

## Hydro Electricity generation using waste water from Textile Industries through unified ETP

Akil Ahammed<sup>1</sup>, Tawheed Kibria<sup>2</sup>,

Institute of Renewable Energy Technology University of Dhaka Bangladesh  
Institute of Renewable Energy Technology University of Dhaka Bangladesh

**Abstract:** In this project, a cutting-edge idea is shown which demonstrates the way to generate electricity using wastage water from textile industries using unified Effluent Treatment Plant (ETP). Discharged water path is from industries to river. This idea is not only a renewable project, but also saves the environment from toxic textile chemicals and unified ETP will save a huge amount of expense. As the discharged water is of low head, this problem is solved by massive discharge rate as textile industries are using huge amount of water. Necessary graphs, diagrams, charts, power calculations, efficiency etc. are shown in this paper to represent the aspect of this project.

### I. Introduction

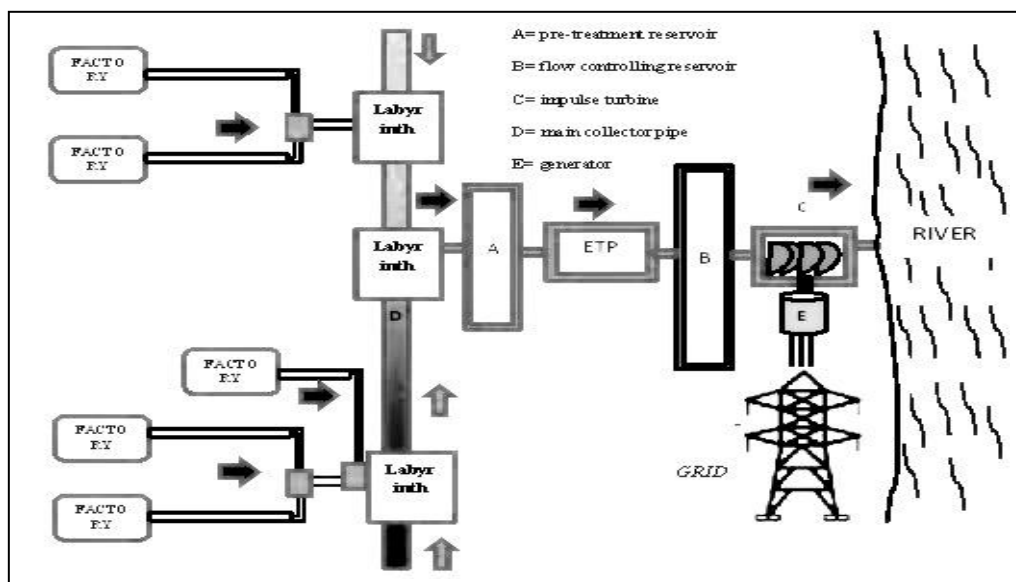
Hydroelectricity is one of the most renowned and well-established renewable energy technologies. It's not only a low cost source of energy but also environment friendly. Textile industries are the backbone of economy of Bangladesh. However, those are the most resource and energy consuming and environment polluting industry. Textile industries use a huge amount of water and the waste water from these industries is toxic. For this reason, these industries use ETP (effluent treatment plant), but running an ETP is costly. So for one or two shift/day, the ETP plant is kept inactive which causes severe water pollution. So a process may be introduced to save the environment, reduce the cost of the industries and can generate pollution free energy (here, hydro-electricity) before the waste water is dumped in the river.

### II. Site Location & Resource

Here, Gazipur area is selected and the resource water path is from the industries in that area to Turag River. The resource for this micro-hydro plant system is huge amount of waste water from textile industries. There are approx. 1700 washing and dyeing factories consuming 435000 ( $\pm 10\%$ ) tons of water daily. The amount of exhaust water is 5-8% reduced to consumption. As the water head (from surface to river water bed) is relatively low (15-20 feet), the high discharge rate of water will be the appropriate 'fuel'.

#### Schematic:

Here is a schematic shown below indicating the path of water from industries to river via ETP, reservoir and several power generating components-



### III. Water collection & filter Technology

The exhaust water from the industries is collected by different flow pipes made of PVC or concrete and those converges into a main collector flow pipe. Then the mainstream heads towards a subsurface pre-treatment reservoir of dimension 100m× 50m ×15m. Then the water enters into ETP. ETP has three main chambers- i) dust & colloid filter ii) centrifuging portion iii) ion filter through osmosis. ETP must have the capacity to filter or purify at least 0.5m<sup>3</sup>/s at a time. Then the purified water enters the post-treatment water reservoir having the same dimension as the previous one. This reservoir helps to maintain constant & aspect discharge rate of water.

### IV. Hydro-electricity generation

Now, the water from post-treatment reservoir having dynamic head of 15-17 ft (4.6-5.2 m) released through a PVC pipes having dia. of 9ft transforming a jet or nozzle of 0.5ft. Then the water jet strikes an impulse turbine connected to a generator. The generator has a stator of permanent magnet. The torque generated on turbine tends to gyrate it and AC current is generated. The power generation formula is -

### V. Hydroelectric Power Output Estimation Formula

$$\text{Dynamic Head (m)} \times \text{Flow (CMPM)} \times 0.18 \times \text{Turbine Efficiency (0.40)} = \text{Output Watts}$$

$$\text{Nozzle velocity- } v(\text{ms}^{-1}) = \frac{q(\text{m}^3 \text{s}^{-1})}{d_{\text{jet}}^2(\text{m}^2)}$$

The turbine peripheral velocity will be half the water jet velocity. So-

$$v_{\text{turb}} = \frac{1}{2} \times v_{\text{jet}}$$

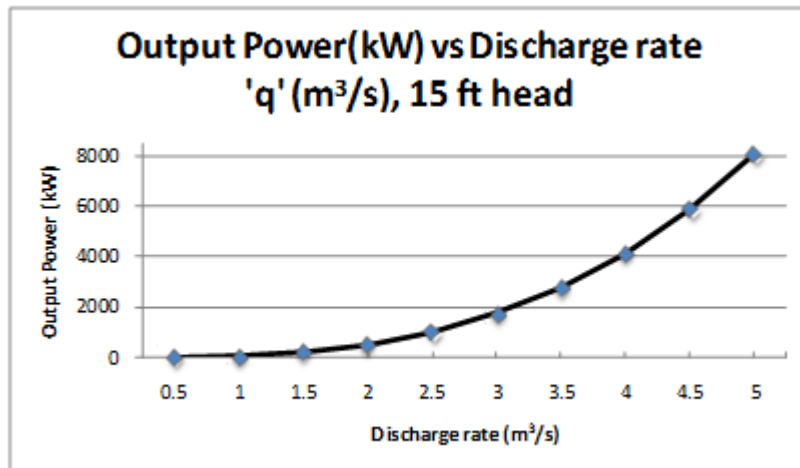
And turbine RPM-

$$\omega_{\text{turb}}(\text{rpm}) = 0.5 \times 229.2 \times \frac{v_{\text{jet}}(\text{ms}^{-1})}{d_{\text{turb}}(\text{m})}$$

**Power Calculation table:**

power vs discharge rate, nozzle dia. 0.5 ft																
discharge rate, q (m <sup>3</sup> /s)	discharge rate, q (USgpm)	static head (ft)	pipe dia (in)	nozzle dia (ft)	HF (ft)	f coef.	Reynolds no.	pipe velocity (ft/s)	nozzle velocity based on friction (ft/s)	nozzle velocity (ft/s)	water jet power (kW)	power at turbine wheel (kW)	elec. cost per month(\$)	pipe length (ft)	turbine rpm	turbine dia. (ft)
0.5	132.085	15	108	0.5	3.8E-07	0.041	3869.8	0.00463	31.0661	215.827	18.0212	<b>8.10955</b>	408.721	250	1648.92	15
1	264.17	15	108	0.5	1.2E-06	0.0333	7739.59	0.00925	31.0661	431.654	144.17	<b>64.8764</b>	3269.77	250	3297.83	15
1.5	396.255	15	108	0.5	2.5E-06	0.02977	11609.4	0.01388	31.0661	647.481	486.573	<b>218.958</b>	11035.5	250	4946.75	15
2	528.34	15	108	0.5	4.1E-06	0.0276	15479.2	0.0185	31.0661	863.308	1153.36	<b>519.011</b>	26158.1	250	6595.67	15
2.5	660.425	15	108	0.5	6E-06	0.02607	19349	0.02313	31.0661	1079.13	2252.65	<b>1013.69</b>	51090.1	250	8244.59	15
3	792.51	15	108	0.5	8.3E-06	0.02492	23218.8	0.02776	31.0661	1294.96	3892.58	<b>1751.66</b>	88283.8	250	9893.5	15
3.5	924.595	15	108	0.5	1.1E-05	0.024	27088.6	0.03238	31.066	1510.79	6181.28	<b>2781.57</b>	140191	250	11542.4	15
4	1056.68	15	108	0.5	1.4E-05	0.02325	30958.4	0.03701	31.066	1726.62	9226.86	<b>4152.09</b>	209265	250	13191.3	15
4.5	1188.77	15	108	0.5	1.7E-05	0.02262	34828.2	0.04163	31.066	1942.44	13137.5	<b>5911.86</b>	297958	250	14840.3	15
5	1320.85	15	108	0.5	2E-05	0.02207	38698	0.04626	31.066	2158.27	18021.2	<b>8109.55</b>	408721	250	16489.2	15

Power generation vs. Discharge rate Graph:



## VI. Costing

### 1. Infrastructure costing:

-The costing and installation for 5 km long and 10 ft. diameter concrete collector pipe having a 4" of thickness is = 120000000 BDT

- costing & installation for two reservoir plant of dimension 100m× 50m ×5m is = 7000000 BDT

- ETP plant installation cost is = 227600000 BDT

ETP plant and maintenance will be provided by textile the industry owners which are very less per head than their individual ETP running cost.

- Costing for sub-collector PVC pipes, Generator and turbine is = 20500000 BDT

### 2. Power generation costing:

From table above, we can find that the monthly cost for 1kW power generation costs  $\approx 50.4\$$

And 1kWh or 1 unit costs =  $50.4 / (30 \times 24) = 0.07\$ \approx 5.7$  BDT

Yearly saving for a 6 MW plant =  $(7.5 - 5.7) \times 24 \times 365 \times 6200 = 97761700$  BDT

Feedback time = total installation cost / yearly saving =

$(120000000 + 7000000 + 227600000 + 20500000) / 97761700 = 3.84$  yrs.

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