Economy Practices On Electrified Leases

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After selection of the most economical type of prime mover to operate a pumping unit is made, is it not true that we sometimes fall short of our duty to see that the equipment we select does the most economical job for us? For the purpose of this paper, let us consider the economic aspects of only electrified leases. The reasons for properly supervising a lease are many, and it usually is the small things, as well as the large things, that count. For convenience, let us divide the economic problem into three general categories. First, "Mechanical Resistance Present", second "Electrical Characteristics Present", and third, the proper application of equipment, power, and knowledge we have at our disposal.

The mechanical resistances present at the unit in general consist of many small items that we need only to mention. Those are such items as friction due to belt tension, gear box drag, bearing drag, etc., but did you ever consider the possible effects of a stuffing box being too tight? There are cases on record where the loosening of a stuffing box to the point where it just held the fluid reduced the peak amperage as indicated by a hook-on ammeter as much as 25%. Are pumpers in general aware of such items as this? How many pumpers actually understand the mechanics of pumping? Almost all companies who have pumpers actually trained in their work tell us that in lease operation the cost of repair, labor and materials is not an important item with electric operation.

A more important aspect of electrified lease economy is the proper handling of electrical power on the lease itself. For a certain load such as a beam pumped lease, several factors must be considered in designing an electrical power distribution system. In addition to the physical design, electrical characteristics must be considered. This brings us to an electrical characteristic called power factor. Power factor is merely a ratio between the apparent power and the actual power being required by an electric motor. Apparent power is calculated from the actual amps and volts going to the motor while the actual power is the amps and volts that are doing the work. Let us take as an example an electric motor running with absolutely no load on it. The amps going to the motor are not doing any work, so let's call them wattless amps. Now, if the motor is loaded, the amps increase and we have power being required of the motor and have amps actually delivering power. The problem now is to eliminate the wattless amps from our lease distribution lines so maximum power can be delivered to the well over minimum sized wire, or in many cases so additional wells could be pulled from an existing system without the necessity of rebuilding to take care of the added load. The wattless amps load our system and cause heat losses on the lines just the same as power amps do. The answer to this problem is an individual capacitor of appropriate size connected on the load side of the starting equipment at the well. The electrical characteristics of the capacitor is such that it supplies the wattless current to induction circuits such as the induction motors used in oil field pumping. Thus, by having equipment that will supply the necessary wattless current at the load it relieves the lines on the lease of the burden of handling it. The reduction of the total current on the system actually will improve the voltage level on the lease, it will reduce the required transformer rating and distribution conductor size as well as reduce power costs and make a more economically operating lease. To give you some idea of the importance of capacitors for a more economically operated lease, here is the data from tests that we have conducted. This first test was made in the Levelland Field. The test was on nine wells using 10 horsepower high torque motors and four KVAR capacitors. Simultaneous operation of the well units using a 75 KVA transformer bank.

Capacitor KVAR	Trans. Volts	Extremity Volts	Trans. Amps	Trans. KW
0	475-480	420-450	85-105	30.2
36	475-482	445-475	45-65	29.37

With no capacitance connected, the extremity voltage varied from 420 to 450 volts, the transformer amperage varied from 85 to 105 amps with an actual KW demand of 30.2 KW. After proper capacitance was installed, the extremity voltage increased to range between 445 and 475. The transformer amperage decreased then varied between 45 and 65 amps and the KW demand actually decreased at the transformers to 29.37 KW. A decrease of about 2.75% in the lease power consumption.

A more impressive test proving the economics of applying capacitors to individual lease use was conducted on a 13-well lease in the Garza Field. This lease was equipped with 7½ HP motors, 4 KVAR capacitors, and a 45 KVA transformer bank. Tests were made with no capacitance and then with proper capacitance. (See table below.)

The installation of proper capacitors increased the extremity voltage from 380/430 to 420/480. The thermal secondary amps were decreased from 100 to 43.2 and the primary KW input to the lease decreased from 35.3 to 30.5 KW, or a decrease of 15% in actual power input to the lease. I think everyone will agree that savings that range up to 15% on any phase of lease operation cannot be taken lightly.

Now let us consider the economical use of electric power by reviewing some graphis tests made on pumping wells in two different fields. This review will be made by first giving you some background information and

KVAR	Trans Volts	Extremity Volts	Thermal Secondary Amps	Power Factor	Pri. KW Input	Primary Volts
0	470-490	380-430	100	50%	35.3	4080
52	500	420-480	43.2	90%	30.5	4120

then the results of the tests. As you no doubt know, electric power companies are confronted with many problems from all phases of the industry, but when the problem concerns the Petroleum Industry, the operator is usually willing to cooperate in any way for the benefit of either industry. Through the fine cooperation of some oil companies, we have been able to develop a service that will be a great deal of help to the operator of marginal wells with a low G. O. R. and low bottom hole pressure.

We knew from the beginning that there were many factors involved in accounting for abnormal bills on leases where there is a problem of making the lease production allowable. For the purpose of this paper, we will consider only two of these factors. They are: *running a well out of balance; running a well after it is pumped off, or both.*

By a systematic study of the instantaneous current in each phase at the well, we readily determined that the problem was not only balancing the well properly, but we needed to know when to do the balancing. Previously, when we told the customer we felt he should balance at maximum production times, he immediately would say that flo-meters and men simply were not available for such tests. We needed something to use as a tool and not a crutch in working with producers with this type of problem. This prompted the study that solved several questions, especially for the independent small operator.

Because we, as an electric company, did not have production equipment available, it was necessary that we use electrical equipment that would give us essentially the same information as production testing equipment.

It was decided that we would use a thermal type graphic demand meter with a 48 hour chart. The thermal meter was selected because of its simplicity, sturdiness, and the fact that when using thermal meters we were not troubled with the indicator swing that always is present in magnetic instruments when testing oscillating loads such as individual beam pumping units. The KW meter was chosen over the ammeter because we wanted an indication of the change in power used by the well under operating conditions. We knew because of the electrical characteristics of an induction motor under varying loads the thermal ammeter would not give a true picture of the power input to the well. Also, by intergrating the KW chart, the KWH consumed can be determined. Since most oil field distribution in this area is 480 volts, we selected a 480 volt KW meter, and mounted two multiple tap current transformers in a box with the meter for ease in connecting to different sized loads. Many tests were conducted over the South Plains of Texas, but we will discuss only two of the more interesting ones here.

The instrument was placed on a 20 HP electrified well in trouble in the Seminole Field, where we knew little gas was present. This well, which we will call Test Well "A", was being pumped around the clock, and Chart 1, Test No. 1A was made under normal operation. By integrating the KW chart, we find that the energy cost per bbl. of oil amounted to 2.34c in the 24 hour operation, with a demand of about 6.8 KW, as shown under the tabulated results of the Test Well "A". The producer cooperated to the fullest extent and changed the time settings as we asked him to. For the first trial the time clock was set for 17 hours operation and 7 hours off, as indicated in Chart 2, Test No. 2A. From a close observation of KW demand Chart No. 2 and production gaging, we determined that the well had begun to pump off after about 4 hours and then for 13 hours the well pumped much less oil. (Note the pump off point marked on the KW charts.) Even though the demand was lower, the KWH requirement per bbl. of oil was much higher during this 13 hour period because of loss in efficiency of the equipment, part of which was due to the fact that the balance of the pumping unit was thrown off when the oil to be lifted decreased. This loss in efficiency tends to increase the demand due only to the operation of the unit and pump itself. This is more than offset, however, by the fact that there is much less oil to be lifted, which means less actual work to be done and thus power requirement as is indicated on the KW demand charts. This made it more expensive to lift each additional barrel of fluid. The next setting, it was determined, could logically be 3-1/2 hours on and 4-1/2 off. With this time setting, the well began to pump off at the end of 2-1/2 hours, as is indicated on Chart 3, Test No. 3A. However, after about 36 hours of this cycling, the build up in production was such that the well ceased to pump off at any time, as is indicated in the latter hours of Chart 3, where there is no pump off point. (KW demand remains constant). In the final analysis of this particular test, the settings were 3-3/4 hours on and 4-1/4 hours off, as shown on KW Chart 4, Test No. 4A. With these settings, the well never pumped off and the unit was in balance at all times. At the beginning of this series of tests, the well was pumping approximately 68 bbls. of oil per day at a cost of 3.28c per barrel for electrical power. At the end of the tests, the well was pumping approximately the same amount of oil at a 36%. In other words, the well was producing at a high rate, and the unit was in balance during the entire 3-3/4 hours operating period. In this particular case, the stroke was not changed. The well was set at 17

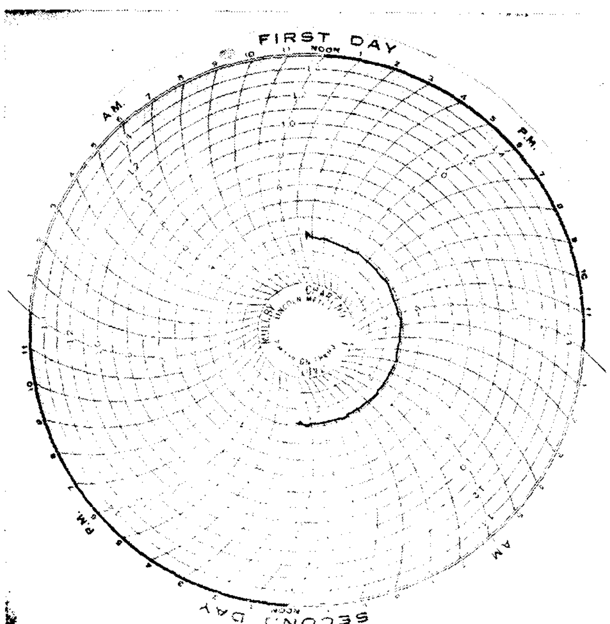


CHART 1—*Troubled well in Seminole field. Continuous 24-hour operation used excessive electric power. Maximum demand was 6.8 kilowatts. Energy cost per barrel was 3.28 cents.*

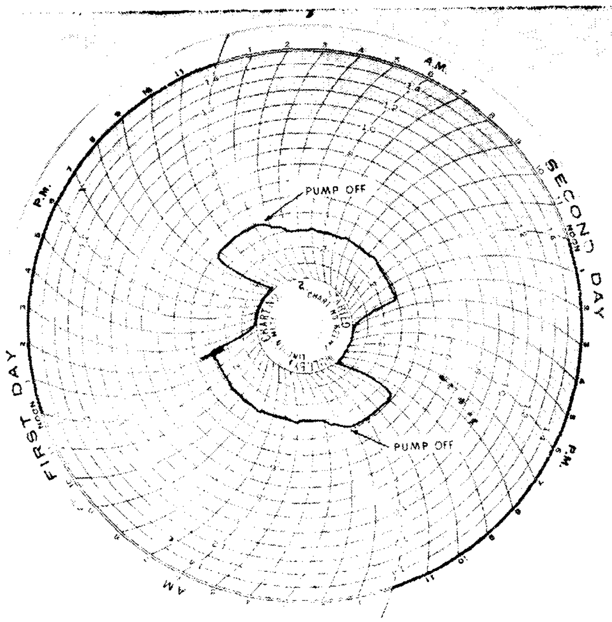


CHART 2—*First trial to balance pumping cycle. Well was operated for 17 hours, then off for 7 hours. Well began to pump off after four hours. Maximum demand was 9.5 kilowatts on this 48-hour chart.*

strokes per minute—54 inch strokes with the fluid testing 5% water.

Tabulated Results from TEST WELL "A"

Test	Time Cycle Hours On	Time Cycle Hours Off	Bbls Oil	KWH Per Bbl	Bbls Per Hr	Cost* Per Bbl
1A	24	0	68.35	2.34	2.85	3.28c
2A	17	7	66.63	2.03	3.90	2.79c
3A	3½	4½	64.41	1.55	6.18	2.16c
4A	3¾	4¼	69.03	1.53	6.14	2.10c

This data is representative of many time settings that were made on this particular well. No spectacular production results were achieved, but operating time was cut to less than half and electrical expense was reduced 36 percent.

*Based on energy charge of 1.375c/KWH

Probably the most interesting test from a graphic standpoint was conducted on a well in the Cedar Lake Field powered by a 15 HP motor with twenty 34 inch strokes per minute. As is our normal practice, the test was kicked off by checking the well under 24 hour continuous operation, shown in Chart 5, Test No. 1B. Under this condition of operating around the clock, the results show a picture that, even at a glance, looks bad. In this test which we will refer to as test on well "B", a production meter was used instead of gaging. This was very beneficial to the tests, since no water was present. In this initial test, the oil pumped amounted to 31 bbls. with an energy use of 90 KWH. This means an energy cost of 3.89c per bbl. to operate this well. In Test No. 2B, a time setting of 5 hours on and 7 hours off was used, as indicated on Chart 6. This means 10 hours pumping time per day as compared to the original 24. It is interesting to note in Chart 6 that the rate of production and the rate of electric power used (KW demand) follow the same pattern. The well produced 34 barrels of oil with the use of only 46.5 KWH, or the well produced 34 barrels of oil at a cost of 1.88c per barrel for electric service. Even with this improved operation, the demand Chart 6 indicated to us that the well had begun to pump-off after about 2 hours. This, as you can see, was verified by the production

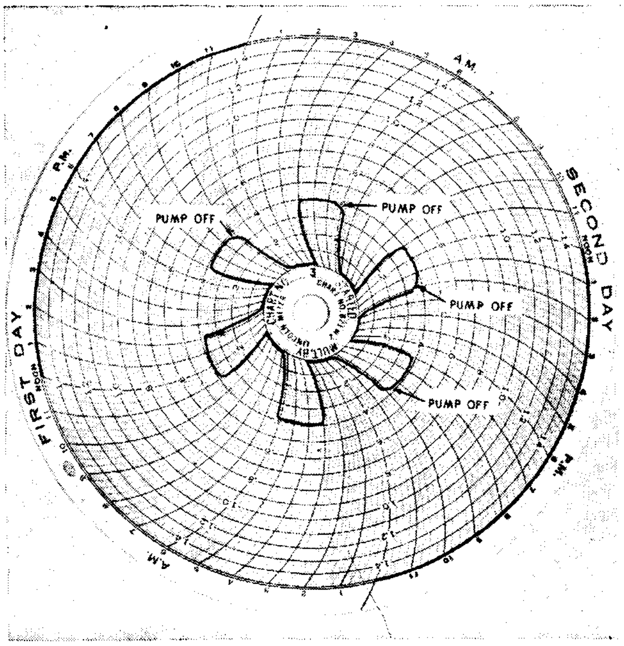


CHART 3—Second setting was 3½ hours on, 4½ hours off. Well pumped off at end of 2½ hours. Maximum demand was 9.5 kilowatts on this 48-hour chart. Power costs wer 2.16 cents per barrel.

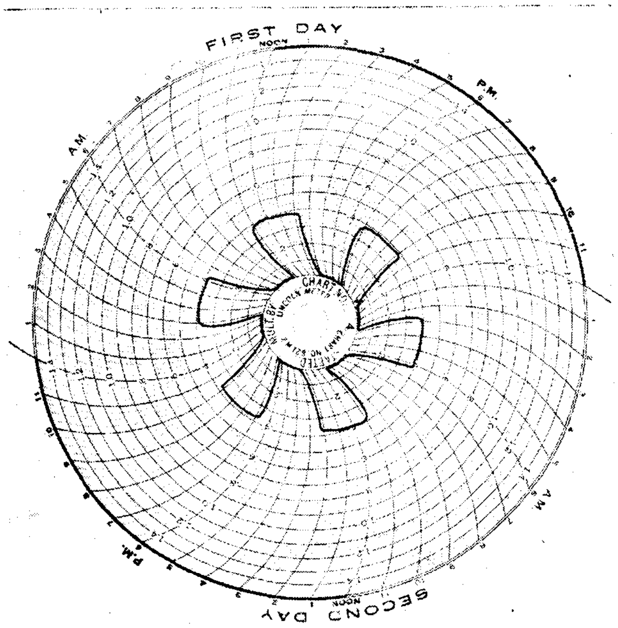


CHART4—Final time cycle was 3¾ hours on and 4¼ hours off. Maximum demand was 9.6 kilowatts, but production increased from 68.35 barrels to 69.03 barrels of oil (plus 5 percent water in both cases). Electric power costs for this setting was 2.10 cents per barrel, a reduction of 36 percent over continuous operating cycle.

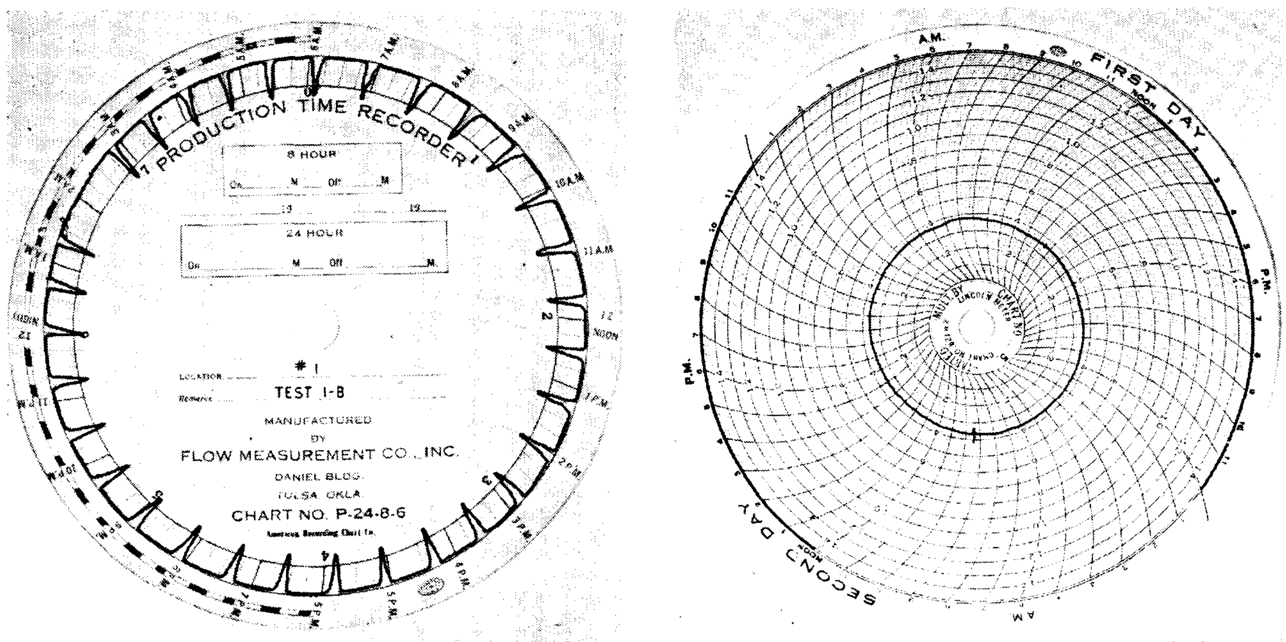


CHART 5—Interesting case in Cedar Lake field, tested first under regular 24-hour operation, using 48-hour charts on wattmeter (right). Maximum demand was 3.8 kilowatts. Production: 31 barrels fluid per 24 hours. Power cost: 3.89 cents per barrel. Production time recorder chart at left indicates time separator dumps.

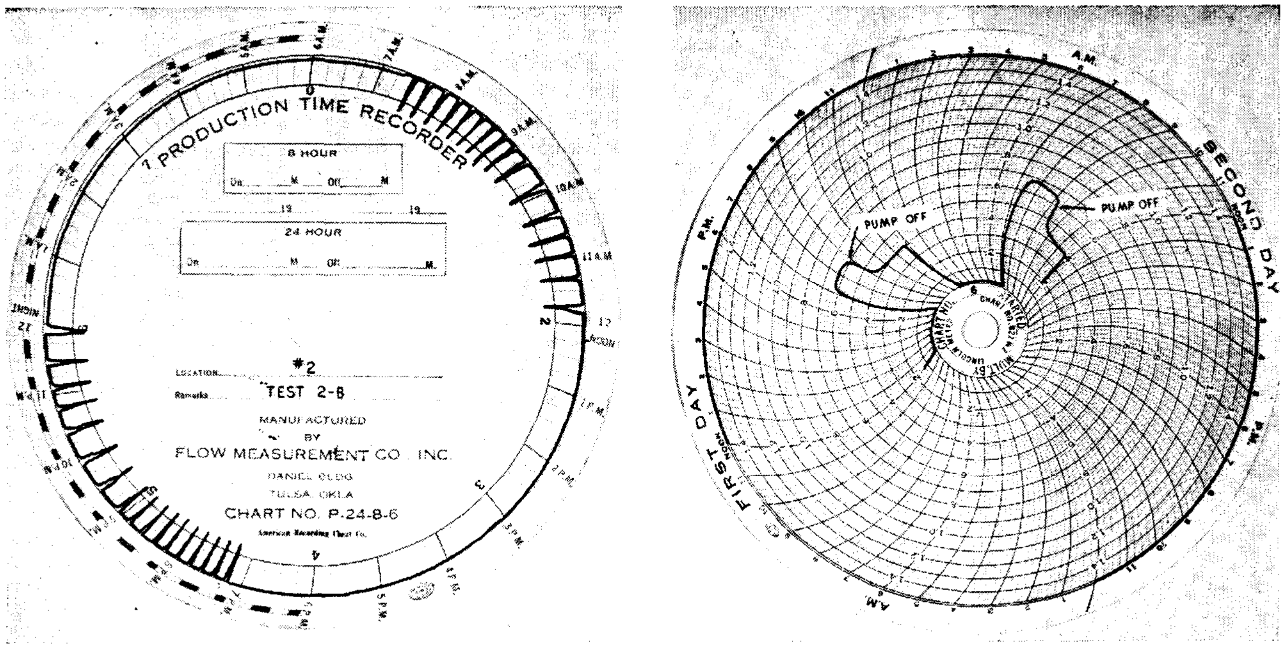
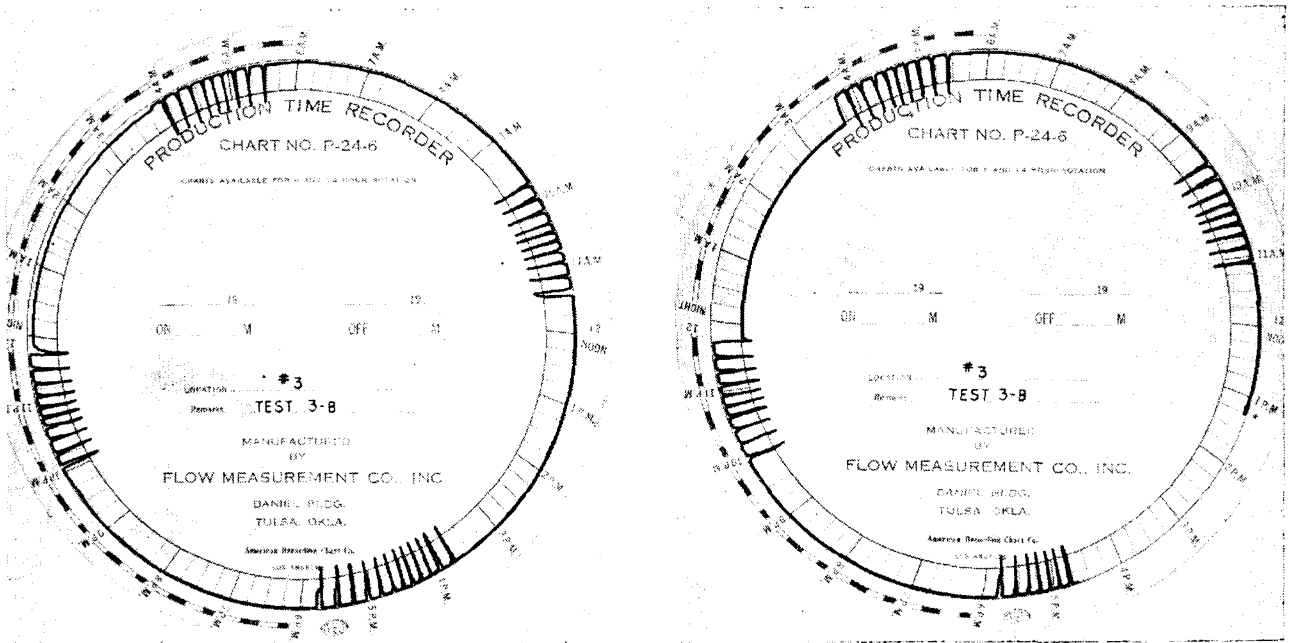


CHART 6—Operating cycle on preceding case was changed to 5 hours on, 7 hours off. Maximum demand was 6.8 kilowatts on a 24 hour chart. Production increased from 31 barrels to 34 barrels at a power cost per barrel of 1.88 cents.



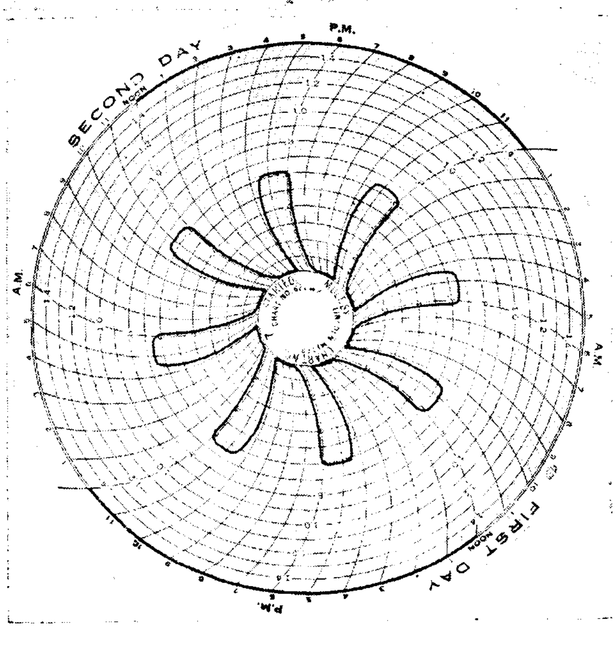


CHART 7—Time cycle changed again to 2 hours on, 4 hours off. Production increased to 38 barrels, power costs dropped to 1.375 cents per barrel. Two top charts record time separator dumps. Both are 24-hour charts. Wattmeter chart at left is 2-day chart.

chart. On the following test we used a time setting of 2 hours on and 4 hours off, shown on Chart 7, Test No. 3B. This was a 48 hour test so we have shown the two 24 hour production charts as well as the 48 hour KW demand chart. As we expected, there was additional improvement. In this case, 38 barrels of oil was produced at a cost of 1.375c per barrel. The production was up almost 25% over the original setting and the cost of energy was less than half of what it was before the tests were started. These results prompted additional study, as shown on Chart 8, Test No. 4B. In Test 4B, the time was left at 2 hours on but the off time was reduced to 2 hours. The production was increased again and was now at a rate of 44 barrels per day. During this 24 hour period, energy was used at a rate of 1.09 KWH per barrel and production was at a rate of 3.66 barrels per hour. This is a decrease in the production per hour of operation and can be easily explained because the production and KW charts indicate that on each cycle the well had begun to pump off. We reduced the pumping time the following day to 1-1/2 hours on and increased the off time to 2-1/2 hours, shown in Chart 9, Test No. 5B. The result of this test was an increase in the cost per barrel as well as decreased production.

Even though costs were less as far as purchased power was concerned with time settings of 2 hours on and 4 off, the customer elected to select the time settings of 2 hours on and 2 off because of the greater production. The final analysis of these tests amounts to an increase in production of from 31 to 44 barrels per day. This is a 42% increase with the energy cost being reduced 60%.

Tabulated Results from TEST WELL "B"

Test	Time Cycle Hours On	Off	Bbls Oil	KWH Per Bbl	Bbls Per Hr	Cost* Per Bbl
1B	24	0	31.00	2.90	1.29	3.89c
2B	5	7	34.00	1.37	3.40	1.88c
3B	2	4	38.00	1.00	4.75	1.375c
4B	2	2	44.00	1.09	3.66	1.505c
5B	1½	2½	35.00	1.58	3.89	2.18c

This data is representative of many time settings that were made on this particular well.

*Based on energy charge of 1.375c/KWH.

In conclusion, we feel that the main advantages of a properly planned time cycle schedule for marginal wells with low G. O. R. are:

1. Increased production.

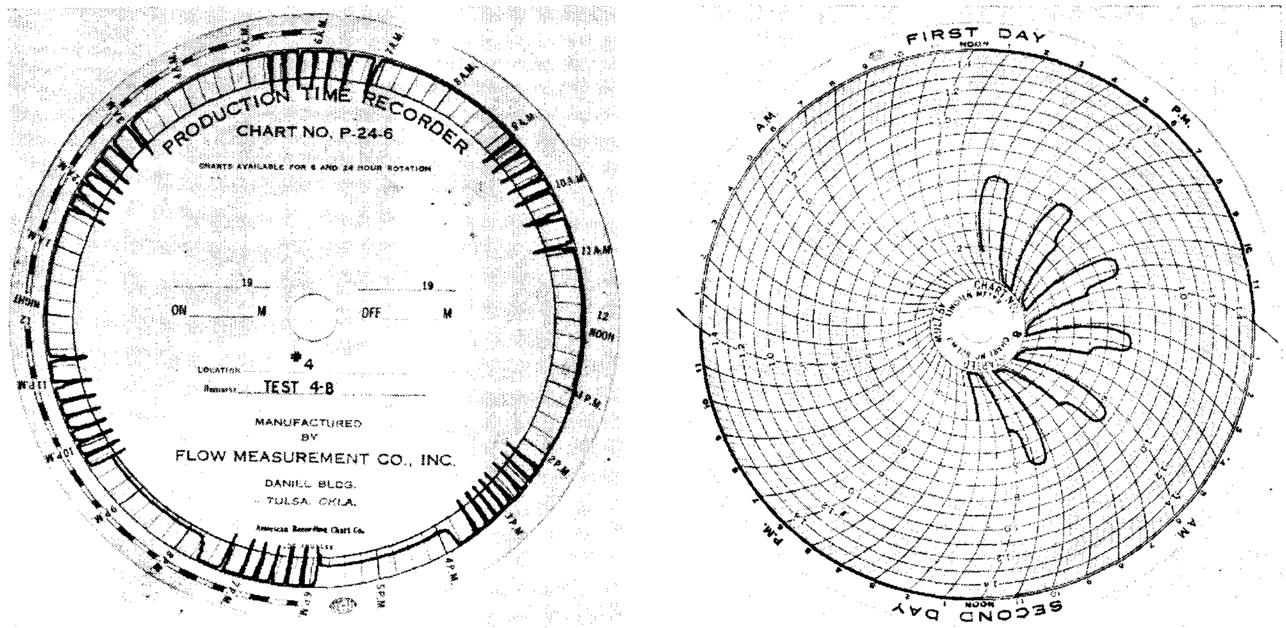


CHART 8—Pumping cycle changed again to 2 hours on, 2 hours off. Production went to 44 barrels on 24-hour test. Maximum demand was 6.6 kilowatts, cost per barrel went up to 1.505 cents.

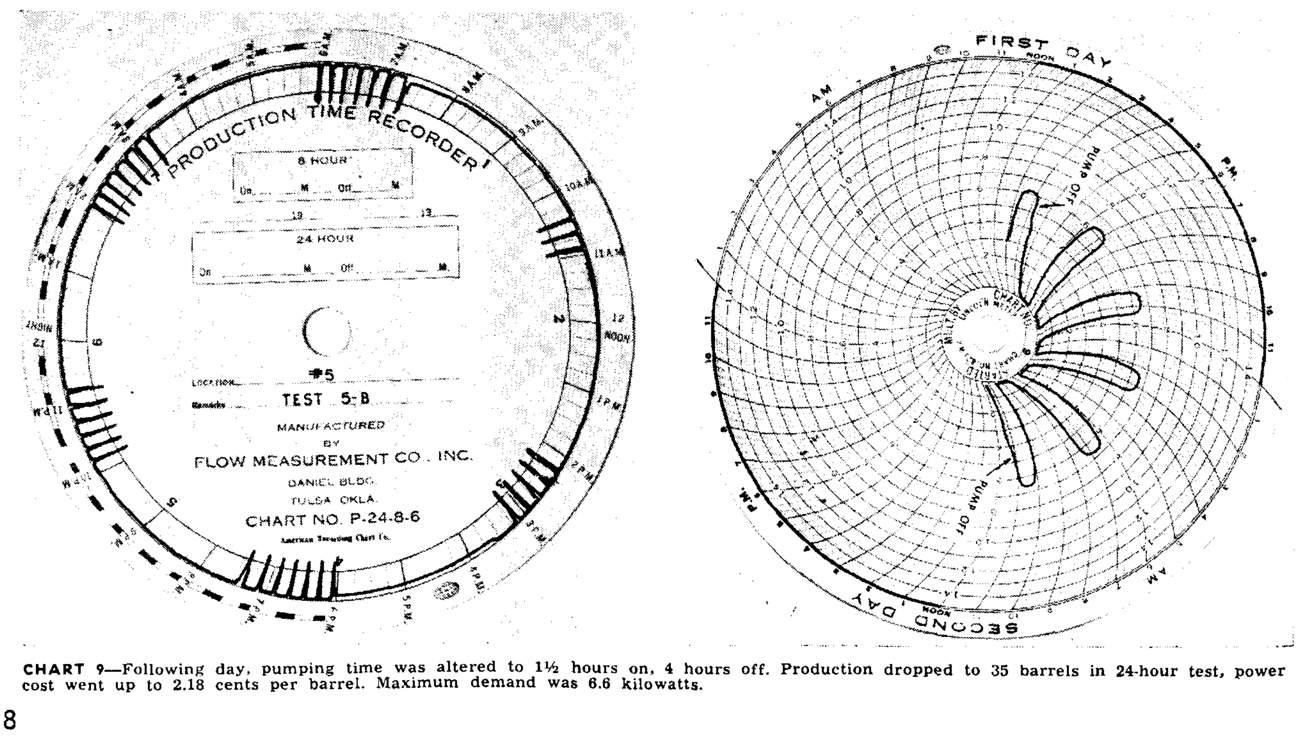


CHART 9—Following day, pumping time was altered to 1½ hours on, 4 hours off. Production dropped to 35 barrels in 24-hour test, power cost went up to 2.18 cents per barrel. Maximum demand was 6.6 kilowatts.

2. Reduced power operating cost.

3. Lowered maintenance through balanced operation and reduced operating time—

(a) Prolonged unit life.
(b) Reduced rod trouble.
(c) Reduced stuffing box trouble
(d) Reduced pump trouble.
(e) Eliminating pounding.
(f) Reduced servicing costs.

4. Increased pumper convenience and efficiency—

(a) Can pump more wells.
(b) Reduces pick-up mileage.
(c) Reduces stuffing box clean-up problems.

5. Tends to conserve formation gas because fluid buildup maintains back pressure on the formation.

The producer who utilizes the advantages of time cycle pumping on electrified leases should encourage other producing companies to seriously consider making additional studies on their production, and in conclusion may I leave you with this thought—"Power like oil is precious, let's not waste it."