



## Distillery spent wash (DSW) treatment methodologies and challenges with special reference to incineration: An overview

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### Abstract

Biofuels are derived from renewable bio-mass resources and, therefore, provide a strategic advantage to promote sustainable development and to supplement conventional energy sources in meeting the rapidly increasing requirements for transportation fuels associated with high economic growth, as well as in meeting the energy needs of India's vast rural population. India is major producer of potable and industrial alcohols. The majority of distilleries use molasses as a feed stock. Ethyl alcohol is an important feed stock for the manufacturer of various chemicals. The effluent from the distillery is described as spent wash/vinasse. It was recognized in 2001 by the CPCB that concentrating or drying the spent wash and burning it with ancillary fuel, with energy recovery in the form of steam, is the most attractive alternative as a fertilizer. Distillery Spent Wash (DSW) is a rich source of organic matter and nutrients like nitrogen, phosphorus, potassium, calcium and sulfur. In addition, it contains sufficient amount of micro-nutrients such as iron, zinc, copper, manganese, boron, and molybdenum. Vinasse incineration can claim to be the best viable solution to treat distillery vinasse economically to meet the zero liquid discharge target of the industry. This review indicates that a wide range of biological as well as physicochemical treatments, over the years for the treatment of distillery spent wash. No single technology can be employed for absolute treatment of distillery spent wash. There is a need to use a mix of treatment options with adequate protocols and guidelines so that spentwash can be gainfully utilized for biogas generation, bio-compost, ferti-irrigation, one time land application, irrigation, sodic land reclamation and co-processing.

**Key Words:** *Biofuels, DSW, Vinasse, incinerator, radiation technology, sustainable.*

### Introduction

India, an agro based country, is the 2<sup>nd</sup> largest producer of sugarcane having about 5 million hectares of cultivated area. In India there are 579 sugar industries producing 14.5 million tonnes of sugar by crushing 145 million tonnes of sugar cane annually. The contribution of distillery industries in the the economic growth of the country is equal to lion's share. Distillery industry is one of the top most industries among the list of industries that cause the most environmental degradation and included in the red category by Central Pollution Control Board (CPCB, 2003; Chittaragi and Byakodi, 2018.). Distilleries are highly polluted as 88% of their raw materials result in waste, which is discharged into fields and nearby water bodies

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(Chauhan and Dikshit, 2012). The effluent from distilleries is described as slop/spent wash/vinasse/stillage (Nandy *et al.*, 2002). Various studies on characterization of distillery has been done (Khanna *et al.* 2003, Bhutiani *et al.* 2003) Distillery spent wash (DSW) also called vinasse, is one of the most polluting by products of the distilling mechanism in molasses based plants. Cane molasses is one of the most common raw materials used in ethanol production. A recent report suggests that there are 325 molasses based distilleries in the country producing 3063 million litres/year (M.Ltr/year) of alcohol and generating 45945 M.Ltr/year of spent wash as waste annually (Joshi *et al.*, 1994; Ayub *et al.*, 2012). For every litre of ethanol produced, 10 to 15 litres of spent wash are generated. Therefore a typical distillery generates over half a million litres of spent wash effluent daily (Saha, *et al.*, 2005; Pant and Adholeya, 2007; Mohana *et al.*, 2009). Carew & Co. Ltd. set up the first distillery in the country at Crwnpore (Kanpur) in 1805, for the manufacturing of Rum for the army. Looking to wide opportunity



in distillery industry, All India Distillers Association (AIDA) and Ethanol India are predicting the birth of many new distilleries along with major expansion in capacity of existing distilleries (AIDA, 2008; Ethanol India, 2008). In India, distilleries are mostly set up inside the premises of the sugar mill because of the readily availability of raw material, fuel and filler materials for compost. Bagasse is a value added byproduct of sugar manufacturing process. It is utilized as a fuel for the generation of steam and power which is utilized by the same factory. This helps in disposal of bagasse as well as generation of high grade thermal power (Alhat *et al.*, 2014). Spent wash leads to extensive soil and water pollution. The major toxic constituents in distillery effluent are high volume of dissolved solids (which increase the turbidity and block out sunlight from rivers and streams due to dark colour, The intense color is due to the presence of a dark brown, acidic melanoidin pigment), electrical conductivity (EC), chlorides, sulphates, low volumes of highly toxic sulphides and high BOD that deplete the DO and prove harmful to aquatic life (Ramakrishnan *et al.*, 2005; Chaudhary and Arora, 2011; Chaudhary and Arora, 2011; Arimi *et al.*, 2014; Farid *et al.*, 2010). It also causes eutrophication problem due to high pollution load and produces obnoxious smell in canals or rivers, due to the presence of putrescible organics like skatole, indole and other sulfur compounds (Shivajirao, 2012). The effective disposal of the vinasse from distilleries is one of the major problems faced by the industry (Balasubramanian and Kannan, 2016). The board has given mandatory guidelines to distilleries for the disposal of effluent by zero liquid discharge in inland surface waters. The center pollution control board has proposed distilleries attached to the sugar factory to acquire bio-methanation followed by bio-composting for the safe disposal of spent wash (CPCB, 2003). Colour and pollutants removal from distillery effluent gained increased concern in the last decade from environmental and aesthetic point of view. Stillage, fermenter and condenser cooling water and fermenter wastewater are the primary polluting streams of a typical distillery. Due to the large volumes of effluent and presence of certain recalcitrant compounds, the treatment of this stream is rather challenging by conventional methods. Therefore, to supplement the existing treatments, a

number of studies encompassing physico-chemical and biological treatments have been conducted (Pant and Adholeya, 2007). Earlier, this waste used to be treated by bio-methanation (producing biogas to be used as fuel in boilers) or converted to manure through bio composting. However, both methods have their drawbacks. Large quantities of waste still remains after biogas production, posing a serious threat to local water bodies and bio-composting is hampered by the requirement of large tracts of land and by rains that spread pollution (Thermax Press Releases, 2008).

**Table 1. Characteristics of distillery effluent.**

Characteristics	Value/Range
% Solids	11.5 to 12.5
Colour	Reddish Brown
PH	4.0 to 4.8
Smell	Caramel Smell
Temperature	80°C
Chemical Oxygen demand (PPM)	88 000 to 1,24 000
Biological Oxygen Deman (PPM)	30 000 to 45 000
Total Nitrogen (PPM)	12 000 to 15 000
Ammonical Nitrogen (PPM)	70
Phosphate (PPM)	250 - 370
Potash (K20) – (PPM)	8 000 – 10 000
Total Solids – (PPM)	1, 03 000 – 1, 10 000
Volatile solids (PPM)	65 000
Ash (PPM)	34 000 to 40 000

**Table 2. Comparison of spent wash with Bagasse Constituent (% Weight).**

Constituent	Spent wash	Bagasse
Carbon	22.22	23.25
Hydrogen	21.15	3.25
Nitrogen	1.85	--
Oxygen	14.50	21.75
Moisture	40.00	50.00
Sulphur	0.62	--
Ash	18.66	61.50
Gross Calorific Value (Kcals / Kg)	1800	2270

(Source: Balasubramanian and Kannan, 2016)

### Treatment methodologies

Different treatment methodologies and their sub methodologies available for the treatment of distillery spent wash (DSW) are presented in fig 1. Ministry of Environment, Forest and Climate Change (MOEFCC), recommended the following technologies / processes for spent wash treatment- 1. Reboiler



2. Bio-methanation
3. Reverse Osmosis (RO) System
4. Multi Effect Evaporator (MEE)
5. Bio-composting and one time controlled land application
6. Ferti-irrigation
7. Turbo Mist Evaporation
8. Concentration and Incineration

**Biological Treatment:** Biological treatment is relatively simple, inexpensive and environmentally sound way to degrade wastes, but factors such as temperature, moisture, pH, nutrients and aeration rate that the bacterial culture is exposed are critical in the optimal removal from the spent wash (Ali *et al.*, 2015). In biological processes, microbes (bacteria, fungi, actinomycetes etc.) are used to degrade the organic matter present in waste water. Microbes use carbon and energy for their growth and oxidize organic materials. Biological treatments of wastewater are more effective due to the higher surface-to-volume ratio, they have less operational costs as systems can operate at ambient temperatures and they are more vigorous. The drawbacks of biological methods are its slow speeds and more uncertainty. Biological methods are of two types (aerobic and anaerobic).

**Aerobic Methods are explained below:**

**Activated Sludge Process (ASP):** This is the most common biological method for the treatment of wastewater in industries and municipalities. In this method micro-organisms are mixed with incoming wastewater in an aeration tank. The three main steps of activated sludge process are as follows-

- (i) An aeration tank (reactor) where micro-organisms grow.
- (ii) A clarifier, which is responsible for the liquid-solid separation.
- (iii) A recirculation system for transporting recovered sludge back to the aeration tank. Organic materials are biodegraded by being in contact with micro-organisms within an aerobic environment. Activated sludge treatment is regarded as a suspended growth process due to microbes being suspended in the water.

**Trickling Filter (TF):** Trickling filters system also called attached-growth processes operates by micro-organisms that attach to a medium to ensure the removal of organic matter. Filters contain fixed or rotating distributor arms that spray wastewater

over media or rock that are covered with a biological layer of slime. Trickling filters system allows air to circulate through and consequently keep it oxygenated due to presence of open spaces between the rock and other media. The microbes present in slime layer (mainly bacteria and algae and various other organisms such as protozoa and metazoa), break down the organic matter. This system also requires a lot of energy and man power so considered as unsustainable.

**Rotating Biological Contactor (RBC):** RBC also known as attached growth process, is a biological process used for the treatment of carbon-based wastewater. In this method a sequence of closely spaced circular plastic disks, which are partly submerged into a tank filled with untreated wastewater move through the wastewater. As they rotate in wastewater, Microbial films develop on the surface of the circular disks which degrade organic material and are provided with oxygen when the disks rotate into the air. RBC has similarities to the activated sludge and trickling filter treatments but the biofilm process is the principal feature of this treatment option. Advantages of RBC over fixed film processes include less land area requirement, fewer complications with noise and odours, the process control is less complex and high removal rates of Biological oxygen demand (BOD). It is also an energy intensive process.

**Anaerobic methods are explained as below:**

**Conventional Digester:** In the standard rate digestion process, the contents of the digester are usually unheated and unmixed. In this acidification, methane fermentation and sludge thickening takes place in single tank. Standard or low rate digesters have intermittent mixing, intermittent sludge feeding and intermittent sludge withdrawal. Detention time for this process vary from 30 to 60 days.

**Di-phasic digestion:** Generally this type of digester is provided when population served ranged from 30,000 to 50,000. In first stage, mainly liquefaction of organic solids, digestion of soluble organic materials and gasification occurs. First stage is usually high rate digester with fixed cover and continuous mixing is preferred. In second stage, some gasification occurs however main use is supernatant separation, gas storage and digested sludge storage.



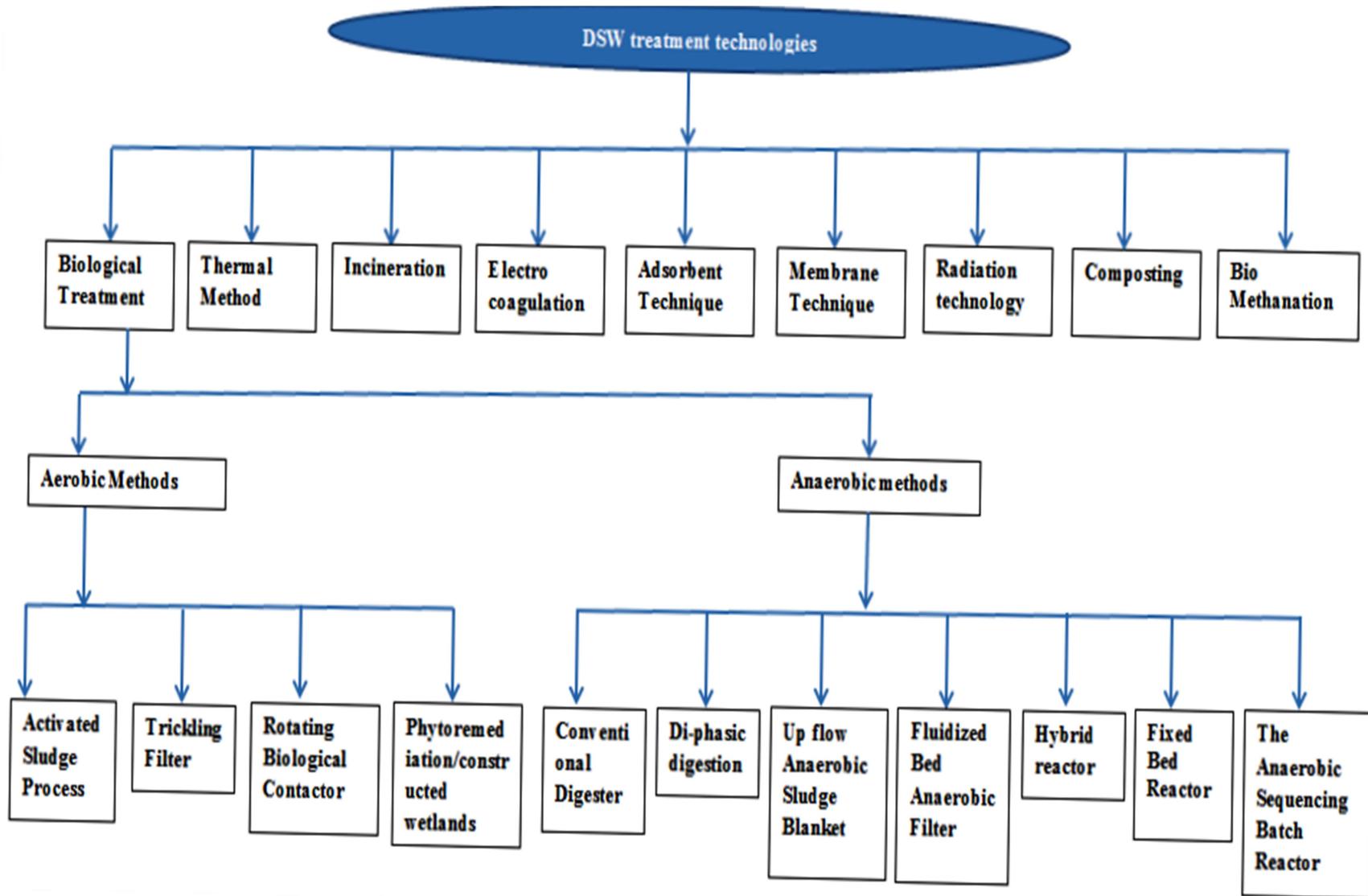


Fig 1. Showing the different treatment technologies for distillery spent wash (DSW).



**Upflow Anaerobic Sludge Blanket (UASB):** The micro-organisms are in the granule, which are in suspension by the biogas produced and by a recirculation of the wastewater. At the top of the digester, an internal settler holds back the granule into the digester (Patyal, 2015). Due to the high biomass and microbial communities within the reactor, UASB is a well-established and proven technology for the treatment of high-strength organic wastewater and widely applied for treatment of wastewaters from the food industry, distilleries, tanneries and municipalities. The reactor can be divided in three parts, sludge bed, sludge blanket and three phase separator (gas-liquid solid, GLS separator) provided at the top of the reactor. Treatment occurs as the wastewater comes in contact with the granules and/or thick flocculent sludge.

**Fluidized Bed Anaerobic Filter:** The fluidised bed is a technology where the carriers for the biofilm are fluidised by liquid recirculation. The carriers are particles or inert material.

**Hybrid reactor:** Hybrid digester is an anaerobic digester, being established for treatment of both high and low strength wastewaters. The hybrid digester is a digester with a sludge bed at the bottom and an anaerobic filter at the top. Hybrid reactor is taller than the UASB reactor (Patyal, 2015).

**Fixed Bed Reactor:** In this method an inert filter medium with a high specific surface for on-growth of biomass such as plastic material are used in the reactor mostly with external separation and recirculation of sludge.

**The Anaerobic Sequencing Batch Reactor (ASBR):** The main steps in anaerobic sequencing batch reactors (ASBRs) are feed, reaction, settling and decantation. ASBRs are high rate anaerobic treatment processes. The first step involves the addition of substrate to the reactor where the contents are continuously mixed. The volume of substrate fed depends on a number of factors, including the desired hydraulic retention time (HRT), organic loading, and expected settling characteristics. The conversion of biodegradable organic matter to biogas is achieved.

**Thermal Method:** These thermal methods are usually costlier. There is a probability of pollution in this method so become a cause of controversy. The advantage of thermal methods are very fast,

compact reactors, less area required, more fool proof, not affected by weather / temperature and less uncertainty hence become sustainable.

**Electro coagulation Method:** Electro coagulation is an emerging technology that combines the advantages of conventional floatation, coagulation and electrochemistry in water and wastewater treatment. Electro coagulation is a straightforward and successful treatment strategy for wastewater. Electrolysis is a procedure in which oxidation and decrease responses happen when electric current is connected to an electrolytic arrangement (Wagh and Nemade, 2015).

**Adsorbent Technique:** The adsorption process involves a mass transfer procedure where matter (adsorbate) is moved from an aqueous phase to a solid phase (adsorbent). The matter binds to the surface of the solid phase by chemical and/or physical interactions. The adsorbent technique is one of best method for removal of pollutants from distillery spent wash and reuses the effluent characteristics so it could be used for irrigation to reduce pressure over normal irrigation water. It is beneficiary to use diluted effluent for better growth of plants. Activated charcoal is an ideal adsorbent for removal of color of wastewater and 99.7% discoloration was found and maximum COD removal of 58.15% by using activated charcoal. Carbon has been utilized as an adsorbent for a considerable length of time. Enacted carbon capacity to expel mixes from wastewater expanded its utilization from most recent 30 years. Adsorption is normal procedure by which atoms of a broke up compound gather on and hold fast to surface of an adsorbent solid. It is ideal to go for adsorption by utilizing enacted carbon before treating refinery spent wash by electro coagulation (Lakshmikanth and Virupakshi, 2012).

**Membrane Technique:** The principle is quite simple, the membrane acts as a very specific filter that will let water flow through, while it catches suspended solids and other substances. Pre-treatment, Pumping, Cartridge filtration, Membranes and Post-treatment are the various steps of membrane technology. Membranes are typically made from polymeric materials, although ceramic and metal oxide membranes are also available. Membrane processes have been applied in the treatment of water, seawater and brackish water for more than 30 years. Membrane



technologies are used for desalinization and the removal of specific ions that are difficult to eliminate by means of other methods and is often applied to wastewater that is intended for reuse as it provides softening and eliminates organic material, viruses, bacteria and heavy metals. The process is grounded on the occurrence of semi-permeable membranes that work as filters. Technologies include: electro dialysis, reverse osmosis, Nano filtration, ultrafiltration, and electro dialysis reversal while heating (Michelle de Kock, 2015; Dave *et al.*, 2013; Garudet *et al.*, 2011; Ali *et al.*, 2015). The drawbacks of membrane technology are membrane fouling, clogging, scaling and cleaning. Membrane and membrane separation techniques with immobilized microorganism or enzyme have very significant role in treatment of distillery wastewater.

**Bio-composting:** In this method of activated bioconversion heterotrophic microorganisms act on carbonaceous materials in the aerobic pathway, depending on the availability of the organic source and the presence of inorganic materials essential for their growth. Composting is particularly effective in converting the wet materials to a usable form thereby stabilizing the organic materials and destroying the pathogenic organisms in addition to significant drying of the wet substrates. In the composting process, under aerobic conditions, thermophilic biodegradation of organic wastes at 40- 60% moisture content occurs to form relatively stable, humus-like materials (Kannan and Upreti, 2008; Patel and Jamaluddin, 2018).

**Radiation technology:** In this method the effluent was treated using an electron beam in combination with coagulant. Ultrasound technology was also applied for the treatment of distillery effluent and the results indicated that ultrasound treatment enhanced the biodegradability of the distillery waste water (Sangave and Pandit, 2004). Chaudhari *et al.* (2008), proposed a novel catalytic thermal pretreatment or catalytic thermolysis (CT) to recover the majority of its energy content with consequent COD and BOD removal. The CT process resulted in the formation of settleable solid residue and the slurry obtained after the thermolysis exhibited very good filtration characteristics (Pikaev, 2001).

**Incineration:** Incineration is defined as the thermal destruction of combustible waste in an enclosed

device. Incineration is the Combustion (controlled burning) of wastes in properly designed and constructed furnace to sterile ash with proper care for air pollution and water pollution. The prime objective of incineration is waste destruction, not power generation or ash recovery.

1. First incineration was reported in early nineteen sixties, but not popular
2. Became popular in late nineteen eighties. Two popular designs were
  - Destrotherm from Thermax, Pune
  - Sprannihilator from PrajConsultech, Pune.

Problems with Incineration of spent wash are discussed as follows-

- Solids content of spent wash is to be brought to about 60% before firing into the furnace.
- This brings the economics down as it is energy intensive and damaging to the material of construction.
- Spent wash is sticky
- It swells up to about 5 times.

#### **Salient Features of spent wash Incinerator**

The incinerator is a three pass boiler with a tall furnace, which gives very high residence time (>10.0 seconds) in the furnace. Hence, low flue gas temperature, well below initial ash deformation temperature, is ensured before the gas reaches super heater coils; No screen tubes are provided at the furnace exit. A set of specially designed slop guns is strategically located in down shot position at about 10 to 11 m from the furnace top. The concentrated vinasse, along with steam, is injected through these guns for atomizing. Atomized vinasse will have more surfaces for faster combustion. About 65 to 70% of combustion of vinasse is completed in suspension. These guns can be cleaned during the running of the boiler without stoppage. Travelling Grate technology is most suitable for such a critical application, where bottom ash and potash rich fly ash is made available separately so that potash-rich fly ash can be sold at a better commercial price. A two stage super heater with one attemperator is provided in the horizontal third pass of the boiler to ensure consistency of steam temperature. A conventional air preheater is not considered in this boiler. A steam coil air preheater is provided at the discharge of the SA and FD fans to avoid dew point corrosion. The spent wash/vinasse incinerator is a multi-fuel fired boiler.



Fig 2. Diagrammatic representation of Spent wash/Vinasse Incinerator (Source: Balasubramanian and Kannan, 2016)

The proposed spent wash/vinasse incinerator is suitable for the following fuel combinations:

- Concentrated spent wash/vinasse + bagasse;
- Concentrated spent wash/vinasse + Indian/imported coal;
- Concentrated spent wash/vinasse + biomass + bagasse;
- 100% bagasse;
- 100% Indian/imported coal;
- 20% of biomass can be mixed with the supporting fuel.

Wall type soot blowers are provided in the water wall panels of the first and second pass to remove the ash deposition from the tubes periodically. With regular cleaning of water wall panels, a desired Furnace Outlet Temperature (FOT), i.e. well below achieved (Balasubramanian and Kannan, 2016).

Retractable soot is provided in the super-agitators. Rotary soot blowers are provided in evaporators and economizers. Bag filters, in this particular application, prove to be the most suitable technology for collection of particulate matter in the flue gas. Bag filters are used as dust collectors as 80% of the ash particles are  $20\mu$  in size. The air to cloth ratio is maintained in the range of  $0.5\text{m}^3/\text{m}^2/\text{min}$ . -  $0.7\text{m}^3/\text{m}^2/\text{min}$ . The outlet dust concentration of  $50\text{ mg} / \text{N m}^3$  can be achieved.

**Importance of spent wash analysis:** It is important to ensure reasonable accuracy in the analysis of the

spent wash at the time of designing. Significant deviation of some of the parameters may cause insufficiency in terms of size of equipment. This may further cause operational difficulties.

**Importance of maintaining sufficient supporting fuel:** Insufficient quantity of supporting fuel would lead to instability of flame in the furnace, which will further lead to heavy draft fluctuation.

**Importance of ash handling system:**

1. After successful firing of spent wash, it is important to withdraw the ash generated from all part of boiler. Improper withdrawal of ash from system would cause accumulation of ash and cause blockage in flue path.
2. Ash from 2nd pass hopper is at temperature of approx.  $500\text{ }^\circ\text{C}$ . If dense phase vessel is placed directly to collect the high temperature ash from 2nd passes, it would cause frequent failure of dome seal. Therefore, a water jacketed screw conveyor is recommended to collect ash from 2nd, 3rd and 4th ash hoppers and dispose through single pneumatic conveying vessel.
3. Accumulated ash would cause burning of bags in case of bag filters.
4. It is also important to ensure that there is no air leakage through ash handling system (Gupta *et al.*, 2008).

**Vinasse Incineration- Concerns**

The only concern is that vinasse is to be fired in a boiler for steam generation

- Highly fouling nature of ash due to high alkali presence.
- Severe corrosion potential specifically on super heaters due to the presence of Alkalies, Chlorides and Sulphur.
- Low temperature corrosion due to presence of chlorine and Sulphur.

#### **Vinasse Incineration advantages**

- Foremost is the disposal of Vinasse.
- About 65% of energy required for the plant produced by steam generation from Vinasse itself.
- In Indian scenario, the variable cost of steam at 42Bar with coal firing will be Rs.750per MT. The steam generated from Vinasse will save Rs.7.3 Crores in fuel cost.
- The Ash from Vinasse can be sold as a fertilizer because the ash is rich in potash.
- China and India have been using this technology for a few years, now they both used both FBC (Fluidized Bed Combustion) and Travelling Grate technology.

**Concentration and incineration not found suitable:** It was recognized in 2001 by the CPCB that concentrating or drying the spent wash and burning it with ancillary fuel, with energy recovery in the form of steam, is the most attractive alternative as it leaves a small amount of residue, which could be used as a fertilizer. The CPCB however accepts that experience with continuously operating full scale plants is not yet available. The Charter on Corporate Environmental Responsibility for Environmental Protection recognizes this as one of the suggested measures prescribed to be used in combination. Importantly the CPCB does not rely on any one measure totally and prescribes that molasses based distilleries will ensure compliance with any combination of methods.

Only a small number of distilleries, about 27 have adopted concentration and incineration process. In Uttar Pradesh there are just 03 Distilleries which have adopted incineration. This process of concentration and incineration is at present still in a trial phase and is very expensive to adopt with high capex (INR 60 Crores) and also high running cost (Rs. 6-8 per BL of Alcohol) that raises the cost of production of alcohol exorbitantly. In addition this process creates problems of scaling, choking of boilers, and frequent failing of furnace refractory material which affects bed fluidization, heavy

sludge accumulation and frequent stoppages of the plant for de-scaling, which hampers not only the production process but also the effluent treatment process as well. Apart from this Installation of special type of boiler which needs to be replaced every 3-5 years due to high wear and tear and quick erosion, disposal of ash after effluent incineration, loss of Bio-Gas are major concerns associated with this technology and the sustainability of this technology may still need to be established. The co-incineration initiative of the CPCB suggested burning concentrated spent wash as fuel in cement/steel industries along with other fuels/raw materials. Co-processing of spent wash concentrate has been recommended to the extent of 3.0 to 3.5% of heat/coal substitution – a concentration up to which co-processing of spent wash has not been considered to influence clinker quality or change kiln behavior. A maximum loading of 1000 Litres per hour has been experimented. This would only mean about 24 KLD of concentrated or about 50 KLD of raw spent wash per day in a 3000 TPD cement kiln. This is a very small quantity as compared to the total spent washes available. Also the availability of willing cement mills, furnaces and TPPs may be limited in the area of the distillery. U.P. has been reported to have 56 molasses based distilleries, with only 1 cement plant and 11 TPPs. This would again support the view of a mix of technologies with bio-composting, ferti-irrigation and one time land application also being considered on account of their ecological and agronomical advantage. Co-processing could however be a preferred option for standalone distilleries and in Karnataka, Madhya Pradesh and Rajasthan where the ratio of cement plants/TPPs to distilleries is higher. Even though the initial trials on coprocessing appear to be encouraging, the effect of inorganic constituents in spent wash on the finished product is to be assessed and the applicability of the technology for distilleries, which are located far away, is to be assessed in terms of cost effectiveness. The guidelines given by the CPCB for co-processing of concentrated spent wash in cement kilns require certain modifications in the cement kilns. The transportation of spent wash from the distillery to the cement factory also requires careful handling in tankers specially designed for this purpose. Air pollution concerns have also to be addressed. The co-processing plants



have to be designed, equipped built and operated in such a way as to prevent emission into the air giving rise to significant ground level air pollution; in particular exhaust gases have to be discharged in a controlled fashion by means of a stack, the height of which is calculated in such a way as to safeguard human health and environment.

### Conclusion

This review indicates that a wide range of biological as well as physicochemical treatments, over the years for the treatment of distillery spent wash. Biomethanation of distillery spent wash is a well-established technology. Recently, among the many treatment methods, high-rate anaerobic digestions have been recognized as effective treatment methods for highly organic saturated sugar industry and ethanol distillery effluents. Even though, UASB bioreactor is practically used in many places for industrial and municipal wastewater treatment; recently, anaerobic filter of fixed-film digester group is emerging with better performance than the other high-rate anaerobic reactors. Biological aerobic treatment employing fungi and bacteria has been investigated essentially to decolorize the distillery spent wash. Due to need of additional nutrients as well as diluting the effluent for obtaining optimal microbial activity and eventually optimal results, there is a need to explore more efficient microbes that can decolorize the effluent using it as the sole source of nutrients without much dilution. Physicochemical treatment methods are effective in both color and COD removal. Thermal methods are costlier but very fast than biological methods. For less quantity of waste the chemical methods are suitable. Adsorption using activated carbon is better choice before treating distillery spent wash before Electro coagulation. Electro coagulation is an economical method for treatment of distillery spent wash but only problem is about secondary sludge developed during EC process. No single technology can be employed for absolute treatment of distillery spent wash. There is a need to use a mix of treatment options with adequate protocols and guidelines so that spentwash can be gainfully utilized for biogas generation, bio-compost, ferti-irrigation, one time land application, irrigation, sodic land reclamation and co-processing. A delve into the various

methods employed fortreatment of distillery spent wash, it is felt that the ideal cost effective and commercial treatment scheme should comprise of biomethanation as the primary step followed by physicochemical treatment and concluding with aerobic treatment. Developing such an extensive and effective treatment will give the triple benefit of environmental protection, energy conservation and production of high value compounds.

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