting fluid pound as there are makes of POC's. As far as the right way to do it is concerned, there are certain criteria that should be considered to determine which method best achieves the stated purpose. Some of the criteria to be considered are:

Simplicity - Detecting fluid pound should be achieved in a simple, straightforward manner so that field personnel without a great deal of specialized training and experience can understand how it works and be able to make adjustments if needed.

Reliability - To a large extent, simplicity affects reliability. A long-touted oilfield axiom states that the reliability of a system increases in proportion to the complexity of that system. Pump-off detection should not require delicate equipment that is easily damaged or wears out quickly.

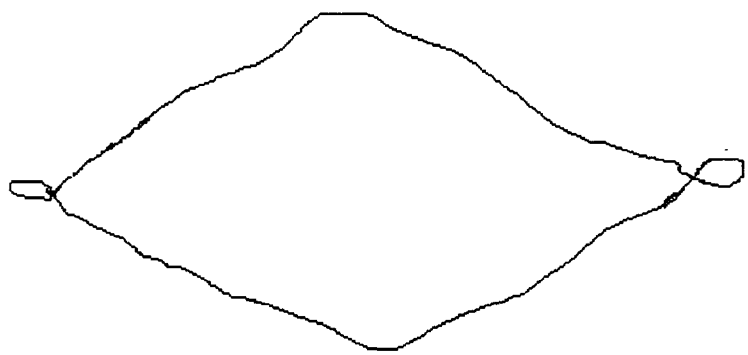
Stability - Detecting fluid pound should be infinitely repeatable without external factors such as an erratic electric supply, increased friction, changing well conditions, gas interference, etc. affecting detection.

Affordability - If operators and producers are to Apply POC's to marginal wells. they must be inexpensive to purchase initially and to maintain over the long term. The means by which a controller determines pump-off affects this criteria more than any other. Some complex controllers require ancillary equipment to be installed such as load cells, strain gauges, etc. that make them too expensive for consideration on marginal wells.

By taking a simple and unique approach to the detection of pump-off, D-JAX Corporation of Midland, Texas has been able to simplify the POC enough to meet the criteria mentioned above. Most marginally producing oil wells are now within the economic range for applications of POC's. The D-Jax, Penny Pincher, Pump-off controller uses stroke speed to determine pump-off, thus no load cells, load transducers or strain gauges need to be installed.. A magnetic reed switch (stroke speed sensor) is attached to the gearbox pedestal, out of the way of well servicing personnel and equipment. In the event that the controller needs to be moved or installed on another unit, no special equipment or personnel is required to re-locate the sensor. A magnetic strip is attached to the counterweight or crank arm and trips the reed switch each time it passes the sensor.

When the reed switch starts the timer, an extremely accurate internal clock times the duration of the stroke in milliseconds. For example, a pumping unit operating at exactly 10 strokes per minute, with a full pump barrel would require 6 seconds per stroke or 6000 milliseconds per stroke.

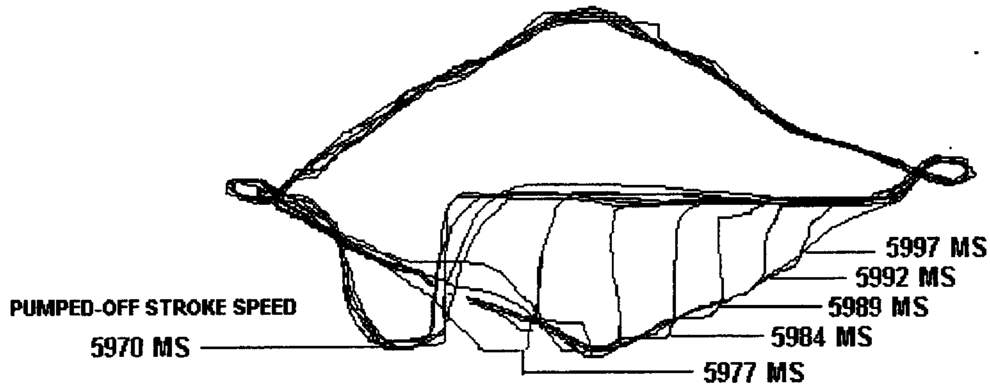
DYNAGRAPH



PUMPING SYSTEM OPERATING AT 10 SPM (6000 MILLISECONDS)
FULL PUMP BARREL

As the well begins to pump off, incomplete pump fillage occurs. The pump plunger falls through the void in the pump barrel resulting from the incomplete pump fillage and the unit speeds up minutely. The stroke duration decreases, to , for example 5997 milliseconds per stroke. Each successive fluid pound stroke results in faster stroke durations as less and less pump fillage occurs and pump-off is achieved.

DYNAGRAPH



STROKE SPEED INCREASES WITH SUCCESSIVE FLUID POUND STROKES

In the previous example, the pumped-off speed is 5970 milliseconds. There is a difference of 30 milliseconds between full barrel speed (6000 milliseconds) and pumped-off speed (5970 milliseconds). The Penny Pincher, Pump-off controller will use 30 milliseconds as the parameter to shut the pumping system down at pump off.

The method of detecting pump-off described above has been proven reliable in over 4000 installations thus far and has several advantages. Primarily the fact that load cells, transducers, et cet are not required results in monetary savings. Also, the controller is easier to set up initially and requires little, if any, re-calibration. Once set properly, factors such as increase in friction, temperature changes, system configuration changes and hot oiling or chem treating have no effect on how the controller senses pump-off.

OPERATING PARAMETERS

During the initial set-up, a dynamometer is used to establish the operating parameters for the Penny Pincher, pump-off controller. The operating parameters are minimal and simple to set: Field personnel are not intimidated by complex equipment and require minimal training to maintain the controllers. Operating parameters consist of:

DELTA - The difference in stroke speed between full barrel and pumped off operations. increasing the delta will increase run time.

PUMP-UP TIME - When pumping systems start-up immediately after a downtime, quite often erratic pumping conditions exist. These erratic conditions could cause the controller to reach delta and shut down prematurely. Pump-up time allows the conditions to stabilize before the controller begins looking for delta. The pump-up time is determined from dynamometer surveys.

DOWNTIME - The amount of time required for the formation to recover sufficiently to achieve complete pump fillage. The appropriate down time is determined by the dynamometer and should be kept as short as possible to maintain maximum production.

SENSOR FAIL RUN TIME - Sensor fail run time allows the controller to continue operating the well in the event of a sensor failure. The rule of thumb for setting this parameter is 10% greater than average normal run time. In sensor fail mode, the controller will act like a time clock until the sensor fail is cleared.

OPERATING OPTIONS

To make the Penny Pincher, pump-off controller applicable to a greater scope of operating conditions, some software options were included without increasing the cost of the unit. Certain operating conditions that would, in the past, have excluded pump-off controls from consideration can be handled through these operating options.

GAS LOCK - The Gas Lock option is for wells that have a tendency to gas lock while running. If the delta is exceeded by double on any one stroke, the controller shuts the system down for the programmed downtime. When the controller starts the well again, it looks for the excessive delta. If the controller finds that delta, it turns the system off again for another programmed downtime. The controller will continue to operate in this manner until the gas lock is broken and normal operations are resumed.

MAXIMUM RUN - The maximum run option is used for wells that have problems with erratic fluid entry. If the controller turns the system on and fluid has failed to build up, the controller will shut the system down for a programmed down time after the unit has run a selected two times or four times the sensor fail run time.

DICTATED RUN - The dictated run option is used to keep fluid pound strokes to a minimum. This option is extremely useful in situations such as fiberglass rod strings, where fluid pound simply cannot be allowed. When activated, the maximum run option will, operate the system from a selected one to nine cycles at a selected 80% to 95% of the last normal pump-off cycle run time.

OPERATIONAL DATA

Certain operational data that enhances the usefulness of a pump-off controller has to do with collecting and storing historical operating data. By comparing current run times with past run times, operating tendencies and problems can be identified in a timely manner and solutions can be effected before problems become failures. This information is available without a severe cost penalty. The Penny Pincher LCD includes current day accumulated run time (since midnight) as a percentage and in hours. The display also shows the previous 24 hours run time as a percentage and in hours. For further comparison, a percentage reference to 32 days previous is also displayed.

CASE STUDIES

COMPANY A

A lease of 400 wells near Westbrook, Texas
135 of the most troublesome wells, many of which were classified as marginal producers were selected for Penny Pincher POC's.

Results:
Average production increased 1.5 barrels of oil per day per well.
Total, bottom line, lifting costs decreased by 30%.
Workovers decreased from 18 per month to five per month.

COMPANY B

A 10 well program on a lease near Penwell, Texas.

Results:
An average production increase of 3.5 barrels of oil per well per day.
Electrical costs decreased by $1,175.00 per month.
Mechanical and workover costs decreased by $5,500.00 per month.

COMPANY C

Five wells on the Calvin Starnes Unit near Plains, Texas. Average production for these wells was 10 barrels of oil and 350 barrels of water with fiberglass rods. Each well was experiencing an average of one rod part per week. Penny Pincher controllers were installed on these five wells.

Results:
Workovers decreased from 21 per month to less than one per month.

COMPANY D

On a lease near Seminole, Tx., ten wells were operating with fiberglass rods to move large volumes of water. The wells in question were experiencing an average of three rod failures per week as a result of fluid pound. While these wells could not be classified as stripper wells, there were marginal because excessive lifting costs and lost production severely eroded profitability.

Results:
Rod failures decreased to two per month.

CONDITIONS THAT EXCLUDE CONTROLLERS

Every well is not necessarily a candidate for pump-off control. There are certain conditions that will only be made worse by installing a pump-off control on the system. For example, a well that has poor fluid "build-up" and will not provide complete pump fillage on any stroke, is not a candidate for control. It is, therefore, critical to conduct a dynamometer survey to determine if a well is a candidate for control.

CONCLUSION

Pump-off controllers are an extremely valuable tool for maximizing profitability in production operations when applied in the right situations. Experience has proved that the economic life of many wells can be greatly extended throughout the use of POC's. Finally, pump-off controllers can and are being applied successfully marginal wells.