Power Line Loss Determination and Analysis

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Echometer Company
1. Sensors can be mounted permanently in the electrical box with a water-tight connection on the side of the electrical box for attachment of a small plug-in radio for wireless communication to a PC and base station.

2. Measurements can be performed without opening the electrical box.

3. In addition, starter boxes without permanent mounted sensors can be analyzed using portable sensors that require opening the box and attachment of two current and three voltage sensors.

4. Wireless high-frequency motor power-current-voltage measurements are used to analyze the electrical and mechanical performance of pumping units.
Analysis of the power, voltage, and current data acquired during one stroke answers:

1. What is the total system electrical efficiency of pumping system?
2. Is the surface electrical efficiency less than 80%?
3. Is the overall total system electrical efficiency above 50%?
4. What is the power consumption, $/month, $/BBL, and power demand, KW?
5. What is the motor current? Does the motor overheat?
6. Does the motor generate electricity at some time during the stroke? Is credit allowed for generation?
7. Is the gearbox overloaded?
8. Is the pumping unit properly balanced?
9. Required movement of counterweights to balance unit?
10. What are transmission line losses in relation to power consumption?
Portable Wireless Power Probes with Cable Harness

Used for wells that are not outfitted with permanent external power sensing connector.
Wireless Power Probe Installation

1. Must open switch box door to install the voltage probes between the fuses and the relay switch.

2. When the voltage probes are above the relay switch, the lease line voltage can be monitored while stopped during the traveling and standing valve tests.

3. Portable current transducers can be above or below the relay switch.
Wireless Power Transmitter with Portable Sensors

1. Portable transmitter-receiver with voltage and current sensors attached to a convenient place on the panel by magnetic tape.

2. Line of sight with base station is desired.
Safe Internal Permanent Power Probe Sensors

Requires:
- mounting two current transformers around power wires and attaching three voltage sensing leads to electrical lines and installing safe external connector in switch box.
Permanent Current Probes

External Feed-through

Millivolt current output to connector pins. Current to ground limited to 0.72 mA for 480 V
Externally Connected Portable Wireless Sensor Plugged into Connector Outside Switch Box.

Wireless Transceiver antenna should be line of sight with base station connected to laptop with software.
Sensor connection may be done while pumping unit is operating.

Sensor is powered up then data acquisition and transmission is initiated by depressing “Acquire” switch.

Volts, power and current can be acquired simultaneously with dynamometer data.
1. Most power measurement devices require the operator to open the electrical switch box to install sensors.

2. The operator is exposed to DANGEROUS HIGH VOLTAGE electricity.

3. The cabled portable power transducers installation procedure requires the operator exercises precaution and follows the recommended procedures in the attachment of the voltage and current sensors and uses proper safety equipment.

4. Permanently installed WIRELESS connector for power/voltage/current sensors eliminates risk of coming in contact with powered electrical wires.
Wireless Power is Acquired Simultaneously with Wireless Dynamometer Data
Simultaneous Wireless Acquisition of Polished Rod Load, Polished Rod Position, Motor Power, Motor Current and Motor Voltage while Performing Valve Test.
Power line loss analysis determines the loss between the electrical system transformer and the pumping unit motor.

1. Analysis is performed to determine the power line loss between the electrical system transformer and/or usage measurement meter to the pumping unit motor.

2. Line loss increases as the length of the wire from the electric motor to the meter increases.

3. Power is generated when motor speed increases greater than synchronous motor speed, during the upstroke due to the weight falling helping to lift the sucker rods.

4. Generated power credit to the power bill depends on the contract with the power utility, the location of the measurement meter, and other factors.

5. In some cases the line losses created by the use of a master meter could offset any credit derived from use of re-generated power from the pumping unit.
To Measure Line Loss:
1) Powered Off V9A
2) Off Disposal Well
3) Acquired Data at V11 for 30 minutes
4) Read KWh from Power Meter on Utility Pole
Use Volts and AMPs During SV Test to Determine “R” the Resistance of the Line

Average of 20.0 AMPs When Motor ON

Average of 465.4 Volts When Motor ON Voltage Drops due to “R” Resistance of Line

Average of 483.9 Volts at V11 when AMPs = 0

Motor OFF to Perform Standing Valve Test

\[ \Delta E = (483.9 - 465.4) = 18.5 \text{ Volts} \]
\[ \Delta I = (20.0 - 0) = 20.0 \text{ AMPs} \]
So, \[ R = \frac{\Delta E}{\Delta I} = \frac{18.5}{20.0} = 0.925 \text{ OHMs} \]
Divide R by 2, because 2 wires
\[ R = 0.463 \text{ OHMs} \]
Read KWh from Power Meter on Utility Pole Simultaneously Acquire Dynamometer Data
Read Utility Meter 30.72 min Elapsed of Time
Began with Stroke #19 thru Stroke #278

Strokes Similar for 30.72 Min.
Average EPT 66.38 in
Selected Stroke #115 as Representative from #19 - #278 because EPT = 66.38 inch

Select Stroke #115 as Representative
\[ R = 0.463 \text{ OHMs} \]

Line Loss = \( I^2 \times R = 21.3^2 \times 0.463 \times 3 \) (3 phase/3 wires)

\[ \text{RMS Current} = 21.3 \text{ AMPs} \]

Line Loss = 630 watts or 0.630 KW for Stroke #115

\[ \text{RMS Current} = 21.3 \text{ AMPs} \]
Compare Power Analysis to Meter

KWh from Meter Reading:
5 KWh Over Elapsed Time of 30.72 Minutes

KWh from Power Analysis of Stroke #115:
9.0 KW for Power Used during 1 stroke
0.63 KW for Line Loss during 1 stroke
Total Power = 9.63 KW

4.93 KWh Over Same Time Interval of 30.72 min.

4.93 KWh from Power Analysis Compares Very Well to 5 KWh Read from Meter
Electric Power (kW) and Current (Amps)
Input to the Motor over the time for Stroke #115

For Stroke #115 NO Generation Credit for 0.8 KW when RPM>1200
# Power Analysis For Stroke # 115

<table>
<thead>
<tr>
<th>Description</th>
<th>Value 1</th>
<th>Unit</th>
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<tbody>
<tr>
<td>Recommended Min NEMA D Motor Rated HP</td>
<td>16.7</td>
<td>HP</td>
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<tr>
<td>Rated Full Load AMPS</td>
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<tr>
<td>Thermal AMPS</td>
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<td>Demand</td>
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<td>KW</td>
</tr>
<tr>
<td>Average</td>
<td>9.6</td>
<td>KVA</td>
</tr>
</tbody>
</table>

## Average Power
- With Generation Credit: 8.2 KW
- No Generation Credit: 9.0 KW

## Average Power Factor
- 68.0 %

## System Efficiency
- 40.5 %
1. Power line loss determination can be used to evaluate the need and economic benefits of upgrading the power line size for the well (or wells) in question or for designing a correct line size in future installations.

2. Wireless power measurement system is designed to give instantaneous values within 1% of actual values.

3. Electrical cost is one of the highest expenses in operating a well.

4. Electric cost are difficult to reduce, unless the operator knows where the losses are located.

5. Operator will become proficient at reducing electrical cost through the use of the power probes.
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