APPENDIX D

Gravito-electric Generator Design and Calculations

OUTPUT POWER CALCULATIONS

In general the power output of a hydro-electric plant is as given in equation *(D-1)*[6].

(D-1) P = head × flow × efficiency × factor

where:

P = output power in kilowatts

head = height through which working fluid falls, in meters

flow = working fluid flow rate in $\text{meter}^3/\text{sec}$

efficiency = fractional mechanical/electrical efficiency

factor = conversion factor

= 9.8 [for water @ 1000 kg/meter^3 and natural gravity of 9.81 $\text{meter}/\text{sec}^2$] [see Δg, below]

Calculations and design of a gravito-electric generator plant are the same as for a hydro-electric plant except as follows.

First an additional factor, Δg, must be added to account for the reduction of gravitation achieved by the gravitic deflector being partial, not comprehensive. That is an effective downgrading of the "natural gravity of 9.81 $\text{meter}/\text{sec}^2$", above, and applies wherever "natural gravity" is inherent in the process. In the following it is estimated that $\Delta g = 0.5$.

Second the flow rate is the continuous rotational flow of the fluid, up in the center of the structure and down in the outer parts. That flow is the velocity times the cross-section area of the flow. The acceleration that the water experiences is to the terminal velocity of an object falling from a height equal to the head. That is for the case of a hydro-electric plant where new, essentially static water is continuously accelerated by the head.

In the gravito-electric case, Figure 6-1, the water continuously re-circulates, the already flowing water receiving continuous additional acceleration through the same head. But, the losses of the water flow to friction and turbulence increase as the velocity of the flow increases. In its steady state the water flow is steady at a velocity at which the additional acceleration just makes up for the friction and turbulence losses plus the power delivered to the turbine.

The component of equation *(D-1)* that needs development is the "flow", which develops as follows. The hydro-electric plant acceleration of the water is to the terminal velocity of an object falling from a height equal to the effective head per equation *(D-2)*.

(D-2) $s = {}^{1}/_{2} \cdot g \cdot t^{2}$ [in general]

where: s = distance of fall in meters
g = acceleration of gravity in $^{\text{meters}}/_{\text{sec}^2}$
t = time duration of fall in seconds
v = terminal velocity in $^{\text{meters}}/_{\text{sec}}$

$$\text{head} = {}^{1}/_{2} \cdot 9.81 \cdot \Delta g \cdot t^{2} \quad \text{[for this hydro-electric case]}$$

$$t = [{}^{2}/_{9.81 \cdot \Delta g} \cdot \text{head}]^{1/2}$$

$$v = g \cdot \Delta g \cdot t$$

$$= 9.81 \cdot 0.5 \cdot [{}^{2}/_{9.81 \cdot 0.5} \cdot \text{head}]^{1/2}$$

$$= 3.1 \times \text{head}^{1/2} \ {}^{\text{meter}}/_{\text{sec}}$$

Alternatively, the same result is obtained considering energy instead of distance and acceleration, as equation *(D-3)*.

(D-3) Potential Energy converts to Kinetic Energy

$$\text{head}\cdot[g\cdot m] = {}^{1}/_{2}\cdot m\cdot v^{2} \quad \text{[in general]}$$

$$v = [2\cdot\text{head}\cdot g\cdot \Delta g]^{½}$$

$$= 3.1 \times \text{head}^{½}\ \text{meter}/_{\text{sec}}$$

That acceleration applied repetitively to the water gives a final velocity dependent on the flow path structure and on the power delivered to the turbine. Typically, for a "very open" flow path structure, that final, steady state flow velocity could be on the order of two, five or more times the above calculated "terminal velocity".

The length of the flow path is essentially twice the "head", the water traveling the "head" once upward and once downward per cycle. The "very open" cross-section area of that flow path is one on the order of the square of half the head. The conservative flow calculation, using the equation *(D-3)* velocity, is per equation *(D-4)*, below.

(D-4) Flow path cross-section = $[{}^{1}/_{2}\cdot\text{head}]^{2}$

$$\text{flow} = \text{velocity} \times \text{cross-section}$$

$$= [3.1 \times \text{head}^{½}]\cdot[{}^{1}/_{2}\cdot\text{head}]^{2}$$

$$= 0.78\cdot\text{head}^{2.5}\ \ \text{meters}^{3}/_{\text{sec}}$$

The resulting overall power output is per equation *(D-5)*.

(D-5) P ≡ gravito-electric power output

$$= [\text{head}\cdot\Delta g] \times \text{flow} \times \text{efficiency} \times \text{factor}$$

$$= [\text{head}\cdot 0.5] \times [0.78\cdot\text{head}^{2.5}] \times \text{efficiency} \ldots$$

$$\ldots \times \text{factor}$$

$$= 0.27\cdot\text{head}^{3.0} \times \text{efficiency} \times 9.8\ \text{kilowatts}$$

For a deflector that deflects only half the gravitation *[Δg = 0.5]* as above and for a mechanical/electrical efficiency factor of *0.75*, Table D-1, below, gives some sample values of gravito-electric outputs based on the above. As can be seen the output increases dramatically with physical size because of the exponents in equation *(D-5)*.

Head meters	Cross-section meters^2	Flow meters^3/sec	Power kilowatts	Power horsepower
1	0.25	0.78	2.0	2.7
2	1.0	4.4	16.	21.
5	6.3	44.	250.	330.
10	25.0	250.	2,000.	2,700.
20	100.0	1400.	16,000.	21,000.

Table D-1
Example Gravito-electric Power Outputs

DESIGN CONSIDERATIONS

The Working Fluid

The power output calculated per equation *(D-5)* is based on the working fluid being fresh water, which has a density of *1,000* $kg/meter^3$. Use of a more dense medium would directly proportionally increase the output power.

However, the vast majority of liquids have density near to that of water. In general the exceptions tend to have problems of potential corrosiveness or poisoning. The most dense liquids are:

- Bromine @ 3.12 times the density of water,
- Iodine @ 4.93 times the density of water, and
- Mercury@ 13.5 times the density of water.

Another method to increase working fluid density would be to add granular high density particles to the fluid, the fluid being selected for the best viscosity compromise between the effect of the viscosity reducing flow velocity and sufficient viscosity to insure continuous sweeping of the added particles along with the fluid. In that regard water is a fairly viscous fluid and at reasonable velocity successfully sweeps particles along with its flow.

The use of such particles might result in unacceptable levels of wear and damage to the turbine mechanisms.

It would appear that methods to increase output by increased working fluid density are not, for gravito-electric power stations, as economically viable as accomplishing equivalent output increase through larger sized gravito-electric units or a greater number of them in parallel.

GRAVITIC POWER GENERATION COMPACT CASES

On the other hand, for applications where minimizing the physical size of the gravito-electric generator relative to its output power is essential such as for land, sea, or air transportation vehicles an alternative arrangement would be appropriate. Such an alternative form is depicted in Figure D-2, below.

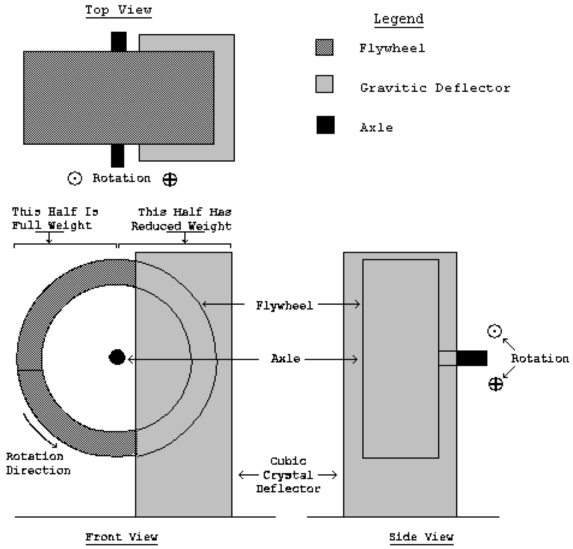

Figure D-2
Flywheel Gravito-Electric Power Generation

Here the generation of rotary motion to drive the electric generator is done by means of a flywheel. A massive wheel is schematically divided into two halves side by side horizontally. A gravitic deflector is placed into operation underneath one of the halves.

The result is that the part of the wheel above the deflector weighs less than that its other half. The lighter half rises while the heavier descends producing a continuous rotation. That rotation drives the turbine that drives the electric generator.

The output power calculations for this case are the same as for the case using water as the working fluid except that the flywheel's characteristics are substituted for those of water.

- The density of the flywheel material would be on the order of ten times that of water. Therefore the "factor" of *9.8* for water becomes *98.* for a typical flywheel.

- The flow rate is the flywheel mass cross-sectional area times the tangential velocity of its center of mass.

The power equation then becomes as follows for the flywheel.

(D-6) P = head × flow × efficiency × factor

= head·Δg × [Cross-Section Area × …

… Rotation Speed] × efficiency × factor

where:

head = height through which the flywheel mass falls in meters

flow = flywheel mass cross-section times its centroid's tangential velocity in $meter^3/_{sec}$

efficiency = fractional mechanical/electrical efficiency

factor = conversion factor

= 98. [for typical flywheel material and natural gravity of 9.81 $^{meter}/_{sec^2}$]

Δg = factor for deflector effectiveness as before.

Assuming that the steady state velocity of the flywheel is ten times the "terminal velocity", Table D-3, below, gives some sample values of flywheel gravito-electric outputs for a deflector that deflects half the gravitation $[\Delta g = 0.5]$ as before above and for a mechanical/electrical efficiency factor of 0.75 as before above.

Head meters	Cross-section meters^2	Tangential Rotation Speed $31 \cdot head^{1/2}$ meters/sec	Power kilowatts	Power horsepower
1	0.5	31	570	750
1	2.	31	2,300	3,000
5	10.	69	130,000	170,000

Table D-3
Example Approximate Flywheel Gravito-electric Power Outputs

[6] http://en.wikipedia.org/wiki/Hydroelectricity