Research Paper Environmental Science

Study of Energy Conservation Practices in Water Supply System By Kolhapur Municipal Corporation

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ABSTRACT

The surface water resources like rivers, streams, ponds, lakes and ground water reservoirs are the major sources of water for various activities. Huge amount of money and efforts have been spent by the municipalities and government institutions to enhance the quality of water and to supply it for civic purposes. Many studies have revealed that energy and money losses occur during various stages of water supply.

In the Kolhapur for city water supply, water from the river Panchaganga is lifted and carried to treatment plants. After treatment this water is carried to water storage tanks and then is supplied to houses. During all these stages loss of energy has been observed.

Certain changes were carried out by officials of Kolhapur Municipal Corporation (KMC) for energy conservation practices which have saved crores of funds. This paper throws light on energy conservation practices in water supply system in KMC.

KEYWORDS Water, water supply system, energy efficiency conservation.

Introduction

Water is one of the vital environmental components for all life forms. The surface water resources like rivers, streams, ponds, lakes and ground water reservoirs are the major sources of water for these activities such as drinking, agriculture, manufacturing, industries, transportation and countless other human activities. The huge amount of money and efforts have been spent by the municipalities and government institutions to enhance the quality of water and to supply it for domestic, irrigation, industrial consumption and for other purposes. Many studies have revealed that energy and money losses occur during various stages of water supply. Approximately 4 % of the nation's electricity goes towards moving and treating water and wastewater (EPRI, 2002), the majority of which is paid for by municipal operating budgets. Reduced electricity consumption at treatment facilities and pumping stations could offer significantly lower costs for municipalities and agencies responsible for their operations (Tripathi 2007).

There have been a number of studies published which quantifies the link between water and energy use (The Brendle Group 2007, Cohen et al., 2004, Arpke and Hutzler, 2006). Many studies have focused on optimization of pump, and treatment plant, efficiency as a first step towards reducing energy costs in the municipal water sector (Sandia National Laboratories, 2008; Arora & Le Chevallier, 1998; EPRI, 1994). Recent work suggested that there are several important opportunities, include optimization of mechanical efficiencies, for incorporating the energy impacts of water supply and wastewater management into decision making and policy (Maas, 2009; deMonsabert & Liner, 2008; Cohen et al., 2004). Three such opportunities are: 1) incorporating the influence of site topography on municipal pumping requirements into both community planning and environmental rating systems ; 2) including the carbon footprint of water use as a criterion for water management decisions; and 3) incorporating water conservation measures as a component of municipal energy efficiency programs.

A study of seven municipalities in Ontario, Canada was conducted to assess the potential for energy savings associated with water conservation (Maas, 2009). Energy is consumed in treatment plants for a variety of purposes, and not all energy used will necessarily be affected by a reduction in water volumes treated. The study has suggested that the portion of energy used for pumping could provide a reasonable estimate of the energy savings associated with water conservation. The energy savings co-benefit of water conservation, termed the "water conservation energy intensity", was therefore estimated by multiplying the total embodied energy intensity by the proportion of energy utilized within a treatment plant for pumping. Pumping consumes an estimated 87 per cent of the total energy demand in water treatment plants, and 8.2 per cent in wastewater treatment plants (EPRI 1994; 2002). Energy consumed for distribution and collection was assumed to be utilized entirely for pumping. Full details of this methodology can be found in Maas (2009).

The Ontario study also suggested in some of the areas communities such as in British Columbia, Canada were served by large reservoirs, gravity flow potable water distribution systems or primary level wastewater treatment systems. Such systems had achieved three goals such as economic, environmental, and social sustainability.

The efficiency measures are related more to the optimisation of energy usage and application of advanced technology. Specifically within the municipal water-cycle chain, the improvements in energy efficiency are related to the pressure management and leakage reduction, off-peak pumping, baseline energy audit, solar heating and composting, digester mixing optimization, oxygenation capacity and efficiency of algal oxidation ponds, submersible versus self-priming pumps, load shedding, load shifting and water distribution system optimization. Hence, there is urgent need that the municipalities should get familiar with the impacts of new measures on their energy usage within relevant supply areas. The implementation of renewable energy technology will reduce the demand for electricity a well as it may also help to reduce green house gases emission and carbon foot printing of water distribution system.

Objectives

The current paper aimed at evaluation of energy conservation practices in municipal water distribution system. This paper is restricted to study carried on the Kolhapur Municipal Corporation's (KMC's) water pumping and suply system on Panchaganga River. Present paper has following objectives:

To study the existing water pumping and supply system of Kolhapur City.

To take a review of innovative practices followed by KMC for energy conservation in water supply system.

Methodology
Both the qualitative and quantitative methods were used for data collection. The methodology adopted for the primary data collection wass based on field visits, personal observations of water pumping stations of Kolhapur Municipal Corporation. The interview scheduled of Hydraulic engineers, water pumping station engineers were conducted to understand the entire process. Secondary data was collected from water supply department of KMC, environmental Status reports and census.

Profile of the Study Area
Kolhapur city is situated at 160 70' N latitude and 740 23' E longitude in the Panchganga river basin. It is situated at an average elevation of 546 m above mean sea level (MSL). Topography of the city shows many undulations and the ground is generally sloping from south to north towards river Panchganga, which is the northern border of the city. Kolhapur is known for its moderate climate, picturesque natural surroundings and quality of life. The city experiences a typical monsoon climate with three distinct seasons - summer, winter and rainy, as else where in India. The height above the mean sea level and leeward location with reference to the Western Ghats has made the city climate moderate and healthy. The average temperature is 27o C and Min 15o C, Max 40o C. Three fourth of annual rainfall of 1025 mm, occurs between June to September, which is about 65 days in a year. The relative humidity in the atmosphere is about 55 %. The geology of Kolhapur consists of Deccan traps with inter-trapped beds. These volcanic lava flows are spread out in the form of horizontal sheets and beds. The rock is mainly of igneous basalt types. The soil type of Kolhapur consists of black soil and red soil. The city has ample supply of water, good quality of soil, plentiful green areas, etc. which are responsible for overall growth and development of the city (Desai & Samant 2016).

It is still a growing city and passes over 66.82 Km2 area. The total population of the city is 5.05 lakhs (census 2011). After proposed expansion of city boundary, 17 villages on the periphery, some with different wilderness habitats will be included in it. The proposed city area will then increase up to 191.09 Km2 and would support population up to 6.80 lakhs (Desai & Samant 2016).

Water Distribution System
Daily 120 MLD of water is supplied to Kolhapur city by Kolhapur municipal Corporation. Raw water is pumped from river Panchganga. There are total of 3 pupming house. Among them Kalamba pumping house at Kalamba tank is the oldest one. Here water was transferred to the lower elevation ware by gravity. This is a model of proper utilization of geographical conditions and technology. Rest of the two pumping stations are located on river Panchaganga. There details are as follows:

Table no. 1 Raw Water pumping stations

Pumping Station	Establishment Year	Capacity (MLD)
Kalamba tank	1946 – 47	08
Balinga	1946 – 47	41
Shinganapur	2000 – 01	71
Total		120

Water pumped at Shinganapur and Baling pumping station at elevation of 540 msl. It is further carried to at Aptenagar at the hight of 560 msl through pipe line with the use of electricity. It is further transferred to Puikhadi filter house at 586 msl for treatment then it is distributed to the 25 tanks throughout the city. Further this water is distributed to house hold level. In this entire process, water is pumped for four times by KMC. At house hold level also initially water is stored in ground level tank then it is pumped to the over head tank. In this entire process lot of energy in the form of electricity is utilised and also wasted at every stage of pumping.

Energy Conservation Measures
Out of Total budget of water supply system 40 to 45% expenditure is done on electricity and 30 to 40% expenditure is done on establishment. Hence, small amount of funds i.e. 15 to 20 % remain available for repair work. Many times due to excess demand for electricity, problem of load shading, pumping of water gets affected. Ultimately this affects the urban life. According to GR 2001 it is a mandatory of municipal corporation to conduct the energy audit and implement the energy conservation program. The energy audit of water supply system of Balinga was carried out by two agencies namely International Resource Group and Prima Techno Commercial Services, Pune (2000) and other one is Maharashtra Jeevan Pradhikaran (2007-08). For proper implementation of suggestions in the report, three stage program was put forward. 1) Establishment of automatic power factor correct panel along with capacitor, 2) Repairing of wrecked and out dated machinery, 3) to change the wrecked and out dated machinery.

The alteration plan suggested in energy audit report was costing Rs. 2.11 Crores which has estimated to save Rs. 2.5 Crores. However, this plan was exorbitant for KMC and was also time consuming. Instead of following the same plan, some other provisions were done by engineers of KMC which has saved money as well as time.

Intra departmental measures initiated are as follows:
Reduce the kVA demand load (Balinga) –
At Balinga Pumping station 1135.75 kW energy is required to keep on running constantly. Two air blowers of Water treatment with the capacity of 25 hp and 30 hp and distilling pumps of pre settling tank with capacity 93.75 hp are need to keep on only for 5 – 10 min which increases demand load. Hence, during this period 300 hp capacity pump is shut down which has improved power factor and reduced the kVA load. This saved about 1000 kVA load and Rs. 70,61,275/- during July 2000 to August 2006.

Closing low level pumping (Balinga) –
If the water level of river lowers than 1754 feet then low level pumping is essential which demands high electricity consumption. To avoid low level pumping, level of water is constantly kept more than 1754 feet. This has saved Rs. 93,25,953/-

Cleaning of Strainers of Vertical and Centrifugal pump –
Plastic, wood waste, Coconut waste, etc. stuck in the strainer is timely cleaned of which has increased working capacity of pumps and reduced electricity consumption.

Removal of silt from jack well and water sump –
Silt and sand accumulated due to water flow and low level pump saturates in the strainer and bowl assembly reduces the water pumping capacity. Hence, silt, sand and dirt deposites are removed once in two year which has improved the suction.

Reducing the static head of pure water sump –
Maintaining the maximum water level reduced the static head which has increased the pumping ifficency and also reduced the electricity consumption.

Removal of leakages from the plants
The pumping house was built 50 years back. Due to continuous use there were few leakages. Removal of leakages from the plant has saved lot of water and electricity consumption.

Maintaining power factor more than 0.90 –
If the power factor is maintained bellow 0.90, then penalty is charged. Hence, the power factor was always maintained

more than 0.90 due to which rebate is gained from MSEB.

Measures suggested by USAID

USAID has suggested few suggestions which include changing of three old pumps of raw water pumping costs Rs. 15,87,189/- which can save upto Rs. 17,05,695/-; Removal of extra electricity consuming V. T. Pump set of 175 hp capacity from raw water pumping (was established in 1984); Removal of purified water pump set of 325 hp capacity (was established in 1983-84); Changing pf old non returning valve – reduced leakages at delivery pumping; Combination of pumps with capacity 300 hp and 335 hp were used for continuous pumping of water. Out of 6 pumps 3 are continuously working for 24 hrs and rest 3 are kept on stand by; The treatment cost for per MLD was Rs. 1669.40/- which is reduced upto Rs. 900/- per MLD

The table no 2 shows details of expenditure made on electricity conservation efforts and money saved by KMC. Total of Rs. 22,52,189/- were spent on expenditure and in returns amount of Rs. 6,25,78,847/- is saved in total. Some of the activities without any expensesreuced the electricity consumption. Reducing demand load due to load shading and closing of low level pumping saved upto Rs. 70,61,275/- ans Rs. 93,25,956/- respectively.

Table no 2 Expenditure and Returns

Sr. No.	Electricity conservation efforts	Expenditure (Rs.)	Money Saved (Rs.)
1	Reducing Demand load due to load shading	00	70,61,275
2	Closing of low level pumping	00	93,25,956
3	Installation of new pumps with 150 hp	15,87,189	28,12,017
4 Other reasons like – leakage removal, valve changing, cleaning of strainer, etc		6,65,000	4,33,79,602
Total		22,52,189	6,25,78,847

Table no 3 gives details of electricity conservation in terms of units and savings in expienditure during 200 to 2007. Conservation of electricity itself is considered as regeration of energy.

Table no 3 Electricity Conservation

Year	Saving in terms of Unit	Saving in Expenditure (Rs.)
2000 – 01	421517	30,84,562
2001 – 02	805706	62,21,312
2002 – 03	1651094	1,36,87,355
2003 – 04	1885766	1,57,84,170
2004 – 05 1761496		1,69,30,542
2005 – 06	1760413	1,61,27,863
2006 – 07	1200494	64,57,367

With the intradepartmental efforts during 2000 to 2007 total of Rs. 64,57,367/- were conserved. Further after energy audit measures namely installation of automatic power factor corrector panel capacitor; Repairing and maintaining of machinery; Installation of new machinery at the place of outdated machinery were undertaked which has conserved about total of Rs. 3,94,85,301.28/-.

Table no 4 Details of Energy Conservation at a glance

SrNo	Measures	Expenditure	Period of Electricity Conservation	Savings out of Electricity Conservation (Rs.)
1	Intra departmental measures taken at Balinga Suggestions given by USAID	22,52,189	July 2000 to October 2007	6,25,78,847
2	Energy Audit as per GR of Maharashtra Govt.	11,00,000	2008 – 2009	----
3	Suggestions from Energy Audit as per GR of Maharashtra Govt.			
	Automatic Power factor corrector panel capacitor installation	29,43,000	January 2009 to March 2014	3,94,85,301.28
	Repairing and maintaining of machinery	23,95,000		
	Installation of new machinery at the place of outdated machinery	1,84,43,030		
4	Installation of Automatic Power factor corrector panel capacitor at other centres	19,93,750		

Conclusions

The optimisation of energy usage and application of advanced technology is essential to solve the current problem of energy need. Specifically sensible efforts at the municipal corporation level helps to reduce energy consumption and also conserves the monetary asset of people.

Small Intra Departmental changes at the operational level has saved large amount of funds of Koljapur Municipal Corporation. Timely conducted energy audit, proper implementation of suggestion along with Awareness and Sensitivity of KMC engineers made electricity conservation possible which has conserved energy as well as money.

Implementaion of green approach of reduce, reuse, repair and regenration accompanied by optimum and innovative use of technology has put forward a positive success story of sustainable use of energy.

References

1. Arora, H & Lechevallier, M.W. (1998) Energy Management Opportunities. AWWA Journal, 90(2):40.
2. Arpke, A & Hutzler, N. (2006) Domestic Water Use in the United States A Life-Cycle Approach. Journal of Industrial Ecology. 10(1-2):169-184.
3. City of Guelph (2008, May 28) City of Guelph announces green power purchase Bullfrog powered facility to reduce carbon dioxide emissions by 400 tonnes in 2008. Accessed at: http://guelph.ca/newsroom_display.cfm?itemID=75468.
4. Cohen, R. & Nelson,B. et al. (2004). Energy Down the Drain: The Hidden Costs of California's Water Supply. Oakland, CA, National Resources Defense Council.
5. Demonsabert, S, Bakhshi, A., Headley, A (2008)., Embodied Energy in Municipal Water and Wastewater, Sustainability 2008- .Green Practices for the water Environment
6. Desai Nilisha and Samant Jay (2016), Perception of Local People on Urban Wilderness habitats in Kolhapur City, International Journal of Scientific Research, Vol.5, Issue 2: 272 – 275
7. Desai Nilisha and Samant Jay (2016), Urban Wilderness in and Around Kolhapur Municipal Corporation Limits, Indian Journal of Applied Research, Vil.6, Issue 5: 173 - 178
8. EIA (2009) http://tonto.eia.doe.gov/energy_in_brief/electricity.cfm
9. Energystar. (2008). "Portfolio Manager Overview.", http://www.energystar.

gov/index.cfm?c=evaluate_performance.bus_portfoliomanager
10. EPRI (1994) Energy Audit manual for water/Wastewater facilities. Available at: http://www.aceee.org/industry/energyaud.pdf
11. EPRI (2002). Electric Power Research Institute, Inc , Technical Report. 1006787. Water and Sustainability (Volume 4):U.S. Electricity Consumption for Water Supply and Treatment- The Next Half Century.
12. GRDC (Federal Institute of Hydrology). (2000). Modelling raster based monthly water balance components for Europe, Report No.26, P133
13. KLEIN, G. (2005). California's Water-Energy Relationship, California Energy Commission.
14. Kolhapur Municipal Corporation (2013) Environmental Status Report 2012-2013
15. Kolhapur Municipal Corporation (2014) Environmental Status Report 2013-2014
16. MAAS, C. (2009) Greenhouse Gas and Energy Co-benefits of Water Conservation. Available at: www.poliswaterproject.org.
17. Pagi & Ieso (2008) Ontario Municipalities: An Electricity Profile. January 25, 2008 Available at: http://www.amo.on.ca/AM/Template.cfm?Section=Conservation_ and_Demand_Management&Template=/CM/ContentDisplay.cfm&ContentID=150110
18. Racoviceanu, A. I., Karney, B. W. et al. (2007). "Life-Cycle Energy Use and Greenhouse Gas Emissions Inventory for Water Treatment Systems." Journal of Infrastructure Systems 13(4): 261-269.
19. Sandia National Laboratoies. (2008). "The Energy-Water Nexus." Retrieved May 4, 2008, from http://www.sandia.gov/energy-water/.
20. Tripathi, M. (2007). "Life-Cycle Energy and Emissions for Municipal Water and Wastewater Services: Case-Studies of Treatment Plants in US. Ann Arbor," Center for Sustainable Systems, University of Michigan.