ENERGY SAVING POTENTIALS OF WATER SUPPLY SCHEMES IN SRI LANKA

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(178249A)

Degree of Master of Engineering in Energy Technology

Department of Mechanical Engineering

University of Moratuwa
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DECLARATION

I declare that this is my own work, and this thesis/dissertation does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Name of the supervisor: **Dr. R.A.C.P. RANASINGHE**

Signature of the supervisor: Date:

ABSTRACT

The water supply industry and the energy sector are closely connected, with substantial energy requirements throughout the water supply process. This relationship is vital as climate change and global water and energy demands emphasize the urgency of enhancing energy efficiency in water supply sectors worldwide. Recognizing this, the National Water Supply and Drainage Board in Sri Lanka, responsible for water supply, acknowledges the need for strategic initiatives to optimize energy efficiency.

This study aimed to identify factors influencing Specific Energy Consumption (SEC) variations and developed a novel tool for investigating energy conservation potentials within Water Supply Schemes (WSS) in Sri Lanka. Studies indicate that approximately 96% of energy consumed in surface water treatment and distribution is attributed to water pumping. Optimum SEC Model introduced in this study utilizes specific speed to identify pump operating characteristics, estimate equipment inefficiencies, and establish economical norms for hydraulic gradient in pumping systems. In contrast to the current energy management concepts used in Benchmarking SEC, this approach replaces traditional energy audits targeting equipment inefficiencies and promotes the use of historical and operational data. Also, this technique opens the opportunity to compare location-specific SEC elements like topology and connection density.

Data gathered from the Matara Integrated WSS, operated by the National Water Supply and Drainage Board in Sri Lanka, was evaluated using the Optimum SEC model, revealing a 45% energy-saving potential compared to the actual electricity demand of 1716 kW. Furthermore, to corroborate these findings, a case study was conducted utilizing the WaterGEM model.

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DEDICATION

I dedicate this study to my beloved parents, who have provided me with the strength and courage to overcome life's challenges. I am truly grateful for their inspiration, sacrifice, and unwavering moral support, which have played a significant role in shaping me into the successful individual I am today.

GDH Kosala

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I am grateful for the cooperation of the Electromechanical Staff of National Water Supply and Drainage Board, Matara, whose support facilitated the regional energy data collection process. Their efficient management of regular tasks allowed me the necessary time to focus on my studies.

Lastly, I would like to express my love, gratitude, and appreciation to my family members, batchmates, and friends, especially Eng. Geethal Siriwardhana and Eng. Chithral Wajirapriya Abeykoon, whose unwavering encouragement and support were indispensable in the successful completion of my postgraduate studies.

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Symbols

C	roughness coefficient
f_D	Darcy-Weisbach friction factor
g	Gravitational acceleration
H,h	Total head (m)
n	rotational speed (rpm)
Q	Flow rate
L	Pipe length of the pumping system
P	Power consumption of a pumping system
E	Pump Efficiency
E_m	Motor Efficiency
h_s	Static head of the pumping system
h_f	Friction head of the pumping system
R	hydraulic radius (A/P Cross Sectional Area of flow/Wetted Perimeter)
S	Hydraulic Gradient (h_f/L)
N_s	Specific Speed
N_{ss}	Suction Specific Speed
V	Velocity
γ	unit weight of water ($\gamma = \rho g$)
ρ	density of the liquid
$\cos \emptyset$	Power factor
$\eta_{M\&E}$	Mechanical & Electrical Efficiency

η_{hy}	Hydraulic/ Transmission Efficiency
η_{sys}	System Efficiency
ΔP	Pressure drop (head loss) in the pipe

Acronyms

BEP	Best Efficiency Point
BSEC	Benchmarked Specific Energy Consumption
CEB	Ceylon Electricity Board
DSM	Demand Side Management
EA	Energy Audit
ESU	Energy Saving (Unit of NWSDB)
GA	Genetic Algorithms
IWA	International Water Association
KPI	Key Performance Indicators
MC	Machine Learning
MIWSS	Matara Integrated Water Supply Scheme
NRW	Non Revenue Water
NPV	Net Present Value
NWSDB	National Water Supply and Drainage Board
PCD	Pressure Control Device

PM	Pressure Management
PRV	Pressure Regulating Valve, Pressure Retaining Valve, Pressure Releasing Valve.
RES	Renewable Energy Sources
SEC	Specific Energy Consumption
VSD	Variable Speed Drive
VSP	Variable Speed Pumping
WDN	Water Distribution Network
WSS	Water Supply Scheme