IRRIGATION PUMP EFFICIENCY – THE EVOLVING ESSENTIALS

William Green, Center for Irrigation Technology, California State University, Fresno
Greg Allen, REDtrac, LLC, Bakersfield, California

PUMP EFFICIENCY and ENERGY COST – THE PROBLEM

About one-third of the irrigation pumps in California operate at less than 50% efficiency. Increasing overall pump efficiency from 50 to 60 percent for a typical well can reduce energy costs by 17% ($13,000 annually).

Energy expenses constitute up to 65% of the controllable operating costs on farms, yet many growers and managers don't have a good understanding of how pump efficiency is measured and how to use that data to manage ground water costs, maintenance and energy expenses.. Timely measurement of pump efficiency enables growers and pump managers to budget water costs and maintain pumps for effective, economic performance of their irrigation systems.

OVERALL PUMP EFFICIENCY BASICS

Overall Pump Efficiency is the relationship between power consumed and the rate of water delivery at a given pumping head. The more efficient the pump and motor, the lower the energy use. The formula for calculating OPE is

(Flow X Total Dynamic Head) divided by (HP-in X 3,960)
Flow - GPM or rate in gallons per minute
Total Dynamic Head - TDH or total lift of the pump including the feet of lift from the Pumping Water Level plus the discharge pressure X 2.31
HP-in – Horsepower-In - the electric demand stated in kilowatts (kW)
Note: kW times 1.34 = input HP; or, nameplate HP times .764 = kW
3,960 – Constant (output HP factor of motor)

Using the equation above, OPE on a sample well with:
Flow – 750 gallons per minute
Total Dynamic Head - 397 feet of total lift in feet
Pumping Water Level measured 300 feet
Discharge Pressure at pump – 42 psi (measured psi time 2.31 times equals 97 feet)
HP-in – 134 kW (measured)

The results:

750 (GPM) X 397 (TDH)	=	297,750
3,960 (Constant) X 134 (HP-in) =	530,640	the "Wire to Water" OPE is 56%

OPE is a factor of the efficiency of the motor, the downhole bowls, impellers and shaft, friction and electric losses plus conditions in the well such as variable pumping water levels. Irrigation wells often degrade over time as the screen is eroded by use or becomes restricted by biological matter, as the gravel pack becomes less permeable, and as the water levels vary.

ADVANCED PUMP EFFICIENCY PROGRAM

Based on APEP tests of about 40,000 pumps in the last 15 years, the average OPE in PG&E territory is about 53%. After repair or replacement, the average pump OPE is increased to 63%. Pumps with motors in the range of 100 to 150 HP-in should be above 60% efficient. Below 50% OPE is considered poor. Very few tested pumps are above 70% OPE.

The Center for Irrigation Technology at California State University, Fresno manages the Advanced Pump Efficiency Program "APEP," a long-term rate payer funded program administered by PG&E using funds from the public purpose charge. In southern California, SoCal Edison provides similar subsidized programs. Public purpose funds are used to subsidize pump efficiency testing as well as to provide incentives for pump repairs and replacement.

BEST PRACTICES and CONTINUOUS PUMP TEST REPORTING

Best practices mandate conducting a pump test twice during each pumping season. The typical hydraulic test report includes the measured variables as well as standing water level, draw down and the Specific Capacity.

Specific Capacity of a well has a strong correlation to the health of the reservoir and the condition of the downhole assembly over time. Growers use Specific Capacity to evaluate the need for remediation and to measure the effectiveness of periodic downhole treatments such as chemical and brush jobs, casing conditions, bowl repairs and other problems including silting of the gravel pack.

Pump efficiency tests have traditionally been conducted by independent firms using on-site personnel and portable measurement tools.

Pump Efficiency and Specific Capacity tests are now conducted on a continuous basis using meters and sensor in the well without the need for on-site personnel or tools. Real time, continuous analysis can predict problems and easily compare results from past tests (in paper formats as well as newer continuous tests.)

Continuous testing accurately compares test results to the manufacturer's pump curves and gives indications of excessive wear, casing problems and screen conditions to assist in the decision to retrofit or repair equipment using objective economic analysis.

Continuous pump tests, in coordination with occasional physical tests can be economically employed on electric motors with soft start, VFD or traditional electric panels as well as diesel and natural gas fired engines. Expertly designed pump test programs include other information such as motor amperage harmonics, water Ph and conductivity, analysis of motor assembly vibration and evaluation of shaft lubrication.

ADDITIONAL BENEFITS OF PUMP EFFICIENCY TESTING

In addition to energy, water and maintenance performance, online continuous pump reports enable growers and operators to evaluate and participate in Demand Response, load shifting, tariff analysis, renewables including solar and battery storage as well as groundwater sustainability programs and reporting.

REDtrac, LLC, 34929 Flyover Ct., Bakersfield, CA 93312 – www.RED-trac.com (844) 733-8722
Center for Irrigation Technology at Fresno State, 5370 Chestnut Ave., MS-OF18, Fresno, CA 93740 – http://www.csufresno.edu/