Energy Conservation Potential for Water Treatment System

Ms. Kalaimathy S. N.[1] and Visvanathan C.[2]
1. National Water Supply & Drainage Board, 2. Asian Institute of Technology - Thailand

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ABSTRACT

Energy is consumed during the process of operation and maintenance of Water supply systems (WSS) from Intake point to end user for the operation of pumps, motors, and other equipment. Approximately 3 - 5 % of the total electricity generated by electric power industry is consumed by water industries for pumping and treatment activities in any city. Improving the efficiency of energy consumption in WSS can have high cost reduction and diminution the damages to environment.

This study was focused on investigation of the potential on conservation of eaergy for WSSs in Sri Lanka. The detail cost analysis of Kandy South WTP exposed the highest cost (nearly 80%) was incurred for electricity in which, greater than 85% of energy was used to pumping raw water and treated water.

The benchmarking of 35 WSSs in Sri Lanka for energy consumption (kWh/ production) was conducted in this study as a performance monitoring indicator. This study reveals that the average energy consumption per m^3 of water production in Sri Lanka is about 0.47kWh and 0.51 kWh for surface and ground water sources respectively. The highest benchmark value obtained for Divulapitiya WSS, 0.82 kWh/m^3 was due to the long distance from the raw water source and the larger distribution network. Some technical considerations during designing and installation of pumps, in valves and in pipelines and peak and off-peak operational schedules can be used to improve the efficiency of the bench mark value.

The Non-Revenue Water (NRW) percentage is also an effecting factor influencing on energy consumption and thereby increasing the cost. Preventing of NRW by 1% will save $ 366 cost or 4032 kWh energy. New approach of ISO 50001:2011 energy management standard is a systematic management process which duly considered all the above factors to reduce the energy consumption in water treatment plants in turn leading to reduce Greenhouse gas emissions, energy cost and related environmental impacts.

INTRODUCTION

The water, energy and greenhouse gas emission are interlinked and are rising concerns over scarce energy resources and global climate change. Energy efficiency improvements at water treatment facilities can have high rates of return, and can significantly reduce the costs since energy costs typically constitute 20 -25 % of the operations and maintenance cost at water facilities. Hence, a proper investigation on strategies for energy efficiency improvement for water supply systems (WSSs) is essential to reduce the cost and to reduce the environment and health effects.

MATERIALS AND METHODS

The benchmarking of water treatment plant is a key tool to improve performance and to reduce the energy cost. Energy audit provides a "bench-mark" for managing energy in the organization and also provides the basis for planning a more effective use of energy for WSSs. The total electrical energy (raw water pumping, treatment and treated water pumping) consumed in kilowatt hours divided by flow (kWh/ m^3) was used in this study as performance monitoring indicator. The secondary data was collected through distributing a questionnaire for the selected WSSs in Sri Lanka. Nearly 35 WSSs responded for the survey (25 surface water treatment schemes, 2 surface water and ground water schemes and 8 ground water source during the year of 2010 and 2011).

The prospective application of ISO 50001 energy management standard was conducted at Kandy South Water Supply System (KSWSS) which is designed for 30,000m^3/day. Energy conservation during operational and maintenance activities and the energy losses during Non-revenue water were also considered in this study.

RESULTS AND DISCUSSION

Benchmark Analysis

According to the data collected, the energy consumption per m^3 of water production was in the range of 0.07 to 0.82 kWh and the average was 0.47 kWh/m^3. The lowest value of 0.07 kWh/m^3 was obtained for Wellawaya WSS. In this WSS the major part of the raw water and distribution network system is fed under gravity. In general, the energy consumption for raw water pumping is lesser than the treated water pumping. Divulapitiya WSS shows high energy consumption for raw water pumping and averagely consumes 0.82 kWh/m^3 for the entire system. The long distant from intake to treatment plant and large distribution network contribute to this high value.

Table 01: Summery of Energy Bench mark analysis with different sources.

Water source	Energy consumption per unit volume (kWh/m^3)		
	Average	Minimum	Maximum
Surface water source	0.47	0.07	0.76
Ground water source	0.51	0.37	0.82
Surface and Ground water	0.6	0.43	0.76

The two case studies, Oslo and Winconsin WSS showed electrical energy consumption of 0.33kWh/m^3 and 0.40 kWh/m^3 (Venkatesh and Brattebo, 2011 and Elliott et al., 2003).

ISO: 50001:2011 and Energy Conservation Potentials

ISO 50001 is a voluntary International Standard to provide organizations an internationally recognized framework to manage and improve their energy performance and is based on the Plan - Do - Check - Act (PDCA) continual improvement framework and incorporates energy management practices into everyday organizational activities. The primary objective of this standard is to establish a benchmark through energy audit for managing energy and also provides the basis for planning a more effective use of energy.

The analysis was conducted at KSWSS based on creating inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. The highest cost (nearly 80%) was incurred for electricity in which, greater than 85% of energy was used to pump raw water and treated water. The average energy consumption at KSWSS is about 0.78 kWh/m^3(range in between 0.69 to 0.85kWh/m^3) which includes the energy consumption for treatment process, low lift pumps, high lift pumps, and booster pumps.

The amount of unaccounted water is due to leaky pipes, main breaks, or meter inaccuracies. Large losses of water through the system may result in higher energy use and expenditures from the pumping of water that is not used for consumptive purposes. The KSWSS losses 43% of its water as NRW. The cost analysis reveals that reducing 1% NRW will save 4032 kWh of energy and $ 366 in costs. Higher % reduction of NRW saving will lead to more saving of funds.

The benefit of reduction of NRW are;

- Financial gains from increased water sales or reduced water production, including possibly the delay of costly capacity expansion;
- Reduced property damage;
- Reduced risk of contamination
- More stabilized water pressure throughout the system

Some technical considerations during designing and installation of pumps, valves, pipelines and peak and off-peak operational schedules can be used to improve the efficiency. Installation of the variable speed drivers or motorized valves will significantly reduce the motor starting power. The pump operating at their best operating point will reduce the unnecessary power consumption without throttling. The tariff system for electricity has three different categories. Therefore avoiding peak hours will significantly reduce the energy cost. Conducting the process maintenance work during peak hours and filter backwashing during off peak hours are some examples. Further, installation of capacitor banks and reducing the ball valve effect significantly reduce the energy consumption.

CONCLUSIONS

There are many factors that influence the energy consumption in a WSS. Identifying the benchmark values of energy consumption of water supply schemes and applying proper methods and techniques for designing, operation and maintenance of the same; the energy efficiency can be enhanced without causing severe damages to the environment as well as energy resources of the generations to come.

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