ISSN: 0975-766X
CODEN: IJPTFI
Available Online through
Research Article
www.ijptonline.com

REVIEWING THE EFFECTS AND REMEDIES FOR INDUSTRIAL WASTE

Ms. Richa Yadav[1] and Dr. Kapila Kumar[1]*
*Department of Biotechnology, Faculty of Engineering & Technology,
Manav Rachna International Institute of Research & Studies, Sector-43,
Delhi-Surajkund Road, Faridabad-121004, Haryana.
Email: kapila.fet@mriu.edu.in

Received on: 09-11-2018 *Accepted on: 14-12-2018*

Abstract

Industrial pollution is the major concern associated with rapid industrialization and urbanization. Developing countries demand rapid industrialization in uplifting nation’s economy. However, industrialization on the other hand has also caused serious health problems and environmental concerns. Therefore, wastes seem to be a derivative of growth and developing countries can ill afford to lose that as sheer waste. In this review, we have discussed about the wastes generated from leather, petrochemical and distillery industries. The type of waste generated, its effects, treatment methodologies and current approaches for its management are mentioned in detail.

Keeping in mind, the difficulties being faced in the management of industrial wastes, this article can help in designing advanced strategies to treat industrial effluent.

Keywords: Industrial waste, leather industry, petrochemical industry, distillery industry.

Introduction

During the past few decades Indian industries have significantly emerged and developed, which has contributed to high economic growth but simultaneously it has also given rise to severe environmental and health problems. The petrochemical and distillery industries are significant contributors of industrial waste water. The water quality is getting affected at a large scale and it is far lower in comparison to the international standards of water quality (1). It has been found that one-third of the total water pollution comes in the form of effluent discharge, solid wastes and other hazardous wastes.

In India, a huge amount of wastewater generated from different industries is discharged on land or into running water. Distillery wastes are characterized by low pH, high COD and BOD values and contain high percentage of organic and inorganic materials. This wastewater also contains considerable amounts of elements like N, P, K, Ca and S.

The leather tanning effluents are characterized by high values of BOD, COD and acidic pH (2). It contains emulsified fat that tends to form foam. However, petrochemical wastewater is characterized by significant concentrations of suspended solids, chemical oxygen demand (COD), oil and grease, sulphide, ammonia, phenols, hydrocarbons, benzene, toluene, ethylbenzene, xylene and polycyclic aromatic hydrocarbons (PAHs). The industrial discharge carries various types of contaminants to the river, lake and groundwater. The quality of freshwater is very important as it is highly consumed by human for drinking, bathing, irrigation etc. The presence of contaminants from industrial contaminant within the water may reduce the yield of crops and the growth of plant and it will poses significant harm to aquatic living organism. Some contaminants accumulate, interact and settle with the living organism, plant and sediments and finally reach the coastal waters and oceans. Plants and living organism in the ocean are important food sources for human intake. Contaminants may then enter human food chain and accumulate in fishes, molluscs (octopus, shellfish, and cockle), crustaceans (shrimp, crab, and lobster), seaweed etc (3). Due to the uncontrolled and unplanned disposal of industrial waste onto the soil surface the land contaminant will infiltrate to the groundwater. The contamination on the soil surface may interrupt human daily activity and bring adverse effect to the growth of plant as well as human health.

The impact to human health is the utmost important criteria to look into apart from the effect to surface water and groundwater on the living organism.

Therefore, it becomes an urgent need of hour to understand the issues, challenges and probable solutions to the waste generated from distillery and petrochemical industries. This review can further help to design strategies for the herculean task of waste management.

Petrochemical Industry

The products produced by petrochemical industry

Petrochemicals are chemical products derived from petroleum. Some chemical compounds made from petroleum are also obtained from other fossil fuels, such as coal or natural gas, or renewable sources such as corn or sugar cane.

The two most common petrochemical classes are olefins (including ethylene and propylene) and aromatics (including benzene, toluene and xylene isomers). Oil refineries produce olefins and aromatics by fluid catalytic cracking of petroleum fractions. Chemical plants produce olefins by steam cracking of natural gas liquids like ethane and propane. Aromatics are produced by catalytic reforming of naphtha (4). Olefins and aromatics are the building-blocks for a wide range of materials such as solvents, detergents, and adhesives. Olefins are the basis for polymers and oligomers used in plastics, resins, fibers, elastomers, lubricants, and gels.

Primary petrochemicals are divided into three groups depending on their chemical structure:

- Olefins include ethylene, propylene, and butadiene. Ethylene and propylene are important sources of industrial chemicals and plastics products. Butadiene is used in making synthetic rubber.
- Aromatics include benzene, toluene, and xylenes. Benzene is a raw material for dyes and synthetic detergents, and benzene and toluene for isocyanates MDI and TDI used in making polyurethanes. Manufacturers use xylenes to produce plastics and synthetic fibers.
- Synthesis gas is a mixture of carbon monoxide and hydrogen used to make ammonia and methanol. Ammonia is used to make the fertilizer urea and methanol is used as a solvent and chemical intermediate.

Scenario of petrochemical production in India

There was an increase by 7.15% in production of total petroleum products, including fractioners, during 2012-13 compared to the year 2011-12. At the same time, the indigenous consumption of petroleum products increased by 4.92 % during 2012-13 compared to the previous year. During the year 2012-13, consumption of petroleum products was 156.528 MMT against total production of 217.736 MMT. Consumption of Petroleum Coke increased by 62.1%, MS by 5%, Naphtha by 10.0% and HSD by 6.8% during 2012-13, where as the consumption of Kerosene declined by 8.8%, ATF by 4.80%, LDO by 3.8%, FO by 16.3% and LSHS/RFO by 22.3% (5). Year-wise production and consumption of petroleum products during 2005-06 to 2012-13 are depicted in the figure-1 below.

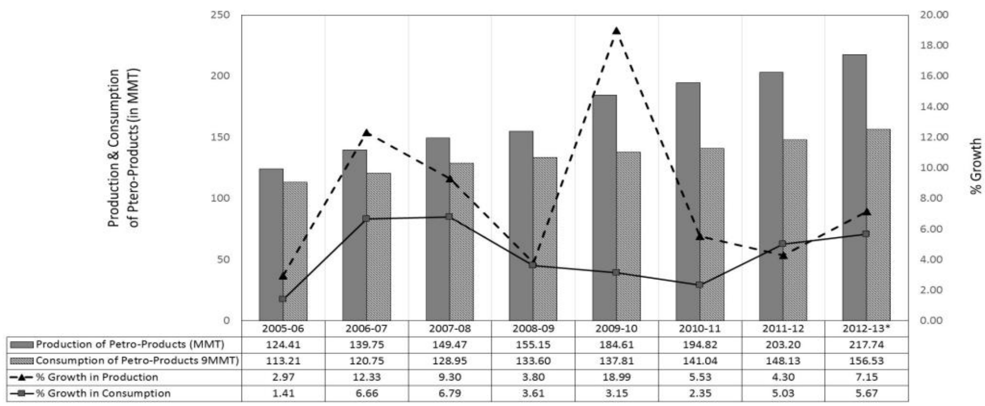

Figure 1: Production and Consumption (indigenous sales) of Petroleum Products.

Processes for petrochemical production

Petrochemicals are chemical products made from the hydrocarbons present in raw natural gas and petroleum crude oil. The largest petrochemical manufacturing industries are to be found in the United States, Western Europe, Asia and the Middle East.

A relatively small number of hydrocarbon feedstocks form the basis of the petrochemical industries, namely methane, ethylene, propylene, butanes, butadiene, benzene, toluene and xylenes. As of 2007, there were 2,980 operating petrochemical plants in 4,320 locations worldwide. The petrochemical end products from those plants include plastics, soaps, detergents, solvents, paints, drugs, fertilizer, pesticides, explosives, synthetic textile fibers and rubbers, flooring and insulating materials and much more. Petrochemicals are found in such common consumer products as aspirin, cars, clothing, compact discs, video tapes, electronic equipment, furniture, and a great many others flooring and insulating materials and much more (6).

Petrochemical industry feedstock sources

- **Methane, ethane, propane and butanes:** Obtained primarily from natural gas processing plants.
- **Naphtha:** Obtained from petroleum refineries.

- **Benzene, toluene and xylenes, as a whole referred to as "BTX":** Primarily obtained from petroleum refineries by extraction from the catalytic reformers (7).
- **Gas oil:** Obtained from petroleum refineries.

Methane and BTX are used directly as feedstocks for producing petrochemicals. However, the ethane, propane, butanes, naphtha and gas oil serve as optional feedstocks for steam-assisted thermal cracking plants referred to as "steam crackers" that produce these intermediate petrochemical feedstocks. Figure-2 below is depicting the major sources of hydrocarbon used in process of making petrochemicals

- Ethylene
- Propylene
- Butenes and butadiene
- Benzene

In 2007, the amounts of ethylene and propylene produced in steam crackers were about 115 Mt (megatonnes) and 70 Mt, respectively. The output ethylene capacity of large steam crackers ranged upto as much as 1.0–1.5Mt per year. The effect of feedstock selection upon the yields of steam cracking products is summarized in the table-1 below.

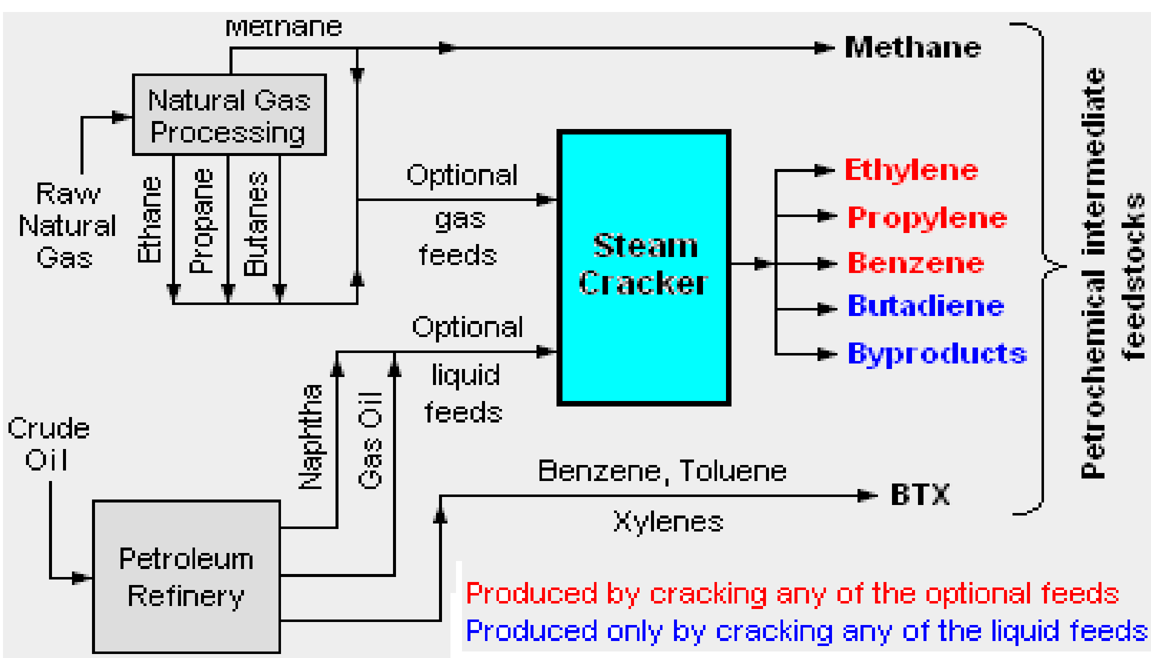

Fig 2: Schematic diagram depicting the major hydrocarbon sources used in producing petrochemicals.

Table 1: Depicts the yield of intermediate petrochemical products.

Steam cracking feedstocks versus yields of intermediate petrochemical products					
	Product Yields				
Feedstock source	Ethylene weight %	Propylene weight %	Butadiene weight %	Aromatics [a] weight%	Other [b] weight %
Ethane	84.0	1.4	1.4	0.4	12.8
Propane	45.0	14.0	2.0	3.5	35.5
Butane	44.0	17.3	3.0	3.4	32.3
Naphtha [c]	34.4	14.4	4.9	14.0	32.3
Gas oil [d]	25.5	13.5	4.9	12.8	43.3

(a) Includes benzene, toluene, xylenes and any other aromatics.

(b) Includes hydrogen, methane, butenes, non-aromatic portion of pyrolysis gasoline and fuel oil.

(c) Full-range naphtha (as differentiated from light or heavy naphtha).

(d) The portion of petroleum crude oil that has a boiling range of about 250 to 550 °C.
That encompasses the boiling range of atmospheric gas oil (AGO) produced by the atmospheric distillation of petroleum crude oil and the boiling range of vacuum gas oil (VGO) produced by the vacuum distillation of petroleum crude oil.

As of 2004, the percentage of the worldwide steam cracking plants using each of the optional steam cracking feed sources was,

- Ethane: 35%
- Propane: 9%
- Butanes: 3%
- Naphtha: 45%
- Gas oil: 5%
- Other: 3%

Production pattern

Olefins (ethylene, propylene & butadiene) are made by cracking of natural gas, C2/C3 fraction of natural gas and naphtha. Currently, 59% of the country's ethylene capacity is based on gas and 40% on naphtha. Natural gas results in higher yields of ethylene compared to other olefins. On the other hand, naphtha gives a wider range of output products (including propylene, butadiene derivatives). Use of alcohol from molasses as feedstock for ethylene manufacture is rapidly declining. Aromatics (Benzene, Toluene & Xylene) are produced by number of processes, predominantly by naphtha reforming, as recovery products from coke oven gas and as refinery by-products (8). Refineries account for 47 %, whereas reformer accounts for 42 % of total Benzene production. There has been a rapid increase in p-xylene production capacity for production of purified terephthalic acid (PTA) due to enhancement in production capacities of synthetic fibers.

Waste generated by petrochemical industry

Wastewater, which is a basic source of emissions, can be categorized in five ways:

(1) Wastes containing a principal raw material or product;

(2) By-products produced during reactions;

(3) Spills, leaks, wash downs, vessel cleanouts, or point overflows;

(4) Cooling tower and boiler blow down, steam condensate, water treatment wastes and general washing water; and

(5) Surface runoff.

Disposal of solid wastes is a significant problem for the petrochemical industry. Waste solids include water treatment sludges, ashes, fly ash and incinerator residue, plastics, ferrous and nonferrous metals, catalysts, organic chemicals, inorganic chemicals, filter cakes, and viscous solids. Table-2 shows the types of pollutant produced during the manufacturing of petrochemicals.

Table 2: Pollutants into Water and Air Environment from Various Processes in Petrochemical Complex Production.

Units in Petrochemical Industry	Pollutants
Cracker plant	Inorganic sulphides, mercaptans, soluble hydrocarbons, polymerised product, phenolic compounds, sulphide, cyanide, heavy oils, coke, spent caustic, SOx, NOx, hydrocarbons, particulates, water borne waste containing BOD, COD, Suspended solid, oil.
Aromatic plant	Dissolved organics, volatile organic compounds, heavy metals, hydrocarbons, particulates, H2S, SOx, NOx, CO, water borne waste containing BOD, COD, suspended solid, oil & grease, toluene, benzene, xylenes, HCl, chlorine, cadmium.

Treatment of waste water from petrochemical industry

Composition of waste streams is a very important aspect in the management of wastes. Composition determines to a large extent the handling, treatment and disposal options. Characterization of waste streams poses challenges because the contaminants of concern may be present only in trace levels.

The hazardous substances found in the petrochemical waste are:

- Trace metals
- Trace Organics (including halogenated)

It is also to be noted that in addition to presence of toxic contaminants, the waste also needs to be analyzed for toxic characteristics. The toxic characteristics include:

- Reactivity
- Corrosivity
- Reactivity
- Toxicity

Toxicity test is of special concern in petrochemical waste streams. This basically comprises Leachate Procedure tests and the one most widely used has been Toxicity Characteristic Leachate Procedure (TCLP) as defined by USEPA. It is recommended that petrochemical industries carry out systematic analysis of waste generated (9). It is suggested that petrochemical industries develop competence either in-house or in reputed certified laboratories for the purpose of waste characterization. Standard methods specified in SW 846 (USEPA) or ASTM may be used for this purpose. Standards for liquid effluents generated in petrochemical production are given in the table-3 below.

Table 3: Petrochemicals: Standards for Liquid Effluent.

Parameter	Concentration not to exceed limits in mg/l (except pH)
pH	6.5-8.5
BOD (3 days at 27oC)	50
Phenol**	5
COD	250
Total suspended solids	100

Waste storage

Wastes awaiting disposal must be stored in an environmentally acceptable manner, and shall not lead to secondary environmental problems such as odor or pollution of groundwater due to rainwater percolation through or run-off from the site. Storage should best be in closed vessels, containers or bags, on a site surrounded by a bund wall or toe wall, with drainage to a prepared system. Special precautions are of course required for pyrophoric materials to eliminate the risk of fires; they must be kept wet, sealed or blanketed with inert gas.

Recycle and reuse

In the last decades, the quantity of waste from the industry which is recycled and reused has grown in many countries and continues to do so. The methods applied vary with the type of waste, *e.g.,* for sludge, recovery of oil during treatment. The aim of recycle and reuse methods is to reuse the waste for its original purpose or to find an alternative use for it to avoid its final disposal. Therefore, waste production is reduced while natural resources are conserved and/or protected. Most of the reuse practices reported in the environmental statements are for off-site recovery from waste stream (10). Industries opting for this route are required to take due care to avoid secondary pollution from recyclers facility. The material is to be sold to only authorize agencies with necessary approvals.

Waste pre-treatment- sludge reduction processes

Treatment methods are used for two main purposes:

- To reduce the quantity of waste requiring disposal
- To recover the oil for recycling

A large proportion of petrochemical wastewater sludge is being treated for one or both of the above reasons. The choice of whether to treat and if so which treatment to use depends on many factors including the composition of the sludge and the choice of disposal route. Centrifugation exploits the difference in density between solids and liquids (or two liquid phases) to separate them by applying centrifugal force. Two main types of decanter centrifuge can be applied at petrochemical wastewater facilities: 2-phase, which yields a solids cake plus a single effluent stream (mixed oil and water); and 3-phase which, as the name suggests, yields separate oil and water streams, as well as the cake. The applications in ETP have been use of decanter centrifuges. Advantages of decanter centrifuges include resource recovery, flexibility and high volume reduction. With good operation, cake suspended solid contents of up to 20% can be achieved. Dewatering/deoiling is used to decrease the quantity of sludge for disposal and to recover oil from them.

Recent facts about petrochemical industry

The petrochemical industry in India has been one of the fastest growing industries in the country. Since the beginning, the industry has shown an enviable rate of growth. Indian petrochemical industry grew at a rate of ~11% in 2010-11. The outlook for 2011-12 is also stable and the chemicals market is expected to grow at 11-13% p.a. over the next five years. This is being led by strong growth in polymers, fiber intermediates, synthetic fiber and elastomers. Per capita plastic consumption in India is still hovering at 7.0 kg as compared to 46 kg in China and 65 Kg in Europe. This signifies huge potential for future growth going by current global average per capital consumption. Ethylene capacity reached 3.1 MMT in 2011 and is expected to reach 6.5 MMT by 2016.Propylene capacity reached 3.9 MMT in 2011 and is expected to be 5.3 MMT by 2016. India is at a thresh hold of growth in consumption of petrochemicals due to increased domestic demand, booming middle class, still nascent retail sector, and focus on infrastructure. The demand for Automobiles, Packaging, White good, Medicare, Agriculture and Building and Construction is likely to remain strong. Combining all the petrochemical sectors, demand in India is expected to remain robust in coming years. This industry also has immense importance in the growth of economy of the country and the growth and development of manufacturing industry as well. It provides the foundation for manufacturing industries like construction, packaging, pharmaceuticals, agriculture, textiles etc. The industry and government will have to work in tandem to achieve the ambitious targets set for the chemical industry.

Distillery Industry

Need for the treatment of distillery waste water

Production of alcohol in industries is used sugar cane molasses as a row material. Total production of alcohol from the sugar cane molasses is more than 13 million m3/annum. But there is aqueous dark brown color effluent produce that is 12-15 times more by volume than the actual alcohol product. It is one of the most complex, hazardous and strongest industrial effluent having extremely high COD and BOD values because of the high concentration of the organic load (11). This distillery effluent known as spent wash and it is a potential source of renewable energy. That's why we need to treat appropriately and proper disposal of this waste water.

Production of distillery product

Carbohydrate source:

Production of ethyl alcohol in distilleries based on cane sugar molasses constitutes a major industry in Asia and South America. The world's total production of alcohol from cane molasses is more than13 million m3/annum. In beer brewing the source used is malt which is fermented to produce the alcohol in beer.

Mash tun:

Mashing is the process of combining a mix of milled grain, known as the "grain bill", and water, known as "liquor", and heating this mixture. Mashing allows the enzymes in the malt to break down the starch in the grain into sugars, typically maltose to create malty liquid called wort.

Fermentation tank:

Yeast is added to the tank along with water, the yeast is allowed to ferment the mash-liquor. It is left for a few days until no more fermentation occurs due to spent sugars and the inhibiting conditions of alcohol.

Filter:

Filtering stabilizes the flavor, and gives a polished shine and brilliance. Diatomaceous earth is added as a filter the yeast, hops, grain and any remaining particles (12). Filtration ratings are divided into rough, fine, and sterile. Rough filtration leaves some cloudiness. Fine filtration removes almost all cloudiness. Sterile filtration removes almost all microorganisms. The fermenter sludge is waste which is very rich in organic matter.

Distillation column:

The fermented liquid is now passed into the distillation unit to remove most of the water and concentrate the Ethyl alcohol until it reaches a purity of 65% to 70%, here also the distilled remaining sludge also referred to as "spent lees" is very rich in organic matter and very heavy with a dark color, this mainly occurs where molasses is used as the carbohydrate source.

Ageing, blending and bottling:

The distilled liquor is then stored in barrels which are then allowed to age to absorb the color and flavor of the barrels, then they are blended with spring water or clean local body water to the appropriate alcohol percentage of 40 to 45 and bottled.

Beer:

In the case of beer, distillation is not done. The fermented liquid is filtered, blended to the right alcohol content of 5% to 10%, bottled and then pasteurized. The waste generated is through the spent water for washing (maintenance of the mashing vessels, fermentation vessels, the filtration unit) the organic waste generated from the filtration of the mash after boiling, organic waste from the fermentation tank after fermentation of the mash, the lees after the distillation (13). All these are very rich in organic matter with very high BOD.

Technologies involved in treatment of distillery waste water

Spent wash treatment is proposed mainly by three different processes; (a) Concentration followed by incineration, (b) Anaerobic digestion with biogas recovery followed by aerobic polishing and (c) Direct wet oxidation of stillage by air at high temperature with generation of steam followed by aerobic polishing.

All of these processes are capital intensive. The incineration process is quite expensive as there is not much recovery in terms of capital potassium is the main mineral that is recovered, whereas the other two processes along with the secondary treatment require an investment of 200-300% of the distillery cost. The unfavorable economics make it difficult to implement these treatment processes on the plant scale. Because anaerobic digestion and wet oxidation are less expensive, these alternatives are more attractive. However, there is a need for development of a suitable process with lower investments and higher energy recovery. Many distilleries allow their effluent for application on land as direct irrigation water, spent wash cake and spent wash-press mud compost.

The methane gas generated in the digesters is used as a fuel to compensate the energy needs of the industry (14). A general estimate suggests that the cost of an anaerobic biological digester is recovered within 2-3 years of installation because of substantial saving of coal and other fuels. These processes are discussed in detail in the next question.

Distillery effluent as a source of renewable energy

The wastewaters generated during the distillery and brewery operations contain high organic loads. It has a BOD from 30,000 to 60,000 mg/1. So due to this high organic contents, the wastewaters can be subjected to treatment for the production of biogas, composting, aquaculture and potash recovery.

A. Biogas:

For the production of biogas from distillery effluent, anaerobic biomethanation of the effluent is adopted, generally. High rate anaerobic technologies are utilized for biogas generation. Fluidized Bed Reactors and Up flow Anaerobic Sludge Blanket (UASB) Reactors are mostly utilized for the production of biogas from the effluents. Some of the biogas production processes being commercial1y established in India at present are:-

- Biothane process: This process uses the UASB reactor for the production of biogas. This is a stable and automatic process with low operational costs.
- Biobed process: It is similar to Bio thane process. It uses UFB reactors. It needs less installation area and its construction cost is lower compared to any other system.
- Biopaq process: In this process anaerobic bacteria are used to treat the distillery effluents for the production of biogas. UASB process is utilized here. The separated sludge in this process makes excellent manure. The generated biogas is used to produce steam for the distillation of alcohol and thus it replaces 50-60% of the total required energy in the process of distillation. For a plant having 40-45,000 kg COD/day 75-80% of COD can be reduced and nearly Rs. 25-50 lakhs can be saved annually for a distillery having 300 working days in a year (15). The generated biogas from UASB reactor of BioPaq process can be collected and be used as a fuel in gas/dual engine per day. The biogas production is in the range of 16,550 to 21,870 m3 per day. The savings in the cost of fuel is in the range of Rs. 312 lakhs to Rs. 652 lakhs per year.

B. Composting:

In this process, press mud generated from sugar mill is utilized to produce compost by mixing distillery effluent. Both anaerobic and aerobic composting systems are practiced. In some plants composting with treated effluent treated through bio-methanation plant is also practiced. This system can achieve zero effluent if the press mud quantity matches with the effluent generated.

C. Potash Recovery:

It is done by incinerating the distillery spent wash. In this process, the raw distillery spent wash is, first neutralized with lime and filtered. This is further concentrated to about 60% solids in multiple-effect forcer circulation evaporators. Now this thick liquor from the evaporator is burnt in an incinerator and is converted into ash. The dry solids of the spent wash in the form of coke in the incinerator has an average calorific value of 2 Kcal/kg, which is sufficient for supporting self-combustion of the thick liquor in the incinerator. The resulting ash is found to contain about 37% of potash as potassium oxide on an average. This ash is further leached with water to dissolve the potassium salts. Then it is neutralized with sulphuric acid and is evaporated. The potassium salts are crystallized in a crystal1izer (16). The crystallized mixed potassium salt contains 73.5% of potassium sulphate (K2SO4) 16.5% potassium chloride (KCl) and 5% of sodium salts. It is estimated that a distillery discharging about 300 m3 of spent wash per day could recover 3 tons of Potassium as Potassium oxide or about 5.34 tons of Potassium sulphate and 1.2 tons of Potassium chloride per day. This potassium is used as a fertilizer.

D. Distillery Wastewater Utilization in Agriculture

Being very rich in organic matters, the utilization of distillery effluents in agricultural fields creates organic fertilization in the soil which raises the pH of the soil, increases availability of certain nutrients and capability to retain water and also improves the physical structure of soil. Mostly the distillery wastewaters are used for pre-sowing irrigation. The post-harvest fields are filled with distillery effluents. After 15-20 days, when the surface is almost dried, the fields are tilled and the crops are sown and subsequent irrigation is given with fresh water. However, the effluent is diluted 2-3 times before application on crops. Apparently, the irrigation with distillery wastewater seems to be an attractive agricultural practice which not only augments crop yield but also provides a plausible solution for the land disposal of the effluents. One cubic meter of methanated effluent contains nearly 5 kg of potassium, 300 grams of nitrogen and 20 grams of phosphorus. If one centimeter of post methanation effluent is applied on one hectare of agricultural land annually, it will yield nearly 600 kg of potassium, 360 kg of calcium, 100 kg of sulphates, 28 kg of nitrogen and 2 kg of phosphates. The distillery effluent contains 0.6 to 21.5 percent potash as KO, 0.1 to 1.0 percent phosphorus as PO and 0.01 to 1.5 percent Nitrogen as N2.

• Economical aspects:

When the distillery effluents are used for irrigation in fallow lands, the microbes present in it transform the lands into fertile ones, giving high yields of paddy and sugarcane. Farmers could save nitrogenous fertilizers worth Rs 1335 corers per annum if at least 200 distilleries of our country recycled their wastes to the agricultural fields (17). However, it is predicted that the utilization of distillery effluent for irrigation of land would make available nitrogen, phosphorous and potash valued at about Rs 500 crores each year. The added advantage of this application would be that these fertilizers would be available to soil in organic form. As the secondary and tertiary systems for the treatment of distillery effluent are highly energy intensive

Characteristics of the distillery waste water

For the manufacturing of alcohol or beverages the molasses is diluted with water into a solution containing 15-16 % of sugars. This solution is then inoculated with yeast strain in the fermentation at room temperature. This fermented mixture is distilled in a series of distillation columns to obtain the alcohol with requisite strength and quality (18). And along with that spent wash effluent also come out which is having the following parameters content. Table-4 shows characteristics of wastewater from distillery industry.

Table-4: Characteristics of Distillery Wastewater.

Sr.no	Parameters	Range
1.	pH	4.3-5.3
2.	Total Suspended solid	12000-14000 ppm
3.	Total Dissolved solid	45000-75000 ppm
4.	B.O.D (5 days)(20°C)	40000-50000 ppm
5.	C.O.D	80000-100000 ppm
6.	Chlorides	5000-6000 ppm
7.	sulphates	4000-8000 ppm
8.	Calcium	2000-3500 ppm
9.	Potassium	8000-12000 ppm
10.	Total Nitrogen	1000-1200 ppm

These all the parameters are having harmful and toxic effects to the environment so that we have to treat with appropriate treatment technologies to remove or reduce them from the waste water.

References

1. Acharya, B.K. Mohana, S, and Madamwar, D, 2008, *99*, *pp4621*-4626.
2. Barakat, M.A, 2011, *4*, pp361-377.
3. Bustamante, M.A. Paredes, C. Moral, R. Moreno-Caselles, J. Pérez-Espinosa, A. and Pérez-Murcia, M.D, 2005, *51*, pp145-151.
4. Capello, C. Wernet, G. Sutter, J. Hellweg, S. and Hungerbühler, K, 2009, *14*, pp467-479.
5. Irwin, A. Simmons, P. and Walker, G, 1999, *31*, pp1311-1326.
6. Mahimairaja, S, 2004, *1715*, p2100.
7. McMichael, A.J, 2000, *78*, pp1117-1126.
8. Moletta, R, 2005, *51*, pp137-144.
9. Nadal, M. Schuhmacher, M. and Domingo, J.L, 2004, *321*, pp59-69.
10. Nataraj, S.K. Hosamani, K.M. and Aminabhavi, T.M, 2006, *40*, pp2349-2356.
11. Pant, D. and Adholeya, A, 2007, *98*, pp2321-2334.
12. Ravanchi, M.T. Kaghazchi, T. and Kargari, A, 2009, *235*, pp199-244.
13. Saha, N.K. Balakrishnan, M. and Batra, V.S, 2005, *43*, pp163-174.
14. Satyawali, Y. and Balakrishnan, M, 2008, *86*, pp481-497.
15. Schwarzenbach, R.P. Escher, B.I. Fenner, K. Hofstetter, T.B. Johnson, C.A. Von Gunten, U. and Wehrli, B, 2006,*313*, pp1072-1077.
16. Song, Z. Williams, C.J. and Edyvean, R.G.J, 2004, *164*, pp249-259.
17. Sponza, D.T. and Oztekin, R, 2010, *162*, pp142-150.
18. Vermeiren, W. and Gilson, J.P, 2009, *52*, pp1131-1161.

Corresponding Author:

Dr. Kapila Kumar*,

Email: kapila.fet@mriu.edu.in