Energy Institute Hong Kong Branch and Hong Kong Institute of Engineers: Gas and Energy Division Study Tour to Guangdong

10-11 November 2017

20 members from the Energy Institute Hong Kong Branch together with members of the Hong Kong Institute of Engineers Gas and Energy Division took part in a 2 day tour of Guangdong with the objective of visiting two very different industrial sites in order to expand members knowledge, experience and interest in the following fields: -

Landfill construction and management
Specialized Medical Waste Disposal,
Waste to Energy
Hydropower
Pumped Storage
Power Grid Demand Management

DAY 1 - Foshan Gaoming Municipal Waste Sanitary Landfill

The first visit was the Foshan Gaoming Municipal Waste Sanitary Landfill. Veolia Environmental Services signed a 30 year BOT Concession Agreement with the municipal government and constructed the first cross-district large scale municipal solid waste sanitary landfill in Guangdong which was opened in 2005.

Each day in Foshan City up to 6,000 tonnes of municipal waste is collected from 4 of the 5 municipal districts. Sanshui District has its own landfill and treats its own municipal waste. Municipal waste from the other 4 districts (Chancheng, Shunde, Nanhai and Gaoming Districts) is handled in either of the two incineration plants in Nanhai and Shunde Districts with the balance being dispatched to the Gaoming Landfill.

There are 4 phases in Gaoming landfill. The 1st one has been full and enclosed since 2008. Currently the 2nd and 3rd phases are being filled and it is planned to commence operations in phase 4 next year.

A Sanitary Landfill is one which isolates waste from the environment until it is safe. The waste in the landfill is considered "safe" when the waste has completely degraded biologically, chemically and physically. There are generally 4 basic requirements which have to be fulfilled in order for a landfill design to be considered "Sanitary". These are: -

(a) the design must take into account local geological and hydrological investigations as well as have a final restoration plan;
(b) full or partial hydrological isolation must be achieved to prevent leakage of water draining through the waste "leachate" entering the water table. Leachate should be collected and treated;
(c) trained staff must be based at the landfill to ensure properly supervised deposit of the waste as well as regular operation and maintenance; and
(d) waste should be deposited in a small area each day, compacted and covered to reduce odour and make the waste less accessible to pests and vermin.

Thanks to an excellent presentation by the site manager followed by an extensive site tour, members were able to understand at first hand how these requirements have been put into effect at Gaoming as well as observe the operation of the well-managed site.

The facility is in a rural area of great natural beauty and members learned that the intent at the end of the 30 years life is to return the landscape back to one comparable with the surrounding environment.

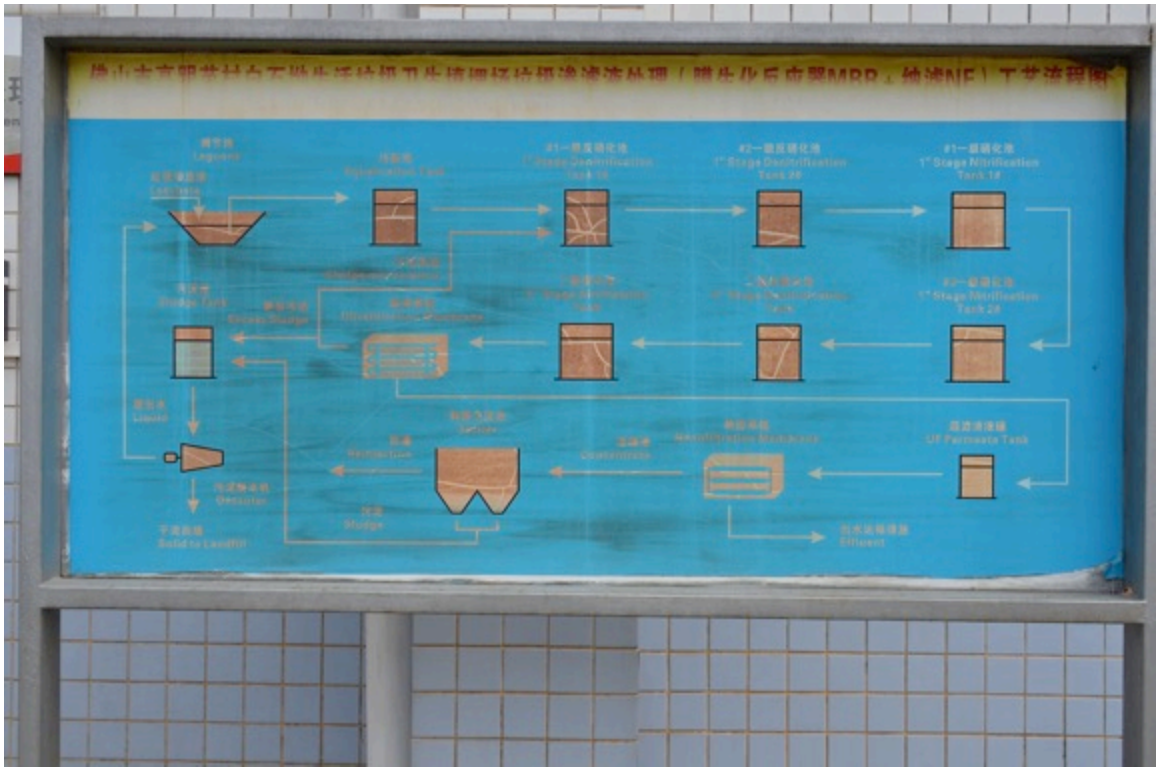
Participants noted that it appeared that there had been little or no removal of recyclable waste from the waste delivered to the site and it was generally felt that this is an area which has yet to be realized in Asia.

Veolia Environmental Services have developed a special methodology for layering the waste in the landfill. After the landfill site is excavated, a perforated groundwater collection pipe is installed in the subsoil. Above this a special membrane consisting of a Geosynthetic clay liner, a 2mm High Density Polyethylene HDPE layer and a 800g/sqm non-woven geotextile layer. Above this is a drainage gravel layer with a perforated leachate collection pipe finally a geotextile filtration layer and it is on top of this that the waste is laid.

Special vehicles are used to run over the waste and compact it. Members learned that it is usual for landfills to achieve a compaction rate of 0.9 tonnes/cum which is the China National Standard, but Veolia pride themselves in achieving a greater compaction of 1.2tonnes/cum. This significantly increases the life of the landfill. After compaction a further layer of HDPE is laid to reduce odour and indeed it was noticeable when the landfill was visited that there was none of the traditional landfill smell.

The leachate is collected and treated in a dedicated treatment plant within the facility using a 15 day cycle comprising a Membrane Bio Reactor with Ultrafiltration

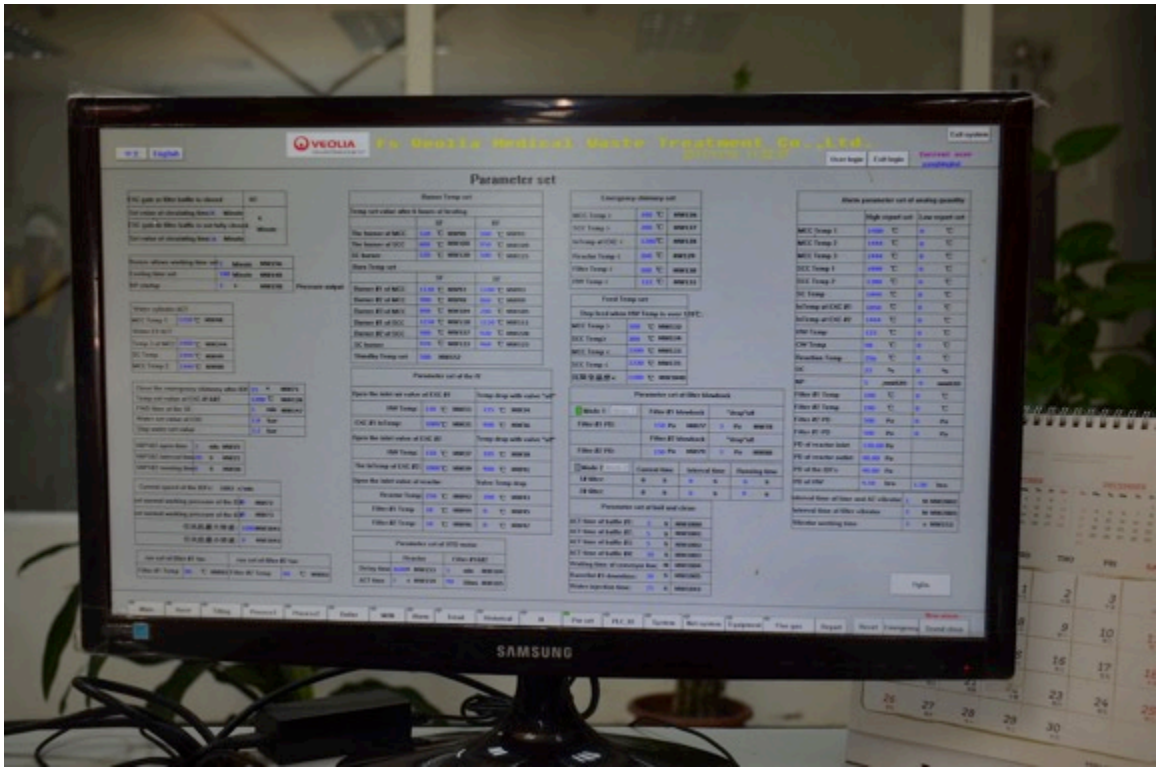
and Nanofiltration. The process uses a combination of biological and chemical treatments before using a ultrafine filtration process system to separate solids from the water. The resulting water is now pure enough to be used for landscape watering as well as washing processes and sanitary flushing. Indeed members were able to observe the "black" water "before" and "clear water after" processing. The solid waste removed from the leachate is returned to the landfill. Currently, 1,450 cum of water is treated everyday resulting in 1,300 cum of grey water for use on site.



Throughout the landfill, vertical and horizontal gas collectors are inserted and connected together which collect methane generated from natural biodegrading of the landfill waste and pipe it to collecting tanks. The methane is used in a gas generator to produce electricity which is currently used on site with any excess being flared. However, it is planned to connect to the electric grid in the near future. Currently there is an installed capacity of 3.12 MW which will ultimately be increased to 6.5MW when the whole landfill is in use.

Another interesting facility at the site is the Foshan Veolia ES Medical Waste Treatment project dedicated to processing medical waste. The plant was completed in 2008 and is designed to process 15 tonnes of waste per day and is reported to be one of the most advanced in China. An incinerator handles the majority of the waste where it is combusted at temperatures of over 1000°C. Strict pollution control is

applied using dry lime and ceramic filters. Flue gas emissions are constantly monitored in the control room where members were invited to inspect the operators at work. The resulting ash is sent to the landfill.

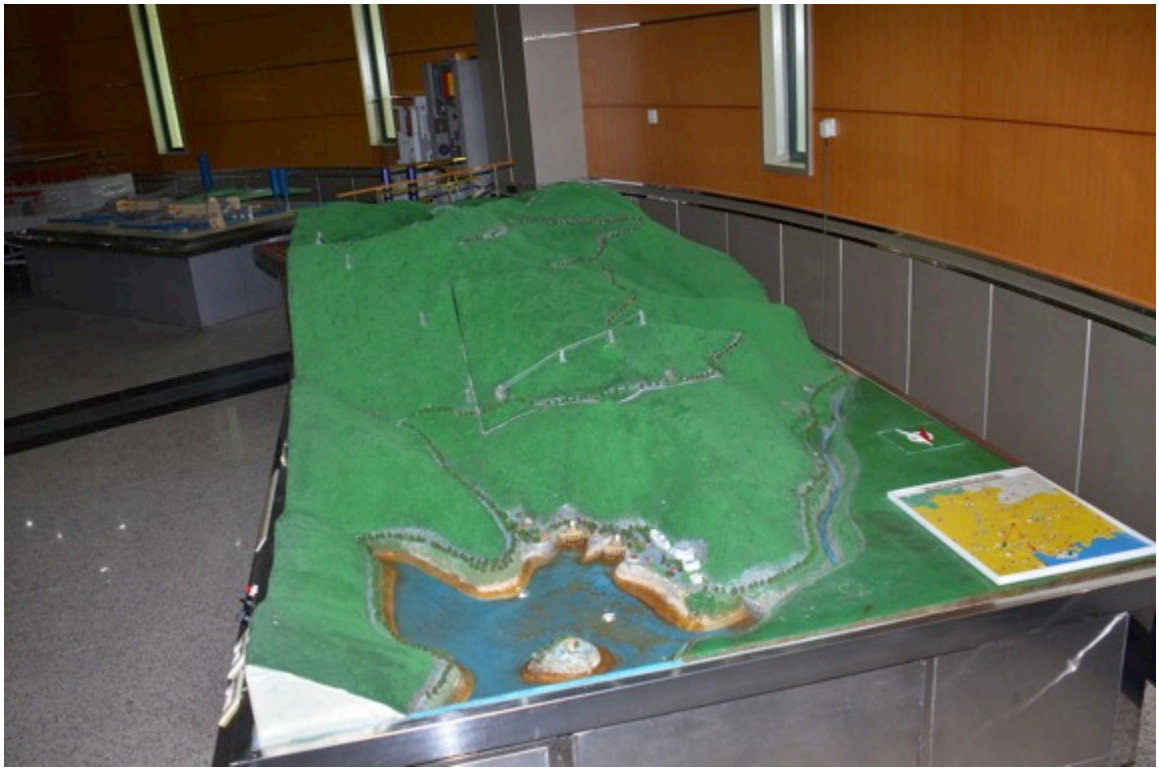


In addition to the incinerator there are two steam sterilizers which are used to process any daily waste exceeding 15 tonnes and pass steam through it at 130-135°C prior to it also being sent to the landfill.

DAY 2 Guangzhou Pumped Storage Power Station (GPSPS)

Guangzhou Pumped Storage Power Station is located in a beautiful rural area near Lutian Town, Conghua County, Guangzhou. Construction started on Stage 1 in 1989 completing in 1994 and Stage 2 was completed in 2000.

At this time it was the largest pumped storage system in the world with an installed capacity of 2400MW. Subsequently, this crown has been taken by Bath County Virginia USA (3000MW) and Huizhou (2448MW). However, all will be eclipsed by the Fengning Hebei installation (3,600 MW) which is now under construction and scheduled to complete in 2021.



GPSPS was originally developed by CLP and designed to work in conjunction with Daya Bay Nuclear Power Plant which was completed in 1993. GPSP acts like a giant battery and is used to store energy and enabling it to be released at times when demand rises above the base load which can comfortably be provided by Daya Bay. Now however, with the growth of the South China Grid, there is more flexibility in the Grid and there is no direct pairing of GPSP with Daya Bay. The harnessing of energy from different power stations is now much more sophisticated and takes into account the energy mix available analyzing current cost as well as emissions. Coal fired power stations provide cheaper energy but their emissions have to be taken into account over time in order to meet the stricter standards now enforced in South China and in Hong Kong. Hence the power mix at any one time is carefully controlled.

As is well known, Nuclear Power Stations need to be run at a constant load to achieve peak efficiency and therefore the electrical energy supply system requires an additional system to provide energy to meet Peak Load conditions. In Hong Kong, Peak Load occurs typically at Noon or between 6-10pm and can occur very quickly. Peak demand can vary throughout the year when air conditioning is used much more in the summer months for example. The South China Grid has 3 potential peak times through the day: hence constant monitoring is essential. Specific events such as grid failures, outages and also special public events can also have a significant short term effects. In an example from UK: the 2006 World Cup

England versus Paraguay match, electricity usage increased by 1,500MW – the equivalent of 600,000 kettles being switched on at once – as thousands of people rushed to use the toilet and fetch a drink during halftime. The similar pumped storage power station at Dinorwig in North Wales has been designed to react in 16 seconds to cater for such a surge in energy demand.

The power station was reached by a two hour drive from Guangzhou through farmland and increasingly beautiful hilly scenery arriving first at the lower dam and lake which covers an area of 13.2 sqkm and can store 23.4 million cum. The main visitors centre is situated at the lower lake as is a recreational resort and hotel which is open to the public. GPSP staff first briefed members on the history and operation of the plant and then introduced a scale model of the installation showing both lakes and the hydropower station located partway down the hillside between the two lakes. The upper dam and lake is smaller in area and covers an area of 5.2 sqkm but, being deeper, is able to hold approximately the same volume of water, 24.08 million cum. The height difference between the lakes is 535m with the upper dam sited at 820m above sea level.

The power station houses 8 hydro turbines each with a rated capacity of 300MW. Normally, a total of 6 turbines are in service at any one time and 2 will be under maintenance. The generators are of the vertical, single stage type as demonstrated in the exhibition area.

The turbines are reversible and can act as a power turbine when water is released from the upper dam and as a pump when under power to pump water from the lower to upper lakes.

Two of these turbines are used to provide power to the CLP distribution network lines to Hong Kong, and 6 provide on-demand power to the Guangzhou grid. Control of the power station is accomplished remotely from CLP Hong Kong control centre and from the South China Grid control. Close cooperation between these two control centres is essential.

Full power can be switched on in 4 minutes and there are up to 4,000 starts per year which means that allowing for maintenance downtime, each turbine is used around once per day generating and once per day pumping. Water will be pumped from the lower reservoir to the upper reservoir by any of the turbine pumps during any period when the grid has excess energy available. The efficiency of the station is in excess of 75%. The water used by the Hong Kong/China turbines is recorded and the work done in pumping is balanced out to ensure a fair share of pumping and water use is maintained between China and Hong Kong.

Members then rejoined the coach to drive up the long intermediate road to the upper dam and lake where they then enjoyed a tranquil walk across the dam in clean cool air which could so easily have been in scenic Europe surrounded by thickly forested hills!

Thanks for the visits are due to the staff at Veolia Gaoming and at GPSPS as well as to EIHK Committee members Chris Chong and Gary Chiang who worked with staff at Veolia and CLP respectively to make the arrangements. Thanks are also due to Coordinators April Li and Committee Member Benson Wong for the excellent logistics and liaison.

Andy Bell EIHK Hon. Secretary