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Analyses on utilisation of solar energy as a sustainable source of clean water production

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Abstract: Availability of clean water depends on either availability of naturally clean water or supply of sustainable source of energy that can be utilized for clean water production process. Solar energy can be utilized as a sustainable energy means for clean water production process. Prospects of solar energy utilization for water pumping and desalination exist in Pakistan on account of availability of solar energy for most of the day hours and round-the-year. Therefore, research survey is carried out of thermal and solar powered clean water production processes in Pakistan. In this paper, a comparative analysis of conventional thermal powered and solar powered clean treatment processes is carried on parameters of production costs, environmental sustainability and self-contained nature of solar powered clean water production process.

Keywords: Solar desalination, environmental sustainability, clean water production.

1. INTRODUCTION

Access to clean water to all the areas of Pakistan is not available on account of lack of sustainable energy powered clean water production processes. However, sustainable energy means exist in Pakistan Asif, (2009). The scale of utilization of these energy sources needs to be enhanced. For instance, solar energy is available in abundance quantities but its utilisation for clean water treatment process is not much common.

The climate in Pakistan is favourable for solar energy utilisation for most of the year Mirza *et al*, (2009), Shah *et al*, (2103).Solar energy can be used not only to pump underground contaminated water but also for to make it potable Shah *et al*, (2013). Solar energy is readily available in various parts of Pakistan and can be used as a source for electrical power generation, desalination, agricultural cultivation and water pumping Harijan *et al*, (2007) and Kher,(2008).

Environmental sustainable clean water production processes are also lacking in Pakistan. The gravity of the situation can be realized from the fact that Pakistan occupies 134th position in the list of countries of emission producers the World Resource Institute WRI, (2005). However, environmentally sustainable solar pumping and desalination processes can be utilized in these areas Shah and Edwards (2011). The process of solar powered clean water production processes can affect environmental of Pakistan and its efforts towards reduction of total environmental emissions.

Clean water production costs are also an important dimension, which deserves due attention. Initial setting up cost of the solar powered clean water production process includes capital and clean water production costs. The capital cost of brackish water reverse osmosis units ranges from \$250 to \$750/m^3 of installed capacity and of a seawater RO unit could range from \$800 to \$1250/m^3 of installed capacity Alt Tech (2014).

In order to evaluate solar energy as a sustainable fuel in terms of energy availability, operational costs optimization and, environmental emission reduction, a research survey of solar powered clean water production processes is conducted and the results are analysed with the aim to establish the basis the use of solar energy as reliable and sustainable energy source for reliable and decentralized clean water production method in Pakistan. The results of the research are promising for utilization of solar powered clean water production processes In Pakistan

2. RESEARCH AND METHOD

Pilot questions and main questionnaire were used for the analysis. Questionnaire survey data is processed and presented in MS Excel software. The parameters of the research hypothesis included the input energy consumption, CO_2 emissions production, clean water production costs and the environmental sustainability.

The samples of the questionnaire survey were selected on the basis of their qualifications and experience in thermal and solar power clean water production centres. Demographic aspects of the samples such as age and sex are also covered in the questionnaire survey. All the respondents were male and

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are in the age group of 30-50 years, and are working in middle and senior level positions. Open and closed type questions are used to extract the required information from the professionals and technocrats working in these industries existing processes.

Precision and accuracy are and maintained at all stages of data generation, processing and presentation. Allowance limit of +/- 10 is provided in the data processing. The results are verified to preclude the possibilities of more than allowance limit.

3. RESULTS

In the first stage the amount of electrical power consumption per m^3 of clean water production are collected and analysed. The input energy consumption is used in kWh per m^3 production of clean water production. Electrical power consumption per m^3 of clean water production is presented in **(Fig.1).**

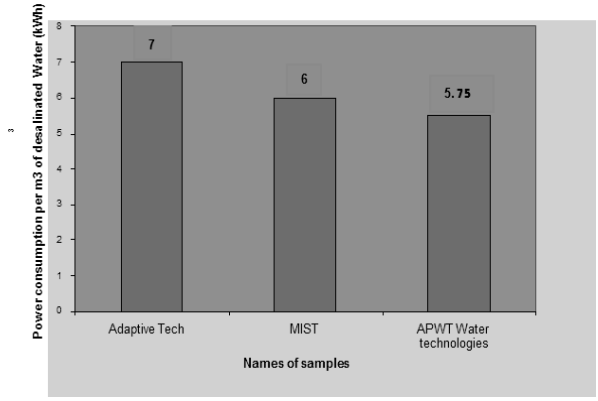


Fig.1.Electrical power consumption requirement for per m^3 clean water production

As regards environmental sustainability nature of thermal powered clean water production processes, it is imperative to study the amounts of CO_2 emissions that could be released to the environment per m^3 of potable water production in fossil fuelled clean water treatment processes. The amounts of these emissions are shown in **(Fig.2).**

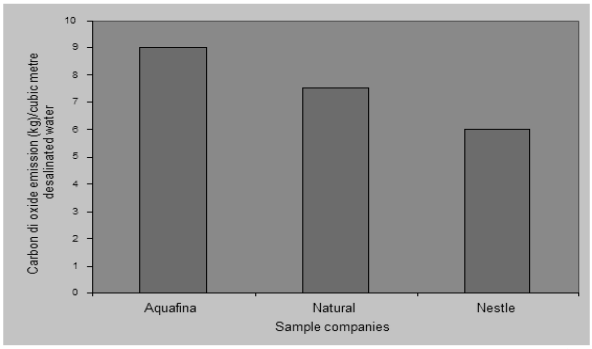


Fig. 2. The counts of CO_2 emission, which are emitted per m^3 of clean water production under fossil fuelled clean water production processes

A breakdown of operational, transmission maintenance and disposal costs of thermal and solar powered clean water production processes is illustrated in **(Fig 3)**.

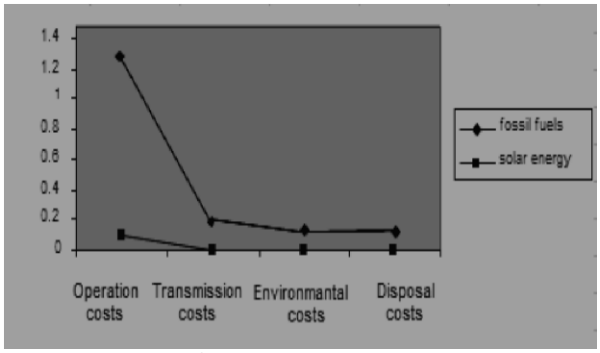


Fig. 3. Comparison of operational, transmission, environmental and disposal costs ($) per m^3 of clean water production under fossil & solar powered clean water production.

As regards the total costs of fossil fuelled and solar powered water treatment processes of it would be helpful to calculate total costs, which are made in both of these processes, which are represented in **(Fig. 4).**

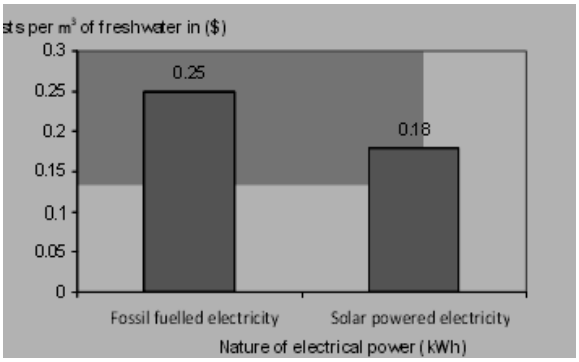


Fig. 4. Total costs of clean water production under fossil fuelled and solar powered clean water production processes

Solar powered clean water production processes are considered environmental sustainability on account of non release of environmental emissions. The environmental sustainability of solar desalination processes is presented in **(Fig. 5).**

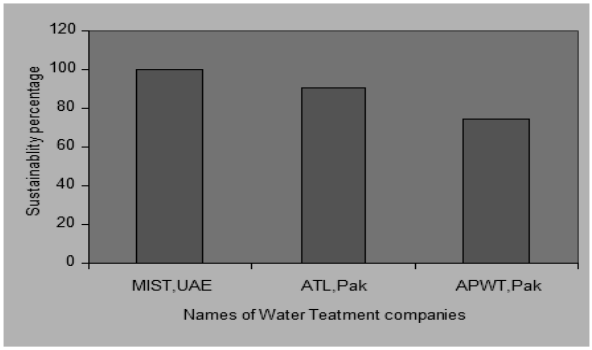


Fig.5. Environmental sustainability for solar desalination process

4. ANALYSIS

As regards the total costs of the fossil fuelled processes and solar powered water treatment process it is essential to break the total clean water production costs into operational, transmission, environmental and disposal costs of both processes. The operational, transmission and maintenance costs ($) using fossil fuels and solar energy fuels per m^3 of clean water production are analysed.

Solar powered desalination systems are considered environmentally sustainable than fossil fuelled water treatment systems on account of the release of environmental emissions during the process of thermal power generation.

Solar water cleaning processes are cost effective, as the capital costs are recoverable in a short span of time i.e. 06-08 years. Moreover operational costs of solar powered clean water production are comparatively lesser than thermal powered clean water production processes.

The analysis establishes the worth of solar energy as a reliable energy source for clean water production in comparison to thermal powered clean water production processes as it is available most of the day and of the year. Solar energy based clean water production process is also feasible economically in comparison to conventional electrical power on account of almost zero power supply costs.

Solar powered pumping and desalination processes provide means for environmental emission reduction as compared to thermal powered water pumping and treatment processes which also produces CO_2 , So_x and No_x, which pose considerable damage to the user and environment.

Therefore, solar powered desalination processes can be used as a potential alternative to the fossil fuelled water treatment systems and are capable of meeting the clean water energy needs of present and future communities in an environmentally sustainable manner. In view of the analysis mentioned in the preceding section it can be said that in areas where solar energy availability is possible can be utilized for meeting the energy needs of pumping and water treatment processes. The use of solar electrical power would decrease dependence on conventional electrical power supply systems and could prove a self-sufficient, sustainable and decentralized water treatment and supply system.

5. CONCLUSIONS

The analysis of fossil fuelled and solar powered clean water production establishes the feasibility of solar powered water pumping and desalination processes leads to the conclusion that solar clean water production processes are feasible on account of energy input availability, optimum clean water production costs and environmental sustainability.

Therefore prospects of using small, medium and large scale solar powered water treatment plants are brighter for various areas of Pakistan. Such development could resolve the problems of clean water scarcity and consumption of unhygienic drinking water, which is common in most of the urban and rural areas of Pakistan.

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