REASONABLE COST IRRIGATION

Danny H. Rogers
Extension Irrigation Engineer
Kansas State University
Manhattan, KS 66506

Irrigated crop production is an energy intensive operation. Energy costs for pumping of irrigation water can represent a significant portion of the production cost budget. Irrigators know the amount of their irrigation fuel bills, but fewer know if those bills are within a reasonable range for their pumping conditions and fuel price structure. Every irrigator should analyze his irrigation pumping costs to see if the costs of pumping a specific volume of water and if pumping costs per unit land area are reasonable.

Irrigation pumping energy requirements can be estimated using the Nebraska Performance Criteria. These criteria are shown in Table 1.

Table 1. Nebraska Performance Criteria for Pumping Plants

Energy Source	WHP-HRS per Unit of Fuel
Diesel	10.94 per gallon
Propane	6.89 per gallon
Natural Gas	61.7 per MCF (1000 cf^3)
Electricity	0.885 per KWH (kilowatt-hour)

The Nebraska Performance Criteria are considered a performance guide for a properly designed, well-maintained pumping plant. Certain pumping plants can exceed these guidelines. Most, however, are lower.

Pumping plant efficiency can be evaluated using the following steps:

1. Measure the pumping rate in gallons per minutes (GPM).

2. Determine the total dynamic head in feet (TDH).

   a. Measure the pumping lift in feet.
   b. Determine discharge pressure (PSI) and convert PSI to feet by multiplying by 2.31.
   c. Add pumping lift (feet) to discharge pressure (feet) to obtain the total dynamic head while pumping.

3. Determine fuel or energy consumption by the power unit.

   Gallons per hour - LP gas, diesel
   Kilowatt hours per hour - electricity
   Cubic feet per hour - Natural gas

4. Calculate water horsepower

$$WHP = \frac{GPM \times TDH}{3960}$$

5. Calculate water horsepower - hours (WHP-HRS) per unit of fuel.

$$\frac{WHP - HRS}{Fuel\ Unit} = WHP/Fuel\ use\ per\ hour$$

6. Compare the actual performance of pumping plant against the performance criteria in Table 1.

   a. Obtain performance criteria (Table 1)
   b. Calculate performance rating

$$Performance\ Rating = \frac{Measured\ Performance}{Performance\ Criteria}$$

7. Determine excess energy use per hour of operation

   Excess Energy Use = (1-Rating) x Measured Fuel Use

The annual savings which could be realized by adjusting, repairing, or replacing inefficient components of the pumping plant can be estimated as follows:

Potential Annual Operating Cost Savings:

= excess energy use/hour x fuel cost x hours of annual operation

The potential annual operating cost saving can be compared against the estimated cost of repair, adjustment, or replacement of the inefficient pumping equipment to determine if improving the operating efficiency is economically justified.

The above procedure for estimating the pumping plant performance requires that the pumping rate, water level while pumping, the discharge pressure and the amount of fuel used per hour be determined. If it appears that your pumping plant is using excess energy, contact a drilling company or an agricultural consulting firm who performs pumping plant evaluation for recommendations on needed changes.

There are documented tests that indicate many existing pumping plants are operating at much less than optimum efficiency resulting in wasted energy, reduced discharge rates, and increased production costs.

An important tool for monitoring pumping plant performance is installation of a water meter. Monitoring discharge rates provide insight as to performance of the pumping plant. This may allow early detection of well, pump, or engine problems before serious damage to equipment or crops occur. Water measurement also allows the irrigator to know the rate of application and the volume of application, which are two important items of information for water management decisions.

Water measurement can open doors to many improved techniques such as:

1. Practicing better water management - producing <u>optimal</u> crop yield per unit of water applied;

2. Improving irrigation efficiency - obtaining the optimum profit dollars per unit applied water;

3. Monitoring pumping plant efficiency - using the least fuel to pump the most water;

4. Detecting well and pump problems;

5. Proper reporting to water resource agencies;

6. Determining the most optimal acreage to be irrigated; and

7. Selecting optimal size of set for furrow irrigation.

Increasing efficiency of irrigated agriculture is becoming more important as production costs rise. These costs can be reduced by operating pumping plants at their peak efficiency which uses the least fuel and pumps the most water for that fuel used.

Regular monitoring of the discharge rate and pumping lift can also give an indication of how efficient the well is. An inefficient well can be costly since it will have more drawdown than an efficient well. This extra drawdown means additional pumping costs. Sometimes wells are inefficient due to improper design or construction. Other times, well inefficiency develops over time due to incrustations or corrosion. Measurements of static water level, pumping water level and discharge rate establish the specific yield of a well. Specific yield is the discharge rate per foot of drawdown. Specific yield changes can indicate a well problem.

A well with a lower specific yield compared to other in the area (or compared to values specific from yield maps from the Kansas Geological Survey) may be a candidate for restoration or replacement.

The performance criteria were used to develop Figure 1. Compare your last season's fuel usage to a value selected from Figure 1 based on your irrigation system total dynamic head and discharge rate. The number selected from Figure 1 can be multiplied by your fuel cost and number of days of pumping to estimate the total pumping cost for the season. For example, a pumping plant discharging 500 gpm against 200 feet of TDH would use about 10 MCF/day of natural gas. Figure 1 is for natural gas. Multiply by the conversion factors from Table 2 to convert to other energy sources.

Table 2: Conversion Factors for Other Energy Sources

Fuel	Units	Factor
Propane	gallon/day	8.96
Diesel	gallon/day	4.94
Electricity	KWH/day	69.72

Irrigation fuel costs can still be high, even if the pumping plant is performing at peak efficiency, since costs are also dependant on the total volume of water pumped. Seasonal irrigation water requirements may be reduced through irrigation scheduling and increasing irrigation application efficiency.

Irrigation scheduling advantages and procedures will be discussed in detail later in the conference. The importance of scheduling as a method of reducing water requirements and lowering energy bills should not be overlooked. Years of high evapotranspiration or crop water use demand generally coincide with low rainfall combine to greatly increase irrigation demand compared to wet years with lower ET. Irrigation applications made without regard to this natural variation between season, to say nothing of within season variations, can be ineffective use of water and energy resources.

Irrigation system efficiency is related to the type of irrigation system but is strongly influenced by management. Investments made in additional equipment or time for additional labor or management may be financed by the savings of fuel through increased utilization of pumped water and reduced length of pumping. Possibly additional land could be irrigated with a more efficient irrigation system or improved yield potential for existing irrigated land.

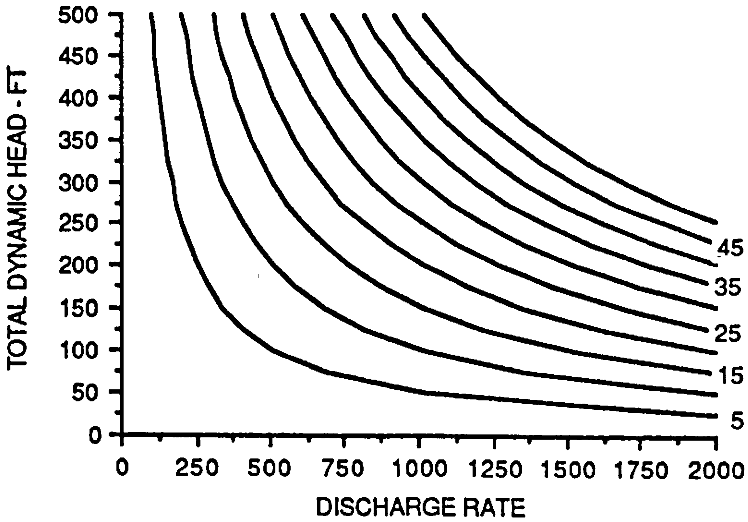

Figure 1: Estimated Natural Gas Fuel Use in MCF Per Day for Various Discharge Rates and Total Dynamic Head