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NEWSLETTER

ISSUE NUMBER 4

Message from the Editor

Dear friends, even as I write these lines, the number of newly reported cases of Coronavirus disease (COVID-19) continues to grow globally. These are testing times for the mankind, and undoubtedly the world is facing one of the toughest challenges in history. The impact of COVID-19 could be felt on all facets of life, across the globe.

The world witnessed one of the largest lockdown in human history, wherein majority of the countries resorted to complete shutdown of activities to curtail the spread of this contagious disease. The lockdown was seen as the last alternative, which definitely resulted in flattening the spread of the disease to an extent, but this also meant shrinking of the economies.

The UN's Framework for the Immediate Socio-Economic Response to the COVID 19 Crisis warns that "The COVID-19 pandemic is far more than a health crisis: it is affecting societies and economies at their core".

The International Monetary Fund (IMF) has predicted that in 2020, the global economy may shrink by over 3%, which would be the steepest slowdown since the Great Depression of the 1930s. The Asian Development Bank (ADB), in one of its reports says, "The global economy could suffer between USD 5.8 trillion and USD 8.8 trillion in losses- equivalent to 6.4% to 9.7% of the global GDP".

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R Rajmohan
CEO, DESL

Inside this Issue

DESL

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Leachate Treatment: Key for WtE Success

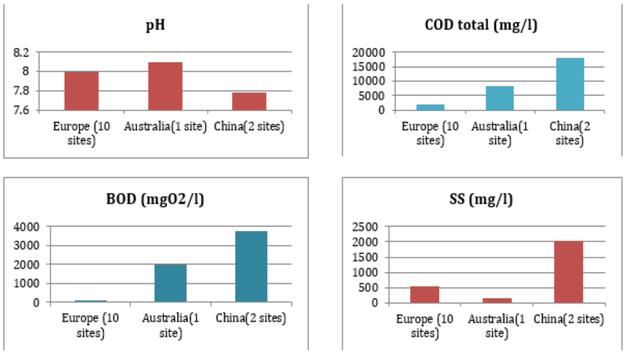
India is one of the fastest growing economies in the world, and is going through a transition phase. The country's strong economic growth trajectory is driving the demand for more and more electricity. Certain part of this electricity demand can be met by India's enormous Waste to Energy (WtE) potential. However, despite being a sustainable energy solution that is not dependent on conventional fossil fuels, the WtE segment is still struggling to find a foothold in the country. Besides the challenges of being a nascent technology with lack of financing and criticality of the components used, a major barrier that has hampered its development in the country is apprehensions regarding treatment and disposal of leachate generated and associated harmful radiations, especially from the incineration technology.

This article tries to focus on the leachate management in WTE plants.

Leachate is generated from municipal solid wastes (MSW) due to their physical, chemical, and biological changes. Leachate is generally formed at landfills, incineration plants, composting plants, and transfer stations, with high strength and toxicity. It usually contains various toxic organic pollutants, heavy metals, ammonia nitrogen compounds, and other components.

The composition of leachate depends on the waste type received, its age, location, seasons, retention time in MSW storage pit at incineration plants, operation modes of transfer stations, etc.

Typical range of leachate characteristics for different regions (Source: Veolia)



The table 1 provides an insight into the evolution of leachate w.r.t. time.

The properties of leachahte may vary from one region to the other depending on various factors. Table 2 provides a glimpse of properties of leachate across India.

It, is, therefore, very important to keep in mind the evolution of the leachate composition with time when selecting the most appropriate treatment option. Typically, the organic content will decrease and the quality of the COD becomes harder to treat with time (less biodegradable). Conversely, the ammonia will increase and decrease much later. (Literature schema on the evolution of parameters)

The leachate generated has several effects like groundwater contamination, surface water pollution, odours and severe health impacts due to pollution and radiation.

Table 1: Leachate evolution with time

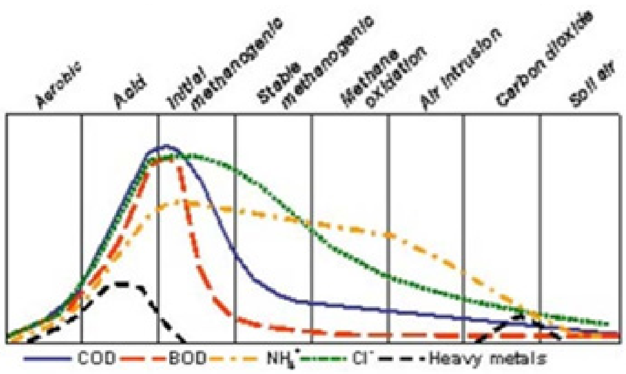
Parameter	Young	Intermediate	Old
Age (years)	< 5	5-10	>10
pH	6.5	6.5-7.5	>7.5
COD (mg/l)	> 10,000	4,000-10,000	<4,000
BOD/COD	> 0.3	0.1-0.3	<0.1
Organic compounds	80% volatile fat acids (VFA)	5-30% VFA+ humic and fulvic acids	Humic and fulvic acids
Heavy metals	Low-medium	Low	Low
Biodegradability	Important	Medium	Low

Source: *Study by S. Renou, J.G. Givaudan, S. Poulain, F. Dirassouyan and P. Moulin, Landfill leachate treatment & study by A.Amokrane, C.Comel and J. Veron, Landfill leachates pretreatment by coagulation-flocculation*

Table 2: Variation of leachate properties across India

Parameters	Gurugram			Okhla			Mavallipura			Jainpur landfilling site		Noorpur belt	
pH	6.82	8.3	8.3	3.5	3.4	4.8	7.4	8.4	7.5	9.3	9.8	9.5	7.58
TSS (mg/l)	1,690	412	1,016	1,040	740	1,500	-	-	-	5,963	7,695	6,579	2,270
TDS (mg/l)	1,4075	-	-	-		5,4190	2,027	1,447	703	5,348	6,563	5,693	23,503
BOD (mg/l)	1,3761	6,771	7,617	47,090	19,802	53,444	1,500	105	3	329	495	406	4,459
COD (mg/l)	34,402	14,000	14,800	120,096	48,038	105,000	10,400	1,080	440	1,335	2,535	2,018	8,350
Nitrate (N) (mg/l)	95	37	644	493	174	-	22.36	0.18	1.09	12.5	18.6	15.9	-

Source: Operating WTE plants in India & study by Naveen B.P et al)



Leachate management

The quantity of leachate generated from the MSW varies from season to season. In the rainy season, it will be higher due to high moisture content in the MSW. In dry and hot season, it will be minimum due to less moisture content present in the MSW. For the incineration plants in India, the quantity of leachate generation varies from 5% to 10% and it may even go beyond 15% based on local climatic conditions. Hence, the above factors need to be considered for selection of capacity of leachate treatment plant.

As there is wide variation in leachate characteristics, the number of samples have to be taken considering the leachate variation due to waste received, age and seasonal variations; at least 5 elementary samples need to be taken at different places and depths each time. Thereafter, the toxicity characteristic leaching procedure (TCLP) test needs to be done to estimate the properties of leachate generated for selection of best technology for leachate treatment. Leachate treatment methods are generally classified into four types, namely,

- Biological processes
- Chemical and physical processes
- Combination of chemical and biological processes
- Co-treatment with Municipal Sewage

Selection of technology

Selecting the appropriate technology for leachate treatment is still a major challenge for operations in municipal landfills. Biodegradation is effective for treating newly-formed leachates, whereas old leachates require processes such as chemical oxidation, coagulation–flocculation, chemical precipitation, ozonation, activated carbon adsorption, and reverse osmosis. Recently, the combination of biological pretreatments followed by physico-chemical processes have shown to be very efficient.

However, selection of leachate treatment technology is done based on results of TCLP tests and taking into account factors like the leachate age, season, climatic conditions, regulation criteria and pollutant concentration, etc. There are several successfully operating plants across the world, which provide hope for sustainable leachate treatment and management in India that would ultimately help success of WtE in India.

Disposal: The treated leachate can be used for gardening, cleaning and for ash quenching purposes based on the level of treatment. Ministry of Environment, Forest and Climate change (MoEF) has proposed certain standards for disposal of treated leachate in SWM Rule 2016 standards. ■

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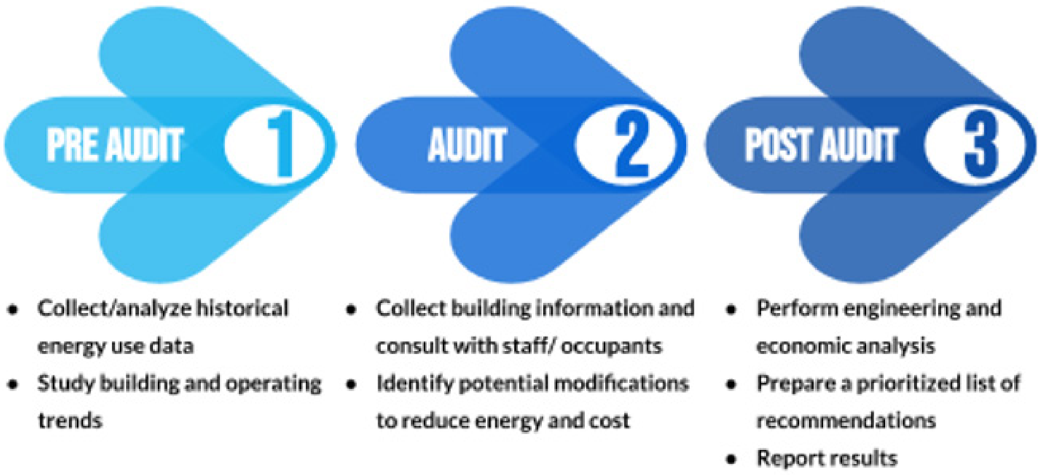
Digitizing Energy Assessments

Virtual energy assessments have gained traction with improvements in energy monitoring and communication technology. Residential remote energy audits are being carried out using a combination of software applications and video calls since 2012. One such application (Energy Elephant) claims to carry out 5-minute virtual energy audits in pubs, bars, hotels, schools, hospitals, libraries, museums, restaurants, B&Bs, golf clubs, churches, offices, etc. Such applications rely on the high level of metering and availability of granular data. In the context of emerging economies, where metering is rudimentary and on-site measurements are essential, planning and conducting virtual energy assessments, therefore becomes a challenge - especially in the current times when travel is severely restricted.

Even before the current pandemic, as a part of a global initiative within Veolia, DESL has been actively involved in digitizing work processes. Digitizing as a strategy is being adopted to optimize level of efforts in the pre-audit and post audit phases and to maximize value delivery to our clients while keeping the cost of energy audits manageable.

Our experience so far has provided the following three scenarios leading to different methodologies for an energy audit



Phases of Energy Audit

Table 1: Different scenarios for data availability & relevant energy audit methodology

Metering	Rudimentary	Sub-metering is available for all major energy-consuming equipment	High level of disaggregated data is available (e.g. PLC/ SCADA/ IBMS)
Engagement/ skill level of facility manager or engineering team	Little to no experience in driving an energy management program	Staff are aware of the benefits of energy audit and would like to raise the bar for an existing energy management program	High level of engagement, energy audit instruments are available in the facility/ factory
Example of facility	Public building	Commercial buildings and SME industries	A certified green building with IBMS
Methodology for Virtual Assessment	Conventional Energy Audit Or Energy Audit with Local Intervention	Partial Remote Energy Audit	Complete Remote Energy Audit

Digitizing as a strategy is being adopted to optimize level of efforts in the pre-audit and post audit phases and to maximize value delivery to our clients while keeping the cost of energy audits manageable.

A comparison of conventional energy audit to the variant methodologies is summarized in the table below:

Table 2: Comparison of conventional energy audit to the variant methodologies

Stages of Energy Audit	Conventional Energy Audit	Energy Audit with Local Intervention	Partial Remote Energy Audit	Complete Remote Energy Audit
Data collection	• Field visit to facility • Data collection through survey and measurement instruments	• Designate a local field representative for survey and measurements • Develop Standard Operating Procedures (SOPs) for local team to ensure process integrity	• Coordinate and provide training to one of the facility representatives for data collection and measurement • This is possible if good quality of data is available in facility (organized data)	There are no field visits, the data is collected through Smart Meters installed in the facility and meetings are conducted through Video calls and videography of premises at equipment, substation level, etc.
Analysis & Estimating energy savings	Conventional method	Conventional method	Combination of conventional methods & Data analytics depending on the quality of data available	Data analytics using software and cloud based storage
Report Generation	Conventional method	Conventional method	Conventional method	Generate report through software application
DESL case studies		In the month of April 2020 DESL was awarded an assignment to execute energy audits in 14 government buildings at Accra, Ghana, under a contract from the Millennium Development Agency. Due to COVID-19 related travel restrictions, the assessments are being carried out by this method, where a local team of Ghanaian engineers, guided remotely by DESL engineers are carrying out the required data collection and measurements, with near real time data processing in the home-office.	ASHRAE Level 2&3 audits were carried out in 4 outlets of IKEA in the Kingdom of Saudi Arabia. Since these buildings had fairly good quality disaggregated data on historical performance, data collection and a few sample measurements were conducted by a lean team with help of facility representatives.	

The digitizing of the audits can make the process quicker and more productive. However, it is always an advantage to have an onsite energy auditor with cross disciplinary experience and eye for details to identify the energy saving projects based on operating practices observed. ■

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Industrial process heat recovery through Organic Rankine Cycle

One-third of global energy consumption is accounted for by the industrial sector. Most part of this energy, as per the published data indicates that the waste heat accounts for 50% or more of the total heat generated in industry. This heat is wasted as exhaust heat due to varied inefficiencies and technical limitations. A large percentage of this exhaust energy is in the form of low-temperature steam or some form of flue gases. Since the worldwide energy demand has been rapidly increasing, but the fossil fuel to meet the demand is being drained, an efficient use of the low-temperature energy sources such as exhaust gas from gas turbine systems, biomass combustion, or waste heat from various industrial processes becomes more and more important. Now there is a catch here, what if there is a closed-loop thermodynamic cycle that is ideally suited for industrial processes to recover this heat and that too focusing on the low-temperature heat recovery? Organic Rankine Cycle (ORC) is one such technology that is widely used for heat recovery of low-temperature exhaust streams. As compared to conventional heat recovery systems based on Rankine cycle, ORC is found to be more efficient as well as environment-friendly.

ORC is a Rankine cycle where an organic fluid is used instead of water as working fluid and appears as a promising technology for conversion of low-grade heat into useful work or electricity, since it exhibits great flexibility, high safety and low maintenance requirements. Apart from that ORC as compared to steam turbine (traditional Rankine cycle) has better thermodynamic features, low operation, and maintenance costs and is highly flexible with good performance at partial load. ORC systems use an organic fluid as a working fluid, generally, a refrigerant, characterized by a molecular mass higher than that of water such as pentane, butane, perfluorocarbon or silicon oil. The advantage of using an organic compound is that it leads to a slower rotation of the turbine, lower pressures, and no erosion of the metal parts and blades.

In an ORC the saturation vapour curve is the most crucial characteristic of a working fluid. This characteristic affects the fluid applicability, cycle efficiency, and arrangement of associated equipment in a power generation system.

Features

The ORC unit is a system based on a closed-loop thermodynamic cycle for the generation of electric and thermal power, especially suitable for distributed generation. In this section the key points of ORC technology compared to steam technology are explained.

Flexibility

- Large range of sizes from small to medium sizes (up to 20 MW per single shaft)
- Different primary energy sources, from renewable energy (geothermal, solar, biomass) to energy efficiency (i.e. waste heat from industrial processes) to conventional fuels (natural gas, flare gas)
- Different kinds of heat carrier fluids: intermediate fluid (thermal oil, saturated steam, water) or directly from industrial smoke through a direct exchange
- Large rangeability: different temperatures of the source (even below 100°C through selection of proper working fluid); partial load (the ORC system keeps high electrical efficiency even when operating with lower thermal power input, even 10% of the nominal one) (Note: The efficiency of the ORC system is always optimized: on average at 50% load, electrical efficiency is still 90% of the

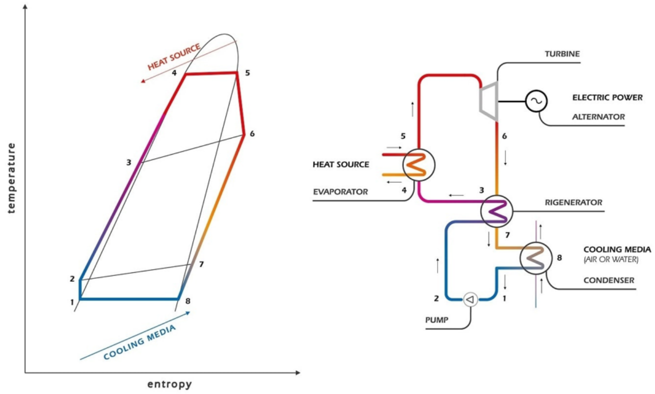

Figure 1: Organic Rankine Cycle: TS Diagram and Schematic Diagram

Advantages of ORC

- Has a wider range of applications worldwide, as it is suitable for lower temperature applications
- There is no liquid phase during the expansion, therefore it has a more reliable and long-lasting expander and lower maintenance cost
- It is a compact and automated system, so either no or less number of operators are required
- Because of operational flexibility, it has a superior off-design performance and because of design flexibility to use the most of the efficient working fluids it has optimized efficiency and customized solution on the resource characteristic
- Since it works on no-water consumption option, therefore, it has a lower environmental impact with no wastege of water

nominal electrical efficiency.)

- Cogeneration mode or power-only mode. In cogeneration, the thermal output can be hot water or steam
- Ease of integration into pre-existing systems (i.e. in waste heat recovery from industrial processes)
- Island mode capability

Easy technology

- Simple technical features: low pressures involved, low speed turbine, limited number of stages of the turbine (≤6), self-lubricating fluids, no water required
- Easy and cost-effective operation & maintenance: automatic operation (no qualified operator required), minimal maintenance activities, no major overhaul (turbine not subject to erosion and corrosion), fast start-stop procedures, no chemical and water treatments, low refiling of fluid required
- Possibility to install the ORC unit in remote places, working efficiently

Reliability

- High availability (98% +)
- Long life
- Sustainability
- Core system for renewable energy and energy efficiency
- Clean generation of power and heat
- Reduction of CO_2 emissions (e.g. in heat recovery or in geothermal where the ORC system operates with zero emissions thanks to the reinjection)

ORC systems are used for power production from low-grade heat (referring to low to medium temperature heat sources) in the range of 80 to 350^{0}C. It is mostly suitable for power generation from 100 kW to 50 MW.

Working Fluids Selection

Given that the ORC relies on a refrigerant as it is working fluid, there is quite a selection to choose from and several important factors to take into consideration when choosing. Two main considerations must be taken into account: 1) its effect on cycle efficiency/cost and 2) its impact on the environment. The range of temperatures seen by an ORC system governs the type of working fluid that can be used.

The main components of an Organic Rankine Cycle power plant design are:

1. **THE TURBINE:** It's the key component of the entire ORC power plant, which determines the ORC system performance. It expands the working fluid producing mechanical energy that is converted into electricity by a generator coupled with the turbine shaft.
2. **THE HEAT EXCHANGERS:** The working fluid flows through the heat exchangers, extracting the heat from the heat source. Shell and tube heat exchangers are usually applied but they can vary geometry and configuration depending on the energy source and the total thermal input.
3. **THE CONDENSER:** With the direct air to fluid heat exchanger, the organic fluid is cooled and liquefied before entering the pump. The use of air eliminates the requirement for water to treat and make up. It is possible to use a water cooled condenser.
4. **THE FEED PUMP:** Brings the organic fluid from the condensation pressure to the maximum pressure of the Organic Rankine Cycle. The pump is usually driven by an electric motor at variable rotating speed.

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Project Updates

DPR for Renewable Energy knowledge park

United Nations Development Programme (UNDP) engaged DESL for preparation of Detailed Project Report (DPR) of a proposed Renewable Energy (RE) knowledge park in the north-eastern state of Manipur. The overall objective is to increase awareness, scientific knowledge, technical & institutional capacities in energy sector for implementation of Energy Efficiency & Renewable Energy mitigation strategies in the state.

Airport utilities study at Kingston airport, Jamaica

Norman Manley International Airport (NMIA) engaged a major international consultant for providing consultancy services for airport utilities study (Energy, Water, Air quality and Solid waste) in the NMIA's facilities. DESL is part of this international team and responsible for the Energy component of the project. The project intends to provide enough information about the current situation to develop a strategic future plan for the next 20 to 25 years for establishing management and monitoring systems to be undertaken to ensure efficiency and sustainability of the operations and infrastructure.

Biomass supply chain development for a common effluent treatment plant in Navi Mumbai

Detox India Pvt. Ltd. (DIPL) engaged DESL for mapping the supply chain for firewood and identification of vendors in the Konkan region for efficient supply of feedstock for power generation by using refuse derived fuel (RDF). DESL were earlier assigned to carry out a study for biomass assessment in the catchment area.

DPR preparation for generation of electricity from MSW

Assam Power Generation Corporation Limited (APGCL) engaged DESL for preparation of Detailed Project Report (DPR) of a proposed WtE Facility at old Chandrapur Thermal Power Station (CTPS), near Guwahati in Assam, India. The estimated waste generation in the city is around 580 t/d.

Contd..... from page 1 ***(From editor's desk)***

This pandemic has created a deep impact on the way we now perceive our world, our health system, our businesses, our social behaviours and our everyday lives. In a way, it has also provided us an opportunity to re-think and re-design the functioning of the society and our businesses. This phase may end one day, as the world eagerly awaits the invention of vaccine; however, the lesson that we should take away is that there should be no place for complacency. The world needs to learn from the mistakes of the past and get ready to bear other such types of shocks that may appear in future editions better. I would like to conclude on an optimistic note by quoting the lines of Emily Dickinson, the renowned American poet, where she says "Hope is the thing with feathers that perches in the soul - and sings the tunes without the words - and never stops at all."

This pandemic has definitely affected the mankind across the globe, irrespective of borders, race, caste religions and ethnicity. However, one thing that this pandemic has given all of us is the opportunity to go back to the drawing board and rewrite our future. We all need to be hopeful and optimistic.

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