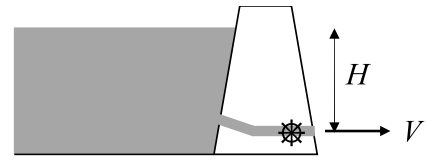


### Fluid Dynamics Homework Problem Hydroelectric Power Generation

Hydropower is easy to understand using the Engineering Bernoulli equation. This picture provides a schematic of a typical scenario, in which water accumulated behind a dam is directed through a turbine (which extracts power), and discharged at some velocity  $V$ , at a vertical distance  $H$  below the surface of the reservoir.



- a) (4 pts) Using the Engineering Bernoulli equation, derive an expression for the power produced by the dam in terms of  $H$ ,  $V$  and the mass flow rate of water,  $w$ . Neglect losses. For what value of  $V$  is the power output theoretically maximized?
- b) (2 pts) How do viscous losses impact power generation?
- c) As a renewable energy source, hydroelectric power offers a number of advantages, but also some well-documented drawbacks, especially related to environmental impacts. From a social justice perspective, there has been increasing awareness of disproportionate negative impacts on indigenous populations.
- d) (6 pts) Please read the paper “Future Impacts of Hydroelectric Power Development on Methylmercury Exposure of Canadian Indigenous Communities” by Calder *et al.* [*Environ. Sci. Technol.* **50**, 13115-13122 (2016)]; a PDF is posted to Canvas. Write a brief paragraph summarizing the chemical/physical/environmental processes in play, and the way in which these create particular risks for indigenous populations.
- e) (4 pts) Conflict between hydroelectric development and indigenous populations is a remarkably common theme worldwide. The paper cited above in part (c) specifically addresses issues in Canada. Please conduct an internet search to identify another example of such a conflict in some *other* country. Write a brief paragraph outlining that situation, noting any similarities or differences with the example from part (c) in how indigenous communities are impacted.
- f) (3 pts) Engineering decision-making often involves trade-offs. For large scale infrastructure projects like hydroelectric power, a wide range of impacts—some positive, some negative—must be considered. How do *you* think the interests of marginalized communities can best be protected when planning such projects?
- g) (3 pts) Look up the Code of Ethics for Engineers published by the National Society of Professional Engineers. Which sections of this document do you feel have bearing on the issues discussed in part (e)?