OIL PRODUCTION AND COSTS.

EMPIRE GAS & FUEL CO.

KANSAS FIELDS.

By John A. Frost.

4 - 1 - 1924.

'LETTER'

Box #394,
Augusta, Kansas.
April 1st, 1924.

Mr. C. E. Sanborn,
Chairman Graduate Committee,
Okla., A. & M. Collage,
Stillwater, Okla.

Dear Sir:-

I here-with submit for your consideration, a thesis pretaining to my work with the Empire Gas & Fuel Company, for which I am desirous of obtaining a professional degree.

This thesis is of a practial nature more than theoretical and deals with actual operating conditions and costs of the production department, in which I have worked the past three years.

If the committee desires information or recomendation regarding my work with this company, I suggest you write to Mr. Weston Payne, Superintendent of Production, El Dorado, Kansas, or Mr. D. W. Williams, Superintendent of Production, Augusta, Kansas.

Respectfelly submitted,

John A. Frost.

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Box 394
Augusta, Kansas.
April 23, 1924.

Mr. C. E. Sanborn,
Chairman Graduate C ommittee,
Okla A & M College,
Stillwater, Okla.

Dear Sir:

After submitting a copy of this thesis to the company officials for approval, it was necessary to make a few changes and omit several pages, to meet the policies of the company.

You will note that pages 13, 14, 25, 26, 27, and 28 have been removed, and the figures on curve sheets 22, 23 and 24 have been blotted out.

I am sending this thesis in, with these corrections to meet the Companies' policies, and trusting it will meet the approval of the graduate Committee, as it now stands.

Respectfully,
John A. Frost.

JAF/VMF

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A KANSAS GUSHER

EMPIRE PIPEYARDS - AUGUSTA, KANSAS

Field Offices, Warehouses and Machine Shop centrally located to serve the "EMPIRE COMPANIES" in the Augusta Oil Fields.

OIL PRODUCTION

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OIL as we know it today, or think of it, generally speaking, is a new thing but History tells us that it was discovered ages ago. It is recorded that the people of Babylon and Nineveh used it some two(2) thousand years before Christ. About the time of Nero, the Romans are known to have brought oil from the Island of Cicily and burned it in their crude lamps. Other countries known to use oil in its crude state, taken from springs are China, India and Persia.

The Seneca Indians have been credited with the discovery of oil in this country and it is said they used blankets to obtain the oily scum from the surface of streams and ponds, later to be used for medical purposes.

Drilling for oil for commercial purposes was started by Col. Drake, who drilled the first oil well in 1859 at Titusville, Pa. Since then, the search for oil has grown to one of the foremost industries in the United States.

Theories on origin of petroleum are sometimes class-

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ified under three (3) divisions, namely:

1. INORGANIC THEORIES
   a-Carbide theory.
   b-Limestone, Gypsum & hot water theory.
   c-Volcanic.

2. ORGANIC THEORIES
   a-Animal theories.
   b-Vegetable
   c-Combination of animal & vegetable.

3. COMBINATION OF ORGANIC AND INORGANIC

While the accumulation is based more on facts.

Oil and Gas in commercial quantities is usually found in higher parts of folds of the earth's surface called "Anticlines, Domes, and Monoclines." Water is generally found in the same stratum as the oil, but lower in the fold.

The location of wells to be drilled depend upon the structural data acquired by geologists or where evidence is shown by oil or gas seepage. After a field has been opened, it is common practice among the larger companies to drill in regular locations offsetting each other. The spacing of same depending upon the amount of oil in sand, grade of oil, depth of sand, and porosity of same. Good practice in this field (El Dorado) seems to be five (5) acres per well.

There are three (3) principal systems of drilling used in oil field work, namely, Standard cable tool, Hydraulic rotary system and combination of these. The choice of one of these systems depends a great deal upon geological factors, but the Standard cable tool system is, perhaps, the more universal for oilwell drilling, due to the permanent rig required to handle heavy strings of casing, deep drilling etc.

The object of drilling oil wells are to find commercial deposits, the drilling of favorable sized hole for obtaining and maintaining a good production, to drill in as short a time as possible and to exclude water from the oil sands.

The size of a hole depends upon depth expected to drill and production expected. In proven fields offtimes, the cost of casing can be cut by keeping logs of first wells drilled. Where the cost of casing is one of the big factors it pays to run as few strings of casing as possible. In this field (El Dorado) it is common practice to start with 12½", 10" inside the 12½", 8¼" inside the 10" and 6 5/8" inside the 8¼" to the 2400' sand.

The less time it takes to drill a well, the less the labor and fuel expense. In new fields where gushers and flush production count, the first few wells usually get the greater part of the oil, many times due to channels being formed in the sand.

A few factors which effect drilling operations are depth, diameter, sands (both wet and dry) limestone, hard strata etc.

The work of "Drilling in" a well is very important and can only be done by knowing the conditions under which the pay sands are found, the depts, knowledge of the water conditions in the surrounding wells and other things in general. The main idea is to keep the penetration slight, that is, be sure to get the best part of the pay and refrain from drilling into the water.

Without a doubt, water is the worst enemy of the oil fields and only in the past few years has anything been done to prevent or exclude it. Some states have enacted laws to cope with the situation.

Mr. Ambrose, of the Bureau of Mines, has recently published a Bulletin dealing with water problems in the oil fields and it is well worth anyone's time to get a copy of this Bulletin, as it takes up all sources of water, methods of prevention, casing and shutting off, not from a theoritical point of view, but from experiments worked and proven in the Kansas and Oklahoma fields.

The aim of every operator is to extract the maximum of oil in the minimum of time at minimum cost. To successfully do this, there are at least three (3) improtant problems to be considered, namely;

1. How best to obtain the largest quantity of oil from his own property.

2. How best to defend his property from drainage by neighboring properties.

3. How best to drain the neighboring properties.

Oil, not like minerals, seeks its level, as well as tends to follow through any outlet that offers easy passage. For these reasons and not knowing exact conditions under-ground, one is not held liable for draining other properties, as they would be, for taking minerals.

Where fields have been drilled, in, the problems dwindle down to keeping a close watch upon water conditions or other things that would hinder maximum production at minimum cost.

FACTORS AFFECTING THE COST OF PRODUCTION

Many think that oil is found without much cost and the reward of a few dollars investment means comfort and riches the rest of their lives. Such dreams and romance joined with hope and speculation has recruited the men and money to keep it going.

It takes from $25,000 to $100,000 to drill a wildcat well 3000 feet deep and the company with a good geological department has one chance in 10 or 20 of opening a new pool, while that of the wildcatter, without such help, has only one in one or two hundred. It is readily seen that it is no poor man's job to look for oil.

To the outsider it might appear that the rest is easy, once oil is found. But to the operating companies and individual producers a list of hazards could be sighted in connection with producing oil, among them, fire, floods, water, cyclones, and probably the most important and sometimes the most disasterous is that of price.

It is fundamental that an industry, to be and remain sound, must pay its way, together with a reasonable profit.

The supply of oil is directly governed by the accident al discovery of new pools and the rapidity with which such pools can be drained after discovery.

The oil industry has just passed through one of the greatest over production periods known to the oil fraternity. The result, the price of oil dropped and in many fields, less than the cost of production, which caused a great loss to producing companies and those not strong enough financially went to the wall.

During the past summer the large pipe line companies refused to take all the oil produced on leases, thereby cutting down earning and causing serious trouble in fields troubled with water. The Empire companies prorated every lease as shown by copy of letter sent out to farm bosses in charge of the different districts. See page # 13 .

The effect on the Augusta field is plainly seen on the production curves following. The prorating went into effect in July just after recovering from a disasterous flood.

Where producing properties are along rivers or in low lands, the same is subject to floods. During the week of June 10-16, 1923, the Empire companies experienced one of the worst floods known in the Augusta oil fields, the result of which is plainly shown on the production curves,

(note that the lost production, during the flood has never been regained.)

To the Kansas operators there is always the fear of cyclones during the summer months, and it is a common practice among some of the larger producers to take out insurance for wind and fire against all oil rigs.

The inclosed pictures of the wake of a cyclone in July 1922, gives some idea of the loss to rigs and properties, and by looking at the production curves, again, the effect on production.

On February 5, 1924 a severe blizzard hit the Kansas fields and in one days time the production in the Augusta field fell [redacted] about 40% of the total field production, so it is readily seen that the extreme cold weather and snow hits the producer mighty hard.

One of the worst things to contend with in the Augusta field, is salt water, which causes an excessive amount of corrosion on any metal it comes in contact with. The last six months of 1923 there was an average of 172 strings of tubing pulled each month, representing an expenditure of $60,881.58 for labor and $108,496.47 for material alone or an agerage of $129.21 per well per month.

The Empire Companies have tried various kinds of tubing, tubing with zinc collars, painted with white lead and galvanized inside and out, but so far have been unable to overcome the trouble.

The painted tubing from my personal observation seemed to give the best results as shown by the following data taken from Wallace #7 -- Section 11 --28 --4 and Miller #11 Section 2 -- 28 -- 4.

Wallace #7 Section 11-28-4.

Date Pulled	Material Used.
3-9-23	5 Jts. Tubing and Standing Valve.
4-6-23	5 Jts. Tubing and Standing Valve.
5-8-23	4 Jts. Tubing, Working Bbl.and Stand V.
6-20-23	6 Jts. Painted,Working Bbl.and Stand V.
9-10-23	1 Jt. Tubing, Working Bbl.and Stand V.
10-13-23	8 Jts. Painted, and Standing Valve.
1-13-23	Working Bbl.and Stand V.

The tubing was pulled on an average of once a month, to replace the lower joints where the water stood in the hole, on June 20-23 six joints of painted tubing were placed on the bottom of the string of tubing and as shown by the data it withstood the action of the salt water for almost three months, then on October 13, 8 joints of painted tubing were used to replace the damaged tubing and at the writing of this report 3-1-24 is still holding out. The same results as shown below hold out for Miller #11 - Sec 2.

Miller # 11 -- 2-28-4.

Date Pulled	Material Used.
3-13-23	5Jts Tubing, Working Bbl, Standing Valve
4-4-23	1Jt Tubing, Standing Valve.
5-24-23	1Jt Tubing, Standing Valve.
6-14-23	8Jts. Painted, Working Bbl, Standing Valve.
8-21-23	Working Bbl, Standing Valve.
9-3-23	Standing Valve.
10-15-23	6Jts. Painted, Standing Valve.
11-12-23	5Jts. Tubing, Standing Valve.
12-14-21-23	40Jts. Tubing parted.

On November 11-23 the tubing was pulled for collar leaks and broken threads and on December 14, the same, but the tubing parted allowing it to fall this time, hence so many joints replaced. This cannot be charged to pulling for corroded tubing as the previous times.

The curves on sheets No. 23424 gives some idea of the rod and tubing trouble from day to day in the different districts.

1

2

3

BOOSTING THE COST OF PRODUCTION

(1) Pulling tubing.

(2) Running Rods.

(3) Pulling tubing. Note: Oil and water spraying as the tubing is being lifted.

The labor charges on pulling and running a string of 3" tubing will average about $28.50. The material charges will vary with different wells and the wear and tear on equipment is no little item. A heavy water well has to be pulled every six or seven weeks to put in a new standing valve as they will not hold up under heavy pumping. E. Varner #6, section 17-28-4, pumps 1500 barrels of water and 90 barrels of oil every 24 hours thru 3" tubing.

At the present time the Company is running a series of tests on the heavy water wells, trying to find a depth where the production will remain about the same, but cut down the pumping time and lifting expence.

WHEN NATURE STEPS IN JUNE 10 TO 16, 1923

This flood was more disasterous and caused greater loss of production than the cyclone in June of 1922, as shown on curves in this report. The damage to equipment and wells was the worst in dristricts #13 and 14 where some 105 wells were flooded.

.WHEN NATURE STEPS IN.
July 10th, '22

The Empire Companies had 378 rigs blown down in this storm beside damage to lease equipment and company houses. See curves for effect on production.

CURVE SHEETS
No. 1 & 2.
Districts # 12-13-14-15 and Total Field.

These curves show the operating conditions of the various districts and the total field from month to month.

The production curves (the black lines) show an average decline of 19½ bbls per month for the period shown in this report. The outstanding variation from the average decline are due to several causes, for instance, in July, 1922 the field suffered from the effects of a cyclone (see pictures) causing a heavy loss of production for two or three months. The winter months shows a small decline below the average decline for 1922-23. District #12 shows quite an increase in production for the months of March and April 1923, this is due to the drilling of one well and deepening of another to the lower pay sand. In June 1923 one of the worst floods on record (see pictures) hit the field, especially is it noticeable in District #13 most of which is in the river bottom. On top of this heavy loss of production the pipe line companies pro-rated the runs from July to November, due to the over-production of the Calif. oil fields and to date the field is still short of the average decline.

One thing noticeable on this curve is, that the production never comes back to normal after any heavy loss of production, this can be accounted for as follows. The field is several years old and the oil sand is flooded with salt water causing a pressure on the sand at all times of some 1,000 pounds per square inch.

The operating cost (the red line) up until November 1923, shows a gradual increase. The months of November and December shows a decrease in cost which was due to the change of operating conditions of the company, at the close of the year.

July 1922 shows a decrease in operating costs, this is due to the cyclone (see pictures) and lack of material to begin work right after the storm, the cost of rebuilding rigs and repairing field equipment is shown on the following few months. The large increase of cost for July and August was due to the flood of June 1923 (see picture).

The cost in cents per bbl (the green line) shows a gradual increase, thus tending to prove that as the production falls off the cost per barrel goes up.

C U R V E-S H E E T S

Nos. 2 & 3.

Districts Numbers 14-15-12-13.

These curves show the actual working conditions in the different districts from day to day.

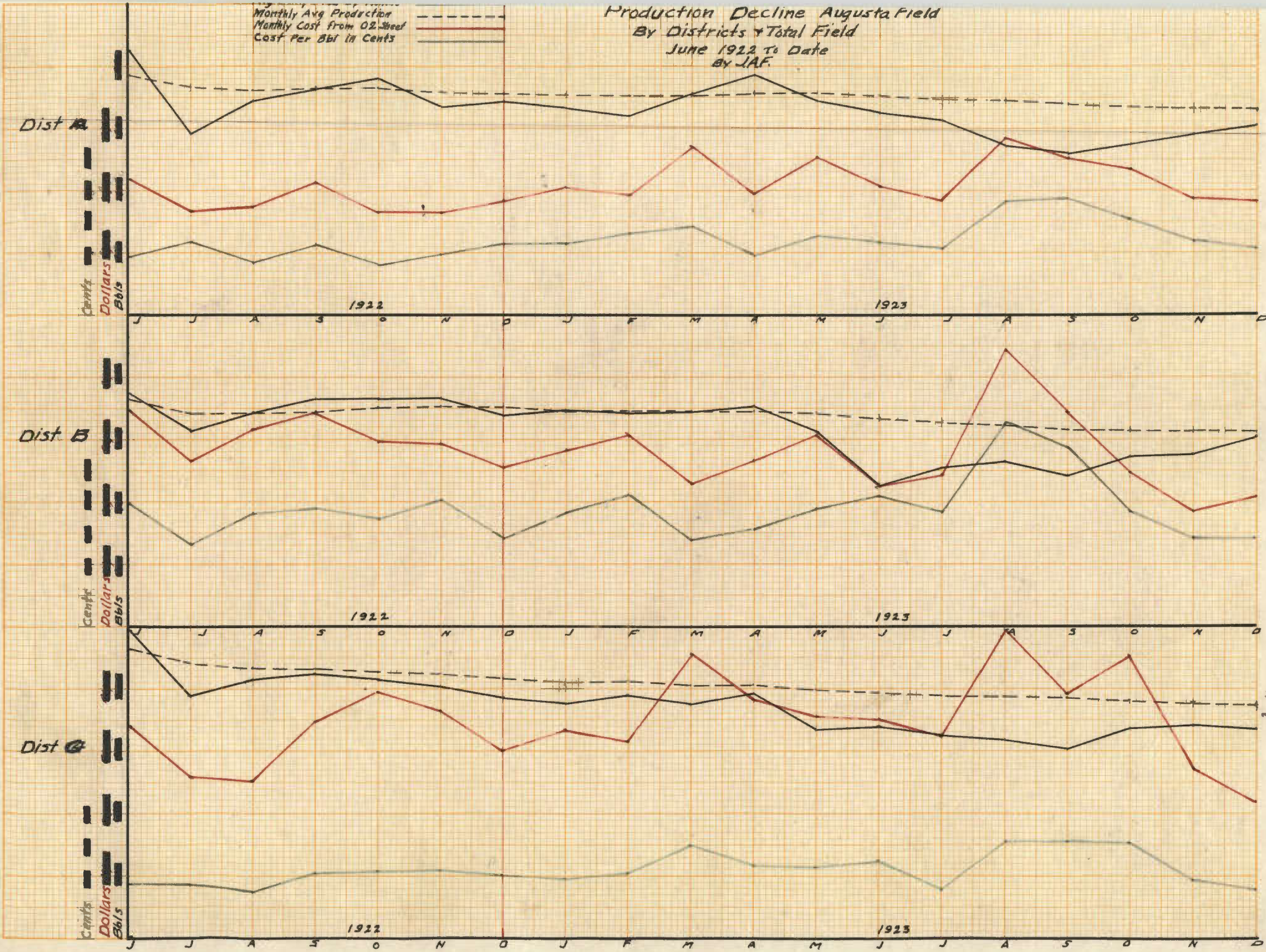
The production (the black line) varies from day to day, depending upon the number of wells down. As the number of wells increases the production decreases, but in District #13 the 15-16 and 17 there is a decided fall in production, while the wells off remain the same. This district, the past year and a half, has fallen off in production more than any other district and it must be due to the salt water flooding the sand. Several of the better wells have decreased in amount of oil and increased a great deal in the amount of water pumped. On the production curves for sheets #1 and 2 it was proven that the production fell after the cyclone and the flood, due to the water flooding the sands, so it stands to reason the water must be responsible for this decline in production. Once the water breaks through the casing or sand it is only a matter of hours, at times, that a well will cease to pump any more oil.

The heavy decline of production in all districts Jan. 1, 2, 3, and 4 was due to a severe blizzard.

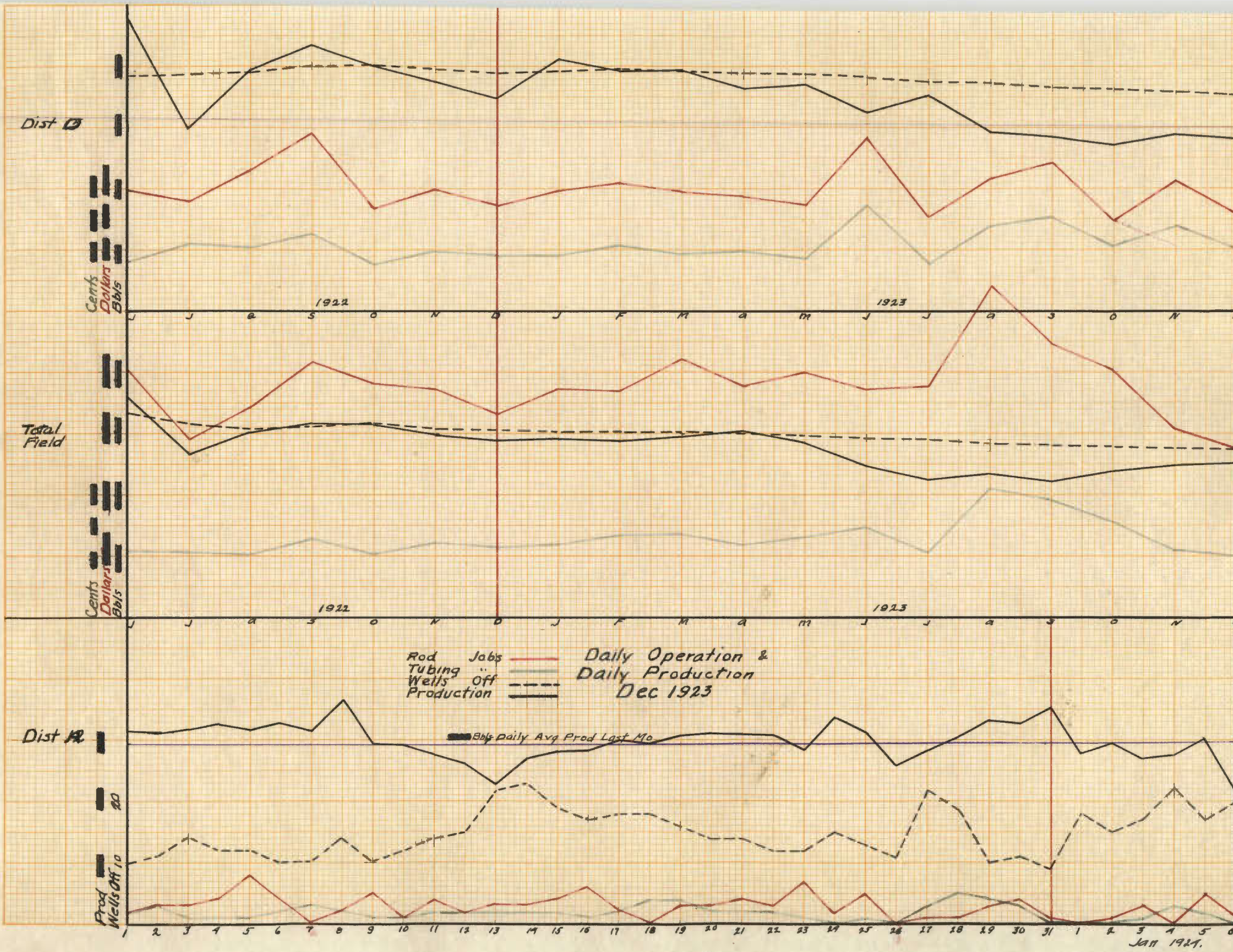
The wells down (dotted black line) shows the actual number of wells off at 7 A. M. each day and may be due to any number of causes, namely, rods parted, tubing jobs, engine trouble, belt trouble, froze up etc. The wells off shows a decided increase during the blizzard of Jan. 1, 2, 3, and 4, due to lead lines and water lines freezing up.

The red and green lines, show the actual number of rod and tubing jobs worked on during the day.

These curves are kept up to date in the production office and any one coming in can see at a glance, without looking through files etc., just what is going on in the field.

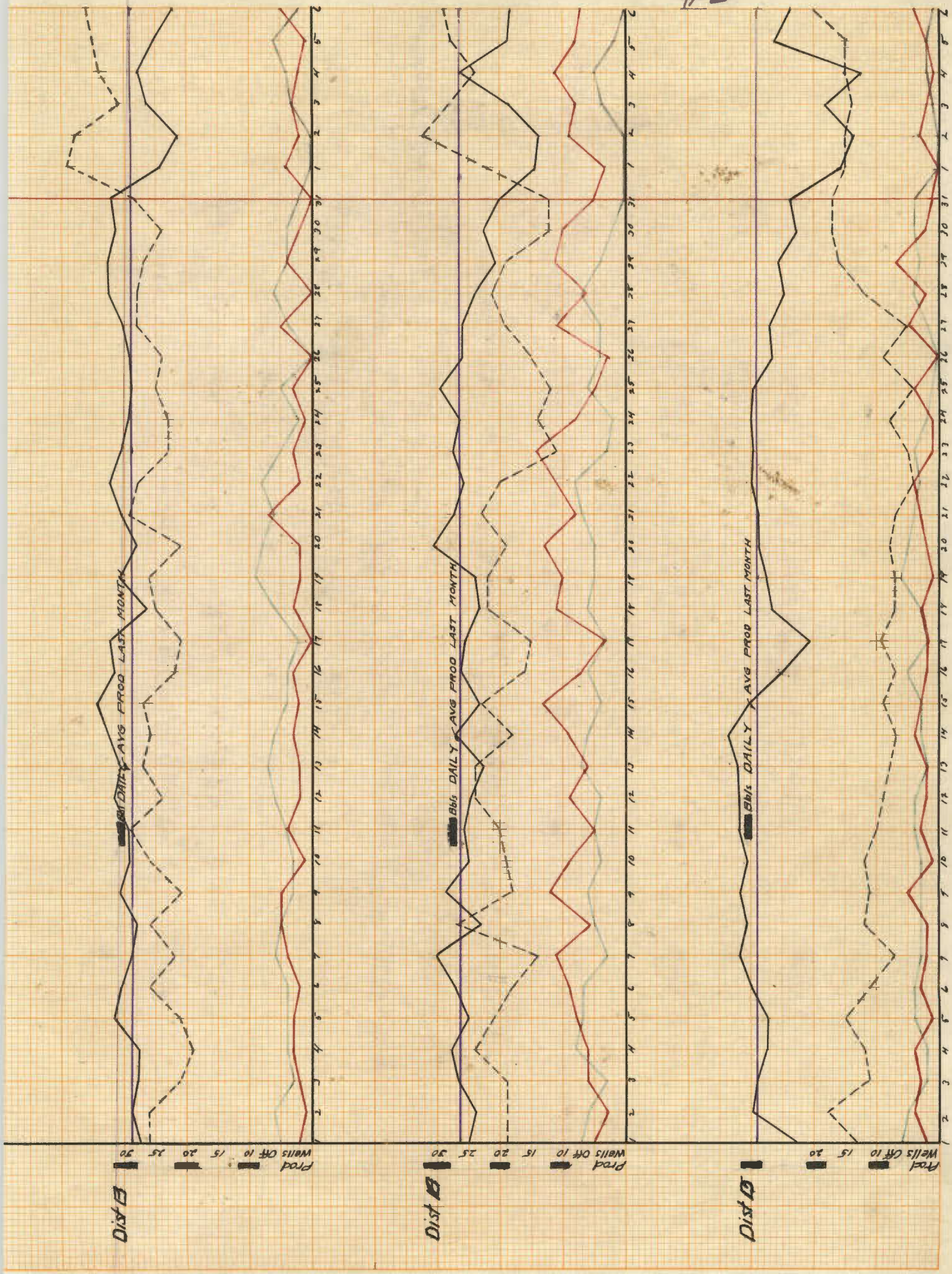

Production Decline Augusta Field
By Districts + Total Field
June 1922 To Date
By J.A.F.
Monthly Avg Production
Monthly Cost from O2 Sheet
Cost Per Bbl in Cents
Dist A
Dist B
Dist C
Cents
Dollars
Bbls
1922
1923
J J A S O N D J F M A M J J A S O N D

#1


Dist [redacted]
Cents
Dollars
Bbls
1922
1923
J J A S O N D J F M A M J J A S O N D
Total Field
Rod Jobs
Tubing "
Wells Off
Production
Daily Operation &
Daily Production
Dec 1923
Dist [redacted]
Bbls Daily Avg Prod Last Mo
Prod Wells Off
20
10
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 1 2 3 4 5 6
Jan 1924.

#2

#3


Dist [redacted]
[redacted] Bbls DAILY AVG PROD LAST MONTH
Prod [redacted] Wells Off 10 15 20 25 30
Dist [redacted]
[redacted] Bbls DAILY AVG PROD LAST MONTH
Prod [redacted] Wells Off 10 15 20 25 30
Dist [redacted]
[redacted] Bbls DAILY AVG PROD LAST MONTH
Prod [redacted] Wells Off 10 15 20

Rod Jobs, Tubing Jobs And Wells Off. Dist's
#14-15-12 & 13. December 1923 to Jan. 6, 1924.

Month	Days	#14 Rod Jobs	#14 Tub Jobs	#14 Wells Off	#15 Rod Jobs	#15 Tub. Jobs	#15 Wells Off	#12 Rod Jobs	#12 Tub. Jobs	#12 Wells Off	#13 Rod Jobs	#13 Tub Jobs	#13 Wells Off
Dec.	1	2	2	10	2	5	26	5	7	19	2	6	15
	2	3	3	11	1	6	26	3	6	19	4	5	18
	3	3	1	14	2	3	31	5	3	19	3	2	11
	4	4	1	12	3	5	19	6	8	24	4	2	12
	5	8	1	12	3	4	21	8	7	21	1	4	15
	6	4	2	10	2	4	26	9	7	18	3	4	11
	7	6	3	10	4	6	22	11	3	14	2	3	7
	8	2	2	14	5	5	26	6	5	27	2	3	12
	9	5	1	10	5	3	21	12	6	18	9	3	11
	10	1	1	12	1	3	26	9	4	19	1	3	12
	11	4	2	14	4	4	29	5	5	20	3	4	10
	12	2	2	15	2	6	24	9	4	24	2	4	9
	13	3	2	22	2	7	27	6	7	24	2	2	8
	14	3	2	23	5	6	26	9	6	18	4	3	7
	15	4	2	19	2	4	27	13	4	25	3	3	9
	16	6	1	17	5	4	22	7	6	16	2	5	7
	17	2	2	18	8	3	21	5	3	15	2	2	9
	18	0	4	18	5	6	25	11	6	22	3	5	7
	19	3	4	16	2	9	26	10	5	22	1	6	7
	20	3	2	24	2	8	21	13	5	19	2	5	8
	21	4	2	14	7	6	29	8	7	23	3	4	7
	22	3	2	12	2	8	28	11	8	20	4	3	4
	23	7	1	12	3	5	23	14	3	11	1	4	5
	24	2	0	15	1	2	25	8	2	14	1	2	8
	25	5	1	13	3	5	25	5	6	12	4	1	4
	26	0	0	11	0	0	24	3	5	15	0	0	9
	27	1	3	22	5	4	28	11	4	19	5	2	5
	28	1	5	19	0	6	28	6	7	21	2	4	12
	29	3	4	10	4	4	27	11	4	19	7	3	16
	30	4	3	11	2	4	24	10	2	12	2	4	17
	31	1	0	9	0	2	28	5	0	12	1	4	17
Jan.	1	0	0	18	4	0	30	3	0	22	0	0	15
	2	1	0	15	2	0	38	9	0	32	3	0	15
	3	3	1	17	3	3	31	8	4	28	2	1	14
	4	0	3	22	2	4	34	11	5	24	1	2	15
	5	5	2	17	1	6	35	8	2	28	2	2	15
	6	1	0	20	5	2	26	7	0	29	0	1	20

E L E C T R I C I T Y

in the

OIL FIELDS.

To the engineer who has observed the changes in operating conditions and practices in the oil fields the past few years, no doubt has noticed the decided tendency toward more efficient management and operation of the properties, particularly among the larger companies. Electric power is playing a large part of this, both directly and indirectly, and everywhere used is showing its superiority.

Where it is available to an oil field it is used extensively to drive water pumps, pipe line pumps, gathering line pumps as well as being used for power in machine shops, electric welding and general lighting purposes. The greatest as well as the most important is in drilling wells and in maintaining them as producers by pumping, pulling and cleaning out.

The Empire Gas and Fuel Company was the pioneer in the using of motors for drilling purposes in the mid continent oil fields. At first such an undertaking was questioned by the field men. Thanks to the engineer for entering the oil business. It is through the trained engineer that many new ideas have found their way into oil field practices. This company has ceased to use steam for drilling or cleaning out purposes in the El-Dorado Kansas fields.

The company kept complete data of its first Electric drilled well, which is itemized on page #36. This report speaks for itself and compared to the average cost for steam drilling in the ElDorado field, shows an average saving of $1,$85 or an average of some $46.00 a day actual drilling time on fuel alone.

The Nevada Ventura Oil Syndicate in the Signal Hill oil field at Long Beach, California operated an electrically driven rotary rig for 31 days in January, 1922, with a 75 HP motor on the draw works, a 50 HP motor on the slush pumps and a ½ HP motor on the blower. The power bill was $501.00 or an average of $16.16 per day. A steam driven rig, operating across the road from this well and burning oil under the boiler averaged $92.00 per day for oil fuel and boiler feed water during the same month. Both rigs ran throughout the month and made about the same amount of hole per day. The San Martinez Oil Company on an electric drilled well averaged $15.81 per day, power cost, for 38 drilling days.

On the completion of a well drilled with Electric power, the salvage or reclaim valve of equipment is estimated at about 90% while steam equipment is worth considerably less.

The operation of producing wells is usually where the big end of the cost of production originates. The more rods and tubings have to be pulled, the greater the wear and tear on equipment. To lay claim to superiority for this work, as the saying goes, the engines must deliver the goods. It has become generally recognized that steam power is far from the best in these respects, and the question has narrowed down to a consideration of the gas engines and the electric motor.

A true comparison involves many factors, the value of which can best be determined by actual experience.

The mere fact that gas is available on a lease does not make the gas engine the logical or the most successful type of power equipment for pumping the wells. The cost of operation is usually the determining factor, but safety, convenience, speed regulation, and reliability must be considered.

Some think that electric equipment is dangerous about an oil field, but the standard modern methods of insulation and wiring used give full protection and prastically eliminates danger.

On the other hand, the gas engine is not free from danger. Men have been seriously injured and even killed by getting caught in the fly wheels trying to start them. The Empire Companies have found that fully a third of its accidents to employes are due to this cause alone.

Reliability in service is measured by the time lost due to preventable troubles to a great extent, especially is it true during the winter months. The effect of cold weather is shown elsewhere in this report on the production curves of the Augusta, Kansas fields. Cold weather does not affect motors but sure plays havoc with gas and water lines. This Company has found that from 4½ to 8% of the available pumping time was lost due to gas engines troubles while with electric motors the loss was from less than 1% to about 2%.

It is a matter of common knowledge that a new gas engine will operate two or three years with very little trouble but after that, repairs increase rapidly. For the first five months of 1922 this Company gave this cost as

$24.14 per engine per month, which was an average for 367 engines, while the average for 241 motors the same length of time was $4.64. The last six months of 1923 the average cost of 297 gas engines per month was $42.93 for the Augusta Kansas field.

The gas engine cost is one of the major items in the Augusta field, due to the presence of salt water in the oil sand. This causes a great deal of damage to rods and tubing, causing an excessive amount of pulling.

The Empire Companies is one of the few operating companies in the mid continent oil fields using electric pumping equipment and one of the pioneers in using motors for drilling purposes. In October, 1918, 26 oil wells in the ElDorado field were operated by electricity and at the present time there are some 650 wells being pumped by motors.

An electrical oil well pumping outfit consists of a 15-30 HP G. E., 3 phase, 440 volt, 60 cycle induction motor, with grid resistances, oil switch, controller, etc, to give a variable speed for pumping and pulling purposes.

An electrical drilling outfit consists of essentially the same as the pumping outfit, only a 75 HP motor is used.

The results of using electrical pumping equipment as shown by the following curves are not strictly the actual results of operation but are those shown by the daily reports. Due to the fact that the reports were somewhat misleading, they were not turned in correctly. For instance a well pumping off in 18 hours was not credited with the full pumping time but rather was charged with being off 6 hours per day, when in reality it pumped 100% of the available pumping time. Other such descrepancies in the daily report make the results somewhat incorrect.

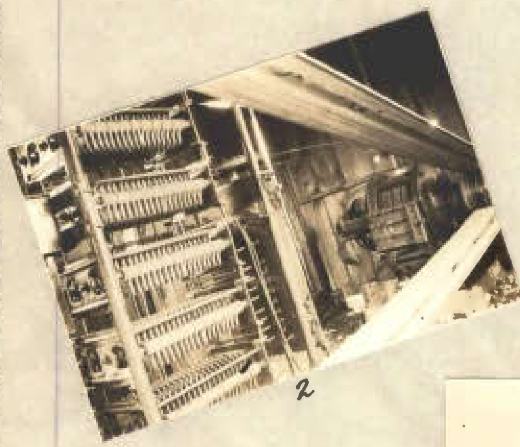
Form EL 3H-10M-8-26

A log showing the comparative cost of drilling by electricity and steam follows:-

Stokes #27	Boiler & Engine	Motor	Loss	Saving
Initial Cost	1,862.00	1,625.00		237.00
Cost of instillation (Inc. belts etc)	432.00	768.03	335.53	
Estimated depreciation per well	290.00	32.50		257.50
Cost of water (day	480.00	60.00		420.00
Estimated cost of fuel oil at $36 per	2,160.00			
Cost of electric power		574.93		
Saving in cost of power				1,585.07
Saving in installing pumping motor in same house or on same foundation				186.16
Saving in oil production during change of pump				1,305.00
Total			335.53	3,990.73
Net estimated saving of electric drilling over steam				3,655.20

The installation charge of the motor equipment was high, due to the fact that equipment was new and changes had to be made which involved labor charges that will be unnecessary in the future outfits. It also includes the cost of building of motor house.

4



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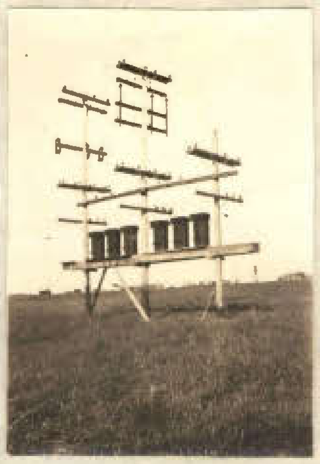


1

EL DORADO KANSAS OIL FIELDS

(1) Typical high line and field transformer installation.

(2) 15-30 H. P. Pumping Motor.

(3) 75 H. P. Drilling Motor.

(4) A Motorized Field

Curve Sheet #1.

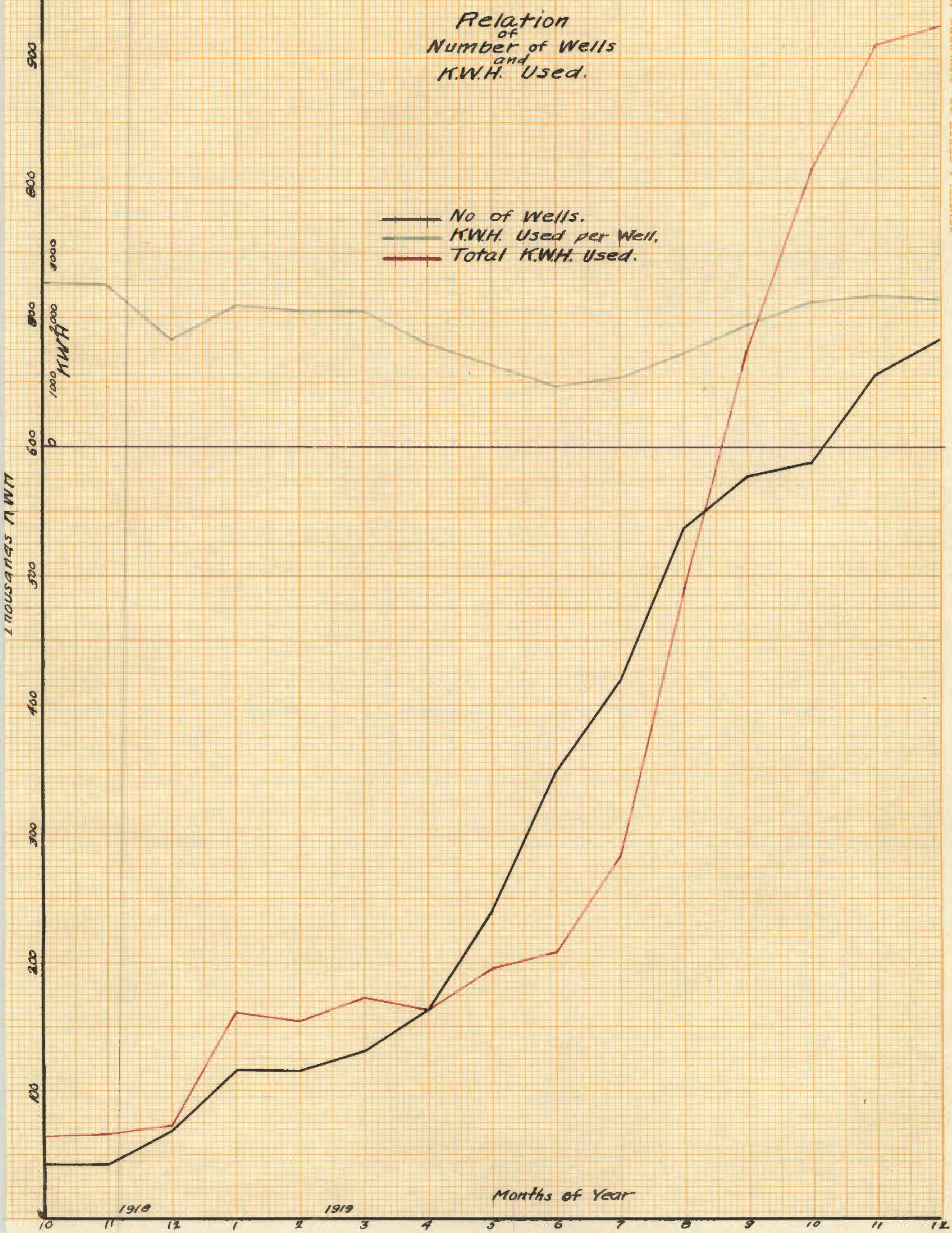
Relative to number of wells and K. W. H. used.

This sheet shows that as the number of wells increases the total K. W. H. used increases also. The two curves rise very nearly together.

The green curves shows the K. W. H. used per well from month to month. Theoretically this should be a line gradually sloping down as the number of wells increases. The curve shown tends to approach the theoretical line.

FORM 202

MONTH 1918	NUMBER OF WELLS	K.W.H. USED PER WELL	K.W.H. USED TOTAL
OCT.	26	2565.	66700.
NOV.	27	2570.	69410.
DEC.	43	1709.	73500.
1919			
JAN.	71	2299.	163260.
FEB.	71	2206.	156500.
MAR.	80.	2197.	175720.
APR.	98	1689.	165550.
MAY	147	1339.	198860.
JUNE	210	1002.	210340.
JULY	252	1142.	287750.
AUG.	325	1519.	493490.
SEPT.	350	1952.	683140.
OCT.	355	2307.	819098.
NOV.	396	2316.	917190.
DEC.	413	2259.	932906.


Relation
of
Number of Wells
and
K.W.H. Used.
No of Wells.
K.W.H. Used per Well.
Total K.W.H. Used.
Thousands KWH
KWH
Months of Year
1918
1919
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
100
200
300
400
500
600
800
900
0
1000
2000
3000

Curve Sheet #2.

Time Off Per Well And The Causes

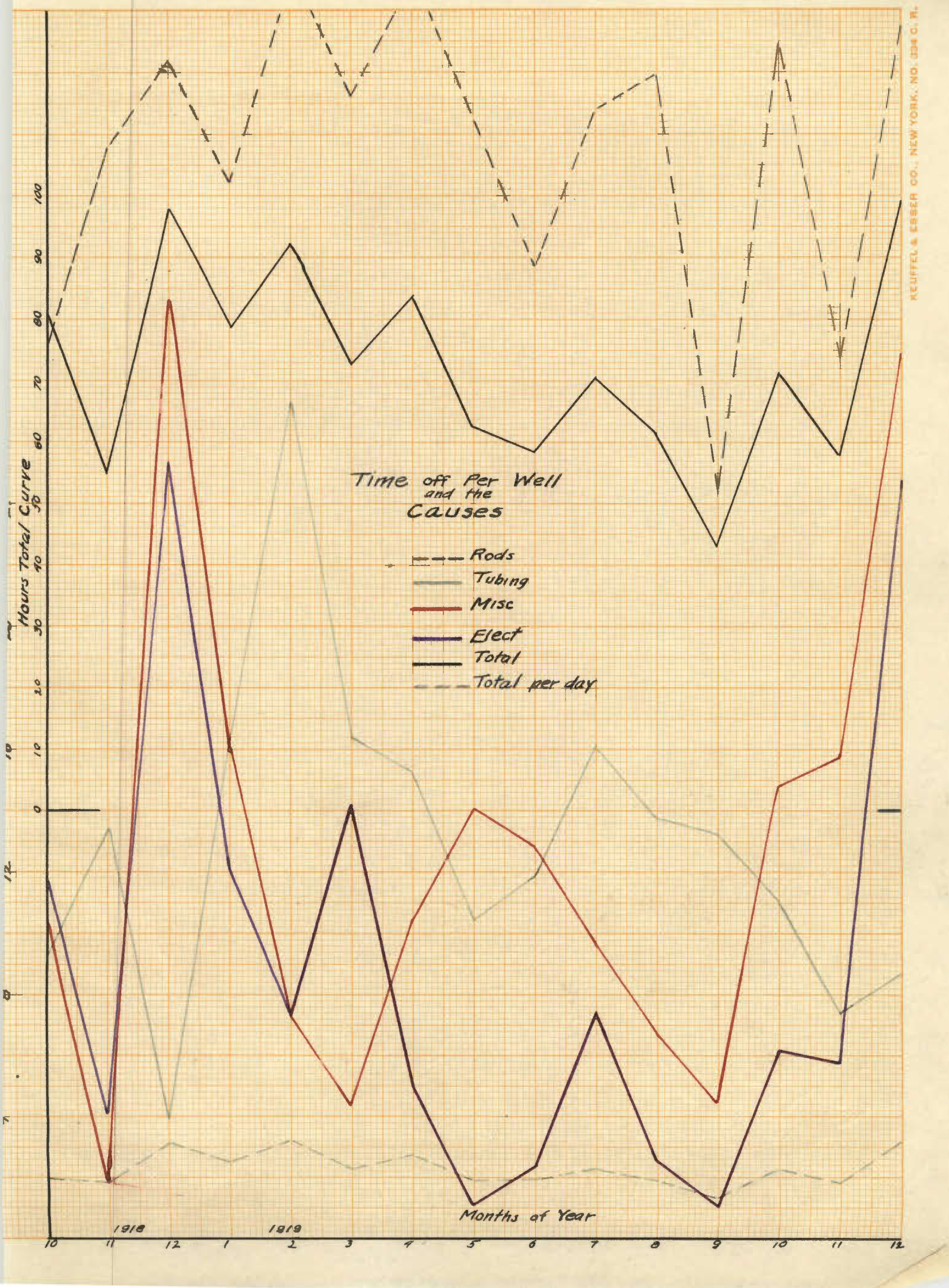
This sheet shows the relative time lost per well due to the various causes. More time is lost due to rods than any other one cause. Next comes tubing and then miscellaneous causes. The lowest is that lost on the account of electrical trouble. This line would be very much lower had it not been necessary to shut off the power on several occasions to make new installation and alterations.

The ~~violet~~ Dotted Green line showing the total time lost per day per well, is a fairly straight line showing that the total time lost due to all the causes averages up to about the same figure each month.

Form EL 38-10M-8-29

MONTH	TIME OFF PER WELL DUE TO RODS	TIME OFF PER WELL DUE TO TUBING	TIME OFF PER WELL DUE TO MISC.	TIME OFF PER WELL DUE TO ELECT'Y	TIME OFF PER WELL	TIME OFF PER DAY PER WELL
1918						
OCT.	29.5	9.4	10.7	12.1	62	2.0
NOV.	35.9	13.5	1.6	3.8	55	1.9
DEC.	38.7	13.9	30.9	25.3	99	3.2
1919						
JAN.	34.6	16.4	16.3	12.1	79	2.6
FEB.	31.5	27.1	7.2	7.1	93	3.3
MAR.	37.4	16.4	4.4	14.2	73	2.3
APR.	52.7	15.3	10.4	5.0	84	2.8
MAY.	36.8	10.5	14.1	1.1	63	2.0
JUN.	31.8	11.9	12.9	2.4	59	2.0
JUL.	36.9	16.1	9.8	7.4	71	2.3
AUG.	38.1	13.8	6.9	2.6	62	2.0
SEPT.	24.3	13.3	4.5	1.1	44	1.4
OCT.	39.2	11.1	14.9	6.2	72	2.3
NOV.	28.7	7.5	15.8	5.9	58	1.9
DEC.	39.4	8.7	27.7	25.8	100	3.2

Form EL 38-10M-8-20

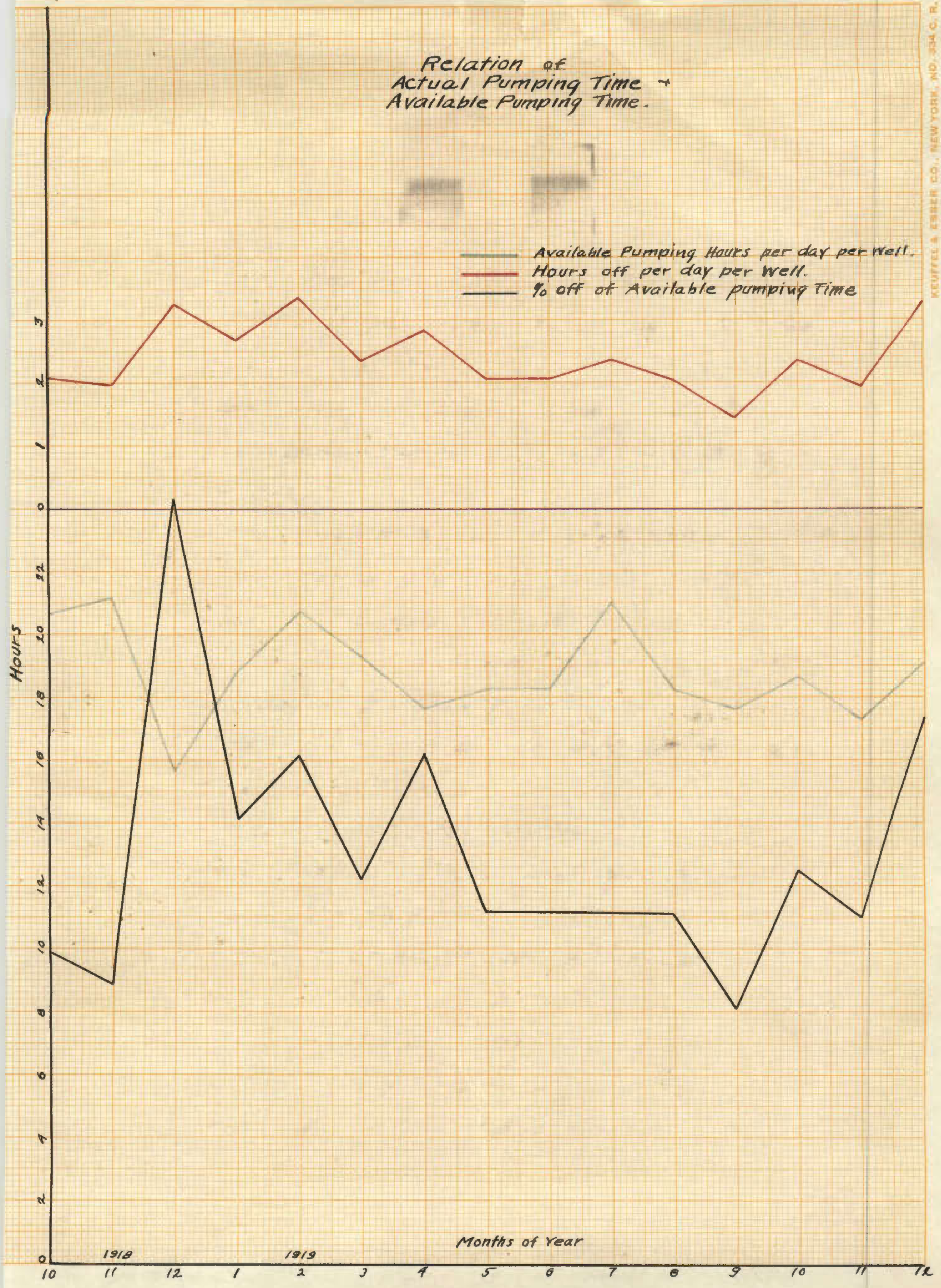

Time off Per Well and the Causes
Rods
Tubing
Misc
Elect
Total
Total per day
Hours Total Curve
Months of Year
1918
1919
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
100
90
80
70
60
50
40
30
20
10
0
KEUFFEL & ESSER CO., NEW YORK. NO. 334 C. R.

Curve Sheet #3.

Relative to actual pumping time & available pumping time

This sheet shows the available pumping time each month, compouted on the average time it takes each well to pump off, the amount of time the well was not pumping and fron these the percent of the availble time actually lost during the month.

MONTH 1918	AVAILABLE PUMPING HOURS PER DAY PER WELL	HOURS OFF PER DAY PER WELL	PERCENT OFF OF AVAILABLE PUMPING TIME
OCT.	20.5	2.0	9.7
Nov.	21.0	1.9	8.7
DEC.	15.6	3.2	24.1
1919			
JAN.	18.7	2.6	13.9
FEB.	20.6	3.3	16.0
MAR.	19.1	2.3	12.0
APR.	17.5	2.8	16.0
MAY	18.1	2.0	11.0
JUN.	18.1	2.0	11.0
JUL.	20.9	2.3	11.0
AUG.	18.1	2.0	11.0
SEPT.	17.5	1.4	8.0
OCT.	18.5	2.3	12.4
NOV.	17.4	1.9	10.9
DEC.	18.9	3.2	16.9


Relation of
Actual Pumping Time +
Available Pumping Time.
Available Pumping Hours per day per well.
Hours off per day per well.
% off of Available pumping Time
Hours
3
2
1
0
22
20
18
16
14
12
10
8
6
4
2
0
Months of Year
1918
1919
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12

STOPPING EVAPORATION LOSS

It is well known to every producer of oil that there is a large and constant loss of oil from stock tanks through evaporation. Just what this loss amounts to on any given lease has never been accurately determined. The only present and easily determined method is that of gauging the tanks.

The average stock tank is of 250 Bbl capacity approximately 15' in diameter by 8' high. In such a tank the summer loss by evaporation, measured by gauging the tank is usually around 1" or more per day for 34 degrees gravity. The higher the gravity the greater the loss. Measured in barrels of oil by gauge this is a loss of 2½ barrels and up for oil in stock tanks.

To determine what the total loss of oil on the lease may be, from well to pipe line, would require accurate metering of the oil as it comes from the ground. The greater loss is in the open gun barrels and flow tanks, where the oil is allowed to spray as it runs over.

Oil is held in stock tanks for varying periods of time waiting for gauger to turn the tanks on. Evaporation is practically continuous as long as there is oil in the tank, whether it is being filled, standing full, or being run.

The Bureau of Mines in their Bulletin 200, which is well worth careful study, gives some interesting data on evaporation losses as follows:

Location of Loss	Summer	Autumn or Spring	Winter	Average
Flow tank	1.2	1.0	.8	1.0
Filling lease tanks	1.2	1.0	.8	1.0
Lease Storage	1.8	1.4	1.2	1.5
Gathering	1.3	.9	.8	1.0
Transportation	1.2	.9	.8	1.0
Tank Farms	.9	.7	.6	.7
Total	7.6	5.9	4.9	6.2

Note that the producer stands better than half the evaporation losses. According to the Chicago bridge and iron works of Chicago Ill, standing storage evaporation in 55000 barrel tanks varies from $1,600 to $10,000 a year for mid continent crude oil—33 degrees to 36 degrees gravity, or in barrels of oil 750 to 3500 barrels a year.

Evaporation losses were never considered until the past few years, by any of the producing companies. But tests and experiments of vapor proof tanks have proven to be a paying proposition both in amount of oil saved and increasing the price where the oil is sold on gravity basis.

The Empire Companies spent thousands of dollars the past summer setting vapor proof tank batteries. As shown by curves following, vapor proof tank installation increases the gravity of the oil, that is the light oil or gasoline is held, instead of evaporating into the air.

The question might be asked, will the new installation pay for themselves? The cost of the new batteries on No onet, Tullace and three Leases are as follows:

Onet ------------$1775.00

Tullace ------------$2195.00

Three ------------$1550.00

The average daily Production of the above leases are as follows:

Onet ------------ 115 Bbls.

Tullace ----------- 100 Bbls.

Three ------------ 40 Bbls.

The difference in prices of the two gravities of oil is 50¢ per barrel or an average per Lease per day as follows:

One ---------------- $34.50

Two ------------- $30.00

Three -------------- $12.00

Dividing the cost of installation by the average gain per day give the following as the number of days to pay out.

One ----------Approximately 52 days.

Two --------Approximately 73 days.

Three ----------Approximately 150 days.

The average production of the Augusta field for six months ending January 31, 1924, was 2361. With few exceptions, the vapor proof tanks put the pipe line oil into the next higher gravity rating, this represents an increased earning of some $21,000 per month for the field.

VAPOR PROOF INSTALATION

A typical tank battery setting of the Empire Companies

Brant Lease, section 2-28-4E. Butler County, Kansas.

CURVES
Showing

Valve of Vapor proof tanks over open tanks.

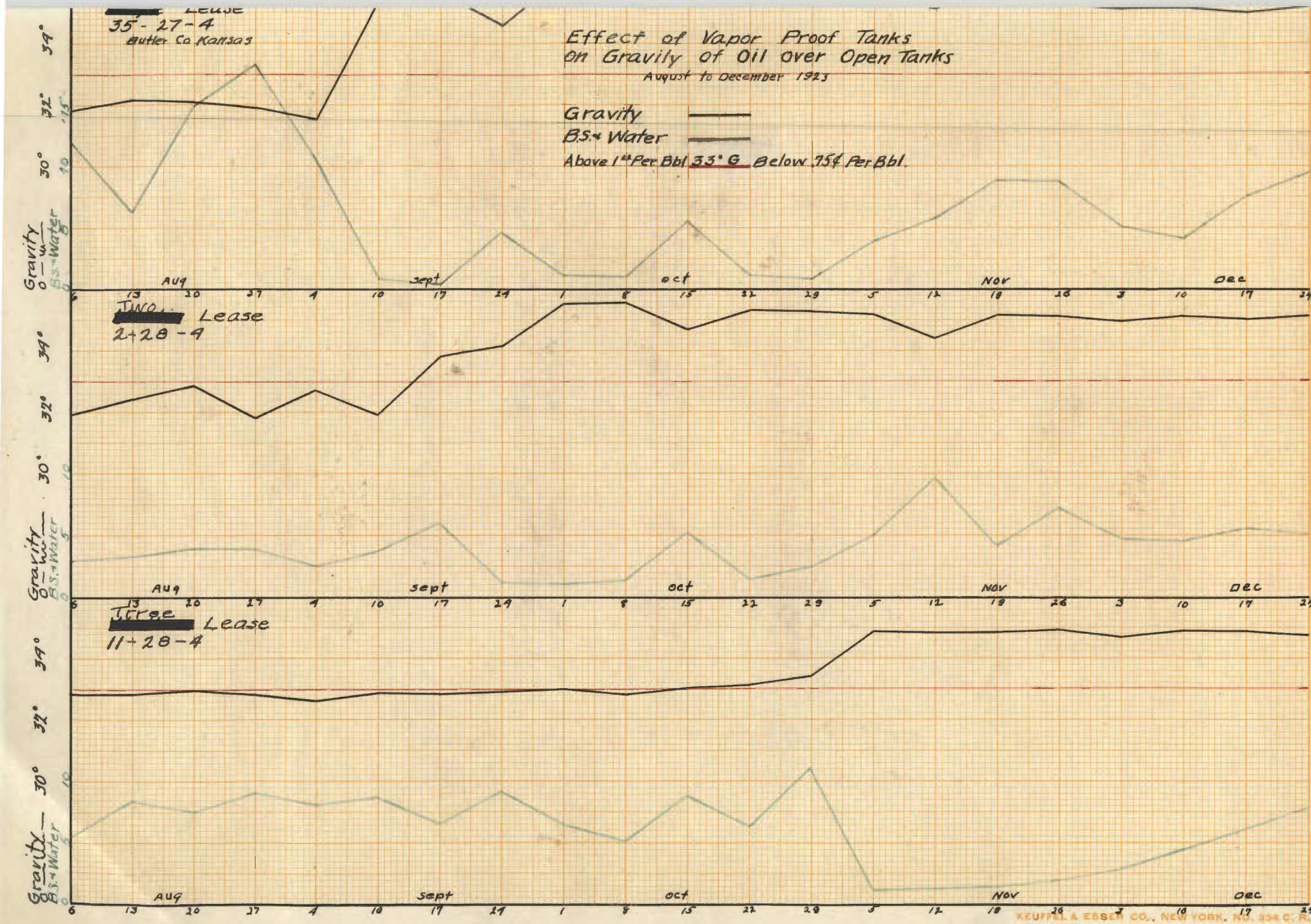
This sheet shows how the lighter oils are saved, when confined in an air tight tank, thereby increasing the valve as well as quantity of oil sold to the pipe line companies.

The black lines show the ratio of increase in gravity between open and vapor proof tanks.

The green lines show the percentage of Base Settlings and water in the oil.

The red lines show the value of 33 degrees gravity oil at the time of gathering this data.

The gravity readings and % B. S. and water, is in each case the average of the number of tanks of oil run for the week ending as shown under each month.


Effect of Vapor Proof Tanks
on Gravity of Oil over Open Tanks
August to December 1923
Gravity
B.S.+ Water
Above 1¢ Per Bbl 33° G Below 75¢ Per Bbl.
[redacted] Lease
35-27-4
Butler Co Kansas
Two [redacted] Lease
2+28-4
Three [redacted] Lease
11+28-4
Gravity
B.S.+Water
34°
32°
30°
15
10
5
0
Aug
Sept
Oct
Nov
Dec
6
13
20
27
4
10
17
24
1
8
15
22
29
5
12
19
26
3
10
17
24
KEUFFEL & ESSER CO., NEW YORK, NO. 334 C. R.

Form EL 38-10M-8-29

Month	Week Ending	One [redacted] LEASE 35 - 28 - 4 B.S.& Water	Gravity	Two [redacted] LEASE 2 - 28 - 4 B.S.& Water	Gravity	Three [redacted] LEASE 11 - 28 - 4 B.S.& Water	Gravity
August	6	11.8	31.6	2.8	31.9	5.3	32.8
"	13	6.2	32.1	3.1	32.4	8.2	32.8
"	20	14.6	32.0	3.8	32.8	7.3	32.9
"	27	18.3	31.8	3.8	31.8	8.8	32.8
September	4	10.4	31.5	3.3	32.7	7.8	32.6
"	10	.6	35.4	3.6	31.9	8.1	32.8
"	17	.5	35.6	8.0	33.8	5.4	32.8
"	24	4.6	34.6	1.1	34.1	9.0	32.9
October	1	1.1	36.2	.9	35.5	6.4	33.0
"	8			1.2	35.5	5.1	32.8
"	15	5.5	35.5	5.1	34.7	8.7	33.0
"	22	1.1	36.1	1.4	35.3	6.3	33.1
"	29	.9	35.9	2.8	35.3	11.0	33.4
November	5	.4	35.5	4.8	36.2	1.1	34.8
"	12	5.8	36.2	9.5	34.4	1.2	34.8
"	19	8.8	35.7	4.1	35.1	1.3	34.9
"	26	8.8	35.3	7.2	35.1	1.4	34.7
December	3	5.1	35.2	4.7	35.0	2.8	34.9
"	10	4.1	35.2	4.6	35.1	4.4	34.9
"	17	7.6	35.0	5.5	35.0	.6	34.9
"	24	8.4	35.2	5.0	35.2	7.8	34.8

The gravity and % of B. S. and water shown is the average of the weeks production run off each lease.

Production Department
Empire Gas & Fuel Company
Augusta Kansas
Crude Oil Production Costs
Augusta Field

BROWN LEASE

- - - - - - -

Operation and Maintenance

June 1, 1922 Augusta, Kans.

Form EL 38-10M-8-20

Crude Oil Production Costs

Augusta, Kansas

BROWN LEASE

Report

Contents

Form EL 38-10M-8-20

(3)

Empire Gas & Fuel Co.,
Production Department,
Augusta, Kansas.
May 31st, 1922.

Mr. D. W. Williams,
Augusta, Kansas.

Dear Sir:-

I herewith submit, for your approval, the operating and Maintenance costs of the W. E. Brown Lease, section 16, Augusta Field,

Cost analysis requested as follows:

1 Cost per barrel.

2 Cost per well.

3 Charges per different accounts.

This report was prepared from the following costs.

Labor Cost were taken from the daily time slips, as charged against Brown Lease. No costs above Farm Boss salary were included.

Material Material distribution charges were made from Warehouse charge Tickets, per request of Farm Boss, through field warehouse orders. Prices for material were obtained from pricing Dept., at Bartlesville.

Fuel & Water Cost for pumping and pulling wells charged as follows:
Pumping 250 cu feet per hour.
Pulling 400 cu feet per hour.
At a cost of 20¢ per M cu feet.
Water was charged as follows:
2½ barrels per well, per day at a cost of .01¢ per barrel.

Shop Orders All costs for labor and material charged by Machine Shop, Planing Mill Dept., and Transportation are included in this report. Drilling & Fishing cost are not included in this report. Shop Orders issued during tests period, only, are considered and those not completed were estimated from similar ones.

(3)
Cont.

<u>Production</u> The figures representing barrels of oil produced were taken from the daily production tickets, allowing 6½% for water, which is the average for the period as shown by the Chemical analysis report.

Respectfully,

John A. Frost.

P. S. The May charges for two clean out strings, working on, Brown wells #10 and 14 amounted to some $1,397.81, which does not include gas or water. To date these jobs have over run their estimates by some $3700.00 which has to be borne by the lease and materially cuts down the earnings of the lease.

(4)

Crude Oil Production Cost

District No. 13.

Operation and Maintenance only — April 29 to May 28, Inc. — Brown Lease Sec. 16. Augusta, Kansas.

Labor Farm Boss	17/54 of $175.oo	55.08	
Head Rousta	17/54 of $150.oo	47.26	
Pumpers	4 at $115.oo	460.00	
Lease Team and wagons	17.54 of $150.oo	47.26	
			$609.60
Roustabouts			
(a) K1120		493.99	
(b) K1122		18.94	
(c) K1160		15.77	
Oil distribution (Field)		55.50	
			$584.20
Lease Cgs.			
Labor		21.92	
Material		39.21	
Transportation		60.70	
			$121.83
Transportation		55.00	$55.00
Power			
Water		11.25	
Gas		273.71	
Oil		78.00	
			$362.96
Material			
(a) K1121		560.75	
(b) K1123		82.71	
(c) K1161		8.89	
			$652.35
Miscellaneous			
Shop Orders			
(a) Material-Machine Shop		46.30	
-Planing Mill		122.33	
(b) Labor - Machine shop		51.29	
- Planing Mill		29.00	
			$156.32
Total			$2542.26
Bbl Production		4820 bbls	
Cost per barrel			.527

Form EL 38-10M-8-20

(5)

Well Operation-
Gas & Water

Well No.	Hrs.Pump	Hrs.Pull	M cu ft gas	Amt.	Water	Amt.
4	186	-0-	46.5	9.30	75	.75
5	223	39	7.35	14.27	75	.75
6	679	18	176.95	35.39	75	.75
7	607	30	163.75	32.75	75	.75
8	220	16	61.4	12.28	75	.75
9	116	23	38.2	7.64	75	.75
10	C.O.String					
11	100	-0-	25.	5.00	75	.75
12	109	15	33.25	6.65	75	.75
13	107	22	35.65	7.13	75	.75
14	25 C.O.S.	-0-	6.25	1.25	—	—
15	514	27	139.3	27.86	75	.75
16	214	49	73.3	14.66	75	.75
17	405	84	134.85	26.97	75	.75
18	580	20	153.	30.60	75	.75
19	121	-0-	30.95	6.09	75	.75
20	703	9	179.35	35.87	75	.75
Total	4909	361	1372.55	273.71	1125	11.25

Form EL 38-10M-8-29

(6)

Well Operation
Labor

Well No.	K115	K1120	K1122	K1160	K1145 x 13
4	31.35	10.95	2.05	.69	.69
5	31.35	60.79	7.21	.69	.69
6	31.35	39.10	2.05	.69	.69
7	31.35	39.22	2.87	1.53	.69
8	31.35	29.04	2.05	.68	.68
9	31.35	34.98	2.05	.68	.68
10	O.O.S				
11	31.35	8.94	2.05	.68	.68
12	31.35	29.58	3.77	1.54	.68
13	31.35	39.25	5.69	.68	.68
14	O.O.S				
15	31.35	31.95	2.04	.68	.68
16	31.35	58.30	2.04	.68	.68
17	31.35	114.27	2.04	.68	.68
18	31.35	32.90	11.64	.68	.68
19	31.35	8.95	2.04	.68	.68
20	31.34	18.64	2.04	.68	.68
Total	470.24	556.84	49.63	26.01	10.24

Form EL 38-10M-8-29

(7)

Well Operation
Material etc.

Well No.	K1118	K1121	K1123	K1156	K1161 x 13
4	5.52	50.86	.40	8.12	.60
5	5.52	6.22	6.83	8.12	.60
6	5.52	9.71	.40	8.12	.60
7	5.52	4.06	19.30	8.12	.60
8	5.52	4.06	23.43	8.12	.60
9	5.52	4.06	.40	8.12	.60
10	C.O.S				
11	5.52	4.06	.40	8.12	.60
12	5.52	5.89	.41	8.12	.60
13	5.52	.540	.41	8.12	.60
14	C.O.S				
15	5.52	4.07	.41	8.12	.60
16	5.52	40.84	.41	8.12	.60
17	5.52	4.07	2.03	8.13	.60
18	5.52	4.07	31.52	8.13	.60
19	5.52	4.07	2.03	8.13	.60
20	5.51	4.07	.41	8.13	.60
Total	82.79	155.51	88.79	121.84	17.89

Form EL 38-10M-8-20

(8)

Well Operation
Total Costs

Well #	Labor	Material	Total Cost	Est. Prod.	Cost per barrel
4			121.26	120	1.01
5			143.04	260	.55
6			134.37	476	.28
7	18.11	14.32	179.19	1616	.11
8	4.71	R 27.71	95.56	224	.43
9			96.83	81	1.21
10 C.O.S					
11	33.31	123.78	225.24	240	.94
12			94.86	335	.28
13	24.16	34.36	93.38	168	.55
14 C.O.S					
15			114.03	189	.60
16			163.95	360	.45
17			197.09	126	1.56
18			158.44	392	.40
19			70.89	1	70.89 *
20			108.72	232	.47
Total	80.29	76.03	2542.26	4820	.527

* Since the writing of this report this well has been plugged and abandoned due to the excessive cost per barrel.