THE ENVIRONMENT MANAGEMENT

A Quarterly E- Magazine on Environment and Sustainable Development

Indian Institute of Environment Management
SIES RISE WITH EDUCATION

पर्यावरणो रक्षति रक्षितः

(for private circulation only)

Vol.: III | July – September 2017 | Issue: 3

Current Issue: Wealth from Waste

Source: Government of India Ministry of Urban Development Campaign Poster

CONTENTS

Wealth from Waste
S.V.Viswanathan --- 02

Initiatives by Indian Women Scientists' Association for converting waste into wealth
Vijayalakshmi Tilak & Shyamala Bharadwaj 04

Energy from Waste
Mahesh Subramanian --- 08

Radioactive Waste as a Resource in India
C.Srinivas ---11

Report on Plantation Drive Conducted under Green Inititaatives . ..13

Biomass waste to energy conversion-
Raji Subramaniam 15

Environment day event report ...24

Environment in News Headlines ---26

From Director's Desk

With increasing economic growth, urbanization and industrialization demand for natural resources and manufactured consumer goods is increasing that is maximising the generation of waste in different streams and consequent environmental hazards. The frequent fires or collapsing of solid waste dumping sites, massive killing of aquatic animals and fire hazards in lakes are some of the incidences that solicits an immediate addressal on local and national level. Waste streams generally consist of organic and inorganic constituents which may or may not be biodegradable. The conversions of biodegradable waste to nutrient source or energy are some of the areas which could effectively be implemented at pilot scale. The recyclable components of waste could be useful as secondary resource for production processes and some of its toxic and harmful constituents could effectively be converted to resource after treatment.

At our institute, we have successfully optimized and utilized several industrial wastes, agro residues, sludge from waste water treatment plants etc. as a fertilizer, carrier for microorganisms, substrate in oil pollution management, recovery of metals from waste streams. The technologies generated were successfully transferred to society through field trials and live demonstrations. The theme of current issue of our institute' s newsletter 'The Environment Management' is 'Wealth from Waste' with focus on the proper management of kitchen waste, grey water, agro waste, radioactive waste, biomedical waste etc. for the generation of resources. I hope that the current issue of newsletter will develop new insight in sustainable waste management.

Dr. Seema Mishra

Waste to Wealth

S.V.Viswanathan
Member, SIES Management Council
E mail: viswanathansv@sies.edu.in

Anything that is not useful for users is a waste. For example, a landlord cuts grass in his porch and the cut grass is a waste. For a cowherd, it is fodder for his cattle. Ideally instead of throwing away the grass, he can sell at a lesser cost or even gift to the cowherd who will be too happy to use it. Thus, a waste has been turned into wealth. In actual life, we have innumerable examples of these where these become financial gains.

Some of the wastes are, Paper waste consisting of Newspapers, Magazines, Books, Comics, Notebooks, cartons, packing boxes etc., Metal wastes such as Iron, Tin, Brass, Aluminum, Copper etc. Plastic wastes such as scrap Toys, Bins, Containers, Pet bottles, etc., Electronic wastes such as TVs, Mobiles, Radio, Tapes, recorders, keyboard, mouse, video player, games, chargers etc., Glass and glass products such as bottles, window panes, auto parts, artefacts etc., biodegradable wastes and so on. Our aim should be therefore to make use of these as input for productive purposes.

Solid waste management is a great challenge facing municipal and state governments. The volume of this only keeps increasing. Hence an efficient collection method and infrastructure is the need of the hour. Solid waste management problems differ in composition, density, political, and economic framework, waste amount, access to waste for collection, awareness and attitude.

The concept of Waste-to-Wealth literally means moving waste from a platform of exhausted utility to valuable and desirable level. Wealth is created and process of creating wealth has some cost implications that the market forces construe this has the price.

Aim of waste to wealth work is to examine the operation of waste markets in the regions, identify the challenges facing its operation, and create awareness on the need to explore opportunities inherent in waste market for environmental and economic benefits. Leading organizations in USA target **'zero waste'** that aim for a reuse or recycle or compost 90% of the solid wastes that include construction debris in USA. One understands that some of the regions have achieved 77% and with a promise to go higher while others are at a 35% level indicating thereby a big opportunity to turnover wastes into wealth besides huge job opportunity creation. Sorting and processing recyclable materials sustain ten times more jobs than incineration or land filling. Beyond the obvious economic benefits, moving toward zero waste is an effective environmental protection strategy and avoids draining of materials.

The impact of 50 years of unbridled plastics production, use, and disposal is now becoming well known and documented. Plastics made from non-renewable petroleum and natural gas resources threaten the environment, human health, species maintenance, and the very life of the ocean. Renewable plastics as the name suggests are degradable plastics and hence present industries are advised to use the same. In short, they are very effectively recycled to ensure better economic solutions.

Thus, wastes from individuals, housing society, corporate, commercial establishment should be managed in a controlled manner

through NGOs or agencies who ensure pickup, recycle and ensure dumping of the left material into demarcated sites or incinerators ensure earnings for many and less drain for the environment is picking up in India. Let us see how wealth is created from wastes.

Metal wastes are sent to smelters who will use these as raw materials as per their normal process. I was with a non-ferrous smelter and found this as one important source of profit. Of course, it involved purification in the smelting process, but the profit was worth it. Invariably this used to be mixed with virgin billets to give better results.

Paper is recycled for making recycled paper or cartons. A lot of SMEs make use of these to produce packing cartons and be competitive. About 35% of municipal solid wastes are paper and paper products. Paper mesh art and craft are popular in India including flowers, decorates,Gods and figures.

Pulverized fuel ash or **fly ash** as it is usually referred, are used in construction as part of the concrete mix, or making of fly ash bricks unlike they were just used as land fill.

Waste tyres are recycled as products for construction, along with bitumen as layers for road, as fuel for cement kilns, melted and reused in crafts.

Wood & wood products are used as fillers in Bakelite manufacturing, used as partitions fillers in construction, wood shavings from sawmills have found application as floor overlay for the collection of bird droppings and easy sanitation, thereby creating a waste market for it. They are also used as handicrafts.

Wet waste or Organic/ Vegetative Wastes are used as animal feeds in farms. They are used to produce composts as manure in farming. Housing societies, educational institutions are encouraged to lay compost pits as a means of encouraging students to developed this attitude and culture.

Glass wastes that are from electrical appliances such as tubelights, etc are dumped while others such as milk bottles, medicine bottles are recycled to manufacturers or others for using it as packing material.

Plastics/ Polythene wastes are recycled as footwear, handicrafts besides as raw material for new components. These are also incinerated to provide valuable energy source.

Waste pickers are very important persons in this process who sort wastes and make things useable. Compliances are also made encouraging households to sort wet and dry waste at origination point. Criminals are also known to be part of this system including melting of wires and metals for financial gain as well as reselling of manhole covers, water meters etc.

CONCLUSION

Effective waste management has become the norm and is a service to the citizen to ensure health, sanitation and maintaining harmony besides being an instrument for fighting poverty and for creation of jobs.

Initiatives by Indian Women Scientists' Association for Converting Waste into Wealth

Vijayalakshmi Tilak and Shyamala Bharadwaj
Indian Women Scientists' Association (IWSA)
Sector 10-A, Dr. Mar Theophilus Marg, Vashi,
Navi Mumbai – 400703
e-mail: shyamala.bhardwaj@gmail.com

Indian Women Scientist's Association (IWSA) was established in 1973 with a mandate to promote science awareness in the society. It houses a Working women's hostel, Day care centre, Nursery, Library, Science lab, Computer lab and Health care centre. IWSA conducts several programs in schools and colleges to bring the latest in science to the students and teachers of these institutions. In parallel, IWSA has taken several measures to conserve natural resources and manage its in-house generated wastes-a program which is referred to as the Green Footprints of IWSA.

In the measures towards conservation, water management has received immense attention at IWSA. Rain water harvesting is going on for several years. In order to reduce our carbon foot prints IWSA has also installed a solar system for generating hot water which is used in the hostel. This helps us in saving energy.

RECYCLING OF USED KITCHEN WATER

Recently a grey water treatment system to recycle the kitchen washing water has been set up on campus. This system is presently fitted with a filter which includes geotextile, sand, gravel and activated carbon, several reservoirs and pumps for efficient and regulated transfer of the water. The possibility of including bacterial cultures prior to filtration so as to improve the quality of the water and the management of the system is being explored. About 400 litres of water is to be treated and used every day for watering the plants in the garden.

Photo: Grey Water Treatment System

NISARGRUNA – BIOGAS PLANT

Bio-gas plant was set up for managing the biodegradable waste generated at IWSA. IWSA is the first NGO in Navi Mumbai to set up this project based on the Nisargruna technology developed by Bhabha Atomic Research Centre, Mumbai. Nisarg means nature and runa means loan. Nisargruna is an effective way to repay your loan to nature.

Kitchen waste from the Working Women Hostel is processed for generating gas as bio-fuel and the residual manure with high nitrogen content is obtained as the byproduct.

The Biogas plant consists of a digester tank, where the organic material is stored and the microorganisms work on them and release gas. Waste is fed through a feed pipe into the digester tank. The gas thus produced is collected in a tank known as gas collector. In a floating type model, this tank is floating in the slurry and moves up-and-down based on the amount of gas stored in it. A guide pipe helps the gas collector tank to move up-and-down inside the digester tank. The fully digested slurry drains out through the outlet pipe. This can be collected, diluted and used as fertilizer for plants. A pipe line from the Gas collector tank is connected to the kitchen and the gas is used for cooking. Biogas is a biofuel produced from the anaerobic fermentation of carbohydrates in plant material or waste (eg. vegetable, fruits peels from kitchen, food waste etc.) by bacteria. It mainly consists of methane,with some carbon dioxide and other trace gases.

What are the advantages of this bio gas plant?

1. It is a very convenient way to treat biodegradable waste.
2. Clean, hygienic and pollution free environment.
3. Airtight top covers of the system hence no odor or smell.
4. No problem with flies, mosquitoes, rats and rodents.
5. Lesser Auxiliary Power and water consumption.
6. Saving on transportation of waste.
7. Smoke free fuel can be used for cooking, in boiler or for Power generation.
8. Compact size.
9. Organic manure as a byproduct

Nisargruna Bio Gas Plant

KITCHEN WASTE COMPOSTING

In addition to biogas plant a big basket containing specific microbes is used to convert organic waste from the kitchen into manure. Good organic manure, BLACK GOLD is formed after a few months and this can be used for the kitchen garden. Plants that are fed with this organic compost show marked improvement in their growth and productivity. In addition one can also grow many plants like chillies, tomatoes, papaya etc. from this manure in the home garden, as seeds of these vegetables in the kitchen waste remain as such without composting and yield saplings which can be transplanted.

Kitchen Waste Composting

“Black Gold”

“ASHUDHHINASHAK” INCINERATORS

IWSA’s working women's hostel is home for about 150 ladies. We have installed a few incinerators to address the issue of disposing used sanitary napkins. A low cost incinerator which arrests littering and is environment friendly is used for this purpose. The incinerator is high enough to stop animals from opening it and the burning operation is very simple. It does not attract attention as it is made from common terracotta material. Used napkins are inserted from the top opening of the terracotta container. Newspaper is inserted from the bottom and then lighted to burn the napkins. Very little ash that is collected at the bottom can be tapped regularly and used as manure.

Incinerator for disposing used napkins

CONCLUSION

It can be seen that by adopting some simple techniques or by using the technology of *Nisargruna* biogas plant, one can easily convert waste into wealth.

These are being successfully followed at the IWSA headquarters in Vashi. If every household or a number of families living in a multi-storey building adopt these methods, the wet waste being sent to the dumping ground causing irreparable damage to the environment can be converted to useful manure and fuel, i.e. invaluable wealth today.

Let us generate wealth from waste and make targeted efforts to increase our green footprints by following the 3 Rs (Reduce, Reuse and Recycle) wherever possible.

Readers of this article are welcome to visit IWSA Complex at the address given in the beginning of this article along with their friends and colleagues.

ACKNOWLEDGEMENTS

Useful suggestions regarding the matter presented in this article by Dr. Surekha Zingde, President, IWSA and Dr. Lalitha Dhareshwar, Vice-President, IWSA is gratefully acknowledged. The green footprint achievements of IWSA are the results of great insights and guidance from the Founder Members and Trustees of IWSA over the years.

Energy from Waste

Mahesh Subramaniyan
Anglo Eastern Academy
Khandpe Village, Karjat, Maharashtra, India
e mail: SubramanianM@angloeastern.com

Waste is a terminology which is extremely relative. Waste from one process can be raw material for other process. While Waste is a term reflecting no Monetary value to a product for a given process, there may still lie benefits and value to other process application. Waste Handling is a laborious process and if not properly dealt with can lead to environmental impacts which can cause sanitation and hygiene issues. Food waste / Wet waste from kitchens and mess areas are generated on a daily basis where there is Human habitation. The type and quantity of waste generated depends upon the cultural, ethnic and class lifestyle of the people concerned.

AEMA is a residential training academy located in the outskirts of Mumbai, 8 Kms from Karjat town, at the foothills of Sahayadri range and near Khandpe Village. There is no Municipal Waste handling facility and is located in green and pristine environment with around 500 people in campus. The Kitchen feeds 500 people 3 meals a day. This activity generates "waste" under 3 categories:-

i. Raw waste :- Greens and uncooked items like vegetable leaves
ii. Production Waste:- waste generated during the process of cooking/ preparation
iii. Consumption Waste:- Waste generated as leftover food not consumed by the people either from their plates or as unutilized food .

Through training and sensitizing the Mess staff and the people, the waste quantity is minimized, but cannot be eliminated. Hence the Waste generation cannot be totally avoided and the waste disposal becomes an issue. Unplanned and unscientific collection and dumping of wet food waste creates the following issues:-

i. Smell
ii. Health and Hygiene issues
iii. Ambience in the place
iv. Insects and Rodents
v. Dumping in Open landfills / decay of food
vi. Logistics of collection, storage and disposal

To overcome these issues, AEMA has invested and commissioned a Bio Gas plant "Nisargruna" under the guidance of BARC Scientist and Padmashree awardee Dr. Sharad Kale. The plant is located at a distance of 50 meters from the Kitchen waste collection centre and has solved the problems listed above.

It requires Minimal Manpower for operation and maintenance.

Nisarg –Runa

- The aim is to release the elements back to Nature for their reuse. Hence it is named as NISARG-RUNA.
- This is a combination of aerobic and anaerobic processes to treat the biodegradable resource.

Science of the Biogas Plant:-The principle of Nisargruna technology is as follows: It produces organic manure (soil conditioner) and biogas based on the process of Biomethanation.

Waste that can be processed	Waste that must be avoided
	

Picture 1: Dos and Donts

The organically rich bio-degradable portion of solid waste is mixed with recycled water to form slurry. The slurry is then aerobically digested in predigester, where organic matter is converted to organic acids. The Predigestion is accentuated by addition of hot water (generated from Solar water heaters) and intermittent aeration. Predigestion reactions are exothermic and temperature rises to 40 ºC by itself. Hot water obtained using solar energy is added to raise the temperature to 50 ºC. If sunlight is not sufficient especially during winter, provision can be made to use part of the biogas generated to heat the required quantity of hot water using methane stoves. Their main role is to digest proteins and low molecular weight carbohydrates to produce volatile fatty acids

The smaller molecules like proteins and simple carbohydrates are degraded during Predigestion. The pH of the feed slurry to predigester is around 7-8. the retention time (Hydraulic time) of 4 days is maintained in the predigester. After the predigestion the pH reduces to 4-5 pH units. The predigested slurry is further digested under anaerobic conditions for about 15 days. The process of methanogenesis takes place in this digester. Methane and carbon dioxide are the terminal products of this process. Methane is produced from two primary substrates viz. Acetate and Hydrogen/ Carbon dioxide (Formate). At this stage the organic acids are converted by consortium of methane bacteria to methane and carbon dioxide. The undigested lignocelluloses and hemi celluloses then flow out as high quality organic manure slurry. The pH of this slurry ranges from 7.5-8. Since the waste is processed at higher temperature, weed seeds are killed completely and the manure becomes weed free.

The three steps of Biogas production are as follows: 1) Hydrolysis 2) Acidification and 3)Methanogenesis.

Various bacteria are involved in these processes.

Byproducts in Nisargruna process

The two by-products of biomethanation process are the 1) Biogas & 2) Organic manure.

I. Nisargjyoti (Biogas)

In Nisargruna technology, 1MT/day of waste material generates around 50-100 m3 of biogas depending on type of waste material

Quantity of biogas generated from various types of waste materials

Type of waste material (one ton)	Biogas quantity (m^3)
Kitchen(Food) waste material	80-100
Vegetable waste material	50-60
Abattoir waste material	40-60
Cattle dung	40-50
Poultry manure	60-120

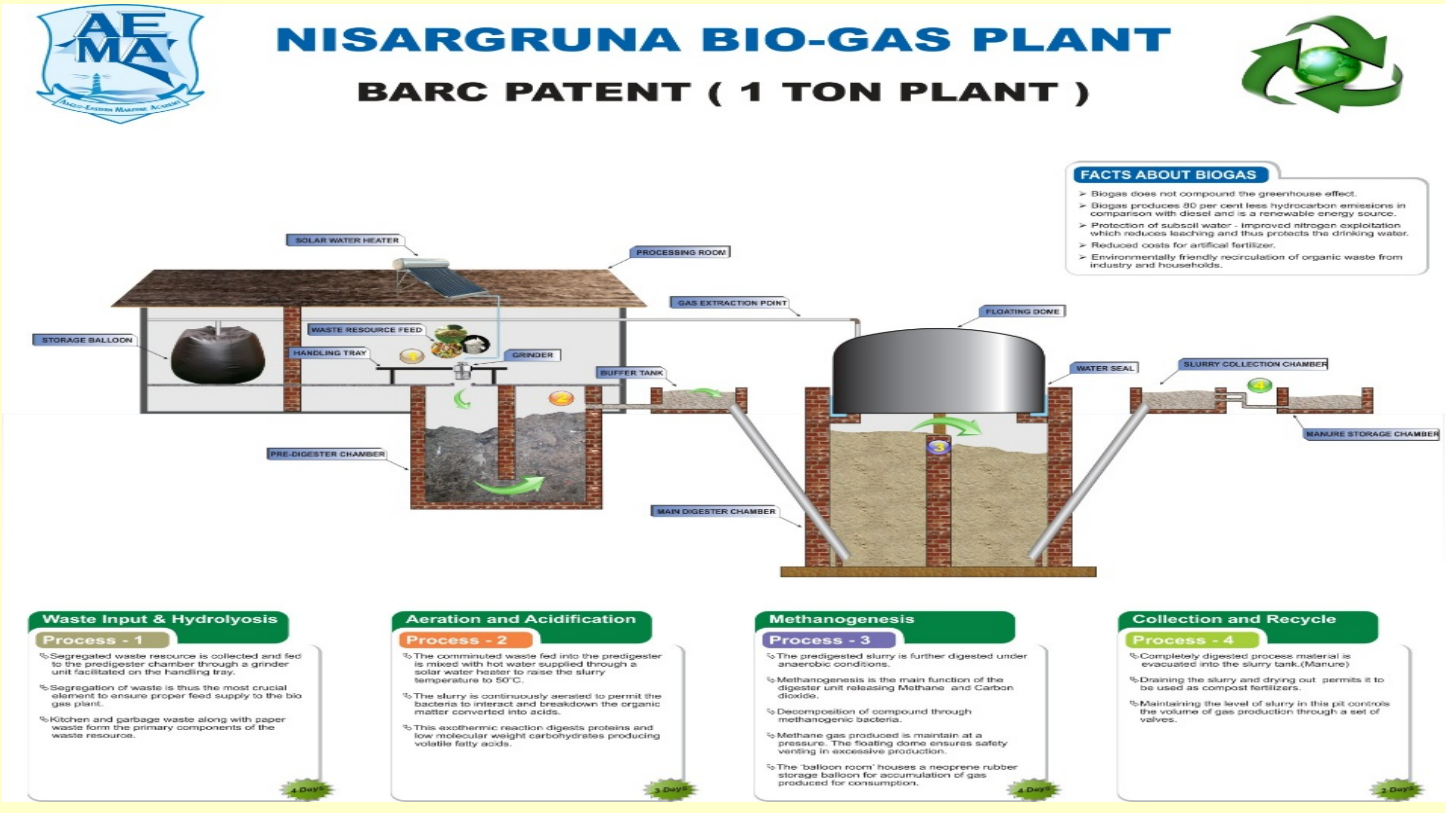
II. Organic manure

Most solids not converted into Methane settle out in the digester as a liquid sludge. Depending upon the raw materials used and the conditions of digestion, this sludge contains many elements essential to the plant life – Nitrogen,Phosphorous,Potassium and small amount of salts(trace elements), indispensable for plant growth such as boron, calcium, copper, iron, magnesium, sulphur, zinc, etc.

The benefits of the organic manure are as follows;

1. Since the process occurs at higher temperature it is weed-less.
2. It is an eco friendly fertilizer which has the entire essential nutrient needed to imporve the soil quality
3. It restores the water holding capacity of soil
4. It helps maintaining the elemental cycle of natural cycle

The Bio Gas is used for Cooking and the Manure used for gardening. Since the installation of the Biogas plant, there has been no organic waste disposal from the Mess area and the campus operated two Biogas burners every day.



Radioactive Waste as a Resource in India

C.Srinivas
SIES - Indian Institute of Environment Management,
Plot- 1E, Sector- V, Nerul, Navi Mumbai, 400706
E mail: srinivasc@sies.edu.in

India is one of the world's largest consumers of electricity, and the bulk of it is generated from coal. In spite of a total installed power generation capacity of about 223 GW as of April 2013 , India is still struggling to meet increasing power demand.

India currently operates 22 nuclear plants,with a capacity of about 6,780 MW. France has 58 nuclear reactors with a total capacity of 63.2 GWe, supplying 36 TWh of electricity in 2014 , 77.5% of the total generated there. There are 65 pressurized water reactors (PWRs) with combined capacity of about 6 GWe and 34 boiling water reactors(BWRs) with combined capacity of about 35GWe in USA.

India will build 10 Pressurized heavy water reactors (PHWR) to boost its nuclear power capacity, the government has recently announced. These homegrown reactors will be built under the ambitious **'Make in India'** initiative, with the government saying it will boost India's nuclear manufacturing capability. From a long-term perspective, India needs to keep the nuclear power option alive. This is because we are short of oil, gas and even coal. More than 70 per cent of petroleum products, 40 per cent of gas and 20 per cent of coal consumption are based on imports. Our known extractable coal reserves will run out in about 40 years if our coal consumption keeps growing as it has over the past 25 years.

Apart from this, the most vital point is that these options lead to greenhouse gas production and climate change. Exclusive dependence on solar and other renewable sources is not a sustainable option in the present state of technological development.

It is known that nuclear energy generation does not involve the generation of greenhouse gases. This is the most attractive feature of this energy source in the present context of climate change concerns. If it is so, why there is huge debate about the relevance of nuclear energy in our country and worldwide? One important issue plaguing the industry is the safe management of radioactive waste that arises from the nuclear energy industry.

Radioactive waste, unlike other wastes, emits radiation in the form of alpha, beta and gamma radiation whose intensity decreases with time. Regulations and controls on radioactive wastes, their management and discharges are as old as nuclear power industry in India and abroad. In this regard, this is one waste receiving utmost care and attention for its disposal. What is the Indian scenario on radioactive waste management? It is not an exaggeration to say that India is a leader in the utilization and management of radioactive wastes. It is relevant to say in this context that the technologies developed for radioactive waste utilization and management are indigenous and innovative.

India has a closed nuclear fuel cycle program. It means that the spent nuclear fuel after use for power production is not considered as a waste but as a resource. It is processed by solvent extraction technology for recovery of nuclear power producing materials. These materials after recovery are converted into nuclear fuel form for power production. In some countries, USA for example, the spent fuel is considered as waste.

One of the radioactive wastes of greatest concern in the global nuclear industry is the waste water arising from the solvent extraction process mentioned above. It contains high amounts of radioactivity and is called high level radioactive waste. India is acknowledged globally as a leader in the utilization of contents of this waste as a resource.

BARC has made outstanding contributions in the development of processes and technologies for the recovery of valuable materials from this otherwise problematic radioactive waste.

The waste contains valuable cesium, strontium, ruthenium and americium isotopes. Cesium-137 isotope, for example, is a better substitute to the presently used Co-60 gamma irradiator in hospitals. Ruthenium isotope is used for treatment of melanoma in the eye. Strontium-90 isotope is useful for the treatment of certain cancers. Its radiation properties are used in the Radiation Therapy (treating cancer by controlling the malignant cells). It is used in a controlled amount for the treatment of Bone Cancer. It is also used in industry for thickness gauging. Americium can be used as power source for various applications including space stations.

By indigenously developed innovative processes at BARC, these isotopes are routinely recovered at engineering scale from the high level waste for medical and industrial applications.

As a result of the recovery of these materials, the high level radioactive waste becomes much less radioactive and is managed by a process called vitrification in which the radioactive waste-bearing water is chemically converted into inert glass matrix. The radioactive materials in water are safely immobilized in this glass matrix in a virtually non-leachable form.

In conclusion, radioactive waste in the Indian context is a valuable source of useful materials. India has successfully adopted the strategy of recovery and use of these materials for medical and industrial applications and minimization of the quantities that require treatment and disposal.

REPORT ON PLANTATION DRIVE CONDUCTED UNDER GREEN INITIATIVES

The plantation drive was conducted by IIEM between June to August 2017 under Green Initiatives by involving students of different academic programs of institute, NSS students of sister institutions, management council members of SIES and Head of institutions of SIES Nerul Campus.

The initiative was supported by Mumbai Waste Management Ltd. by providing 3000 saplings. Total 3,200 tree saplings of tree species viz. Banyan, bamboo, jamun, karanj, gulmohar, mango, champa etc. were planted in 5 rounds at SIES Nerul campus as well as other places at Panvel and Kharghar.

The plantation drive was initiated on 10th June 2017 at SIES, Nerul Campus. In that, Dr. Subhajit Mukherjee, Mission Green Mumbai participated and encouraged participants to not only plant trees but adopt one. The second round of plantation drive was conducted on 14th July 2017 at SIES Nerul campus in which management council member, head of SIES institutions, faculties and staff of different departments have participated. The third round of plantation was conducted on 15th July 2017 at Shantivan Ashram, Panvel with active participation of Principal, faculties, NSS coordinators and students of SIES Graduate School of Technology, Nerul.

On 23rd July 2017 the fourth round of plantation drive was conducted at SEAL Ashram, Panvel. In that students of Post Graduate Diploma in Environmental

Pollution Control Technology of our institute have actively participated. The fifth and final round of plantation was on 2nd August 2017 at Kharghar Hills with active participation of Principal, NSS coordinators and 200 NSS students' volunteers of SIES Arts Science and Commerce College, Nerul. Local tribal residents of Kharghar Hills were actively involved in the plantation. The Forest officials and local Corporation representatives have also supported the event.

Disclaimer:

Editors have taken utmost care to provide quality in this compilation. However, they are not responsible for the representation of facts, adaptation of material, and the personal views of the authors with respect to their compilation.

BIOMASS WASTE TO ENERGY CONVERSION

Raji Subramaniam
Associate Professor
Sivajirao S Jondhle College of Engineering and Technology Asangaon(East)
email: civilssjcet@gmail.com

Biomass is the material derived from plants that use sunlight to grow which include plant and animal material such as wood from forests, material left over from agricultural and forestry processes, and organic industrial, human and animal wastes. Biomass comes from a variety of sources such as forest residues, agricultural residues such as straw, cane trash and green agricultural wastes, Municipal Solid Wastes etc. Biomass waste-to-energy conversion reduces green house gas emissions in two ways. Heat and electrical energy are generated which reduce the dependence on power plants based on fossil fuels. The greenhouse gas emissions are significantly reduced by preventing methane emissions from landfills. Moreover, biomass energy plants are highly efficient in harnessing the untapped sources of energy from biomass resources. Plant materials use the sun' s energy to convert atmospheric carbon-di-oxide to sugars during photosynthesis. In combustion of the biomass, energy is released as the sugars are converted back to carbon-di-oxide. Thus energy is harnessed and released in a short time frame, making biomass a renewable energy source. Though fossil fuels have also been derived from atmospheric carbon-di-oxide, the time frame is very long - in the order of millions of years as compared to a few years in case of biomass. Currently, biomass contributes 14% of the total energy supply worldwide and 38% of this energy is consumed in developing countries, predominantly in the rural and traditional sectors of the economy [IREDA].

Biomass Potential of India

India is a tropical country blessed with sunshine and rains and thus offers an ideal environment for biomass production. Further, the vast agricultural potential also makes available huge agro-residues to meet the energy needs. With an estimated production of about 60 million tonnes of agricultural waste every year, biomass is capable of supplementing the coal to the tune of about 260 million tonnes. This can result in a saving of about Rs.250 billion, every year[IREDA]. The estimated potential of biomass based renewable energy are 16000MW and with bagasse co-generation 3500 MW [IREDA] .

Technologies involved in Biomass Energy Production

Biomass is a complex class of feed stocks with significant energy potential to apply different technologies for energy recovery. Typically technologies for biomass energy are broadly classified on the basis of principles of thermo chemistry as combustion, gasification, pyrolysis and biochemistry as anaerobic digestion, fermentation and trans-esterification. Each technology has its uniqueness to produce a major calorific end product and a mixture of by-products.

The most common technique for producing both heat and electrical energy from biomass wastes is direct combustion. Thermal efficiencies as high as 80 – 90% can be achieved by advanced gasification technology with greatly reduced atmospheric emissions. Combined heat and power CHP systems, ranging from small-scale technology to large grid-

connected facilities, provide significantly higher efficiencies than systems that only generate electricity. Biochemical processes, like anaerobic digestion and sanitary landfills, can also produce clean energy in the form of biogas and producer gas which can be converted to power and heat using a gas engine[3]. Various technologies of energy generation from biomass are as follows[3].

Combustion

In this process, biomass is directly burned in presence of excess air oxygen at high temperatures (about 800^{O}C), liberating heat energy, inert gases, and ash. Combustion results in transfer of 65– 80% of heat content of the organic matter to hot air, steam and hot water. The steam generated, in turn, can be used in steam turbines to generate power.

Transesterification

The traditional method to produce biodiesel from biomass is through a chemical reaction called transesterification. Under this method, oil is extracted from the biomass and it is processed using the transesterification reaction to give biodiesel as the end-product.

Alcoholic Fermentation

The process of conversion of biomass to biofuels involves three basic steps:

1.Converting biomass to sugar or other fermentation feedstock

2. Fermenting these biomass-derived feedstocks using microorganisms for fermentation.

3.Processing the fermentation product to produce fuel-grade ethanol and other fuels.

Anaerobic Digestion

In the absence of air, organic matter such as animal manures, organic wastes and green energy crops (e.g. grass) can be converted by bacteria-induced fermentation into biogas (a 40%-75% methane-rich gas with CO_2 and a small amount of hydrogen sulphide and ammonia). The biogas can be used either for cooking/heating applications, or for generating motive power or electricity through dual-fuel or gas engines, low-pressure gas turbines, or steam turbines.

Pyrolysis

Pyrolysis is a process of chemical decomposition of organic matter brought about by heat. In this process, the organic material is heated in absence of air until the molecules thermally break down to become a gas comprising smaller molecules (known collectively as syngas). The two main methods of pyrolysis are “fast” pyrolysis and “slow” pyrolysis. Fast pyrolysis yields 60% bio-oil, 20% biochar, and 20% syngas, and can be done in seconds. Slow pyrolysis can be optimized to produce substantially more char (~50%) along with organic gases, but takes of the order of hours to complete.

Gasification

In this process, biomass reacts with air under extreme temperatures and results in production of producer gas, to produce power (or) react with pure oxygen to produce synthesis gas for fuel production. The combustible gas, known as producer gas, has a calorific value of 4.5 - 5.0 MJ/cubic meter. A wide range of biomass in the form of wood or agro residue can be used for gasification.

Biomass Densification through Briquetting

One of the major limitations of biomass for energy purposes is its low bulk density, typically ranging from 80–100 kg/m3 for agricultural straws and grasses and 150- 200 kg/m3 for woody biomass, like wood chips [3]. The low bulk densities of biomass often make the material costly to store, transport, and use. Low bulk density also presents challenges for technologies such as coal cofiring, because the bulk density difference causes difficulties in feeding the fuel into the boiler and reduces burning efficiencies. Further, high moisture content in the biomass makes transportation and storage inefficient. Densification is used to overcome these limitations. During densification, biomass is mechanically compressed, increasing its density about ten fold. Commercially, briquetting is a commonly used methods for densification. Another common method is pelleting. There are different densification technologies, including pellet mills, screw press, piston press, and roller press[4].

In the biomass briquetting process, the material is compressed under high pressure and temperature. The biomass particles self-bond to form a briquette due to thermoplastic flow. Lignin(it is one of the main constituents of biomass;the other important constituents are cellulose and hemicellulose), which is a natural binder is made available from high temperatures and pressures resulting in the formation of high-density briquettes. The dense briquette is a clean fuel that can be used in boilers(to generate steam for power generation), furnace(to heat a feed) or open fires.

Biomass can play the pivotal role in production of carbon-neutral fuels of high quality as well as providing feedstocks for various industries. This is a unique property of biomass compared to other renewable energies and which makes biomass a prime alternative to the use of fossil fuels. Performance of biomass-based systems for heat and power generation has been already proved in many situations on commercial as well as domestic scales.

Biomass fuel sources are readily available in rural and urban areas of all countries. Biomass-based industries can provide appreciable employment opportunities and promote biomass re-growth through sustainable land management practices.

References

[1] Tumuluru et al. 2011. A review of biomass densification systems to develop uniform feedstock commodities for bioenergy application. Biofuels, Bioprod. Bioref. 5:683–707, 2011.

[2] Indian Renewable Energy Development Agency, IREDA.

[3] IEA. January 2007. IEA Energy Technology Essentials: Biomass for Power Generation and CHP.

[4] Grove, P.D. and Mishra, S.K. 1996. Biomass Briquetting: Technology and Practices, Food and Agricultural Organization of the United Nations, Bangkok, April 1996.

SIES IIEM DEDICATED TO ENVIRONMENT MANAGEMENT THROUGH R & D AND OUTREACH ACTIVITIES

ABOUT SIES IIEM

- SIES IIEM was established in 1999. It has been contributing in the fields of R&D activities and Academics in the areas of Environment Management and Biotechnology.
- IIEM is recognized by Department of Scientific and Industrial Research for research activities and has successfully completed various research projects with funding from DST, BRNS, DBT, ICMR, MOEFCC, MMREIS and several other agencies.
- IIEM also conducts consultancy services, organizing seminars, workshop and providing community service through research and creating awareness.




INFRASTRUCTURE AND FACILITIES

State of Art Facilities to conduct R & D and consultancy in the areas of Environmental Science and Management. Laboratories are equipped with the advanced equipments (HPLC, AAS, GC, HVS etc.)

CONSULTANCY SERVICES

GREEN MANAGEMENT

Environmental Monitoring and Analysis

- Water, Soil, Air, Waste
- Eco-toxicity studies

Conservation of Resources and Biodiversity

- Eco restoration of Resources
- Biodiversity mapping and indexing

Waste Management

- Wastewater management for zero discharge
- Solid waste management
- Industrial sludge management
- E- waste management

Expertise in:

- Advanced oxidation processes
- Aerobic and anaerobic processes
- Bio- and phyto- remediation

EIA and Sustainability Solutions for Mitigation of Climate Change Vulnerability

GIS based Environmental Planning and Management

- Natural resource mapping
- Groundwater recharge study
- Site selection
- Database management

GREEN COMMUNICATION

Providing CSR Solutions for Environment and Society

- Environmental Education
- Training and Awareness programme
- Water audit and energy audit
- Carbon footprint mapping
- Capacity building
- R&D proposals and report writing
- Events – workshops, seminars and conferences

Areas of Research	Specific Areas
1. Total Water Management	1. Purification of drinking water by using low cost techniques. 2. Management of nitrite contaminated wastewater 3. Textile wastewater management. 4. Phytoremediation. 5. Oil spill management by biosurfactants. 6. Management of brine generated from water purification technologies. 7. Assessment and management of marine pollution
2. Solid Waste Management	1. Management of industrial waste. 2. Management of MSW and other solid wastes. 3. Management of agro- residue.
3. Applied Biotechnology	1. Utilization of biofertilizers and biopesticides in soil fertility management and agriculture. 2. Exploitation of beneficial microorganisms in remediation of heavy metals, oil pollution etc.
3. Management of Natural Resources	1. Pollution monitoring and management 2. Ecorestoration. 3. Studies on Climate Change. 4. Biodiversity Studies. 5. GIS & Remote Sensing

MAJOR FUNDING AGENCIES

- Ministry of Environment Forest and Climate Change
- Department of Science and Technology
- Department of Biotechnology
- Board of Research in Nuclear Sciences
- Indian Council of Medical Research
- Mumbai- Metropolitan Region- Environment Improvement Society

OUTREACH ACTIVITIES

Plastic on Road to Plastic in Road

Amol Mahajan
Tata Steel Ltd., Tarapur, Boisar (P.O.)
amol.mahajan@tatasteel.com

Plastic waste is a major environmental and public health problem at Jamshedpur. Plastic shopping or carrier bags are one of the main sources of plastic waste. Plastic bags of all sizes and colors dot the city‘s landscape due to the problems of misuse, overuse and littering. Besides this visual pollution, plastic bag wastes contribute to blockage of drains and gutters, are a threat to aquatic life when they find their way to water bodies, and can cause livestock deaths when the livestock consume them. Furthermore, when filled with rainwater, plastic bags become breeding grounds for mosquitoes, which cause malaria. Burning of chlorine-containing PVC releases toxic HCl vapours and emits noxious gasses like dioxins and furans which are the most toxic and poisonous substances on earth and can cause a variety of health problems including damage to the reproductive and immune system, respiratory difficulties and cancer. Land filling of plastics into properly designed disposal sites takes up valuable room in the site for a non-toxic, non-leachable, non-decomposable material. Whether plastic is a menace or not depends on how we use it and how we dispose of it minimizing the impacts on the environment. We are collecting the threat(waste plastics) from the source, segregating the waste and shredding the same into 2-4 mm size and mixing the shredded plastic to make a coating over the aggregates used for road construction providing the road a tremendous strength at no extra cost. Plastic gets coated over stone and the hot plastic coated stone is mixed with bitumen (tar) and the mix is used for road laying.

INTRODUCTION

Preparation of the mix- The aggregate mix, used for flexible road construction is first coated with molten plastics waste and this plastic coated aggregate is used as raw material. (The plastic used was disposed carry bags, films, cups, and etc. with a maximum thickness of 60 microns). To the hot plastics coated aggregate (165^0C), bitumen (160^0 C) is added and mixed and used for road construction. *The Bitumen Was Not Blended With Plastics Waste.*

Properties Of the plastics waste coated aggregate-bitumen mix:

1. Even after 96 hours, there is no stripping of bitumen layer showing the resistance towards stripping and pothole formation.
2. Marshall Stability Value increases depending upon the percentage of plastics used for coating from 1265kg to abut 2500 kg thus increasing the strength of the road. The field trials are still in progress.
3. Extraction of bitumen from the above mix is very slow compared to non-plastic-Bitumen mix showing the increased strength of binding of bitumen
4. Plastics coated aggregate has low percentage of voids, hence less oxidations of bitumen and less raveling and rutting.
5. Plastic coated aggregate – bitumen mix have very low moisture absorption and hence no stripping or pothole formation

6. The percentage of bitumen needed to form an effective mix can be reduced from 5% to 4.5% thus a saving of bitumen, not less than 10% is also possible.
7. Plastics coated aggregate, when soaked in water for 72 hours, there is no stripping. The aggregate gains non-wetting property with respect to water.
8. Plastic coated aggregate, when mixed with hot bitumen, mix well and the blend can be used for road construction. Coated plastics waste helps to increase both blending property and binding property.

METHODOLOGY & PROCESS

The roads can be constructed with plastic wastes (8%) in conjunction with bitumen (92%). This process has two way benefits – Reusability of hazardous plastic, which could have otherwise clogged drains causing flooding, choked animals that eat them. Burying plastic forever into roads is the safest. Polymer-Modified Bitumen is in use since long. It is approved in the Indian Roads Congress' Special Publication 53 guidelines, 1999. Reduced penetration and ductility, a higher softening point, less rutting and cold cracking. Marshall Stability value is initially 25% better, later 200-300% better than unmodified roads. Test samples show 260% improved resistance to water-soaking, hence ideal for sub-grade. 100% improvement in fatigue life of roads. Greatly reduced road cracking after 1 year on Bangalore-Mysore Rd vs. unmodified road.

- *Step I:* Plastic waste made out of PE, PP and PS cut into a size between 2.36mm and 4.75mm using shredding machine.
- *Step II:* Similarly the bitumen is to be heated to a maximum of 170^0C to have good binding and to prevent weak bonding. (Monitoring the temperature is very important)
- *Step III:* At the mixing chamber, the shredded plastic waste is to be added to the hot aggregate. It gets coated uniformly over the aggregate within 30 Sec, giving an oily look Plastic coated aggregate is obtained.
- *Step IV:* Hot bitumen is then added over the plastic coated aggregate and the resulting mix is used for road construction. The road laying temperature is between 110^0C to 120^0C. The roller used is 8-ton capacity.

Characteristics of the process:

- Easy process without any new machinery
- Simple process without any industry involvement
- In situ process
- Use of lesser percentage of bitumen and thus savings on bitumen resource
- Use of plastics waste for a safe and eco-friendly process
- Both Mini Hot Mix Plant and Central Mixing Plant can be used
- Only aggregate is polymer coated and bitumen is not modified
- Use 60/70 and 80/90 bitumen is possible
- No evolution of any toxic gases like dioxin
- Fly ash can also be used to give a better performance

Easy Disposal of waste plastics

- Plastics waste like carry bags, disposal cups, thermo Coles and polyethylene and polypropylene foams can be used.(1ton ~10 lakhs carry bags)
- There is no need of segregation.
- No need for much cleaning
- Multilayer films can also be used.
- No special machinery is required.
- The machinery available for road construction can be used without any extra modification.
- No external industry is involved.
- No granulation or blending is needed.
- Land filling and incineration process can be avoided.
- Burning of plastics can be avoided
- Nearly 7500 tons of Co_2 emission due to burning was saved so for
- Carbon Credit have been achieved

High Quality of Plastics Tar Road:

- Strength of the road increased by 100% (Increased Marshall Stability Value)
- Better resistance towards rain water and water stagnation
- No stripping and have no potholes.
- Increased binding and better bonding of the mix.
- Increased load withstanding property(Withstanding increased load transport)
- Consumption of bitumen decreases by not less than 10%
- Reduction in pores in aggregate and hence less rutting and raveling.
- Better soundness property.
- Maintenance cost of the road is almost nil.
- The Road life period is doubled
- No leaching of plastics.
- No effect of radiation like UV.

Figure 1: Plastic Menace in the Swarnrekha river side, Jamshedpur

Figure 2: Plastic Tar road, CH area road no.1, Jamshedpur

Environmental benefit

1. The waste plastic is used only for the lamination of stone aggregate. There is no evolution of any gas during the process. There is no air or land pollution.
2. There is no evolution of CO2 (only melting of plastics)
3. If 1Km of single lane plastic tar road laid, 1 tone of plastics is used and this helps to avoid the evolution of 3 tons of CO2, which may otherwise result due to burning of plastics.

Nearly 8 km road has been laid till toady and this has prevented the evolution of 24 tons of CO2.

4. This road withstands heavy rain and water stagnation.
5. No pot holes have formed till date.

Total Investment

There is no additional investment. Actually there is a reduction in the cost and saving of bitumen. There is no maintenance expenditure for five years.

Returns

1. Clean environment, free from plastic waste.
2. Better road without any deformation due to rain or traffic load)
3. Saving natural resource.
4. Use of plastic waste effectively.
5. Eco-friendly way for the use of waste plastics.

CONCLUSION

The process of using low end waste plastic to construct roads has been included in Plastic Waste Management & Handling rule amended on 4th Feb'2011'. It indicates that it has been a proven technology to take care of Mother Earth this way. We are mixing shredded waste plastic for laying all the present and future roads of Jamshedpur.

World Environment Day celebrated at SIES-IIEM

SIES Indian Institute of Environment Management (SIES-IIEM) and SIES Central Training Department jointly organised a seminar on 10th June, 2017 on theme "Connect With Nature".

The seminar was inaugurated with a plantation drive of fruit bearing plants in the campus by chief guest and members of institute. NSS Coordinators, students and faculty members from different institutions attended the half day seminar.

Dr. Seema Mishra, Director, SIES IIEM gave the welcome address and mentioned it is responsibility of every citizen to take care of Mother Nature and the seminar aims to sensitize students, faculty and staff on eco- friendly lifestyle and to reconnect them with nature. She has also informed about the academic programmes, viz., PG Diploma in Sustainable Environment Management and M.Sc. in Sustainable Development and Environment Management conducted by institute for working professionals and regular students,

Shri. S. V. Viswanathan Jt. Hon. Secretary, SIES briefed about the history of environment day and also said it should be celebrated every day. He cited all the things which can be done at individual level by every citizen independently from plantation to kitchen gardening to taking care of nature and enjoying the gift of nature in best possible way. On the auspicious occasion, SIES IIEM also released the book entitled, "Current Perspectives in Sustainable Environment Management" compendium of research articles and quarterly e–newsletter 'The Environment Management' Vol –III Issue – II.

Dr. Subhajit Mukherjee from Mission Green Mumbai, mentioned plantation is important and must be done by every individual. With his passion towards eco-friendly living, he initiated with Mission Green having a slogan of "Each One Teach One to Plant One". With this idea he has been successful in planting trees in Western Suburbs of Mumbai and taking the initiative to other cities.

Ms. Pournima Shirgaonkar from Enviro Vigil, an NGO working with green consultancy, oriented towards how to manage different types of dry and wet waste and demonstrated compositing at household level. She also shared her experience on kitchen gardening.

Mr. Satej Dhimar from Mumbai Waste Management Ltd. enlightened on management of hazardous waste and shared the initiative taken by the organization to educate all classes of people in the society towards clean and green living.

The seminar concluded with gratitude Start Today Save Tomorrow……..

Environment in News Headlines

1. Olive mill wastewater transformed: From pollutant to bio-fertilizer, biofuel

Olive oil has long been a popular kitchen staple. Yet producing the oil creates a vast stream of wastewater that can foul waterways, reduce soil fertility and trigger extensive damage to nearby ecosystems. Now in a study appearing in ACS Sustainable Chemistry Engineering, scientists report on the development of an environmentally friendly process that could transform this pollutant into green biofuel, bio-fertilizer and safe water for use in agricultural irrigation.

Source: ACS Sustainable ChemistryEngineering, 2017

DOI: 10.1021/acssuschemeng.7b0176

2. We must accelerate transitions for sustainability and climate change, experts say

We must move faster towards a low-carbon world if we are to limit global warming to 2 degrees C this century, experts have warned.

Source: Science News, September 21, 2017

3. April 17 was second-warmest April on record

April 2017 was the second-warmest April in 137 years of modern record-keeping, according to a monthly analysis of global temperatures by scientists at NASA's Goddard Institute for Space Studies GISS in New York.

Source: NASAs Goddard Institute for Space Studies

4. BMC may stop collecting garbage from 23,161 Mumbai societies that don't segregate waste

Source: Source: Hindustan Times, Date: Jun 17, 2017

5. Water evaporation could be a promising source of renewable energy

If we were to harvest evaporation energy from the existing lakes and reservoirs in the US-excluding the Great Lakes in the Midwest-we could generate 325 gigawatts per year. That is about 70% of the total US electrical energy generation in 2015.

Source: Nature communications, September 26, 2017

Upcoming Events

Student Fest on 'Sustainability' on November 24, 2017

Details on page 7

Articles, photos etc. are invited for next issue (October to December 2017) of 'The Environment Management' on the theme 'Corporate Social Responsibility & Environment Management for addressing Sustainability issues '

Published by-

SIES - Indian Institute of Environment Management,
Sri. Chandrasekarendra Saraswathi Vidyapuram
Plot 1 E, Sector V, Nerul(E), Navi Mumbai 400 706
Tel.: 022 6119 6454 / 55/ 56 ; FAX: 022 27708360
E- mail:iiemoffice@sies.edu.in; Website:http://siesiiem.edu.in