ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

Application of Hydropower Technology in Wastewater Treatment Plants Step Towards Sustainable Environment

Digisha Patel[1*], Hemali Jardosh[2]

Department of Environmental Engineering, Sarvajanik College of Engineering and Technology, Gujarat, India[1]

Department of Civil Engineering, Sarvajanik College of Engineering and Technology, Gujarat, India[2]

ABSTRACT:Water and Wastewater treatment plants requires huge amount of energy operation cost. As per the energy demand, water companies require cost reducing and sustainable solution to produce energy. The generated energy should reduce its dependence on fossil fuel. For this study, different types of hydropower technology have been studied. And as per suitable criteria of wastewater treatment plants, Gravitational water vortex flow power plant which is one of the best low head and low flow rate basedhydropower technology have been selected. To determine optimum efficiency of power plant, a lab scale model will be prepared for selected hydropower technology. Generated electricity will be considered for co2 reduction energy and it can use in plant itself which can reduce its cost. Parameters of wastewater will be check for selection of appropriate turbine blade materials. This will be an innovative approach which can reduce the energy cost of wastewater treatment plants.

KEYWORDS: Hydropower, Wastewater treatment plants, Cost, Carbon emission, Sustainable environment

I. INTRODUCTION

Climate change and its social, environmental, economic and ethical results widely recognized which are interconnected problems facing human societies. Its impact and cost is large, serious and unevenly spread. The main reasons behind global warming are consume fossil fuel based energy and deforestation by human societies for different purposes.

Conventional technologies for the conversion of energy into secondary and final energy are based principally on the combustion of fossil fuels-coal, oil and gas fired power plants. These conversion technologies are the source of large quantities of GHG emissions, especially CO_2.

In contrast, conversion technologies for the production of energy from renewable energy resources do not emit GHG and are known as Carbon Neutral technologies.

Renewable energy resources, such as Solar energy, Hydropower, Wind energy, Geothermal energy, Biomass energy, Thermal conversion processes and Chemical conversion processes offer an alternative energy source to meet the growing demand.

Water and Wastewater treatment processes requires huge amount of energy around 30 to 80% of industrial operation cost. As per energy demand, water companies require cost reducing and sustainable solution for energy production. The generated energy should reduce its dependence on fossil fuel and also helps to reducing energy cost. Hydropower can be at the doorstep of Wastewater treatment plants, which has been identified as the solution to a sustainable energy option for the water industry.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

Gravitational Water Vortex Flow Power Plant is one of the best Hydropower technologies which can be use in Wastewater treatment plants to produce clean energy. This Hydropower technology is suitable for Wastewater treatment plants because of its low hydraulic requirements (Table 1).

Others	Flow Range (m^3/s)	Head Range (m)	Power Output (kW)
Impulse Turbines			
Pelton	0.008-0.01	3-100	<1.6
Cross flow	0.01-1.0	5-60	<100
Reaction Turbines			
Kaplan	1.5-60	1.5-20	20-3500
Vortex Francis	0.05-20	0.7-2	0.5-160
Pump as Turbin	0.03-6	3-80	310,000
Others			
Gravitational water vortex flow power plant	0.7-3	1.5-2.5	5-50

Table 1. Types of turbine based on low head and flow rate.

II. LITERATURE REVIEW

Several Hydropower technologies which can apply to the Wastewater treatment plants were investigated by scientists. There are two basic hydraulic requirements in hydropower technology sufficient head and flow rate to produce electricity. On the basis of research work application of hydropower technology is quite difficult because of limitations in head and flow rate. There is requirement of such kind of hydropower technology which can suitable for limited head and flow rate.

I Loots et al.[1] studied a review of available low head hydropower technologies. Study was carried out in South African region. They identified the sites where technologies can be implemented which are grouped as follow: dams and barrages, rivers, irrigation systems (canals and conduits) and urban areas (industrial and urban discharge, storm water systems and water distribution systems). There was some important parameters which they consider when planning a low head hydropower plant like reliability of flow, nearby utilization of electricity, environmental factors and water quality. They also mentioned that because of hydropower development, primary function of the infrastructure and its function should not be compromised.

AH Elbatran et al. [2] studied the various types of low head hydropower turbines on the basis of their cost, operation and performance. He concluded that low head and micro-hydropower is the most secured alternative solution to overcome the problem of lack electricity supply and financial problem in rural and poor areas to ensuring better future for the population.

Kyu Chang Chae et al. [3] studied a Micro Hydro (MHP) system with a flow-variable turbines was tested for more than one year to investigate its applicability for small scale municipal wastewater treatment plants (WWTP) with different flow fluctuations. The applied MHP was Semi-Kaplan which is highly flexible and guranteeing high performance within wide operation range. The effluent in existing MHPs was used to produce electricity under optimized control strategies for the net head and turbine blade pitch. In Korea, wastewater based hydropower was considered impractical due to low turbine efficiency. This study suggests a new possibility of clean energy from WWTP because of its simple installation, economic viability andminimal environmental impact.

DB Patil et al. [4] studied feasibility of implementing hydroelectric turbine systems in wastewater treatment plant. The treatment plant named, Ichalkarnji Textile C.E.T.P. Ltd., Ichalkaranji, Kolhapur, Maharashtra, India was selected for a case study analysis. On the basis of study they found that Hydroelectric turbine at the CETP Ichalkaranji would

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

generate 26 kW at an average flow of 0.65 m^3/s, which is approximately 2,07,261 kWh of electricity per year.This generated electricity can used in plant itself which can save Rs. 14,00,000 electricity cost per year.

Karan Bhandari et al. [5] studied about how Micro Hydropower plant (MHPP) can be used to meet high demands of electricity. They found that MHPP in S.T.P has been practised in many parts of the world. They studied about advantage and disadvantage of installing Micro Hydropower plant in S.T.P. They did theoratical case study in which MHPP has been installed in one of the S.T.P. of Jodhpur, India. They discussed about selection of specific turbine on the basis of available flow and head at the site. Their results showcased that this mathodology can produce 73, 355 units annually and return on investment period being 1.5 years.They concluded that MHPP is an efficient and renewable source of energy generation and high demand in future.

Anjali MM [6] studied that Gravity Vortex Power plant can be cost effective solution for drainage disposal. The main advantages of this power plant are power generation, aeration and segregation. Power generation from drainage water can be major source of renewable energy. Metropolitian cities such as Delhi, Mumbai and other major cities which can be benefit by application of Gravity Vortex Plants. This installation leads to reduced water pollution.

Christine P et al. [7] studied the maximum efficiency of Vortex flow power plant.They found maximum efficiency was 15.1% found with the largest blade area, the maximium flow rate,th 25 IH and a resistence force equal to 60% of the maximum force applied.Higher efficiencies of up to 80% by commercial companies and 30% by experimental research studies.

Dipesh T et al. [8] studied about different inlet geometries of flow channel in the quality of vortex produced under steady state flow condition.They found that vortex channel having triangular inlet geometry was effective for vortex flow hydroelectric power plant. This geometry can produce very symmetric vortex pattern which causes very less imbalance radial force that was resposible for the bending for turbine shaft. Study also shows that vortex flow channel with rectangular inlet geometry path was not much effective as triangular inlet geometry.

Rahman MM et al. [9] studied tha highest efficiency in the model vortex turbine were found 38.6% at 0.06 m of water head, 41.1% at 0.08 m of water head and 42.1% at 0.12 m of water head.The maximum efficiency was found with three blades and outer diameter was 0.027 m of length. They found that maximum efficiency was originated when the rotating speed was half of the tangential velocity of vortex. On the basis of experimental studies they found that the model vortex turbine had been produced sufficient hydraullic power from the low water head.

Sritram P et al. [10] studied on material of Turbine. They found that light weight water turbines with changing in material could increase the efficiency of electricity production. They found that the torque value and electricity production efficiency of aluminium turbine was higher than steel turbine.They concluded that the materials for making the turbines were effective for electricity production.

III. CONCLUSION

Application of Micro Hydropower technology in waste water treatment plants is the clean and sustainable energy source which can reduce carbon emission by avoiding fossil fuel based energy. There is no harmful impact as compare to the large hydropower project.This study will be useful for implementing small scale power project into other Wastewater treatment plant to reclaim the energy from wastewater.

REFERENCES

[1] Loots, M. van Dijk, B. Barta, SJ. vanVuuren, JN. Bhagwan, "A review of low head hydropower technologies and applications in a South African context", Renewable and Sustainable Energy Reviews, pp. 1254-1268, 2015.

[2] AH.Elbatran, OB. Yaakob, YM.Ahmeda, HM. Shabaraa, "Operation, performance and economic analysis of low head micro-hydropower turbines for rural and remote areas: A review", Renewable and Sustainable Energy Reviews vol. 43, pp. 40-50, 2015.

ISSN(Online): 2319-8753
ISSN (Print): 2347-6710

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 7, Issue 2, February 2018

[3] KJ. Chae, IS. Kim, X.Ren, K.Cheon, “Reliable energy recovery in an existing municipal wastewater treatment plant with a flow variable micro-hydropower system”, Energy Conversion and Management,vol.101, pp. 681-688, 2015.

[4] DB.Patil, RA. Oak, RH.Jadhav, “Captive Power Plant - A Case Study Of CETP Ichalkaranji, Maharashtra”, International Journal of Research in Engineering and Technology, Vol. 5 no 5, 2016.

[5] K.Bhandari, OP.Rahate, “Micro Hydro Electricity Generation in S.T.P, A Case Study of S.T.P, Salawas-Jodhpur”, International Research Journal of Engineering and Technology (IRJET), vol4 no 3, 2017.

[6] MA.Mohanan, “Power Generation with Simultaneous Aeration using a Gravity Vortex Turbine”, International Journal of Scientific & Engineering Research, vol. 7, no. 2, 2016.

[7] C. Power, A.McNabola, P. Coughlan, “A Parametric Experimental Investigation of the Operating Conditions of Gravitational Vortex Hydropower (GVHP)”, Journal of Clean Energy Technologies, Vol. 4 No. 2, 2016.

[8] D.Thapa, A. Mishra, “Effect of Inlet Geometry in the Quality of Vortex Formed using vortex flow channel”,International Journal of Mechanical Engineering and Technology (IJMET), vol 8 no. 5, pp. 515-524, 2017.

[9] MM. Rahman, TJ. Hong, R. Tang, LL. Sung,FBM.Tamiri, “Experimental Study the Effects of Water Pressure and Turbine Blade Lengths & Numbers on the Model Free Vortex Power Generation System”, International Journal of Current Trends in Engineering & Research, Vol 2 no. 9, pp. 13–17,2016.

[10] P.Sritram, W.Treedet, R.Suntivarakorn, “Effect of turbine materials on power generation efficiency from free water vortex hydro power plant”, 4th Global Conference on Materials Science and Engineering, 2015.