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ECONOMIC ENERGY CONSERVATION THROUGH
OPTIMAL MANAGEMENT OF PROCESS PUMPS OPERATION*

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The subject of energy conservation is of ever-increasing importance to plant management. As energy costs continue to rise, new opportunities to reduce operating costs will occur throughout existing installations when the present value of possible energy savings increases to a level equal to or greater than the cost incurred in implementing energy-efficient operating procedures. The plant engineer, therefore, has the opportunity to expand his role and perform periodic reviews of operating procedures and costs as part of a regular plan to identify and change uneconomic and energy-wasteful operations.

This article describes an analysis done for pump installations where operation had been continuous, not to satisfy the process requirement but to decrease the probability of motor failure due to the formation of condensation on motor windings. Investigation of the existing facility identified 20 such pumps, ranging in size from 1 to 25 hp, used for low-conductivity water (LCW) and cooling tower circulation. Shutdown of these pumps required that a resistance heater be placed on the motor windings to prevent damaging condensation. The changes proposed required modification of the motor control center to accommodate heater switching, additional wiring in the motor circuit conduit, and installation of heater strips within the motor end bell, as illustrated in Fig. 1.

Running time, as a function of total time, is used as a critical element in the analysis. "Use factor", in this article, means the fraction of an 8760-hour operating year that equipment is on-line and running. For example, if a motor runs 12 hours per day, seven days per
week, the use factor would be \( \frac{12 \times 365}{8760} = 0.50 \).

The relationships of the savings and cost factors are illustrated in Fig. 2. Operating cost is a straight-line function proportional to the energy rate and horsepower while the costs incurred which permit equipment shutdown contain both fixed and variable components. These are, the capital charge of modifying the installation and an energy cost incurred in operating the winding heaters.

For existing installations, two types of criteria were applied. One was short-term and very conservative, where the capitalization of the retrofit cost is recovered in the first year's net operating savings. The other was a medium-term approach where the retrofit cost is recovered over a 5-year period with the time value of money taken into account (see Table I). This latter criteria approximates a life-cycle-costing approach where 5 years is taken as the probable future life of the existing installation.

For new installations, a life-cycle-costing approach is taken assuming a time value of money and a 30-year life. Simplifying assumptions used throughout tend to make the results conservative and are:

- Energy cost = constant = $0.02 per kWh
- Demand charge = insignificant
- Motor load factor = constant - 0.8 \( \times \) rated hp
- Present operating policy = constant operation (24 hours per day, 8760 hours per year)
- Winding heater power = 28, 56, or 84 W depending on motor hp
-4-

- 1800 rpm motors (to allow display of results in terms of hp instead of frame size)
- Operation and maintenance costs = constant (savings in machine wear offset by cost of maintaining additional retrofit gear)
- Discount rate = 0.06

Table I shows that, for an average use factor of 0.8 (equivalent to 146 days per year of 12 hour daily shutdown), the minimum size that should be operated intermittently is 25 hp if capital recovery is made in the first year; 5 hp if a 5-year life is used; and 3/4 hp for new installations.

From the foregoing, it can be concluded that significant savings can be made in operating costs with little additional capital investment, if operating environments are poor and use factors can be reasonably projected. The plant engineer, therefore, can usefully review operating practices and the design of new facilities at his plant, and reduce energy use within an economic framework.

About the Author

ERIC FESTIN is a registered professional engineer in Virginia, North Carolina and California. His engineering studies took place at the University of Arizona, and he holds an MBA from Wake Forest University. At present, he is a member of the plant management group at LBL and is active as a part-time consultant to business.
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<th>HP</th>
<th>Existing Installations</th>
<th>New Installations</th>
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<tr>
<td></td>
<td>First Year Payout, Maximum Average Use Factor</td>
<td>Five Year Payout, Maximum Average Use Factor</td>
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<tr>
<td></td>
<td>Retrofit Cost</td>
<td>Installation Cost At Time Of Original Construction</td>
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Note: The decision rule is: install winding heaters in motors operated less than or equal to the time represented by the use factor given in the table. For example, if an existing 7 1/2 HP motor is needed 4380 hours per year (use factor = .50), it will pay to change its operation if a 5-year basis is used, but it will not pay if the modification expense must be recovered in the first year.
1. Install normally closed auxiliary contact on magnetic motor starter. Heaters turn "on" when motor is stopped.

2. Install 2 #14 wiring in motor circuit conduit.

3. Install winding heater elements in motor.

Fig. 1. Design modifications for installation of winding heater.
Fig. 2. Breakeven chart for process pump operating costs.
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