The Pico Power Pack: a new design for pico hydro

by Phil Maher & Nigel Smith

A new type of pico hydro unit is soon to be tested in the village of Kushadevi, Nepal. The unit is called the Pico Power Pack (PPP) and as well as producing mains AC power it has a free shaft that can be coupled to mechanical loads. If successful, it will improve the financial viability of pico hydro projects by enabling greater use to be made of the power produced. A grinding mill is planned in Kushadevi, which will operate during the day-time. Electricity will also be produced, primarily for lighting, although it is hoped that home-industries will develop.

The heart of the new design is a Pelton runner directly coupled to an induction generator, an arrangement that has proven to be very successful in the form of the Peltric Set pioneered by Akkal Man Nakarmi (see newsletters 1 and 3). This is a simple, robust and low-cost turbine-generator arrangement. The Pelton runner and induction motor are sized according to the site characteristics and standard sizes can be used over a range of head and flow conditions. Capacitors are connected to the induction generator to provide the necessary excitation currents for AC generation and an electronic load controller is used to regulate the voltage and frequency of the electrical supply produced. Excess power is diverted to a suitably sized heater load.

Unlike the Peltric Set, the generator for the Pico Power Pack is positioned horizontally. One advantage with this arrangement is that the turbine and nozzle can be easily accessed for inspection and maintenance. The lightweight turbine case can be removed by unscrewing it from the side-plate, leaving the other components in place. The side-plate is fixed rigidly to the steel-angle base frame and also to the face of the generator. The seal between the turbine and the generator is achieved by means of a short length of plastic pipe fixed to the side plate and adjusted to give a very small clearance between it and the runner.

Another advantage of the horizontally driven shaft is that it is more suitable for driving mechanical loads. The drive shaft for the loads can be obtained by extending the shaft of the induction machine at the fan end. This avoids the need for additional bearings and bearing housings. Motors with extended shafts at either end are available from manufacturers, or as is the case for the demonstration project in Nepal, the shaft of a standard motor can be extended in a workshop. It is necessary to check that the fan-end bearing is the same as the other bearing. If not, it should be upgraded to cope with the mechanical loads by fitting a heavy duty ball bearing or a roller bearing.

The electronic load controller works well with mechanical loads. When the mechanical load is absorbing all the power from the turbine, the generator shaft speed is too slow to excite the generator. When the mechanical load is reduced the turbine speeds up causing the generator to excite and the controller to divert excess power to the heater load. Hence the generating system acts as an electrical brake and prevents excessive overspeeding. This is particularly beneficial with loads such as mills and saws, where the power requirement varies with throughput,

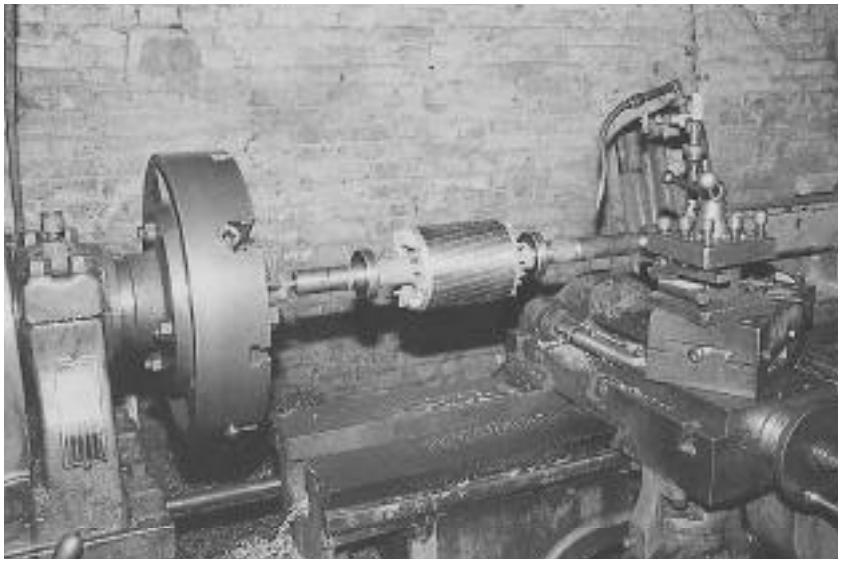
Scheme Data

Location: Kushadevi, Kabhrepalanchok,Nepal
Number of households: 108
Gross head: 80 metres
Flow: 9 litres per second
Penstock: 400m HDPE (140/125mm diameter)
Turbine: Single jet Pelton 200mm pcd
Generator : 7.5 kW 4 pole induction motor as generator
Design P ower : 4kW

Induction generator with shaft extension and fitted with Pelton runner

The turbine buckets are polished with a drill attachment after casting, prior to assembly of the runner

Cutting the sheet steel for the casing with a guillotine



An extension has been welded to the motor shaft and is then turned on a lathe

because it improves their performance and operating life.

The new design shares the benefits of existing pico hydro designs. Being relatively light-weight, it is easily transported to remote areas, particularly when disassembled. The unit lends itself well to fabrication in a basic workshop and all the component materials have been chosen because of their good availability.

The flow required is typically 3 to 15 litres per second, often only a fraction of the amount of water flowing in an irrigation canal or a mountain stream. The head range is 25m to 100m. One disadvantage of a horizontal drive arrangement is that it is not so easy to produce and install multi-jet machines. With this in mind, research at Nottingham Trent University is in progress to develop Pelton runners, with acceptable efficiencies, which can accept a larger diameter jet (up to 20% of the turbine pitch circle diameter), so that a single jet machine can be produced which delivers the same flow as a multi-jet machine.

The first Pico Power Pack was built at The Nottingham Trent University with the help of German exchange student, Lutz Homeier. The design was tested and improved and has been manufactured for the demonstration site by Nepal Yantra Shala in Kathmandu with funding from the UK Department for International Development. Intermediate Technology (ITDG) in Nepal are managing the design, installation and monitoring of the demonstration scheme.

A report on the installation and performance of the PPP will be included in the next newsletter and a manufacturing guide produced to enable the design to be built in other countries.

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