Tuesday 19 November 2024

Project Design: Hydroelectric Unit with 10 kW Generation Using 10,000-Liter Tanks

Design basis:

Please I want to build a hydro-electric unit that will generate about 10kw of electricity, the water reservoir height is 40m and the hydro-turbine water flow rate is 40liter/seconds, the water pipe diameter is 250mm. I want the water exiting the hydro turbine to go to a circular concrete fishpond and the water exiting the fishpond to be treated and transfer back to the water overhead tank, part of the treated water to be heated to boiling point and stored to cooldown to ambient temperature for human drinking and the water to continuously feed the hydro turbine to keep it running continuously for 365 days. The overhead tank must not be empty and must not overfill. The concrete fishpond must not empty and must not overfill. Design the above project, indicating the diameter of the overhead tank and numbers of the overhead tank to use, also indicate the diameter of the concrete fishpond and the number of the concrete fishpond to build, recommend other necessary equipment and where to buy them to make this project a robust design. Design this project with maximum of 5 quantity of 10,000 Liters overhead tank

**System Requirements**

* **Hydro-turbine Specifications**:
  + **Flow rate**: 40 liters/second
  + **Head height**: 40 meters
  + **Pipe diameter**: 250 mm
* **Storage**: Maximum of **5 overhead tanks**, each holding **10,000 Liters**.
* **Fishpond**: Collects turbine-exiting water.
* **Water Treatment**: Ensures recycled water is fit for turbine reuse and drinking.
* **Continuous Operation**: Prevents tanks and fishpond from overfilling or emptying.

#### ****. Key Calculations****

##### **Water Requirement per Day**

* Turbine flow rate = **40 liters/second**.
* Daily operation = 40×60×60×24=3,456,00040 \times 60 \times 60 \times 24 = 3,456,00040×60×60×24=3,456,000 liters/day.

##### **Storage Capacity**

* **5 tanks × 10,000 liters = 50,000 liters**.
* The storage tanks will cycle water continuously and act as buffers rather than holding the entire daily requirement.

##### **Fishpond Volume**

* To act as a secondary buffer, the fishpond should hold at least **50,000 liters**, matching the overhead tank capacity.

#### ****Tank and Fishpond Design****

##### **Overhead Tank Design**

* **Quantity**: 5 tanks (10,000 liters each).
* **Placement**: Elevated to maintain a 40-meter head.
* **Material**: High-density polyethylene (HDPE) or fiberglass.

##### **Fishpond Design**

* **Volume**: 50,000 liters.
* **Shape**: Circular for optimal water circulation.
* **Diameter and Depth**:
  + Volume (VVV) = π×r2×h\pi \times r^2 \times hπ×r2×h.
  + Assuming depth (hhh) = 2 meters: r2=50,000π×2  ⟹  r≈2.82 meters.r^2 = \frac{50,000}{\pi \times 2} \implies r \approx 2.82 \, \text{meters}.r2=π×250,000​⟹r≈2.82meters.
  + **Diameter** = 2×r≈5.64 meters2 \times r \approx 5.64 \, \text{meters}2×r≈5.64meters.
* **System Components**

| **Component** | **Specification** | **Purpose** |
| --- | --- | --- |
| **Hydro Turbine** | Pelton or Turgo turbine, 10 kW capacity. | Converts water flow to electricity. |
| **Overhead Tanks** | 5 × 10,000-liter HDPE or fiberglass tanks. | Store and supply water to the turbine. |
| **Fishpond** | 5.64 m diameter, 2 m depth circular concrete fishpond. | Buffer and aeration for water recycling. |
| **Water Pump** | Centrifugal pump capable of 40 liters/second at 40 m head. | Pumps water back to the overhead tanks. |
| **Treatment System** | Multi-stage filter, UV sterilizer, and heating unit. | Treats water for reuse and drinking. |
| **Control System** | Float sensors, automated valves, and PLC-based automation. | Prevents overfilling/emptying of tanks and fishpond. |
| **Pipes** | 250 mm diameter, high-pressure PVC or HDPE. | Ensures optimal water flow. |
| **Heater** | High-efficiency immersion heater (sized for drinking water demand). | Heats water for drinking purposes. |

**Water Recycling Process**

1. **Turbine Output**: Water exits the turbine and flows into the fishpond.
2. **Fishpond**: Aeration and initial settling occur in the pond.
3. **Treatment System**:
   * Filtration to remove debris.
   * UV sterilization for biological safety.
   * Heating for a portion of the water for drinking.
4. **Pump to Overhead Tanks**: Treated water is pumped back to the tanks for turbine reuse.

**Recommendations for Equipment and Suppliers**

* **Turbine**: Pelton or Turgo turbines from Ossberger, Canyon Hydro, or a local supplier specializing in small hydropower systems.
* **Tanks**: HDPE tanks from Enduramaxx or Sintex.
* **Pumps**: High-pressure centrifugal pumps from Grundfos or Pentair.
* **Filters and UV Units**: Filtration and UV systems from Pentair or Aquafine.
* **Automation**: PLC systems from Schneider Electric or Siemens.