Performance Enhancements for Kinetic Hydropower

What is Kinetic Hydropower?

Kinetic hydropower involves the use of underwater turbines that draw their energy from existing water currents such as:

- Rivers with high velocity flows;
- Tidal currents; and
- Ocean currents.

The main components of a kinetic hydropower system are depicted below.

![Kinetic Hydropower Components](image)

ADVANTAGES

Kinetic hydropower has several advantages over other kinds of energy production:

- No large infrastructure (e.g. dams or powerhouses) are required:
  - Installation cost is small
- No reservoir or spillway is required:
  - Environmental impact is minimal
- Water flows are a steady, reliable energy source:
  - Predictable revenue
- Back-up energy production requirements minimal
- Modular design leads to an easily scalable energy output

CHALLENGES

By their nature kinetic hydropower involves external flow and therefore they are exposed to less than ideal conditions:

- Turbulent and debris laden flow can cause serious damage:
  - Fallen trees during spring run-off (i.e. river kinetic turbines)
  - Rocks and boulders during coastal storms
- Minimal control over the flow regime:
  - Difficult to include nozzles and diffusers
  - Interference of ocean floor or riverbed greatly reduces output

EXPERIMENT # 1 TURBINE SHROUD

Large hydroelectric dams greatly boost the power production using downstream diffusers. The flow in kinetic hydropower does not pass through any ducts or pipes, therefore it cannot use traditional diffusers. However, most kinetic hydropower configurations include a shroud to protect the turbine. If the geometry of the shroud is carefully selected, it may be able to act as a diffuser, and increase the power output.

Streamlines through unshrouded turbine

Power available is less than 60% of the power in the freestream:

\[ P_{\text{unshrouded}} < 60\% \times P_{\infty} \text{ (Betz Limit)} \]

Streamlines through shrouded turbine

Power available is increased by the thrust from the shroud:

\[ P_{\text{shrouded}} = \frac{1}{4} \times P_{\text{unshrouded}} \]

EXPERIMENTAL PARAMETERS

Two design variables:

- Angle
- Area ratio

RESULTS

- Power increased by a factor of 3.1
- Drag increased by a factor of 3.9

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SUMMARY

The challenges facing kinetic hydropower can be overcome using cost-effective technologies, leading to the full realization of this promising alternative energy.