INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH TECHNICAL VISIT TO CHEMICAL WASTE TREATMENT FACILITIES ON 25/1/2014

IMechE-HKB delegation to Chemical Waste Treatment Centre

Waste is generated in any human habitat. Being a cosmopolitan in Asia, Hong Kong generates much waste every day, which some is chemical in nature: lubricants, spent oil, substances contained by acid and heavy metal. Such waste cannot be disposed of in the same way of municipal waste in its original form by the means of direct landfill, ordinary incineration and sewage treatment. Instead, it has to be specially treated in a dedicated process facility to reduce its toxicity and harmfulness to the environment prior to the final disposal. Hong Kong, fortunately, does not leave the page of treating chemical waste for the protection of the environment empty. Its Chemical Waste Treatment Centre (CWTC) is a state-of-the-art complex to process the chemical waste generated by all trades in the territory in a safe, environmentally friendly and efficient way. In the morning of 25/1/2014 (Saturday), 28 members of Institution of Mechanical Engineers (IMechE) were privileged to visit CWTC on Tsing Yi Island in the New Territories of Hong Kong and appreciated how it contributes to the environmental protection of the territory.

General

In 1988, the Hong Kong Government issued a "White Paper" addressing the environmental protection policy. The "White Paper" formulated that a dedicated facility to process chemical waste should be built. The government adopted the proposition, and after international tendering, in 1990 a 15 year Design, Build, and Operate contract for the CWTC was awarded to the consortium Enviropace Limited led by Waste Management International, the USA-based largest waste processing company. Operation commenced in 1993 and, 15 years later, when Waste Management International subsequently became the current Veolia, in 2009 a ten year contract of operating the CWTC was awarded to Ecospace Limited, which is 100 % owned by Veolia Environmental Services Hong Kong Ltd.

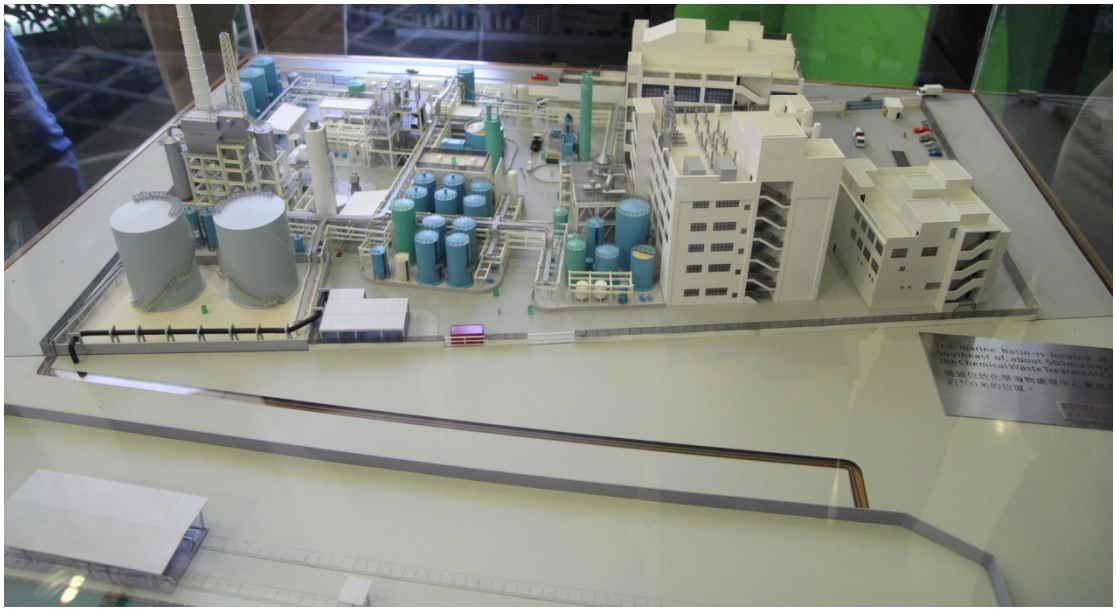
Veolia operates the two (2) hectares CWTC owned by Environmental Protection Department (EPD) of the Hong Kong government, which organic waste incinerator, physical/chemical waste treatment (PCT) and oil-water separation facilities provide total installed process capacity of 100,000 tonnes per annum. Dedicated warehouses provide temporary storage of the chemical wastes collected from the industry. A comprehensive environment monitoring plan is executed to track the discharges real-time, whereas EPD stations ten (10) staffs to monitor the discharges. CWTC has its own accredited laboratory to examine the constituents of the chemical wastes and decide the most suitable treatment method. The laboratory is the first commercial laboratory in Hong Kong to perform dioxin analysis.

From 0830 hours to 1730 hours, 185 staffs work in the CWTC. As the incinerator operates round-the-clock, two (2) shift operation from 0700 hours to 1900 hours daily, rotated by four (4) shifts, is deployed. Ordinary servicing is done in-house, whereas the annual maintenance is executed by contractors.

In 2003, mercury (Hg) handling facility was introduced to process Hg-containing components such as fluorescent lamp and devices alike. The Hg recovery rate reaches 99.999 %. In the ten (10) year contract started in 2009, the conditions of EU standard-complying emission and providing a clinical waste process facility were incorporated. A new purpose-built building was consequently commissioned to handle clinical waste.

CWTC operates its own logistics. Special chemical waste containers are provided to customers and, upon 72 hour notice collection is made. In contrast, clinical wastes are

not collected, whereas delivered to CWTC directly by the waste collection contractor engaged by the hospitals. As a specialist in chemical waste handling, CWTC provides first instance assistance to government departments to handle chemical waste incidents.



Model display of CWTC; process facilities on left and storage on right of photograph

CWTC divides chemical wastes into organic and inorganic in type. Organic wastes are treated by incineration, whereas inorganic wastes are treated by oxidation, reduction or neutralisation. Upon the receipt of non-clinical chemical wastes which come in bucket, they are first detected for radioactivity, and then weighted and "finger-print sampled" to check for compliance of the wastes with declaration submitted. After confirm compliance, they are stored in warehouses and waited for batch treatment.

Incineration

Organic wastes are also energetic wastes, such as lubricants and solvents. From buckets after detecting for radioactivity and weighting, they are transferred to the containing vessels inside CWTC and then tested for heat value, sulphur and chlorine content. Upon the test result being satisfactory, the cocktailed aqueous waste is admitted to the incinerator for combustion.

The incinerator at the design capacity of 15,000 tonnes per annum is a 1990 design of Waste Management Design in the U.S., comprising a Solid Waste Elevator, Rotary

Kiln, Secondary Combustion Chamber, Heat Exchanger, Air Pollution Control Equipment, Bag House and Stack. High temperature decomposes organic compounds into carbon dioxide with the destruction and removal efficiency of over 99.9999 %. The temperature of various incineration stages is as tabled below:-

Incineration Stage	End-of-Process Temperature
Rotary Kiln	Not less than 850 ˚C
Secondary Combustion Chamber	Not less than 1000 ˚C
Secondary Combustion Chamber (for PCBs, PCDDs, PCDFs, Polychlorophenols and Polychlorobenzenes)	Not less than 1100 C
Heat Exchanger	400 ˚C
Air Pollution Control Equipment	180 ˚C
Bag House	180 ˚C
Stack (at full-load)	Above 160 ˚C

Complete combustion is facilitated by the admission of 6 % excess oxygen into the incinerator, together with the minimum two (2) seconds of retention time for the gases to be burnt inside the combustion chamber as well as the tumbling effect of the wastes generated by the rotary kiln.

The high energy in the 1200 ˚C exhaust gas leaving the Secondary Combustion Chamber is recovered by the Heat Exchanger. Water passes the Heat Exchanger and leaves it as saturated steam at about 185 ˚C, supporting the PCT process and reducing the exhaust gas temperature to 400 ˚C.

The high temperature combustion generates nitrogen oxides (NO_x). NO_x emission is abated by the reaction with ammonia (NH_3) to reduce to nitrogen gas. Urea, a stable and non-harmful NH_3-carry compound, in pallet form is injected into the economiser of the incinerator, where the 400 ˚C exhaust gas decomposes the urea pallet and releases NH_3 for the reaction. To remove sulphur oxides (SO_x) in the exhaust gas, limestone slurry is sprayed against the gas to form non-harmful calcium sulphate, or gypsum. The exhaust gas temperature, after this "de-NO_x and -SO_x" process, drops further to 180 ˚C and passes through active carbon for the absorption of the remaining dioxin to below the statutory emission limit of 0.1 ng/m^3, and then the Bag House for dust collection. At the 76 metre tall stack, the exhaust gas is monitored its chemical composition levels such as NO_x, NH_3, Hg, SO_x and dust and, where acceptable, finally discharged to the atmosphere.

Clinical wastes are also incinerated. In the statute there are six (6) groups of clinical wastes, whereas in CWTC they are handled either as Group 3 (Gp-3) or non-Group-3 clinical waste. Gp-3 clinical waste is the waste human and animal tissues such as organs and binned in yellow-coloured container, whereas non Gp-3 clinical waste is all other clinical wastes, such as consumed cotton with blood, and binned in red-coloured container.

Clinical wastes delivered to the dedicated clinical waste reception building in CWTC, about 250 kg of which are Gp-3 waste daily, are first scanned for radiography, weighted and will be sent to incineration on the same day. When the incinerator is shutdown for normal or emergency overhaul and maintenance, Gp-3 waste will be stored in the refrigerator below 0 ˚C while non Gp-3 waste will be stored in the area below 20 ˚C within the building. If the two (2) day storage capacity of the non Gp-3 is exceeded, such waste will be delivered to the licensed landfill for disposal.

The admission of clinical wastes at the Solid Waste Elevator, or hopper, into the Rotary Kiln is monitored by close-circuit television (CCTV) inside the Central Control Room (CCR). The emptied containers are all manually inspected in-situ to ensure no clinical waste is left inside the bin after tipping.. Inside the CCR, which is equipped with Honeywell-made Distributed Control System, CCTV provides real-time images of the combustion inside the Rotary Kiln. The Rotary Kiln combusts 50 to 60 tonnes of waste daily, whereas is subject to annual overhaul in March or April for 30 to 35 days. Ultra-low sulphur diesel is used for start-up.

The oil-water separating facility removes hydro-carbons from water principally generated in the marine industry. Its design capacity is 15,000 tonnes per annum.

Physical Chemical Waste Treatment

Inorganic wastes, either acid or alkali, are treated by PCT. Unlike incineration which is continuous operation, PCT runs by batch, albeit currently only 30 % of its design capacity of 75,000 tonne per annum is utilised. Subject to chemical properties, the inorganic wastes are processed by oxidation, reduction or neutralisation to lower their toxicity. For instance, chromium (Cr) “6+” ion is highly toxic and it is reduced to the less toxic form of Cr “3+”.

The facility operates at 30 % of its design capacity, which is a reflection of the reduction of industrial activities in Hong Kong. As an example, in the past, much of

the acidic and alkali liquid waste came from the circuit board printing industry and the dye of the textile industry respectively, which both have moved away from Hong Kong.

The marketable heavy metals, such as copper, are recovered in the PCT process. To incentivise thorough waste treatment, the CWCT operator can retain the full amount of the proceeds of reselling the heavy metals. The recovered copper is in the copper oxide form and is sent to the U.S. for re-processing.

Residual handling

The residue of the treatment processes, both incineration and PCT, is subject to stabilisation. It is mixed with cement and fly ash to solidify. The cement provides an alkaline environment to entrap the heavy metals to within the solid, which otherwise upon contact with acid will leak and cause contamination. The stabilised solid waste is examined and, upon satisfaction, sent to landfill for final disposal. About 16 tonnes of the stabilised solid waste is generated every three (3) days.

The effluent of processing the inorganic waste in the PCT process is handled by the waste water treatment (WWT) facility. The 185 ˚C steam recovered by the heat exchanger in the incineration process to heat the effluent for the decomposition of organic components where any. Then the effluent passes through active carbon and sand filter for the absorption of organics and filtration of any remaining waste in solid form. The resulted waste water is discharged to the public sewage for primary treatment in the public WWT works.

Remarks

Chemical wastes, if not properly handled and processed, would cause much harm to the environment and public health. Hong Kong is acting responsibly by having the CWTC to treat the chemical wastes and minimise their resulted impact to the environment and man-kind in a safe and efficient manner. IMechE Hong Kong Branch was privileged to appreciate first-hand its accomplishment. Special thank is given to Mr. Larry Wong, QEHS Manager and Ms. Mandy Chiu, Communications Department of Ecospace Ltd., Hong Kong for facilitating the visit.

- END -

WHT