Physico-Chemical Process for Wastewater Treatment

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Lecture 56

Case Study Wastewater Treatment in Distillery

Good day everyone and welcome to these lectures on Physico Chemical Processes for Wastewater Treatment. In the last lecture, we started understanding various wastewater treatment strategies which are followed in different industries. And in the last lecture we studied regarding the sugar industry and what are the different effluents which are generated in the sugar industry? What are their characteristics? And how the wastewater treatment is done in those in the sugar industries? We understood that.

Now, in the sugar industry, molasses is produced, which is containing very high COD and BOD load. Now, this molasses is used in India for further alcohol production in distilleries. So, we will be understanding that how the alcohol is produced not only in the molasses based industry? But other types of distilleries. And after so we will try to see that what are the different wastewater streams which are produced and how far the treatment is done with respect to wastewater in these distilleries?

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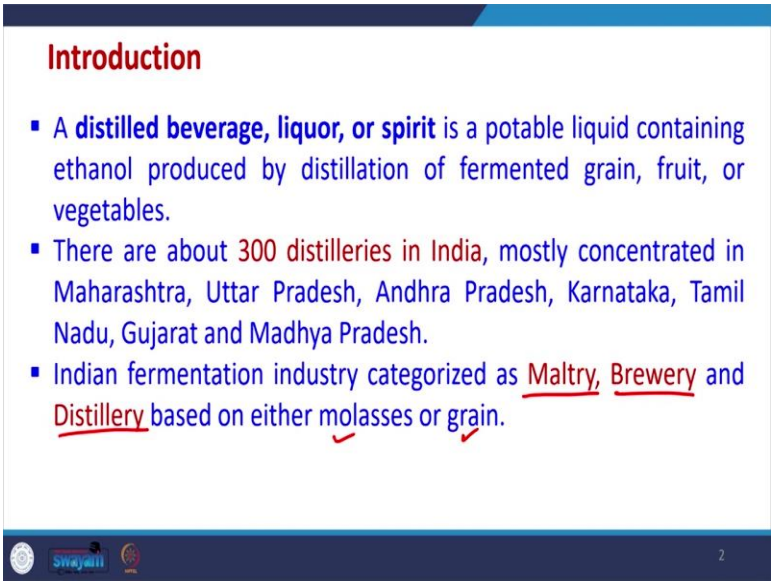

So, starting a distilled beverage, or liquor or a spirit is a portable liquid containing ethanol produced by distillation of fermentation, fermented grain, fruit or vegetable. So, in general, we

can say that any of the fermented grain fruit or vegetable can be used for making ethanol out of that, and that the concentration of ethanol is done by distillation. So, this whole unit is called as a distillery.

So, there are about 300 distilleries in India and they are mostly concentrated in all those states where sugar cane production is more so because in India most of the ethanol is produced from the molasses. So, most of the industries are also based in these states only which are Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat, Madhya Pradesh, etcetera. Now, Indian fermentation industry can be categorized as Maltry, Brewery or Distillery based upon whether the molasses is being used for making alcohol or grain is being used for alcohol. So, we have Maltry, Brewery and Distillery.

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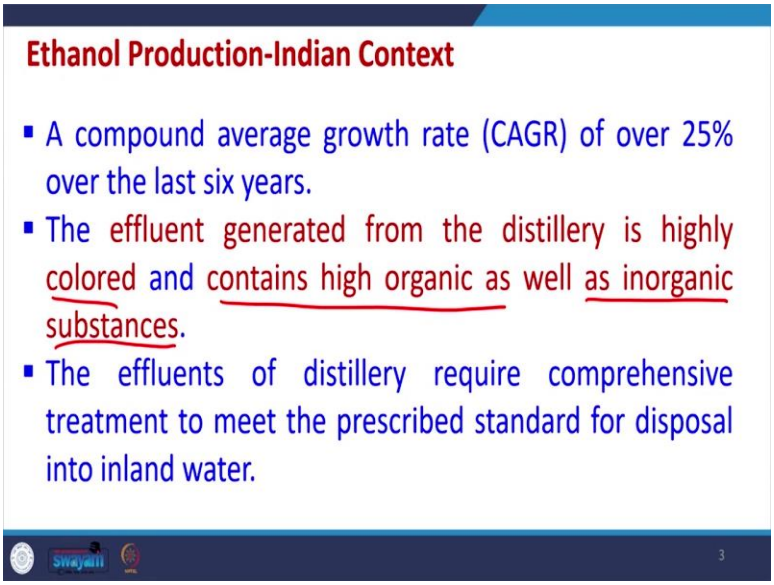

Now ethanol production with respect to Indian context. So, this ethanol production is a cumulative growth rate which has been observed in the last few years is around 25 percent. So, that means the ethanol production is increasing day by day in India. And this is more so, because the amount of molasses produced owing to the increased amount of sugar cane produce is also becoming higher and higher.

Because of this the effluent generated from the distillery is also increasing. Also, in general the effluent generated from distilleries highly colored contains very high amount of organic as well as inorganic substances. That means, we have to critically follow a treatment strategy, so that we

can meet the norms as desired by the Government of India with respect to treated water from this industry. The effluent of distillery require comprehensive treatment to meet the prescribed standards of disposal into inland water. So, this is there.

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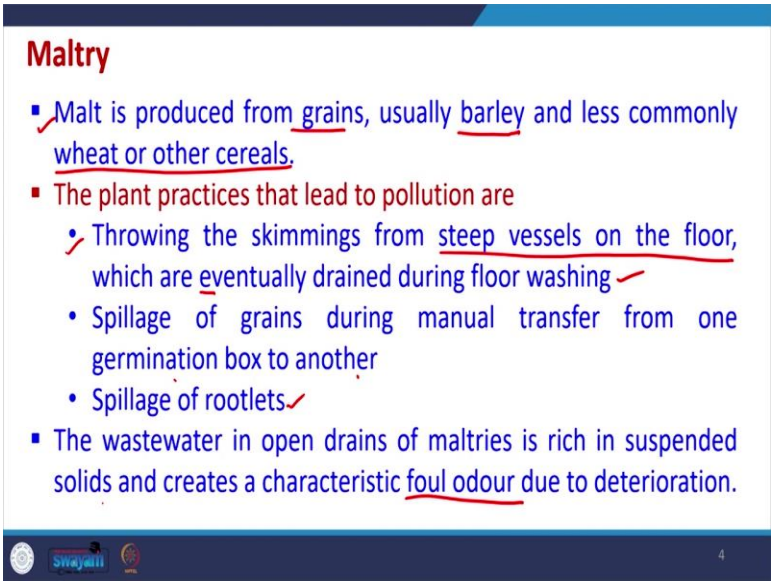

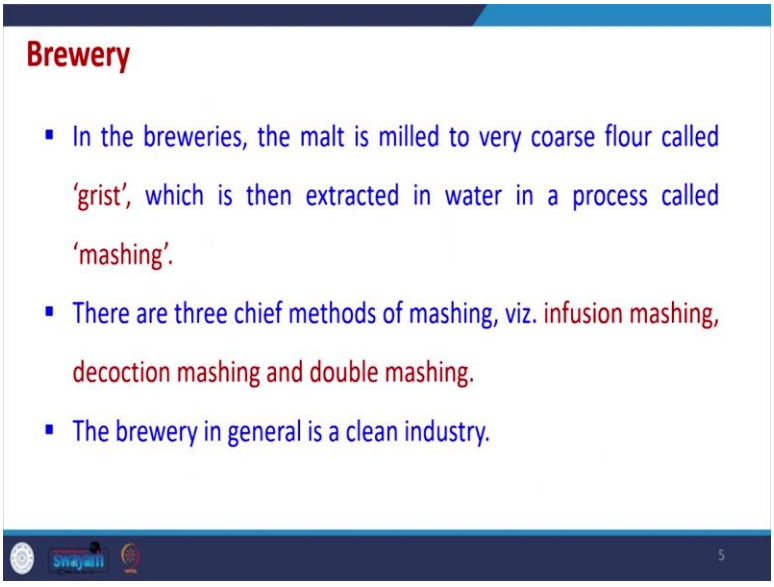

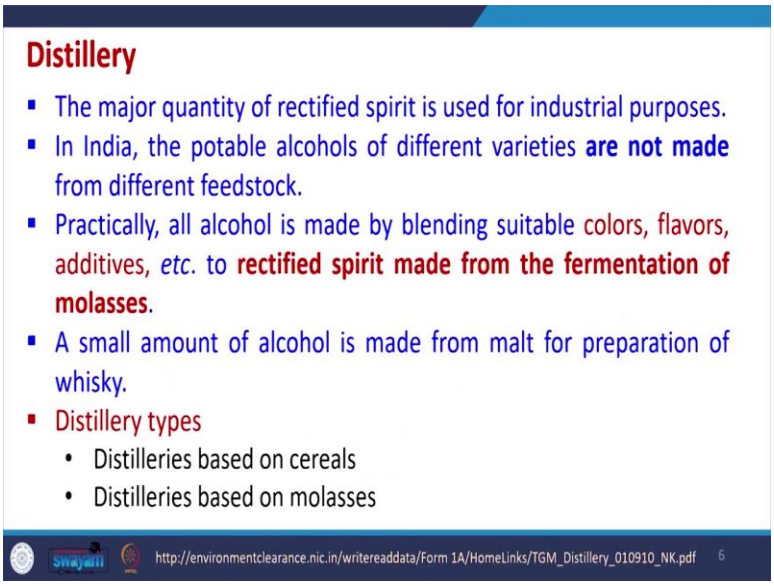

Now, as informed earlier we have Maltry we have Brewery and we have distillery so, we will try to understand each of them. Now, Maltry in this the malt is produced from gains usually barley, but less commonly wheat or other cereals in India. So, generally barley will be used to produce malt. Now the plant practices that lead to pollution in the Maltry may include. Throwing the skims from steep vessels on the floor, which are eventually drained during the floor washing. So, these will go into the water.

Similarly, spillage of grains during manual transfer from one germination box to another. So, this is another place. Similarly, spillage of rootlets that can also cause a problem because that will go into the washing. The wastewater in open drains of them, maltries is rich suspended solids and creates the characteristics of foul odor due to deterioration. So, all these aspects have to be taken care of in the Maltry.

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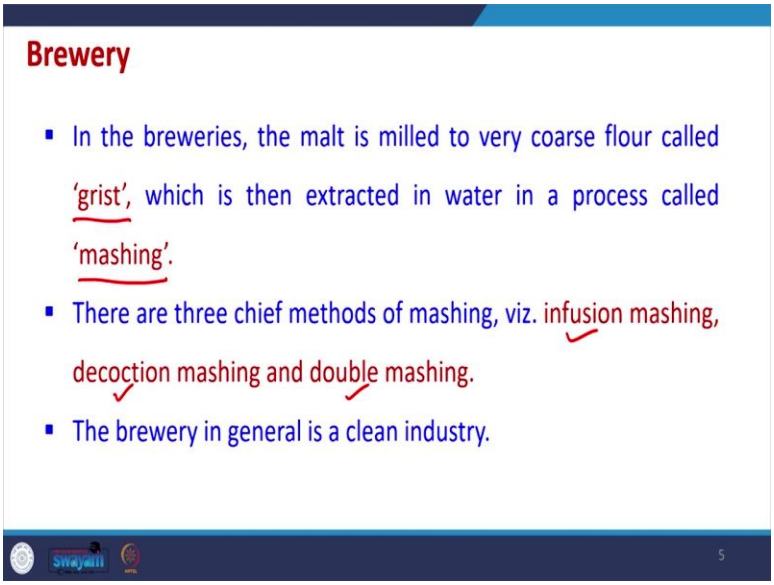

Now, in the brewery, the malt is milled into very coarse flour which is called as 'grist', and which is then extracted in water in a process called as 'mashing'. So, this is there, there are different mashing methods including infusion mashing, decoction mashing and then double mashing. The brewery in general is a clean industry as compared to Maltry.

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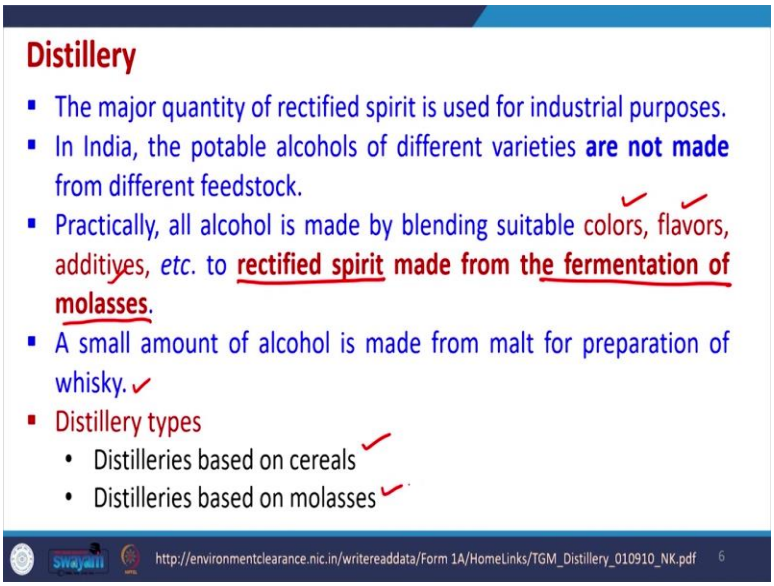

Thereafter we have distillery, the major quantity of rectified spirit, spirit which is used for industrial purposes is produced in the distillery. In India the portable alcohol of different varieties are not produced as such which are done in different other countries. Practically all the

alcohol in India is produced from rectified spirit which itself is made via the fermentation of molasses, which is obtained from the sugar industry.

So, this rectified spirit, sprit is further blended with colors flavors and additives to make the alcohol. So, this is there. A small amount of alcohol is made from malt for preparing the whisky in India, but majority of alcohol is produced from rectified spirit only. So, distillery types may be based upon the distillery may be based upon cereals and based upon molasses. In India it is mostly it is based upon molasses.

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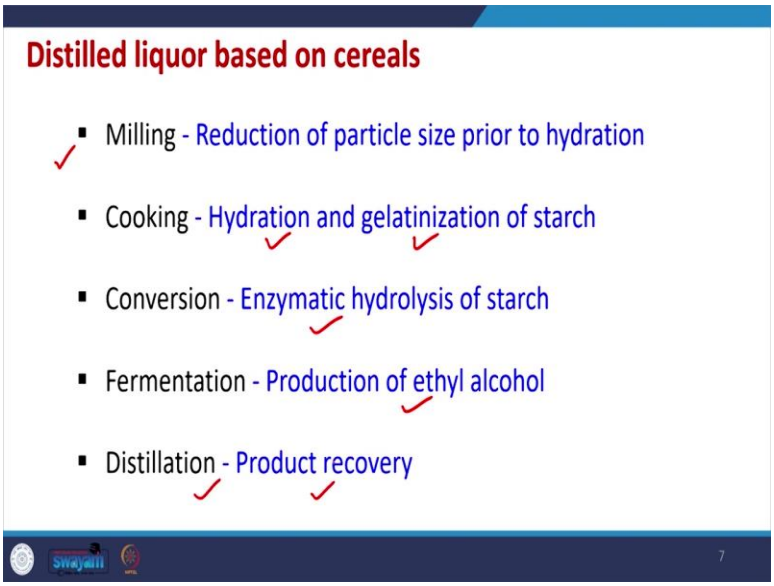

Now, distilleries which are based upon cereals what are the different operations which are performed in these industries. So, these include milling, a milling is done so, as to reduce the particle size prior to hydration. After that the cooking is done. So, in this hydration and gelatinization of the starch is done. After that this particular product is enzymatic hydrolysis of starch is performed and here the conversion happens. Further the fermentation is done to produce the ethyl alcohol and then the ethyl alcohol is further concentrated in the distillation unit for getting the product which is ultimately obtained.

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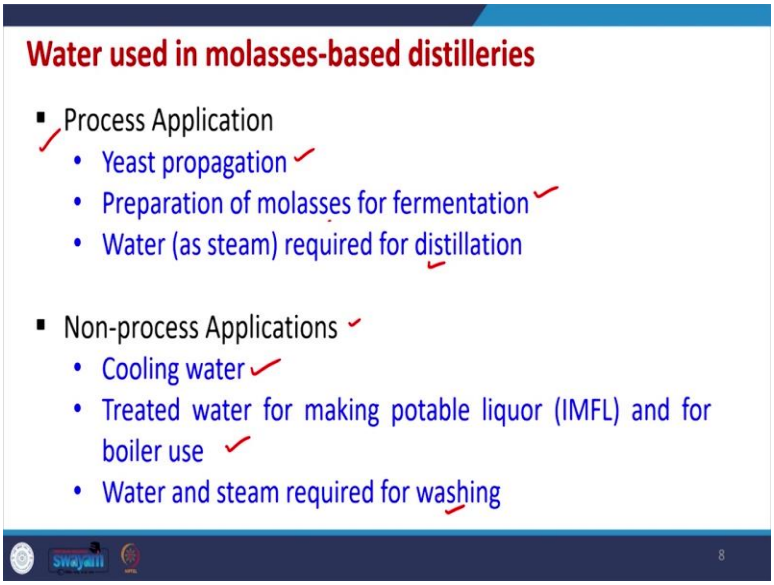

Now, what are the places in which the water is used in the molasses-based distilleries? Molasses based distilleries also have similar units. There are many places in molasses-based distilleries in which water is used, what are those bases? For process applications like yeast propagation, preparation of molasses for fermentation, and water as such is required as a steam in the distillation process itself.

So, in these all these process applications, water is use. Similarly, many places for non-process applications like cooling water, treated water for making portable liquor and for boiler use water is required. And water is also required, water and steam are also required for washing purpose. So, these are the process, non-process applications of water.

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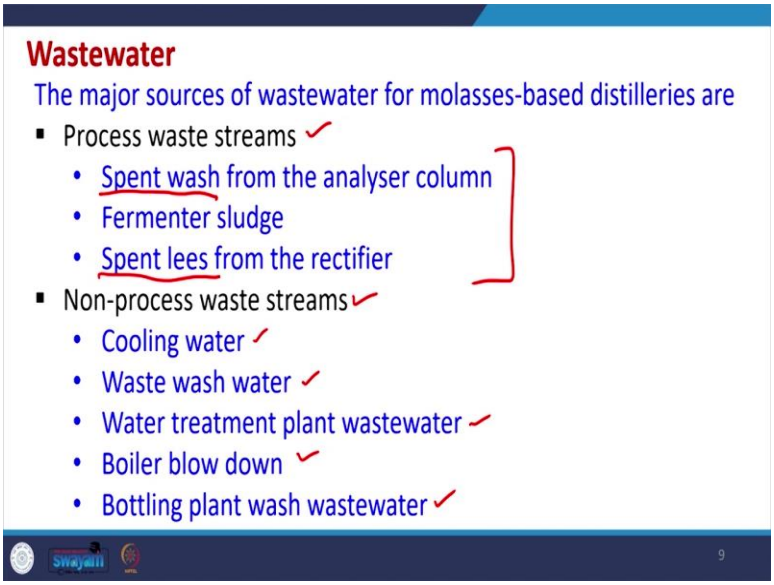

Now the wastewater which is generated in these distilleries, they may depend upon that whether these are process waste streams or non-process waste streams. So, process waste streams are more difficult and they have characteristics which make them highly polluting. So, these process waste streams include spent wash which is from the analyzer column, then the fermenter sludge water, then the spent lees from the rectifier. So, this is there. Also, there are many non-process waste streams, including cooling water waste wash water, then water treatment plant, wastewater which is generated finally, boiler blow down, and bottling plant wash water. So, this is these are the different non-process waste streams within distillery.

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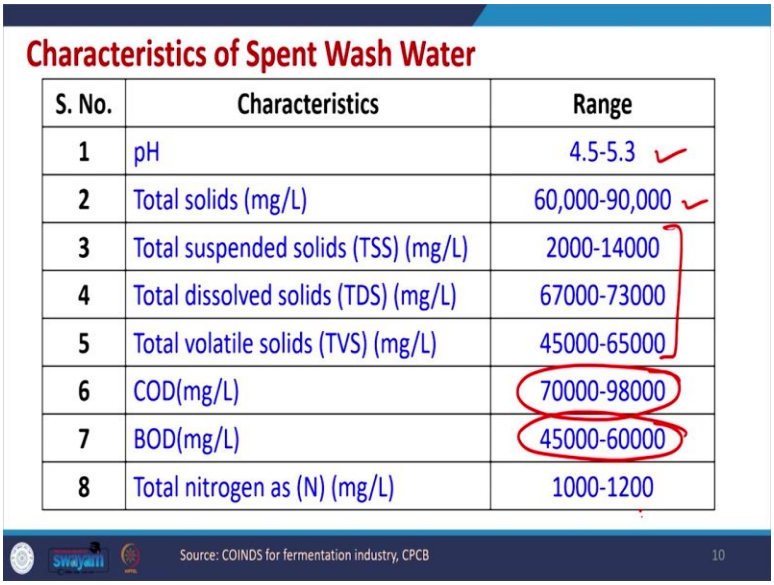

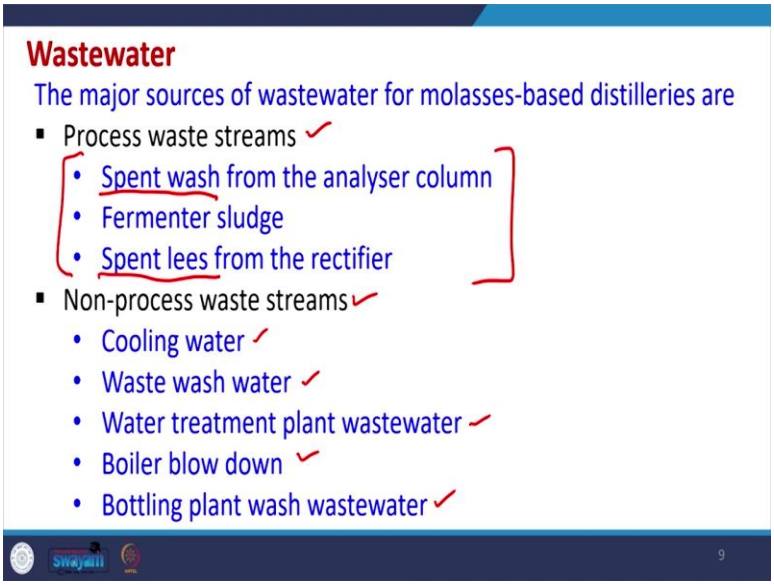

The characteristics of spent wash water. Now, all these are the most difficult thing. So, the characteristics of these process waste streams are difficult, so, we will try to understand them. So, characteristics of a spent wash water. So, the pH is 4.5 to 5.3 we can see that total solid is very high that COD value is 70,000 to 1,00,000, the BOD value is 45,000 to 60,000. So, these are very, very high values as compared to sugar industry or any other industry.

So, that is why distillery wastewater is considered to be highly polluting and it is very difficult to treat these wastewater. In addition, the total suspended solids total dissolved solids and total

volatile solids may range in this for these wastewater. The nitrogen content may also be high for the distillery waste water or in particular for spent wash water.

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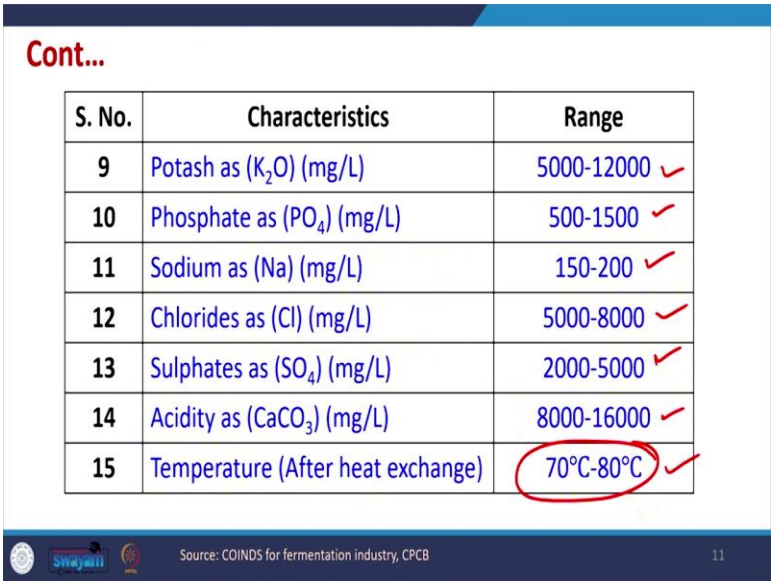

Now, in addition to previous characteristics, other characteristics are also very high. Potash phosphate, sodium chlorides, sulfates acidity as CaCO3 and temperature may also be high in the range of 70 to 80 degrees centigrade. So, we can see this spent wash water is has very high pollution load.

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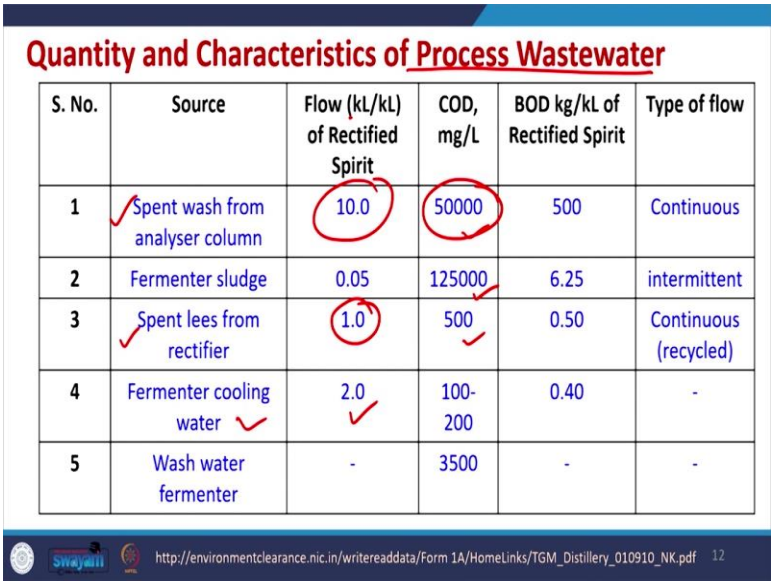

Now, further understanding the quality, quantity and characteristics of different process wastewater, so spent wash already we discussed. Then the amount which is produced kiloliter per kilolitre of rectified sprit. So, we can see that if suppose, we are getting one liter of sprit, so, we have 10 liter of water which is getting produced, which is very high.

Similarly, a spent lees also gets produced in high amount. So, it is one is to one and fermenter cooling water is around two times the per liter of rectified spirit and we can easily see the every COD in fact it is up to one lakh and this fermenters sludge also very high COD. The COD value of ferment spent lees is much lower, but still it is higher than the standard values and BOD values are also very high.

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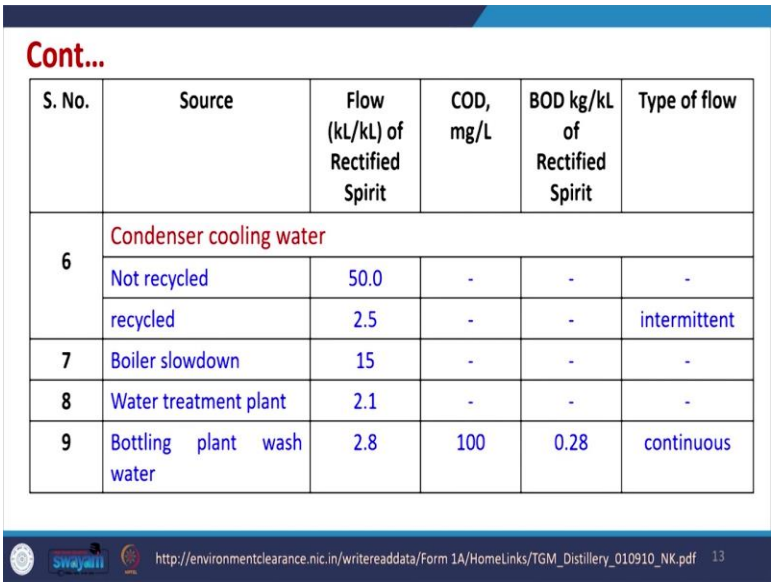

Now, similarly, for non-process wastewater the values are much lower and the amount of water maybe also sometimes it is higher with respect to per liter of rectified sprit produced.

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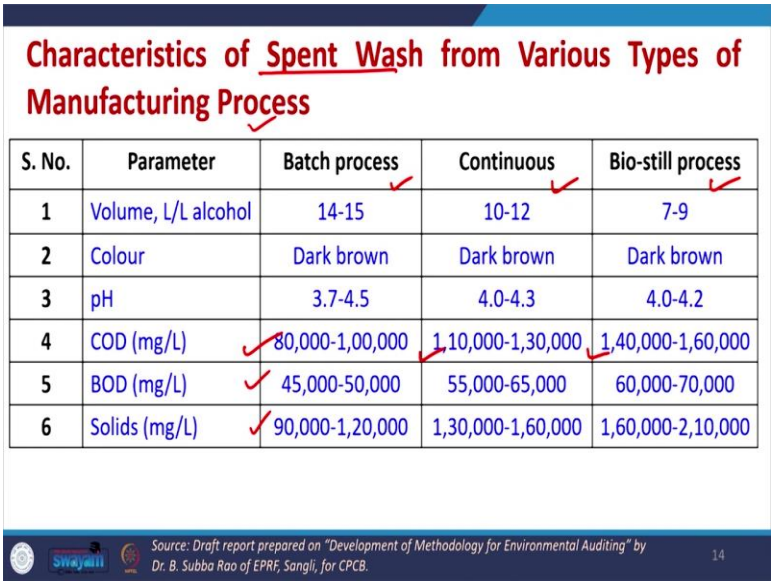

Now, characteristics of a spent wash from various types of manufacturing processes. So, alcohol produce in distilleries there are different types of processes which are may be followed, one is Batch process, Continuous process, Bio-still process. So, depending upon that the spent wash characteristics may also vary, we can see the COD value they are changing with respect to different types of manufacturing processes being followed in the distillery.

Similarly, BOD values all it content, everything is varying depending upon the type of operation being performed and volume of this is spent wash produced per liter of rectified sprit that is also changing with the process whether it is Batch, Continuous or Bio-still. So, depending upon the production, this thing may vary.

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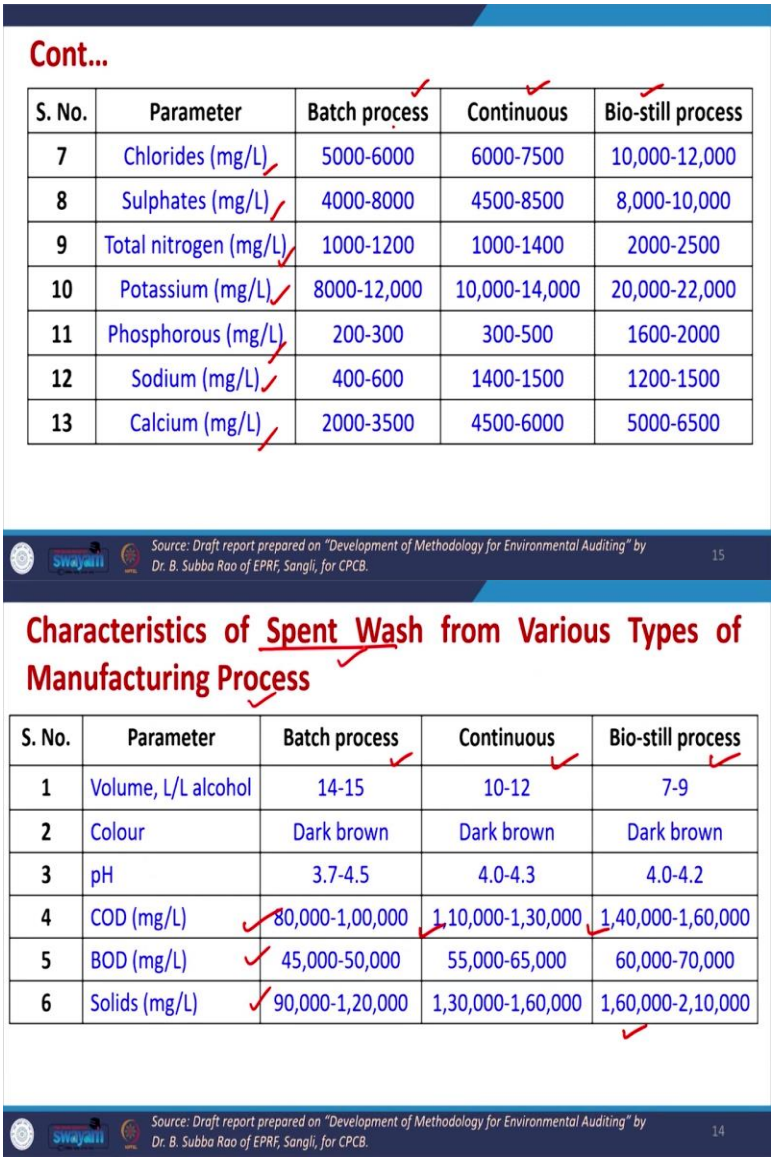

Similarly, the other characteristics of the spent wash like chlorides, sulphates, total nitrogen, potassium, phosphorus, sodium, calcium, all these values they depend upon the various types of processes whether it is Batch process, Continuous or Bio-still process which is being followed for rectified sprit production from molasses. So, depending upon these the characteristic of a spent wash varies a lot.

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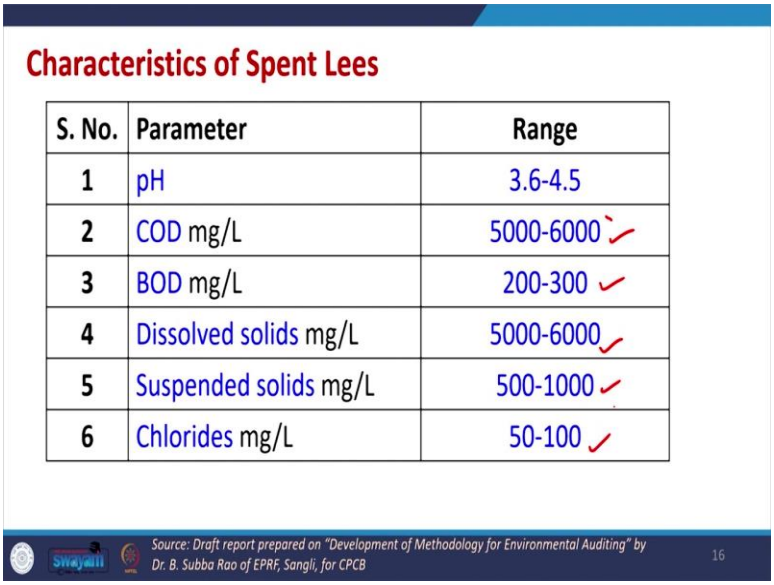

Now, characteristics of spent lees which is another one of the waste streams in the distilleries. We can see the pH, the COD value is still high, but not as high as the spent wash itself, the BOD value is also high, the dissolved solid concentration, the suspended solids chlorides all values are higher than the specific norms which are there.

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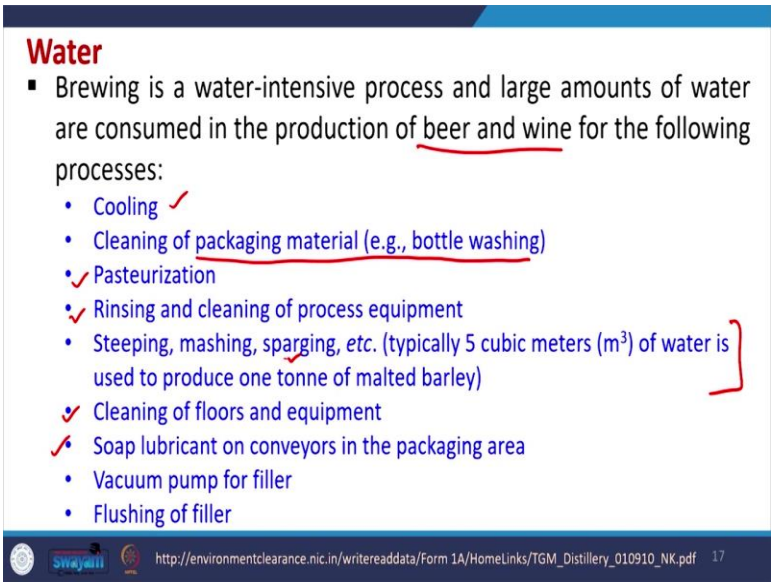

Now, in the brewing, the water is again, water is also used in the brewing industry. So, brewing is a water intensive process and large amount of water is consumed in the production of beer and wine. And it is used in the following processes for cooling, for cleaning up packaging materials

like bottle washing, for pasteurization, for rinsing and cleaning up process equipments for steeping, mashing and sparging etc, typically 5 cubic meter of water is used to produce one ton of malted barley.

Similarly, for cleaning of floors and equipments, for soap lubricant uses on conveyors in the packaging area, what are is used. For in the vacuum pump of fillers and for flushing of fillers, a lot of water is used. So, thus the brewing industry is highly water intensive industry.

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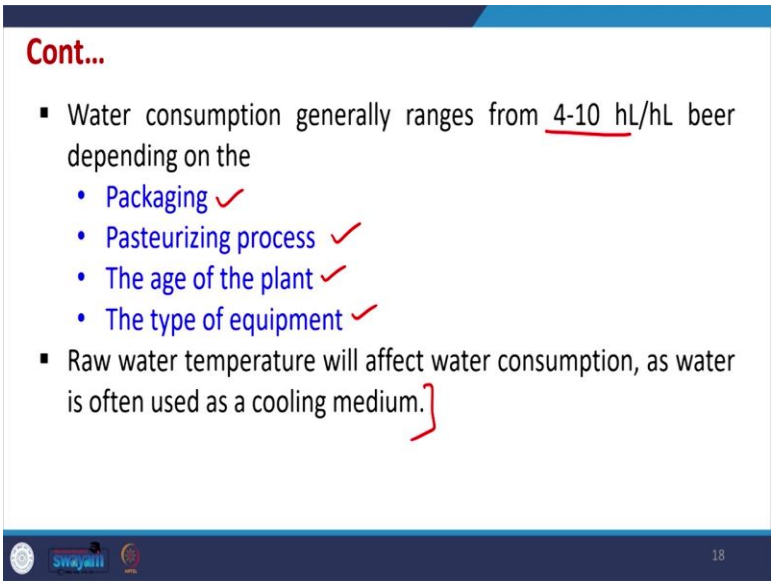

The water consumption in the brewing industry ranges from 4 to 10 liter per liter of the beer produced depending upon the packaging pasteurizing process the age of the plant and the type of equipment being used. So, raw water temperature will also affect the water consumption as raw water is often used as a cooling medium. So, because of that, the raw water consumption or raw water temperature also affects the amount of water being consumed.

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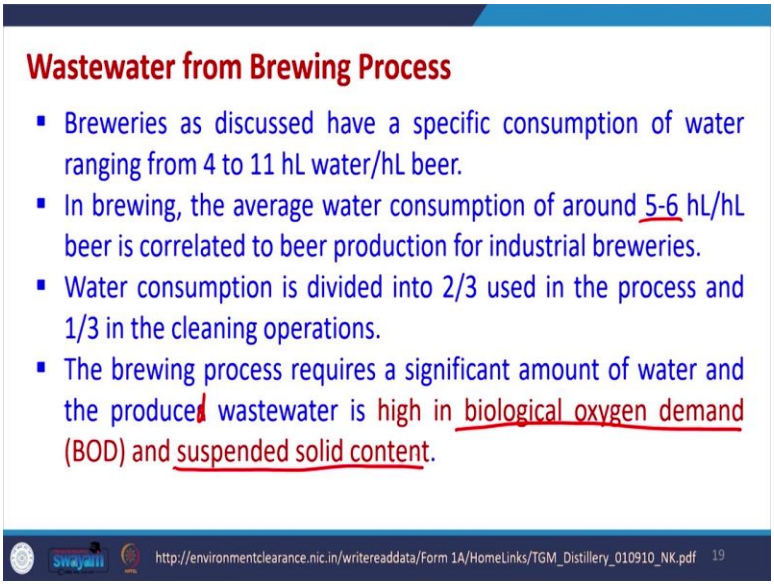

Now, wastewater from the brewing process, what are the different wastewaters which are produced and what are their characteristics. So, brewing as discussed have a specific consumption of water ranging from 4 to 11 liter per liter of beer and in brewing the average water consumption is around 5 to 6 liter per liter of beer and is correlated to beer production for industrial breweries.

Water consumption is divided into two third used in the process and one third for the cleaning operation, the brewing process requires a significant amount of water and the produce what wastewater is high in biological oxygen demand. So, this produce water is high in high amount of biological oxygen demand and lots of suspended solid content is present in the brewing process wastewater.

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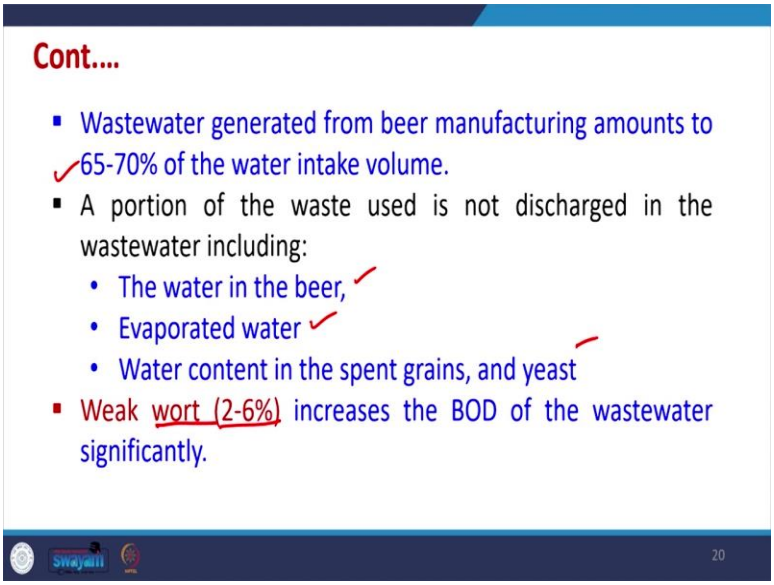

The wastewater generated from the beer manufacturing amounts to 65 to 75 percent of the water intake volume. So, out of the 1000 liter if it is going into the industry 700 liter will be produced as wastewater. A portion of the waste is used is not discharged in the wastewater including the water in the beer, the evaporated water and the water content in the spent grains and yeast. So, this is the portion which is not discharged. So, week wort around if it is there in that 2 to 6 percent range, increases the BOD of the wastewater significantly. So, it will depend upon the what is the wort percentage which is there in this brewery.

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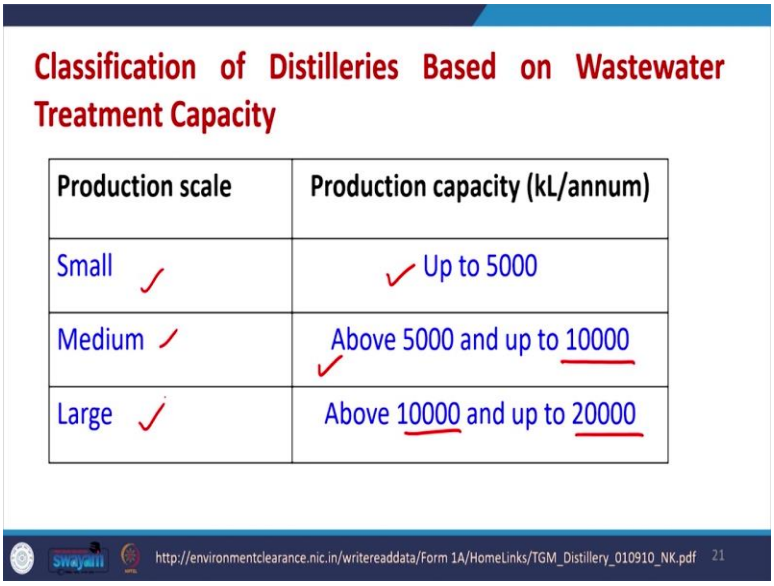

Now classification of distilleries based upon the wastewater treatment capacity. So, distilleries may be classified based upon the wastewater treatment capacities also. So, the production capacity may be up to 5000 kilo liter per annum above 5000 up to 10,000 and beyond 10,000 up to 20,000 kilo liter per annum. So, they may be classified as a small, medium and large industries.

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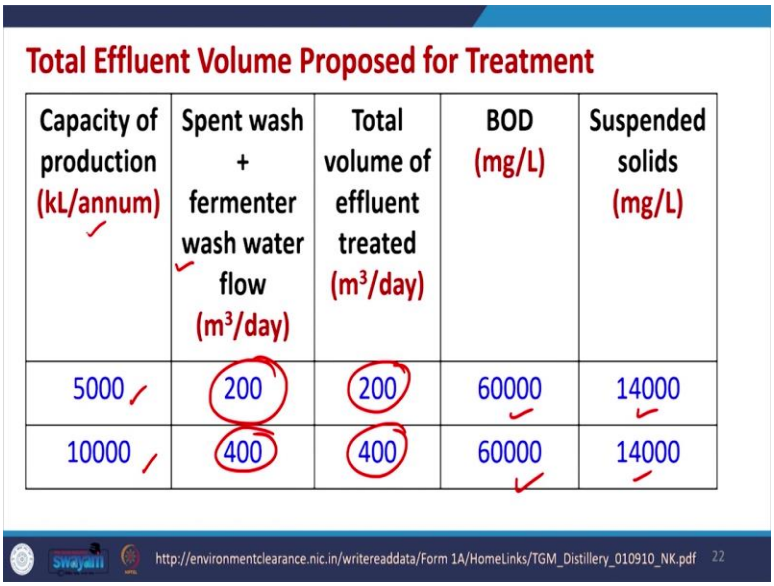

The total effluent produced for treatment. So, that depending upon the capacity of production suppose kilolitre per annum, so, whether it is 5000 10,000. So, spent wash plus the fermenter wash water flow rate will be tentatively 200 to 400 total volume of effluent to be treated will be around 200 to 400. The BOD will be around 60,000 and the suspended solids may be there. So, this is the total effluent volume, which has to be treated further.

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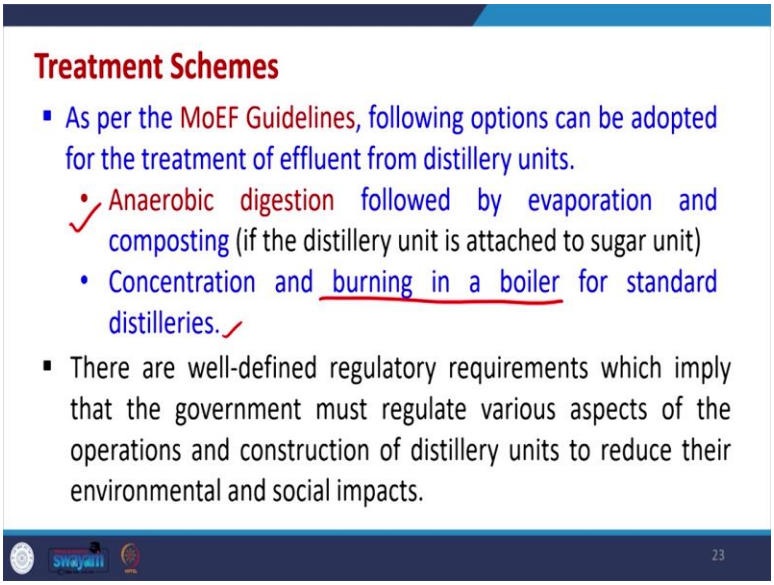

Now, what are the treatment schemes which are followed in the distilleries, so we will discuss this now, as per the Ministry's guidelines. So, following options can be adopted for the treatment of effluent from distillery unit. So, anaerobic digestion followed by evaporation and composting. So if the distillery unit is attached to the sugar unit, so if both are very close together, that the distillery unit is attached to the sugar unit, because we are using the molasses from sugar industry only, so it is possible that both the units are attached together to under that condition, anaerobic digestion followed by evaporation and composting is suggested and then the concentration and burning in a boiler for standard distilleries.

So, if distillery is alone, so concentration and burning in a boiler, it is suggested for these types of distilleries which will be individual distillery unit, where sugar is industry is not close by. Now, there are well defined regulatory requirements, which must be a which have been implied by the government and these must be regulated in various aspects of operation and construction of distillery units. And if they are followed, it will reduce the environmental and social impacts.

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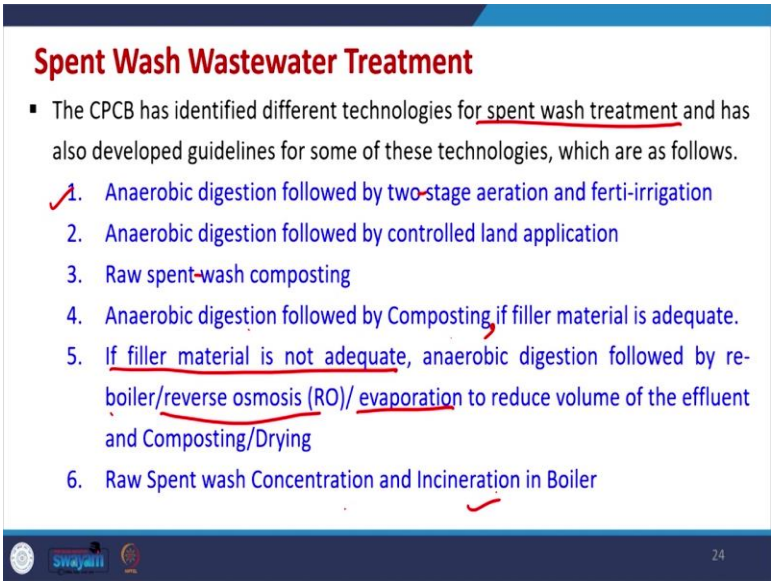

The spent wash wastewater treatment. So, because spent wash is the most polluting stream in the distilleries. So, what are its guidelines? So CPCB, the Center Pollution Control Board has identified different technologies for spent wash treatment and they developed guidelines for some of these technologies are as follows anaerobic digestion followed by two stage aeration and ferti- irrigation, this is there then anaerobic digestion followed by control land application, raw is spent wash composting, anaerobic digestion followed by composting if filler material is adequate.

So, this is there, if filler material is not adequate, anaerobic digestion followed by re-boiler or reverse osmosis or evaporation to reduce the volume of effluent followed by composting or drying. So, this is there then also raw spent wash concentration and incineration in boiler, this is another strategies. So, there are different strategies which can be followed for is spent wash wastewater treatment. Now, this will depend upon the composition of is spent wash and also the amount of spent wash being produced and also whether the sugar industry is adjacent to the distillery unit or not. So, there are a number of parameters that will affect that which strategy has to be followed for is spent wastewater treatment.

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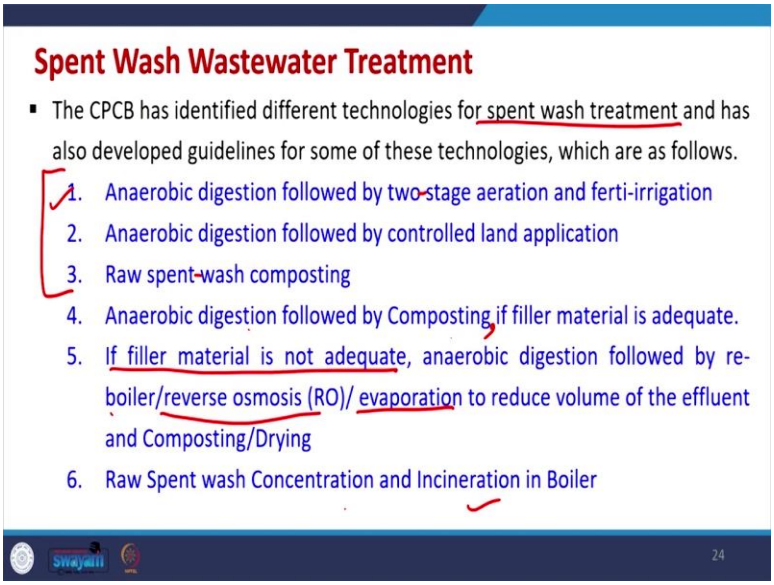

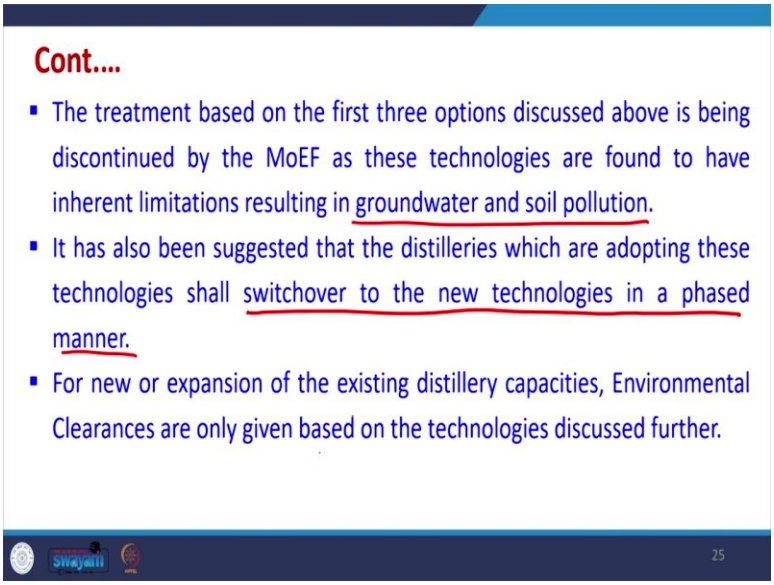

The treatment based upon the first three options discussed here. These three options, they had been discontinued as these technologies have not been followed, found to have inherent limitations resulting in groundwater and soil pollution. So, these are not now that much recommended.

Now, it has been suggested that distilleries which are adopting these technologies will switch over to the new technologies in phased manner. So, this is here, because these three technologies are not found to be good enough with respect to the checking the groundwater and soil pollution.

For new or expansion of the existing distillery capacities, Environmental clearances are only given based upon the technologies which are discussed further.

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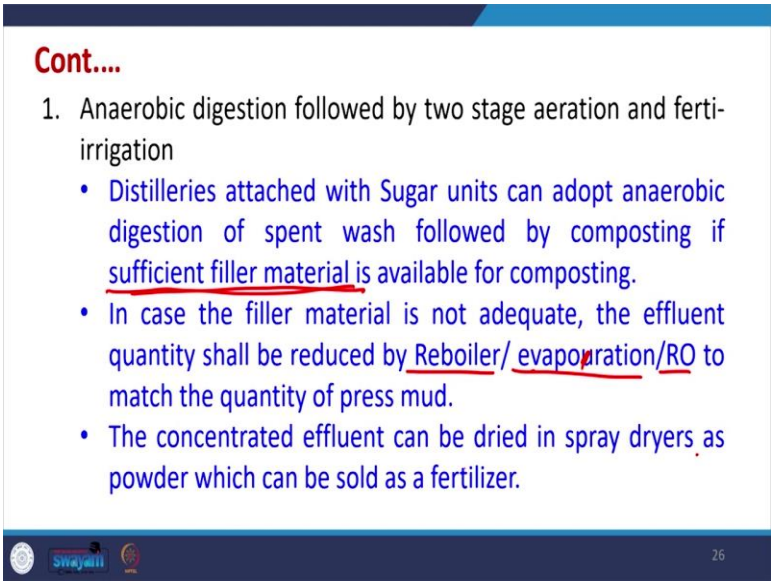

So, the three technologies which are discussed here, so, anaerobic digestion followed by two stage aeration and ferti-irrigation. Distilleries attached with sugar units can adopt anaerobic digestion of spent wash followed by composting if sufficient filler material is available. So, this technology has to be followed if this sufficient filler material is available for composting.

In case the filler material is not adequate, the effluent quality, quantity has to be reduced by using reboiler. So, we have to use the reboiler that means concentrate we have to use evaporation okay or we have to use the RO Reverse Osmosis units to match the quantity of press mud which is generated. Now, the concentrated effluent can be dried in spray dryers as powders which can be sold as fertilizers.

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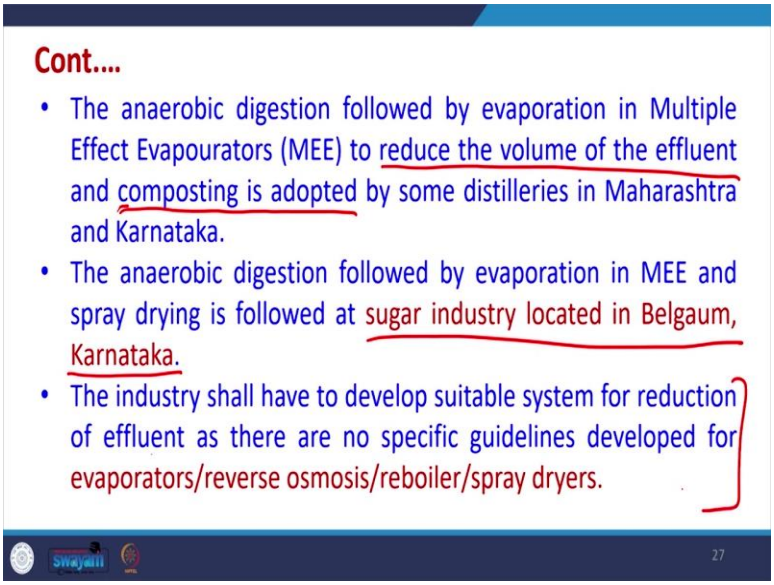

Now this is there, the anaerobic digestion followed by evaporation in multiple effect evaporators, so as to reduce the volume of effluent and followed by composting is to be adopted by some distilleries in Maharashtra and Karnataka. So, it has been done the anaerobic digestion followed by evaporation in MEE and the spray drying is being followed in sugar industries located in Belgaum, Karnataka, so, this is already being followed in some of the sugar industries in Karnataka. The industry have to develop suitable systems for reduction of effluent as there is no specific guidelines developed for evaporators, RO, reboiler, spray dryers. So, this has to be seen by the sugar industry themselves.

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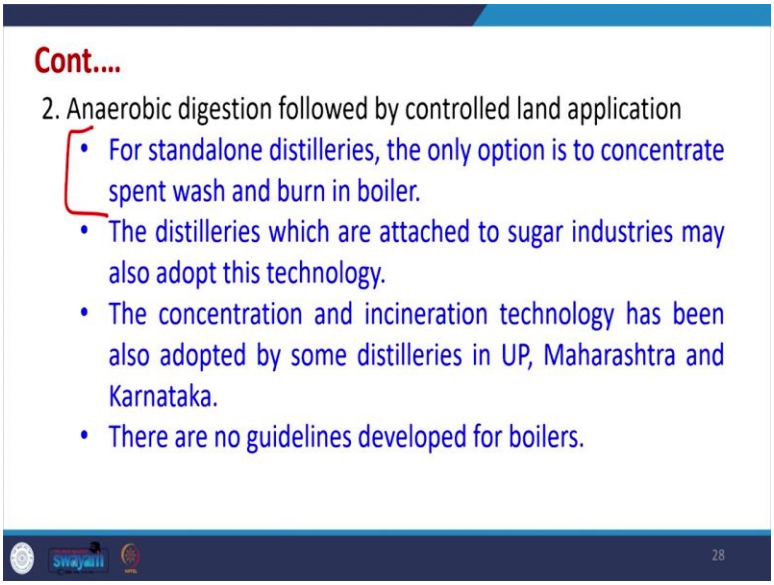

Then there is another technique anaerobic digestion followed by control land application. So, for standalone distilleries, the only option is to concentrate the spent wash and burn in the boiler. So, this is the only option which is there. The distilleries which are attached to the sugar industries may also adopt this technology. The concentration and incineration technology has been adopted in some distilleries in UP, Maharashtra and Karnataka. There are no guidelines as far for boilers.

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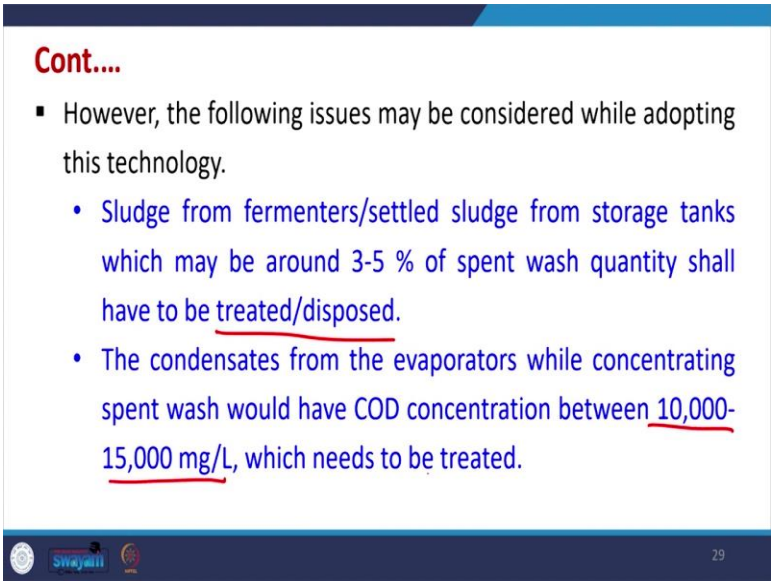

The following issues may be considered while adopting these technologies, the sludge from fermentation, fermenter and settled sludge from storage tanks, which may be around 3 to 5

percent of spent wash quantity shall have to be treated or disposed. So, this is this is one of the challenges. The condensates from the evaporators while concentrating spent wash may have COD concentration ranging in this and this this. These themselves have to be treated that means the condensate have to be treated themselves while adopting these technologies.

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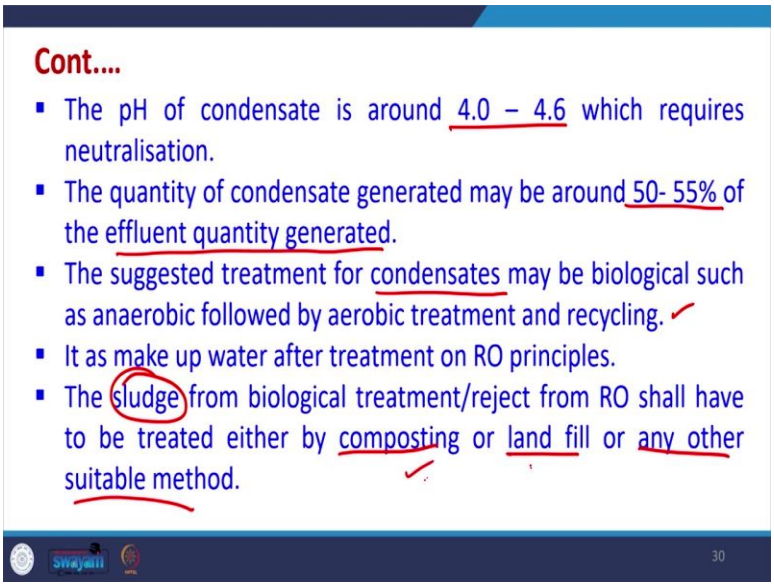

The pH of condensate may be around 4 to 4.6. And this will require neutralization that means, some other waste material has to be used for this, the quantity of condensate generated maybe around 50 to 55 percent of the effluent quality generated. So, this is very, very high and still we have to and also the COD value is also high. So, we have to treat this.

The suggested treatment for condensate may be biological such as anaerobic followed by aerobic treatment and recycling. It is make up water after treatment in RO principles. So, the sludge from biological treatment or reject from RO shall have to be treated either by composting or landfill or any other suitable method. The sludge which is generated from biological treatment here has to be further taken care of via any of these techniques which may be there.

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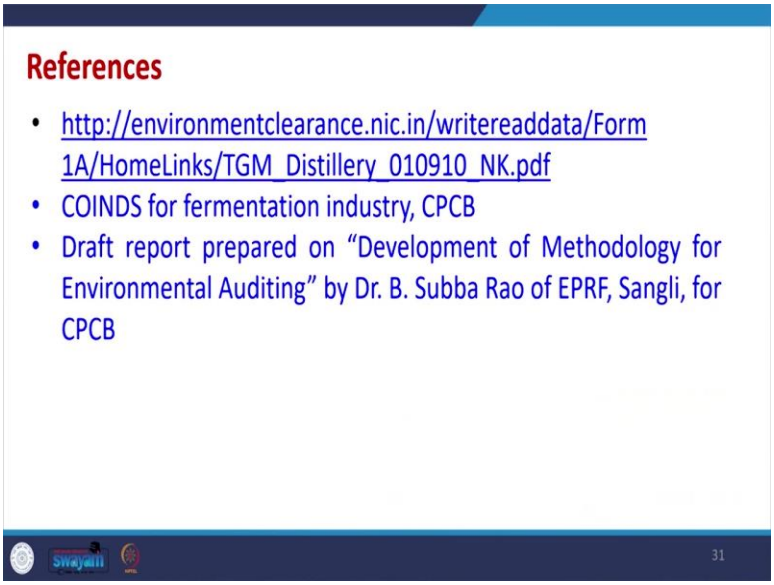

This is there and these are the references which have been followed in this. The distillery industry is highly polluting in nature. It has a lot of issues and challenges. The multiple evaporated technique is being followed currently in most of the many of the distilleries for concentrating the spent wash etc. But still there are many challenges in particular with respect to condensate, its high pollution load and it further treatment.

So, all these challenges are there, those industries which are adopting older technologies, so, they have lot of challenges and they have to further use the new methods for treatment of spent wash and other spent lees, etcetera. So, that they can properly manage them and the environmental pollution which is happening which may happen because of the discharge of this highly polluting wastewater from distilleries so, the industries themselves have to take care of them.

And no further deterioration is being allowed by the government with respect to all these distilleries. So, they have to adopt new technologies for wastewater treatment. There is no alternative with respect to that. So, with this, we will end this section and this case study on wastewater treatment in distilleries. So, thank you very much.