

Power generation by Archimedes screw

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Archimedes screws used as pumps and power generation for the 2012 Olympics.

A 'revolutionary' renewable energy method based on an Archimedes screw is saving Yorkshire Water over £127,000 a year in electricity and another application will help competitors train for the London 2012 Olympic Games.

The Yorkshire Water application installed at Esholt treatment works near Bradford uses two Archimedes screw turbines designed by Spaans Babcock in series. Each turbine is connected to an ABB 110kW standard AC induction motor and ABB industrial drive in generator mode. The two generators produce a total of 180kW of power and operate 24 hours a day. The electricity generated from the hydro-turbines is used to reduce the imported power demand of the treatment works, saving £350 a day in imported electricity costs.

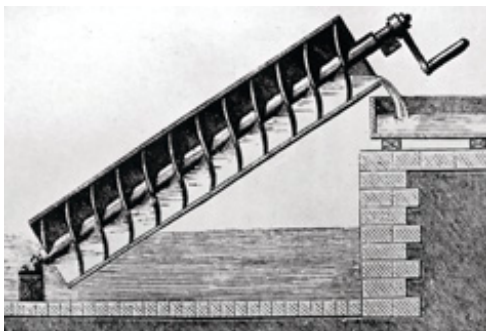
It is the first installation in the UK to use untreated sewage for hydro power generation.

Two options were investigated before the system was ordered. The first option was to use a four-pole induction generator with three-stage gearbox and the second to use a ~300rpm base speed PM generator with two-stage gearbox.

Overall system efficiencies were calculated at different loads and speeds for both systems. However, with this type of hydro turbine it is not possible to control the prime mover to give a constant screw speed. An inverter is required to control the generator and return energy to the grid, using standard variable speed drive hardware.

The option Yorkshire decided upon was to use an induction generator with higher ratio gearbox as, while the string efficiency was 1-2 per cent lower than for the PM design, the initial cost was 50 per cent lower than for the drive and motor.

Mitsubishi PLCs provided the required control and monitoring with data being sent via a Profibus link. ABB and Spaans Babcock have worked together to model the power output from the system at different loads and speeds and concluded that the screw speed should follow the flow rate of the river, but this is often difficult and expensive to obtain.



However, the maximum power can be extracted by controlling the height of the water in the penstock preceding the turbine itself.

'The monitoring is ongoing in terms of its energy consumption but we have not completed the energy optimisation yet,' explains Steve Moore from ABB Drives Motors & Machines.

ABB is also working on similar installations with Spaans Babcock, including a 200kW version for the Tees Barrage that will aid white-water rafting training at the 2012 Olympics. The project forms part of a multi-million-pound upgrade of the Tees Barrage white-water course which involves redesigning the main course, building a second, shorter course and installing the screws to create guaranteed conditions for canoeists, rafters and other white-water sports activities.

Steve Garcia, project manager from British Waterways, responsible for the upgrade, said: 'Once completed the new, upgraded course will provide the UK's first fully sustainable white water course.'

The equipment being installed comprises four 3.1m diameter 13m long Archimedean screw pump/generators each of which weighs over 30t.

'The system is currently being installed,' confides Moore, 'the drives are onsite and the motors are with the OEM and the screws are due to land later in September. The motors on the installation are 4 x 200kW all running in parallel with each other.'

When conditions permit, the environmentally-friendly screws will also use excess river water to generate more than 130kW each, making the course sustainable in energy terms. 'Imagine you have a river that can be diverted over a white-water rafting course, which goes from a higher to lower level. When the river flow is high enough they will divert it through the white-water raft course and let the river water flow over the screws so they generate power. When the river water is too low they will use the screws in a pumping mode and pump water from the lower to higher level to increase the flow over the course.'

The Teesside project is unique in that it will be the only installation in the world where the Archimedes screws are used as both pumps and generators.

Further information

- www.abb.com
- www.spaansbabcock.com/eng/
- www.yorkshirewater.com/
- www.britishwaterways.co.uk
- www.teesbarrage.co.uk
- www.london2012.com

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