The Lease Pumper's Handbook

Chapter 14
Well Testing

Section B

STANDARD TESTS

B-1. The Reservoir and Drive Mechanisms.

The reservoir can be thought of as a portable sprayer such as might be used to spray fertilizer or weed-killer. Once the sprayer has been pumped up, air is pushing against the fluid in the tank. Squeezing the handle allows the air to push the liquid out to create the spray. Until the trigger is squeezed, the fluid stays in the tank even though it is under pressure. The tank is like the reservoir, holding fluid under pressure. Drilling into the reservoir is like creating a spray tube and the valves in the well are like the trigger on the sprayer, allowing controlled releases of the fluid in the tank. Various types of forces—either natural or artificial—may force the oil out of the well. However, like the sprayer, when that force declines to the point that it cannot force the oil to the surface, then the well will stop producing just as the sprayer will not spray until it has been recharged with air.

The reservoir can have pressure applied to it just as the sprayer can be recharged. One type of pressure is that exerted by water that is trapped in the oil-bearing formation or in surrounding formation. As the oil is removed from the reservoir, water migrates into the reservoir to replace the oil and forces more oil out of the reservoir. This is an example of *water drive*. As the oil is produced out of the formation, the perforations must be moved upward to continue producing oil. Unless this is performed, the well will change to water production only. The water may be a natural part of the formation or it may be pumped into the formation to enhance production.

Some formations are completely saturated with liquid with natural gas contained within the liquid. When a new well is produced, the natural gas will break out of the oil as it is being produced. After a certain amount of oil has been produced, the formation will then begin to have free natural gas breaking out that will begin to work its way to the top of the reservoir. This is an example of *solution-gas drive*.

In some cases, the top of the reservoir is filled with natural gas with oil pooled at the lower part of the reservoir. The operator must drill deep enough so that the casing perforations are in the oil-bearing zone. This is an illustration of *gas cap drive***.**

A fourth type of formation has almost no pressure, except for the weight of the oil itself. Perforations must continue to be lowered toward the bottom of the hole to continue to produce oil. This is an example of a *gravity drainage reservoir***.**

The type of reservoir drive is important to well production, the method utilized, and the rate of depletion. In the geology of the well, the type of structure is important. The type of drive can also greatly influence well testing.

B-2. Potential Tests.

The potential test is performed on a well that has very recently been drilled or worked over. The primary purpose of this test is to determine how much oil, water, and gas this well will produce in 24 hours. To prepare for this test the well is usually shut in for 24 hours before the test begins, and the test is usually run for 24 hours.

Another factor determined by the new well potential is the pay-off factor. The potential helps determine if it will be profitable to drill other wells and, if it was a worked-over well, it will assist in determining whether it would be profitable to work over additional wells.

Purposes of the new well potential test. If the well is new, information gained from this test is important to the company. Some questions that it should help answer are:

- Will the regulating agencies place an allowable on the well to regulate production?
- Is this a profitable well? Will the well pay out?
- Should offset wells be drilled? Would they be commercially feasible?
- Should casing be run?
- What size tank battery should be built? Where should it be located in order to be convenient to receive flow lines from these additional wells?
- If it is a commercially viable well, how large is the estimated reservoir? How much oil and/or gas will it produce in the future?
- Should a pipeline be built to it when selling oil or should the oil be hauled by transport?
- Does it produce enough natural gas to be commercial? How many wells should be drilled to justify building a gas line?
- How much water is being produced? What should be done with it?

Purposes for conducting a potential test after working over an existing well. Some of the important questions answered by conducting a potential test after working over an existing well are as follows:

- Did the workover solve the production problems or achieve the goals of the workover?
- Did the well produce more hydrocarbons than it did before it was worked over, or was production restored to anticipated levels?
- Was excessive water production successfully plugged off by theworkover?
- Will the workover ever pay out and make a profit?
- Should the same or similar type of workover be performed to other wells in the same reservoir?

Potential testing conclusions. The potential test is used to analyze new well performance and to solve problems in maintaining and enhancing production from existing wells. It covers such a broad spectrum, it can be easily understood why special names may be attached to particular facets of it.

B-3. Daily Production Tests.

After a well has been normalized, a daily production test may be performed. This test indicates how much oil, gas, and water is normally produced by the well.

The daily production test is performed once each month on every well owned by the company. The results of these tests are posted in a permanently maintained record book with a sheet for each well. For each

year, the company will have 12 postings on the sheet for an individual well. If possible, the ledger paper should be wide enough that each monthly record only occupies one line. The lease pumper should also maintain appropriate records in the **lease records book.** (See Chapter 19.)

In preparation for conducting the monthly *daily production* test, the well must be normalized. This means that the well must be produced during this period of time without serious problems. As the test is performed, the well will be producing its normal production for the full 24-hour period. Since the average well is produced at its maximum capacity every day, and daily allowable may be set higher than the well can possibly produce, the well is already being produced at its maximum capacity during the test.

As these tests are posted in the record books, a very important collection of reference information is accumulated. At a glance, it can be seen if the well is producing normally or if production is falling excessively each month and problems are beginning to develop. After a new pump is run, production will probably increase because of the improved efficiency of the pump. As the pump begins to wear, the pumping unit may need to be run longer or stimulated in some other manner to maintain the production average.

Without a properly maintained lease records book, the pumper is basically operating by guesswork in performing the testing and daily duties. The operator is not in a verifiable position to reach precise reasons for lowered production, and part of the ability to know when there is a problem is lost until perhaps there is a production failure. The pumper should be able to alert the supervisor about a lease problem, rather than vice versa.

With a one-well tank battery, the company may make a monthly production average and discontinue the monthly daily production test. The problem with this system is that it does not give an accurate picture of how much production was lost during the month because of downtime caused by pump failure, equipment failure, unexpected problems, and other reasons that may be corrected. The pumper should still pick a convenient day and continue to perform the test. This will reveal how much production was lost during the month due to problems. This is valuable information when asking the supervisor for problem solving work or expenditures to improve production.

The advantages of conducting a daily test each month include the following:

- Identifies failingdownhole pumps.
- Indicates problems caused by a closed casing valve on a pumping well.
- Identifies a gas locked pump.
- Alerts the pumper to increasing flow line pressures on pumping wells. As a flow line plugs, it will cause a corresponding production drop due to increased formation backpressure.
- Reveals leaking flow lines.
- Reveals casing and gas anchor perforation plugging.
- Reflects salt bridging in cyclic producing wells.
- Indicates tubing leaks.
- Indicates time clock problems.

B-4. Productivity Tests.

This series of tests is performed as needed or upon request to help determine the best way to produce a well. Basic productivity tests should be conducted by the lease pumper on a periodic basis to help maintain or improve production. This procedure

takes several days or weeks with many adjustments to production time to gather adequate information.

The best results in conducting productivity tests may be achieved by having an echometer and dynamometer available where draw-down rates and fill times can be accurately established and pump action carefully calculated and observed. This method requires valuable equipment and somewhat specialized training that may not be available. Some pumpers, however, are very proficient at this analysis with no special equipment—just experience and an understanding of what is happening downhole. When conducting productivity tests, it helps to understand what type of drive exists in the formation.

To begin a productivity test of a pumping well, the casing should be pumped empty of liquid in the bottom of the well. At this point, the pumping unit should be shut in. By running an echo analysis every fifteen to thirty minutes, the fill rate of liquid entering the casing in the bottom of the well can be established. The longer the pumper waits, the more bottom hole pressure the well develops, and the slower the liquid enters. After sufficient liquid has accumulated, the pumping unit should be placed back in operation, and an echo analysis run every fifteen minutes or so to establish the draw down rate. This rate depends upon pump efficiency, size of tubing and pump, strokes per minute, and other factors.

Many people work for smaller companies that do not have echo analysis or dynamometer equipment available, and the lease owner will not be receptive to the expense of hiring this service. Their reasoning is that wells were produced for many decades before these pieces of equipment were designed and improved to the level that it has been developed today.

Even for companies that own this equipment, it may take a few days or longer before the lease can be tested. The pumper may not be able to wait days or weeks to analyze problems and take action that will continue and possibly enhance production.

Some of the productivity tests that can be performed without instruments include:

- Experimenting with well time controls to enhance production.
- Making changes slowly. It may take several days to a week before the effect of the changes settles back down to normal.

Some alternative methods of obtaining this information include the following:

- How to recognize some changes without instruments.
- Some wells running intermittently will produce more oil than if they run continuously.
- With many wells, rods can be lightly gripped with two fingers and so that the pump pounding the liquid can actually be felt. The pumper will also know if the pump is tapping bottom.
- With many wells the pumper can also feel when the pump is pumping well.
- By lightly touching the rods with a damp finger, the temperature changes will tell the pumper when it is pumping (cool rod), and when it is pumping off (warm to hot rod).
- When the pumper opens a bleeder hose into a bucket to check pump action and to determine if the well has a problem, the release of pressure expands the gas, allowing the well to flow for a few strokes. Once true pump action is obtained, the pumper can determine if there are pump problems.

Some factors that will help the pumper in analysis of the production from a well are:

- History of the well. What is normal production?
- Scale and paraffin accumulation, especially in the well bore and perforation area.
- Type of formation and how tight it is.
- A large pump moves liquid quickly. Is this the best way?
- A small pump moves liquid slowly. Is this the best way?
- Type of drive.
- Type of reservoir.
- Frequency of pump repairs.
- Strokes per minute of the pumping unit.
- Setting of tubing perforations in relation to the casing perforations.
- Flow line backpressure against the formation.

B-5. Gas/Oil Ratio Tests.

These tests are performed as needed to determine the ratio of cubic feet of gas being produced to each barrel of oil.

The purpose for conducting the gas/oil ratio tests is for pumper use and to inform regulating agencies how many cubic feet of natural gas are being produced per barrel of oil. This amount of gas, multiplied by the number of barrels of oil produced, equals the total cubic feet of gas that is being removed from the reservoir daily.

In some reservoirs it is important to leave as much gas in the formation as long as possible or even to return it to the formation until the oil has been depleted. Then the gas will be produced and sold. This can become important because when the natural gas supply in the reservoir is exhausted, no force remains to push crude oil toward the well.

When reservoir pressure is depleted, the pumper must re-inject another force into the reservoir to replace it to stimulate production or plug the wells. Without this gas movement and pressure, oil will no longer be produced.

Most reservoirs are large enough that many different operators own the wells that produce hydrocarbons from one. If the reservoir slopes upward, one operator may have several wells in the higher gas zone. The offset operator's wells, being higher up in the reservoir, only produce gas or gas with very little oil. This operator produces all of the gas possible out of the reservoir, while others produce very little gas. Production from the first operator's wells, in time, will begin to slow down for lack of a pressure maintenance program. If the whole reservoir is water drive, these wells will be the first ones to turn to water.

If gas had remained in the reservoir longer, the pumper would have produced more oil for several years longer. One set of wells may be progressively harmed by premature over-production of gas by other operators. Low gas production limits are good. Gas allowables are enforced to protect the wells to permit maximum hydrocarbon recovery.

Gas/oil ratio tests are necessary and enforced to extend the life of an oil field. This results in a higher hydrocarbon recovery, which is good for the industry, the mineral right owner, and the country. One of the best solutions is to unitize the field under one operator so long-range planning and good production practices may be possible.

B-6. Quick and Short-Term Special Purpose Tests.

The pumper should learn the many ways that abbreviated tests can be performed that

determine which wells are not producing according to schedule. Sometimes the solution to returning the well to service is as simple as bumping bottom for a few minutes. This troubleshooting ability should be acquired by the lease pumper because these talents are used almost daily when producing marginal wells.

Bucket and barrel tests. In a situation where there are a large number of pumping wells producing into the same tank battery, the tank is gauged in the morning with one or more wells are off. The pumper must make an effort to determine which wells are off. To perform a full daily test might require two weeks or more, so quick testing procedures need to be performed.

Part of the problem in performing a bucket test through the bleeder is that when the valve is opened the flow line pressure is removed. When this backpressure is removed, the gas in the column of oil begins breaking out and expanding, giving a false reading of new oil being produced. A small backpressure valve that screws into the bleeder valve opening will prevent the loss of backpressure and give a more accurate reading.

The pumper needs to become proficient at performing bucket and barrel tests in order to isolate problem wells very quickly.