The Reality of Pump ENERGY EFFICIENCY and PERFORMANCE

Canada Sets Example in Characterizing Actual Energy Efficiency of Water Pumps with Province-wide Testing Program

BY DJORDJE RADULJ AND FABIAN PAPA, HYDRATEK & ASSOCIATES INC.

FABIAN PAPA

DJORDJE RADULJ

This article briefly discusses the findings of a large-scale testing program that was conducted across Ontario on more than 150 water pumps ranging in size from 30 hp to 4000 hp. The program was primarily sponsored through the Ontario Power Authority Conservation Fund in order to raise awareness and promote energy conservation in the municipal sector, as represented by eight participating municipalities of varying size and geographic location.

The accurate and innovative Thermodynamic Method (see Figure 1) was utilized for more than 90% of the tests.

The results of the program revealed that there is an average 9.3% loss in the peak efficiency of the pumps in use today relative to their original manufactured condition. Add to this the additional inefficiency of pumps being operated outside their peak efficiency range, and the average overall gap increases to 12.7%. In fact, it was found that the average wire-to-water efficiency for all the pumps tested was 69.4%, meaning that more than 30% of the energy input is lost. The implications of these findings are numerous: 1) there is substantial scope for energy and financial savings resulting from pump retrofits and changes to operating protocols; 2) that the hydraulic models used to make important capital investment, operational and asset management decisions may be utilizing inaccurate information; 3) that performance testing after commissioning and regularly thereafter can valuably inform operators of developing problems; etc.

Benchmarking

The value of this program's findings for benchmarking purposes is exceptional. Given the large number of pumps tested and assessment of various performance indicators, it is

Figure 1: *PUMP TESTING EQUIPMENT USING THERMODYNAMIC METHOD*

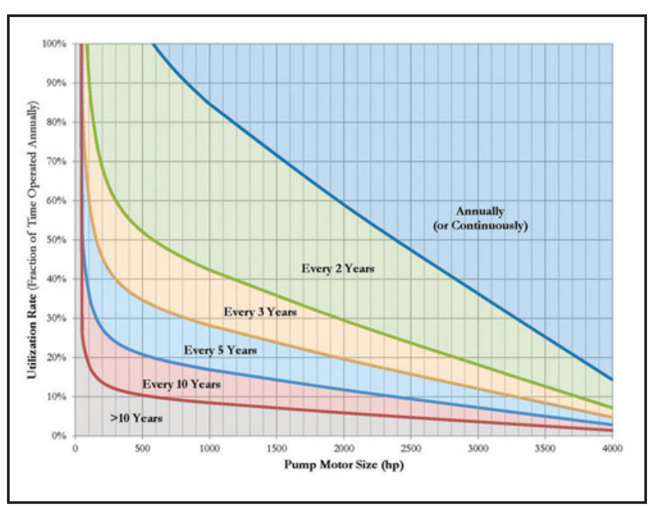

Figure 2: *GUIDELINE FOR PUMP TESTING FREQUENCY*

both clear and intuitive that the assessment of the energy efficiency performance of pumps must relate energy consumption to both of the fundamental outputs produced: flow and pressure (or head).

The Pump Energy Indicator (PEI) was developed as part of this program and represents the instantaneous amount of energy consumed once normalized against the flow and pressure produced by the pump, and is expressed in units of kWh/Mm^3/m. This performance indicator was shown through the program's results to be vastly superior to the often quoted Specific Energy Consumption (i.e., Volumetric Energy Consumption) metric, which only normalizes against flow and is expressed in units of kWh/m^3.

The average PEIs for the pumps tested are as follows:

- Manufacturer's Best Efficiency Point (MBEP): 3350 kWh/Mm^3/m
- Tested Best Efficiency Point (TBEP): 3770 kWh/Mm^3/m (or 12.5% higher than MBEP)
- Tested Typical Operating Point (TOP): 3980 kWh/Mm^3/m (or 18.8% higher than MBEP)

The Value of Refurbishment

Two of the pumps tested in this program were refurbished and re-tested with encouraging results. In both cases, significant recoveries in lost efficiency were realized, moving the tested efficiency curves closer to the original manufacturers' curves. These refurbishments resulted in recoveries of 65% and 71% of the efficiency loss. These experiences along with economic models can be used to develop business cases supporting pump testing and refurbishment activities for a municipal utility.

Best Practices

The program's findings are provided in a publicly available report that includes a distillation of best practices in a set of 10 recommendations. One of the more notable and useful tools resulting from this program was the development of a guideline to inform utilities with respect to the appropriate testing frequency for pumps (see Figure 2), which relates the recommended frequency to the pump motor size (and power consumption) and the utilization rate of the pump.

The more power consumed by a pump, and the longer it is operated, the more important and valuable it is with respect to energy consumption and electricity costs, and so deserves more attention in the form of more frequent testing. This guideline was developed using the economic models discussed above and will help utilities in their prioritization and planning of pump testing as part of their routine asset management practices.

Djordje Radulj and Fabian Papa are with HydraTek & Associates. Additional information on this testing program and its results, including a copy of the final report, can be found at www.hydratek.com/opa or by contacting info@hydratek.com.