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Life cycle cost and energy consumption behavior of submersible pumps using in the Barind area of Bangladesh

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Abstract

In this work the ground water level and water pumping for irrigation and drinking purposes in Barind area of Bangladesh have been studied. The depth of ground water level remains under 30ft throughout the year that enforcing the use of submersible pumps in most parts of Barind zone. The Barind Multipurpose Development Authority (BMDA) and Rajshahi WASA are the major water supplying authority in the Northern Part of Bangladesh by using 14386 and 87 nos of submersible pumps, respectively. An investigation for the values of life cycle cost elements of submersible pumps has also been carried out. The performance of the pumps running in different sites in Barind area were investigated and compared with the lab test results of new pumps. Energy consumption cost is dominating the life cycle cost of the pumps using in Barind region and improper matching of pump standard running conditions and operation/system requirements are the main causes of lower efficiency. It is found that the efficiency of the running pumps is reduced by 20 – 40% than that of lab test results.

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Keywords: Life cycle cost; Energy consumption behaviour; Submersible pump; Barind area; Ground water level

1. Introduction

It is estimated that pumping systems consumed near about 20% of the world's electrical energy and this system are mainly used in industrial plant operations, which is ranging from 25-50% [1]. There are various sectors where pumping

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systems are used such as in domestic services and different industries like mechanical, pharmaceutical, chemical, petrochemical etc. It is also used in agricultural services, municipal water/wastewater services and industrial services for food processing. There are some interdependent major factors upon which the cost of energy and material of the pump is relayed. The design of the pump, the design of the installation, and the way the system is operated are the major factors [1-3]. Now-a-days the demand of a submersible pump is rising very much. The BMDA has set a base on geographical identification upon which the part of greater Rajshahi, Dinajpur, Rangpur, Bogra and Joypurhat districts of Bangladesh and the Indian territorial Maldah district of West Bengal are announced as Barind Tract [5]. It is known as Varendra Bhumi by Bangladeshi inhabitants. The Varendra Bhumi situated over an area covering near about 7,770 square kilometers. The geographical location of Varendra Bhumi is between 24°20'N and 25°35'N latitudes and 88°20'E and 89°30'E longitudes [6]. It is located at the northwest of the confluence of the upper Padma and Jamuna rivers and is bordered by the floodplains of the Mahananda river to the west and the Karatoya river to the eastern tributaries of the upper Padma and of the Jamuna, respectively [3]. Without the wet season, which is ranging from mid-June to October Barind area has always existed with a dry climate. The range of temperature and rainfall varies in Varendra Bhumi between 4°C to 45°C and 1500 mm to 2000 mm, respectively [5]. Sometimes in different region of Rajshahi, especially in Lalpur upazila approximately the 45°C or more temperature is experienced. The opposite picture is captured in winter season. The temperature falls to 5°C in some region of Dinajpur and Rangpur districts of Bangladesh [6]. Although there are varying brands of submersible pumps available in the marketplace, but some of them are cheap but shorter lifespans and high maintenance and energy consumption costs. The cheapest brand pumps draw the primary interest of the most customers. Some other brands have comparatively longer life span with low maintenance and energy costs. The customers do not feel interest for the high price of these pumps that is very lower than the energy consumption cost during its life. Under these circumstances it is crucial to study the life cycle cost (LCC) and performance of submersible pumps using in the Barind area of Bangladesh.

Nomenclature

η_c	Combined Efficiency (%)
Q	Discharge (m^3/hr.)
H_p	Pump head gain (m)
S	Specific gravity of water
P	Electricity Consumption
d_1	Diameter of the well
d_2	Diameter of the discharge pipe
P_1	Suction pressure at datum line
P_2	Delivery pressure in water distribution line
H_p	Pump head gain
h_{fm}	Major head loss due to friction in the discharge pipe of diameter d2
h_{ls}	Head loss at pump inlet including effect of screen
h_{lb}	Head loss at the bend.
h_{lf}	Head loss in flange joints
n	Number of flange joints
L	Length of discharge pipe
ρ	Density of water
h_{lo}	Head loss at outlet of discharge pipe at point 2

2. Methods

2.1 Performance of submersible pump used in Barind Area

The popularity of a pump depends on some factor like cost, availability, longer life spans, low running and