CSU | Washkewicz College of Engineering

Hydro-Ram Generator

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Abstract

In the modern world of technological advancements and dependency upon electricity, sustainable electrical energy is paramount. The many devices that have become necessary for our way of life, be it personal or professional, require a consistent, clean, and capable source of electricity. We seek to prove that given a source of water; our design can allow for a constant, cyclical water flow that can generate 3-phase alternating current voltage.

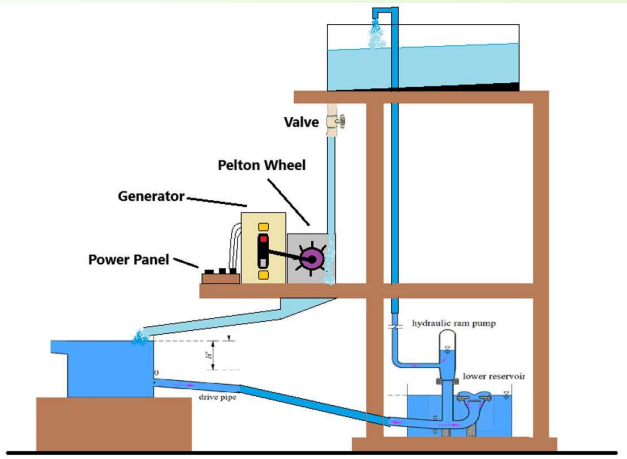
Introduction and Background

The inspiration for this project is rooted in a problem of trying to create electricity in a remote area. What if we could design an isolated system that uses the principles and practices of physics and engineering to pump water to a higher elevation to be used for the generation of electricity and then return it back to the source? That is what lead us to the Hydraulic Ram Pump and a 3-phase Permanent Magnet Generator.

Advantages of this energy:

- Scalable
- Sustainable
- Safe (environmentally)

System Design



Experimental Results

3-phase Synchronous Generator Bench Test

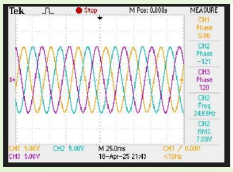


Figure 1: Wide View (25 ms/div)

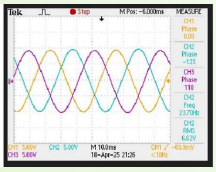


Figure 2: Tight View (10 ms/div)

$E_a = \sqrt{2}\pi N_c \phi f_{sc}$

E_a = Voltage

N_c = Number of turns in coil

$\phi = B\pi r^2$ = Magnetic Flux

B = Magnetic Density (Tesla)

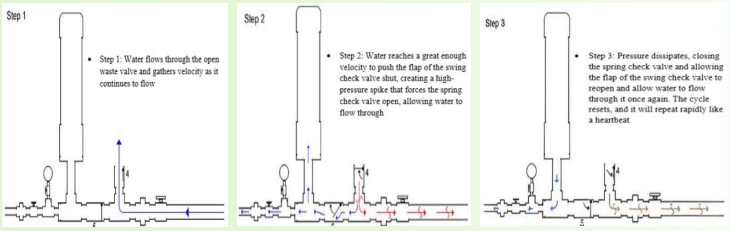
r = Radius of closed loop

$f_{sc} = \frac{N_m P}{120}$ = Frequency

N_m = Rotor speed (RPM)

P = Number of magnetic poles

Functionality of the Hydraulic Ram Pump



Drive Pipe Length Calculation

Minimum Drive Pipe Length =
150 x Drive pipe diameter (inches)

Min. Drive Pipe Length =
150 x 1.5” = 225/12 = 18.75 feet

Maximum Drive Pipe Length =
1000 x Drive pipe diameter (inches)

Max. Drive Pipe Length =
1000 x 1.5” = 1500/12 = 125 feet

Output Water Flow Equation

D = 0.6 x **Q** x (**F**/**E**)

Q = Available drive flow (gpm)

F = Fall in feet from water source to pump

E = Elevation from pump to water outlet

D = Flow rate of the delivered water (gpm)

D = 0.6 x 10 x (4/9) = 2.67 gpm

Pelton Wheel Design

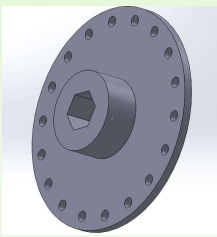


Figure 3: Runner

Figure 4: Buckets

Runner Diameter (D) $= \frac{60 \cdot K}{\pi \cdot N} \cdot V$

Bucket Width = 3.4 x **d**

Bucket Length = 3 x **d**

Bucket Depth = 1.2 x **d**

Number of Buckets $= 15 + \frac{D}{d \cdot 2}$

K = Ratio between the runner’s tangential velocity and the jet velocity at maximum potential.

N = Ratio between the net head (distance the water will fall) and the input power of the water

V = Velocity of the water jet

d = Water jet diameter

Conclusion and Future Recommendations

The Hydro-Ram Generator is capable of manufacturing 3-phase AC voltage. The system’s water flow is partially-cyclical (20-30% water retention). Solving the problems of achieving fully cyclical water flow and generating higher levels of electrical energy will require further research, funding, and time.