Micro Hydro-Electric Evolution

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Since the 1970s, there have been many examples of very small hydro machines to enter the marketplace. I am referring to those machines which are usually used in a battery based system, with an output of typically a few hundred watts and usually less than 1 kW. To put this in perspective, meeting the electrical demands of a typical home usually requires 3-400 W continuous. This is sufficient power to operate lights, refrigerator freezer, washing machine and entertainment.

Most of these generators have used impulse turbine runners as the hydraulic component, including Pelton, turgo, and some cross-flow designs. Materials for these runners include bronze, aluminium, steel and plastic. With efficiencies of the runners alone exceeding 80%, it is unlikely that much improvement will be possible here.

Automotive alternators are usually used to convert the shaft power of the runner into electricity. While this technology can provide a cost effective means to generate power, it is far from ideal. On the plus side, they are readily available, cheap, simple, and the field current can be easily varied in order to match the output of the turbine runner with the generator. On the down side, they usually employ carbon brushes to carry the field current (creating a maintenance issue), the efficiency is low (around 60%), and performance at low shaft speeds is problematic, since most machines use direct drive (often the speed is simply too low to achieve desirable outputs without using belt drives, etc).

It has proven advantageous to rewind these automotive alternators, as the stators are usually not more than half filled with wire. By using more wire, the efficiency can be raised and we can now use the wire size that best matches output to the load. However, the basic limitations are still there, in that these alternators were designed and evolved for automobiles, not hydropower. Note that by combining an 80% turbine efficiency with a 60% alternator efficiency, the best one could hope for would be an 48% water to wire efficiency.

It is only natural that a machine designed for the task of residential power generation would eventually be developed. Ideally, it should be brushless; use permanent magnets to avoid field losses and excitation problems; be water cooled since all that water is only a few centimetres away; be highly efficient; and be easily adjustable so load matching can be facilitated by the average user.

This has now been done with the alternator used on the Stream Engine made by Energy Systems and Design. Neodymium magnets are used in the rotor to maximise field strength, the alternator and rectifier are both thermally bonded to tile turbine housing to ensure cooling, and efficiency is typically in the 80% range at full load. The output is adjustable by raising or lowering the rotor which affects its proximity to the stator in tills axial alternator design. In this manner, turbine power can be matched to generator output. Reconnectable windings are used so that outputs of 12, 2.4 and 48V can be produced front the same machines, and in some situations, stators .arc custom wound to transmit at 120V over long distances, thereby minimising wire losses.

An example of a typical installation follows:

Renewable energy dealer Harold Lunner of British Columbia, Canada, has recently completed an installation of a Stream Engine. The head vertical drop at this site is approximately eight meters. The system, with two 22 mm nozzles, uses about 10 l/s and is fed by a 150 mm pipe, 200 m long. Output from the machine is 8.5 amps. in a nominal 48V system, which actually operates at 54V at this current level. This gives an output, in watts, of 459. A water to wire efficiency of 65% is achieved.

Micro-hydro systems have come a long way. They can produce power more cost effectively than any other kind of renewable energy system. It will be interesting to see what the future brings.