WEEG NEWSLETTER December 2018

The newsletter is published monthly by the University of Southampton's Water and Environmental Engineering Group WEEG, and reports things of interest in this field worldwide, as well as ongoing undergraduate student and research work in WEEG itself.

We believe that water and energy are the most important topics worldwide for the next decades. Our work covers river and coastal engineering, water and wastewater and energy related to water.

Editorial: In April we looked at the Swansea Lagoon Tidal Energy project which now – as of October – seems off the cards. There is however another tidal Mega-Project in the planning stage, the Brouwersdam Tidal Power Station at Lake Grevelingen in the Netherlands.

Hydraulic Engineering International: *Tidal power: Lake Grevelingen*

Lake Grevelingen is an artificial lake with a surface area of 110 km^2, which was created when one of the River Rhine's estuary channels was cut off from the sea by a dam in 1971. The water quality in the lake has been deteriorating continuously, since the reduced mixing of the layers prevents the oxygenisation of the lower areas of the lake.

Fig. 1: Lake Grevelinge / Rhine Estuary

This resulted in a reduction in fishing as well as a decline in tourism. The Dutch Government therefore decided to create an opening to the sea to allow a regular exchange of water, and a mixing of the layers of the lake. This opened up the possibility to use the flow of water to generate hydropower with a tidal power plant.

The conditions for the operation are quite staggering: for a head difference of 0.50 to 1.50 m, the flow rate has a maximum of 5,000 m^3/s (average flow: 3,500 m^3/s; for comparison, the River Rhine has a flow of 2,900 m^3/s). With a turbine efficiency of 80%, this gives a maximum power output of 60 MW. At the same time, the turbines must be able to pump 900 m^3/s for a head difference of 2.5 m in case there is a flood event in the River Rhine combined with an exceptional tidal High Water Level. The total investment was estimated as ranging from 252 M€ for the option 'lock only', to 512 M€ for a tidal power station with bulb turbines.

The yearly power production is estimated as 190 GWh, giving a relatively high load factor of 0.36. In the initial design, two different hydropower converters were assessed: bulb turbines, with an efficiency of 80% or a siphon driven air turbine with an efficiency of 50%.

The very low head difference of 1.5 m for a maximum tidal elevation of 2.5 m means, however, that it is difficult to employ available technology cost-effectively. At the same time, the dimensions of the project require a proven technology for application.

Fig. 2: The Brouwersdam / Lake Grevelingen

So, the Dutch Government decided to build a tidal energy research centre, the tidal Technology Center Grevelingendam (TTC-GD), right on site. For 25 M€. This centre has three channels and tubes which link the North Sea with Lake Grevelingen and can be used to test near full-scale hydropower converters with a power output of up to 1 MW, Fig. 3. The largest channel has dimensions of 10.4 x 5.75 m, and flow velocities of 4 to 7 m/s.

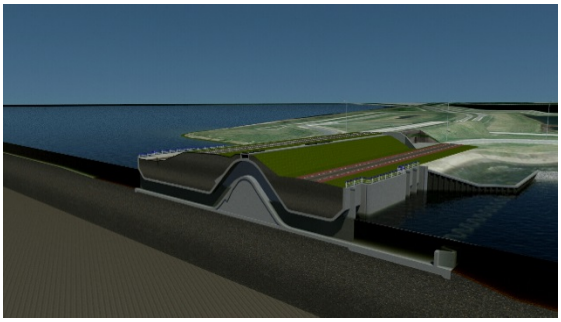

Fig. 3: Tidal power testing station, Lake Grevelingen / Netherlands

The test centre will be completed in 2019. The assessment of the current situation shows that the critical part of the whole tidal power project is the hydropower conversion technology. The combination of very high flow volumes with very low head differences and the potential exposure to wave action on the North Sea side means that it becomes difficult to use existing technologies, and new developments are required.

3rd year student project: *Online educational videos on hydraulics*

The success of YouTube and other video platforms has brought about a proliferation of free, high-quality learning materials in many disciplines of Science and Engineering, which benefits people (lay and otherwise) all around the world. Hydraulics is one discipline that has not benefited greatly from this trend, however, with few or no good-quality educational videos available online.

This project's objective is to create top-quality videos on standard hydraulics problems and phenomena (e.g. hydraulic jump, weirs etc), which can be uploaded to YouTube. This will benefit our students as well as the worldwide community interested in the topic (e.g. Civil Engineering students from many countries). It will also establish our university as an international centre of expertise in this field.

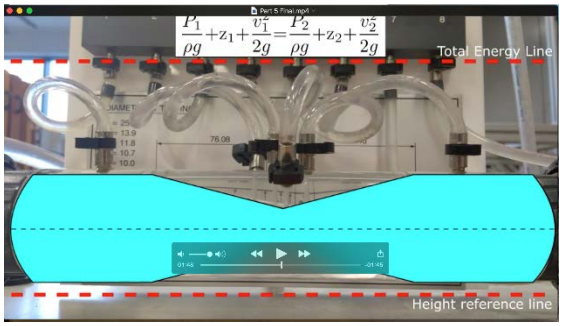

Fig. 3: Bernoulli experiment

Supervisor: Dr Sergio Maldonado, email: S.Maldonado-Villanueva@soton.ac.uk

3rd Year student Project: *Methane production using microbial electrochemical system*

A range of renewable energy production routes such as photovoltaics and wind turbine has now been deployed for electricity production. Due to their intermittent nature, energy storage for power grid balancing becomes essential.

A hybrid technology, developed by combining microbial electrochemical system with bioconversion of organic pollutants in wastewater, will allow renewable energy to be stored as methane. Methane is a gaseous fuel and equivalent to natural gas, and can therefore be distributed as compressed natural gas in cylinders or in the gas grid.

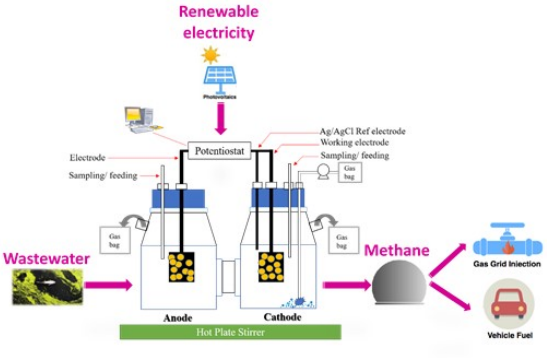

Fig. 4: Microbial electrochemical system for wastewater treatment and methane production

In this project, the student aims to identify the methane production mechanisms at the cathode and hence to improve the cathode performance. The results obtained will then be used to model a real life scenario integrating this system with a source delivering electricity intermittently.

Contact: Dr Yue Zhang, Y.Zhang@soton.ac.uk

Jobs in water engineering:

This gives you an idea of the type of work you can do when working in industry.

Advert: This one sounds exciting - it needs a lot of experience but is the sort of opportunity to aim for in future

expedition Senior Civil Engineer - London

https://www.icerecruit.com/job/176596/senior-civil-engineer/

Civil and Environmental Engineering at Southampton University:

WEEG: the Civil and Environmental Engineering pathway offers the chance to deepen your knowledge in water-related areas, and gives you a better preparation for environmental engineering projects.

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Further information:

We have two Facebook pages, which provide a logbook of our laboratory activities:

www.facebook.com/Hydraulicslaboratory/

www.facebook.com/environmental.lab.university.of.southampton/

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