In-Pipe Spherical Turbine for Energy Extraction

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Abstract - *A spherical turbine configured to rotate transversely within a cylindrical pipe under the power of fluid flowing either direction therethrough the fluid will strike the blades of the spherical turbine and thus providing the rotary motion to the shaft which is operatively coupled with a generator to produce electricity. The blades of the turbine are twisted in a plane that is inclined at a relative angle to the rotational axis of the central shaft. The blades of the spherical turbine are designed considering the aerofoil cross-section to optimize and reduce the resistance of the hydrodynamic flow, which is also used to minimize cavitation and to maximize conversion from axial to rotational energy which leads in extracting energy more efficiently without interrupting flow. This energy potential of moving water produces clean, low-cost electricity and which is reliable.*

***Key Words*: Energy Extraction, Spherical Turbine, Low Scale Power Generation, Auxiliary Power Generation, Less Flow Interruption**

1. INTRODUCTION

The water flowing through pipe, especially vertically downwards, possesses a lot of energy in form of kinetic and pressure energy. The flow rate inside the pipe always remains constant. And in many cases, the end-user requirement is just flow-rate and not the pressure. Hence, a part of the pressure energy can be extracted and stored in the form of electrical energy. The turbines available till now occupied a large amount of cross-sectional area in pipe. Hence as the area reduces the pressure energy gets converted into kinetic energy. Hence velocity increases. And the spherical turbine is the most efficient way to extract pressure energy from the pipe-flow.

The experiment will run as when the water flows through the pipe, it will strike the blades of the spherical turbine which leads to the rotation of it. The turbine shaft is coupled to the D.C. generator; hence it produces the electrical energy. This energy is stored into the lead batteries and utilized like lighting purposes.

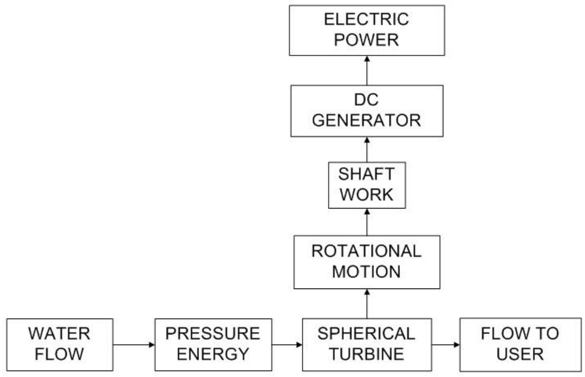

Fig -1: Basic Flowchart

2. COMPONENTS AND ITS REQUIREMENTS

2.1 PVC Tee-Joint

A Tee-joint made of polyvinyl chloride act as the housing for the spherical turbine. The inner diameter of a t-joint is the same as the outer diameter of the pipe carrying the water flow. Hence, the turbine unit can easily be accommodated.

The web of the T-joint is covered with a PVC cap and a hole is drilled in the centre. Another drill-hole is drilled on the axis of the web at the bottom of the pipe. Two ball-bearings are fixed into these holes. The shaft of the turbine is mounted into the bearings for reducing the friction offered to the rotational motion.

2.2 Spherical Turbine

A spherical turbine for any fluid type at any depth or elevation, which is capable of unidirectional rotation under reversible flow conditions, is disclosed. A spherical turbine is advantageous because, by design, it always remains symmetrical to flow, which is particularly useful in urban areas with tall buildings and in planar regions where winds are unstable, e.g. Patagonia. Moreover, in the field of mechanical engineering, a spherical frame is potentially the strongest and most reliable three-dimensional frame.

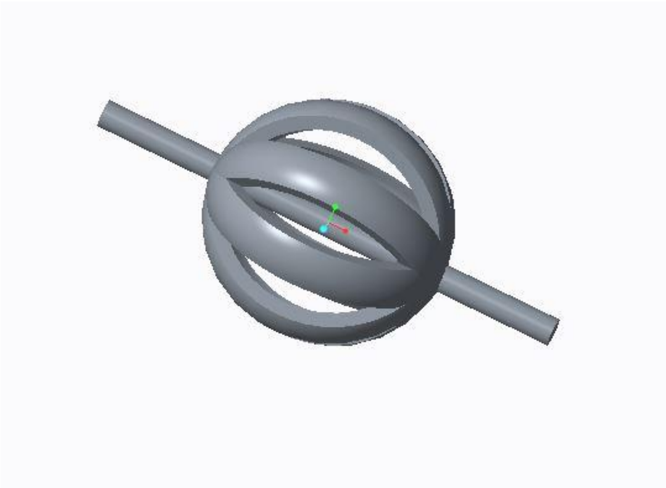

Fig -2: Spherical Turbine

The turbine includes a rotatable shaft that is adapted to rotate about an axis of rotation and turbine blade support members that are fixedly attached to the rotatable shaft and to a plurality of meridian turbine blades. Geographically, a meridian is an imaginary arc on the Earth's surface that extends from the North Pole to the South Pole. In this invention, a meridian blade is an arced section lying on the surface of a non-solid sphere, extending from a "north" point to a diametrically-opposite "south" point.

2.3 Operational Requirements

1] Flow Velocity

Water velocity is the most important indicator for determining the energy generating capacity of a pipeline. The power generated by the Pipe is proportional to the cube of the water velocity.
Water velocity helps determine the optimal size of the Pipe system that can be operated in a pipeline. Also factored in are the pipeline diameter, head pressure that is available for extraction and the capacity factor (frequency and duration of water flow).

2] Flow with Full Head

Water flowing with full pie is the basic requirement for the rotation of the spherical turbine and gaining the maximum rotation possible. Ultimately it helps in extracting more energy.

3. EXPERIMENTAL SETUP WITH ANALYSIS

The experiment relates generally to the field of hydro-electric power generation. More particularly, the experiment relates to hydro-electric power generation via fluid flow which passes a spherical turbine. The fig-3 above shows the front view of the pipe. The spherical turbine is fitted inside the pipe with help of the bushing at the upper mount and the lower mount. The turbine shaft is coupled with the generator assembly. A gearbox is provided in between to increase the RPM of the generator. The electricity generated is stored in a storage battery for the utilization when needed. Flanges are provided at the both sides of the assembly or tee-joint to attach the pipes.

Fig -3: Front View

Various cylindrical turbines for power systems, the blades of the turbines extending helically to sweep out an open cylinder. The fig-3 discloses mounting such turbines in rectangular and/ or square cross-sectional channels or ducts capable of conveying Water that rotates the turbines to generate hydroelectric power. Cylindrical turbine has helically curved twisted blades or vanes mounted to a central shaft by radial struts or spokes of seemingly arbitrary or at least non air foil, e.g. circular, cross section.

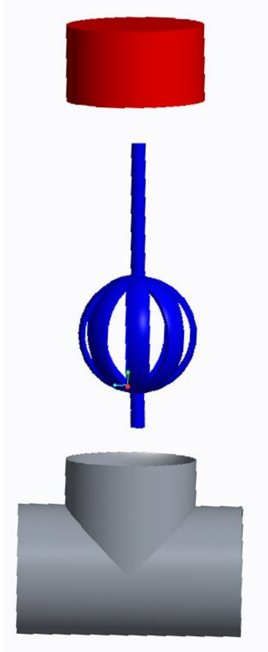

Fig -4: Exploded View

The fig-4 is an isometric exploded assembly drawing of a first embodiment of the invented in-pipe hydro-electric power system featuring a spherical turbine. The figure includes housing of the generator with mechanical-lift tab attached with a cap which is coupled with a circular plate. The whole thing is sealed with an annular seal. The tee-section of the pipe is covered by an arched plate and a cylindrical spacer. The flange for the bolting the generator assembly is on the top of the tee-section. The bottom most part has a mounting plate and a bearing arrangement for the lower mount of the centre shaft.

3.1 Analysis

Initially, we run the experiment with full flow inside the pipe. And the theoretical analysis shows the following data in table-1. After that, the inlet of the pipe was blocked gradually by 50% as show in the fig-5. This acts a nozzle for the working fluid and the part of the pressure energy gets converted into the kinetic energy.

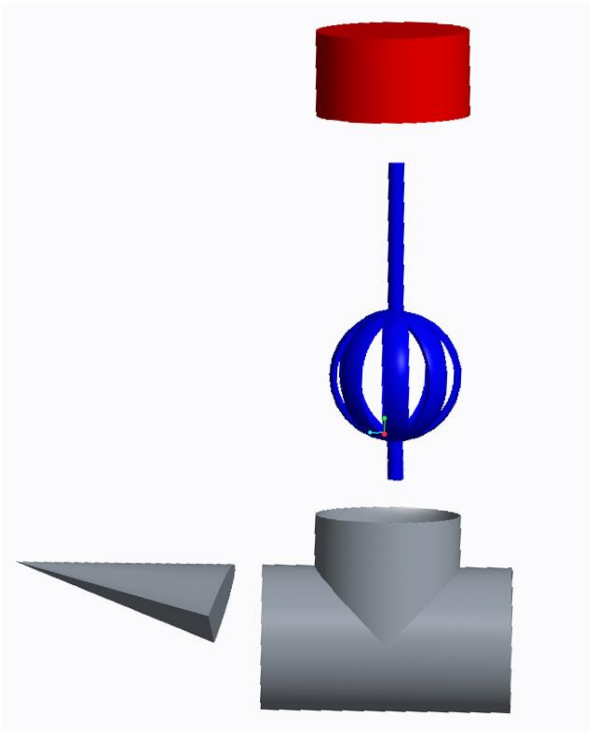

Fig -5: Exploded View with Blockage

Also the flowing water strikes only one half of the turbine sphere, hence the reaction from the other half in eliminated. The working fluid striking the blades with high velocity produces high impulse and more rotational speed is generated. Some back-pressure and water logging will be generated. But that will not affect the flow or the turbine work to a measureable extent.

4. SCOPE AND ADVANTAGES

4.1 Potential Areas of Application

The possible area of utilization:

- **On the hilly areas**

The higher pressure head is easily obtained due to the altitude. And the velocity of the fluid is more due to the gravitational acceleration.

- **The multi-storey building, where the water almost flows constantly**

The overhead tank is filled and emptied very frequently in the buildings and the apartments. Hence we get almost continuous flow, which can be a great help in generating the electricity. The general purpose lightings of the building can be lit up by the stored energy.

- **The government water distribution pipes for the different areas of a country**

Big pipe lines, used in the government projects for supplying the water to the dry areas of a country have also a large potential for this application.

- **Agriculture and industries**

The water is the primary need of the agriculture and the industries. The turbines can be installed in the pipelines with sufficient diameters in these fields.

4.2 Advantages

- Pipe extracts very little head pressure per turbine, just 1 – 5 PSI.
- The modular pipe system to be placed in series, while allowing for uninterrupted water flow.
- Pipe does not need to be placed in a pressure transient zone or where extreme differential pressures are needed.
- Produce clean, low-cost electricity.
- It is reliable, cost-effective electricity.
- Water and energy intensive industries, municipalities and agricultural irrigation districts can install this system to generate renewable electricity from the water already flowing through their pipelines-without interrupting flow.
- To maximize electricity generation, several Pipe systems can be installed into a single pipeline.

5. CONCLUSIONS

Using this experiment, the waste energy from the flowing water inside the pipe can be extracted, which helps fulfilling small scale electricity requirements. This is an eco-friendly method and has less installation and maintenance cost.
By performing the above experiment, we conclude that the energy extraction can be maximized by gradually reducing

the inner diameter by 50% of the pipe facilitated by some arrangement of blocking.

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