

1968

EC68-775 Your Pumping Plant May be Using too Much Fuel

Paul Fischbach

John Sulek

Deon Axthelm

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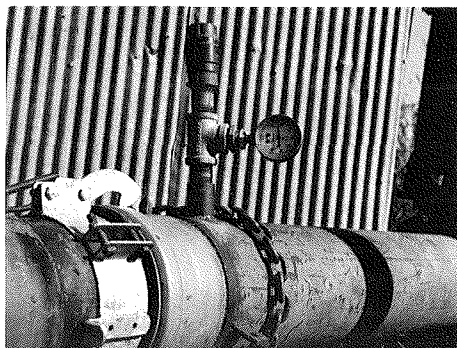
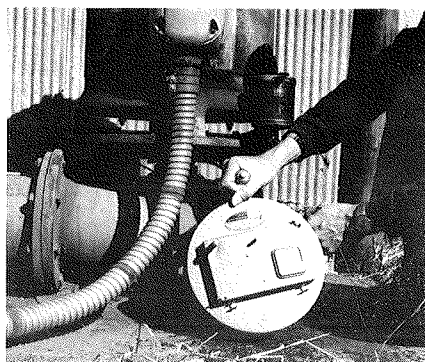
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Your Pumping Plant May Be Using Too Much Fuel

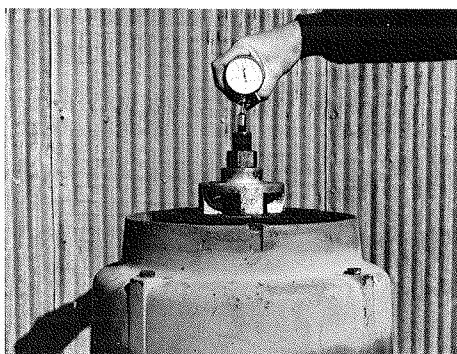
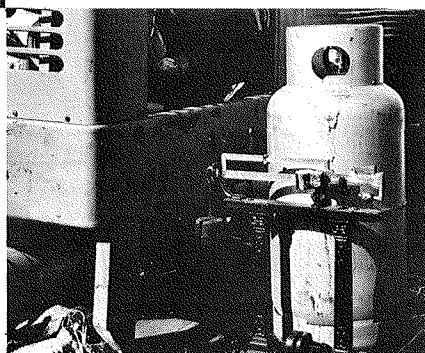
University of Nebraska College of Agriculture and Home Economics
Extension Service
and U.S. Department of Agriculture Cooperating
E. F. Frolik, Dean J. L. Adams, Director

An electric water level indicator is a good tool to determine depth to static and pumping water levels in a well.



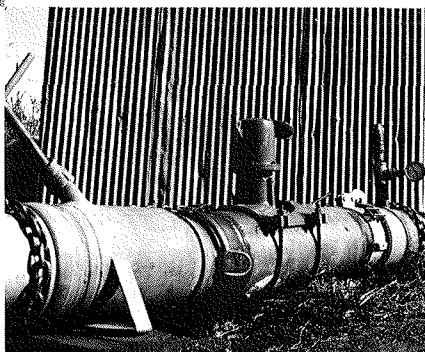
Most sprinkler and gated pipe systems have a fitting for a pressure gauge. However, the pumping plant technician should furnish a calibrated pressure gauge for the test.

Weighing the fuel for a period of time is the best method of determining fuel consumption. A canvas tarpaulin can be used to protect the scales under windy conditions.



An accurate tachometer is needed to help evaluate the pump and engine performance.

A portable water meter is one of the best methods of measuring the water.



Want to Save Money?

Your Pumping Plant

Paul E. Fischbach, John J. Sulek,
Deon Axthelm

Does your irrigation pumping plant operate efficiently, or do you pay too much for fuel?

Tests by the Nebraska Experiment Station and Agricultural Engineering Extension Service show that one out of ten deep well pumping plants uses twice as much fuel as it should.

For example, one pumping plant used ten gallons of propane per hour when it should have used only five. The plant operated 1,000 hours per year. With propane at ten cents per gallon, the operator spent \$500 more than he would have if the pumping plant had met the Nebraska Performance Standard.

Evaluating pumping plant performance involves two procedures:

1. Determining performance by means of a test.
2. Comparing test results with a performance standard.

Test results show the amount of work obtained from each unit of fuel or electrical energy used. The standard indicates the amount of work per unit of fuel that can reasonably be expected from a properly engineered plant. Standards are shown in Table 1.

The actual performances of a new or reconditioned plant should be at least as good as the appropriate standard in Table 1.

Test Benefits

Information obtained from a pumping plant test includes the pumping rate, water levels while pumping, discharge pressure, pump and engine speed, and fuel or energy used per hour. These are necessary for establishing a performance rating on a pumping plant and for determining causes of poor performance.

Knowing the pumping rate can tell you if it is possible to extend your irrigated crop acreage. Pumping rate is one of the essential

May Be Using Too Much Fuel

Table 1. Performance standards for deep-well pumping plants.

Energy source	Rated load hp-hr/gal for representative power units	Performance standard in whp-hr/gal ¹
Diesel	14.58 ²	10.94
Gasoline	11.54 ²	8.66
Tractor fuel	10.48 ²	7.86
Propane	9.2 ²	6.89
Natural gas	88.93 ³ per 1000 cu. ft.	66.7 per 1000 cu. ft.
Electric	88 percent efficient	0.885 ⁴ per kw-hr

¹ Based on 75 percent pump efficiency.

² Taken from Test D of Nebraska Tractor Test Reports. Data corrected for 5 percent drive loss.

³ Manufacturers' data corrected for 5 percent drive loss.

⁴ Not corrected for drive loss. Assume a direct connection.

factors in determining water application and irrigation schedules.

It also can help you avoid wasting water. Soils require certain amounts of water to fill the profile to capacity. Excessive irrigation wastes water, increases fuel costs, causes drainage problems and results in loss of plant nutrients.

Knowing water levels while pumping can help determine if you are using all the water your well can safely produce—can help determine if you are overpumping your well, causing air or sand pumping.

Knowing water levels can indicate if pump bowls are deep enough for efficient operation at the present pumping rate or at an increased rate.

Knowing the discharge pressure can help determine if you are wasting money by using a poorly designed discharge system.

Knowing the pump and engine speed can tell you if you are operating your pump and engine at the most efficient point for your pumping conditions.

Knowing the fuel used per hour can give you accurate information on irrigation costs. This is a key factor in evaluating the performance of a pumping plant.

How to Evaluate

Accurate test measurements are necessary to evaluate your pumping performance unit. They are used as follows:

The measurements of lift, dis-

charge pressure, and gallons per minute are used to determine water horsepower (whp), the *rate work is done* by the plant.

The whp and gallons of fuel used per hour are combined to establish a level of performance in terms of whp-hrs. per gallon.

The measured whp-hrs. per gallon are compared with the Nebraska Standards, Table 1, to obtain a performance rating.

If the components are all above average in efficiency, it is possible to have a plant that will exceed the standards. A unit that obtains less whp-hrs. per gallon or unit energy or uses more fuel than calculated from the Performance Standard is termed "sub-standard."

Standards Within Reach

Table 2 shows that 33 of 376 irrigation pumping plants exceeded the standard. Another 56 plants were operating within 90% to 100% of the standard.

But many of the pumping plants tested were far below the standard. In fact, 132 of 376 were operating between 75 to 89 percent of the standard; and 121 of 376 were operating between 50 to 74 percent of the standard.

There were 34 of 376 units using

Table 2. Performance ratings of pumping plant tests, seven year composites, summary, 1956-1962

Exceeding standard	Percent of Standard				Total Wells
	90-100%	75-89%	50-74%	49% or less	
33	56	132	121	34	376

twice the amount of fuel or more compared to units operating at the standard.

Pumping Lift

Pumping plant standards are affected by the total lift conditions. Two or more bowl assemblies of deep-well turbine pumps are generally more efficient than a single bowl assembly. Pumping plant tests show only two of 82 tests exceeded the standards where the total pumping lift was less than 50 feet, while 14 of 60 tests exceeded the standard where the total pumping lift was over 200 feet (Table 3). However, a considerable number of pumping plants, 39 of 139 tests, only attained 50-74% of standard with lifts of 100 to 200 feet.

Age and Performance

Seven of 27 tests on pumping plants in operation for five years exceeded the standard. If the pump, drive, and power unit are properly selected for the conditions and are in adjustment they will perform satisfactorily for at least five years (Table 4).

The fact still remains that a large number (59 of 218) of the pumping plants aged one to four years were only performing between 50-74% of the standard.

One pumping plant that irrigated 70 acres each year for 10 years still exceeded the standards.

Causes, Poor Performance

The Pump—Turbine impellers are selected to lift efficiently a particular amount of water to a certain height (including pressure), at a specified speed.

If pumping conditions have changed or if impellers are not matched to existing conditions the pump will be inefficient.

Piping systems such as gated pipe or sprinkler not considered in original pump design will cause

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Want to Save Money?

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changes in pumping conditions and plant efficiency.

Pump impellers may be out of adjustment on pumps with semi-enclosed impellers and some enclosed impellers. This results in a reduction in water or higher than normal pump and engine speeds to deliver the required water.

The pump may be operating below or above the design speed. This can cause inefficient operation. An accurate tachometer will enable the operator to set the pump at the speed designated by design specifications.

The Engine—The engine may be under or overloaded. Engines work more efficiently when operated at 75–100% of their continuous rated horsepower at a reasonable speed.

The engine may need repair or adjustment. The ignition, timing and carburetion should be repaired, replaced, or adjusted on spark ignition engines. Diesel units may need fuel injection timing.

The engine may have burned or leaky valves. Loss of compression due to leaky valves may result in poor fuel economy.

The engine may not be matched to the fuel used. Compression ratio and carburetion equipment should be designed for the fuel used. Engine manufacturers' kits are available to convert gasoline engines to operate efficiently on propane or natural gas if desired.

Efficiency of electric motors will seldom change during use. It is important to know if a motor has become overloaded. Continuous overloading may change its useful life.

The Drive—The drive ratio may be incorrect for matching pump and engine speeds. This causes inefficient operation of the pump or engine or both.

Drive misalignment decreases efficiency. It also reduces drive life.

PAUL E. FISCHBACH is Associate Professor, Agricultural Engineering (Agricultural Extension). JOHN J. SULEK is Associate Professor, Agricultural Engineering. DEON AXTHELM is Associate Professor, Agricultural Extension Service.

Table 3. Number of pumping plants attaining a standard of performance with various lift conditions.

% of Standard	Lift			
	50' or less	50–100'	100–200'	200' or over
Exceeding the standard	2	7	11	14
90–100%	1	12	32	10
75–89%	20	30	53	29
50–74%	39	37	39	6
49% or less	20	9	4	1
Totals	82	95	139	60

Table 4. Number of pumping plants attaining the standard of performance by age of pumping unit.¹

% of Standard	Years used									
	1	2	3	4	5	6	7	8	9	10 or over
Exceeding the standard	4	9	7	1	7	1	0	0	0	1
90–100%	13	13	6	6	3	4	2	1	1	1
75–89%	11	33	22	18	9	8	6	1	2	11
50–74%	8	17	20	14	8	7	5	1	4	17
49% or less	3	6	3	4	0	0	3	1	0	10
Totals	39	78	58	43	27	20	16	4	7	40

¹ Age of unit not obtained in 44 cases.

Example of Test Measurements and Evaluation

Field Test Data—Pumping rate gpm..... 1000
 Lift in feet..... 77
 Discharge pressure
 in lbs. per sq. inch..... 10 (1 lb.
 per sq. in.
 = 2.3 ft.)
 Fuel used in gallons
 per hour 4.9 (propane)

1. Determine water horsepower.

$$\text{whp} = \frac{\text{gpm} \times \text{total lift in ft.}^*}{3960}$$

*Total lift (100 ft.) = lift from well (77 ft.) + discharge pressure in ft. (23 ft.)

$$\text{whp} = \frac{1000 \times 100}{3960}$$

$$\text{whp} = 25.3$$

2. Determine measured whp-hrs. per gallon.

$$\text{whp-hrs. per gallon} = \frac{\text{whp}}{\text{Gallons fuel used per hour}}$$

$$\text{whp-hrs./gal} = \frac{25.3}{4.9}$$

$$\text{whp-hrs./gal} = 5.16$$

3. Determine the performance rating.

$$\text{rating} = \frac{\text{measured whp-hrs./gal}}{\text{Nebraska Standards whp-hrs. per gal.}} \times 100$$

$$\text{Rating} = 5.16 \times 100\%$$

$$6.89 \text{ (Nebraska Standards for propane from Table 1)}$$

$$\text{Performance rating, \% of Standard} = 75\%$$

4. Determine fuel waste.

Fuel used in gallons per hour (determined by testing fuel consumption of the power plant, 4.9 gal/hr Propane) times the performance rating, % of Standard (75%)

$$4.9 \text{ gal/hr} \times 75\% = 3.68 \text{ gal/hr}$$

$$4.9 - 3.68 = 1.22 \text{ gal/hr}$$

1.22 gallons of propane per hour could be saved if the unit was operating at 100% of the Nebraska Performance Standard. If propane was 10 cents per gallon, and the unit was operated 1,000 hours per year, the operator could save \$122.00 worth of fuel per year.