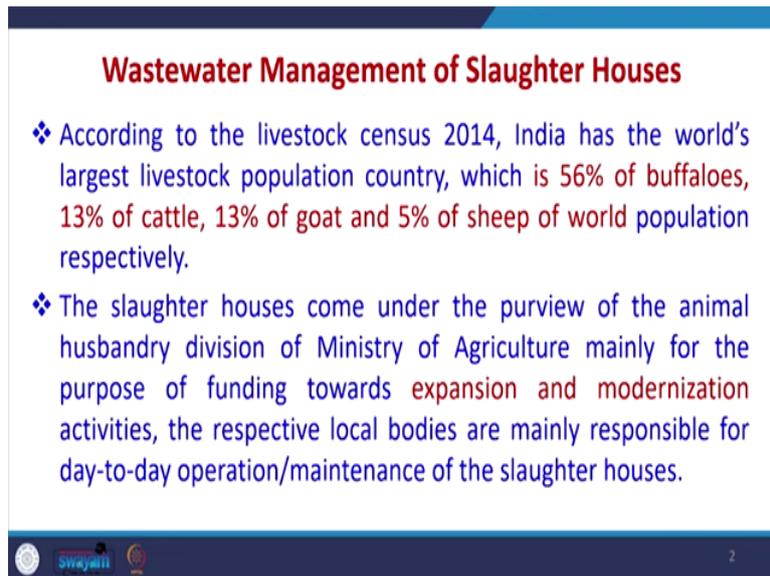


**Biological Process Design for Wastewater Treatment**  
**Professor Vimal Chandra Srivastava**  
**Department of Chemical Engineering**  
**Indian Institute of Technology, Roorkee**  
**Lecture: 39**  
**Management of Wastewater from Slaughterhouse**

Welcome everyone in this NPTEL Online Certification Course lecture on Biological Process Design for Wastewater Treatment. So today, we will be studying the management of wastewater from slaughterhouse. In the previous lecture, we studied the management of wastewater from dairy industry.

So, we are trying to understand the, how the wastewater treatment happens in some of the industries. So, we are trying to take some case studies. So, today we are going to study the management of wastewater from slaughterhouse. So, wastewater management from slaughterhouse.

(Refer Slide Time: 1:05)



**Wastewater Management of Slaughter Houses**

- ❖ According to the livestock census 2014, India has the world's largest livestock population country, which is 56% of buffaloes, 13% of cattle, 13% of goat and 5% of sheep of world population respectively.
- ❖ The slaughter houses come under the purview of the animal husbandry division of Ministry of Agriculture mainly for the purpose of funding towards expansion and modernization activities, the respective local bodies are mainly responsible for day-to-day operation/maintenance of the slaughter houses.

swayam

So, according to Livestock Census 2014, India has the world's largest livestock population country, which is 56 percent of the buffaloes, 13 percent of the cattle, 13 percent of the goat and 5 percent of the sheep's of world population regulation are actually in India.

So, that means the buffalo, more than 50 percent of the buffalo of the world are actually in India. So, the slaughter houses come under the purview of animal has been the division of Ministry of Agriculture. Mainly for purposes of funding towards expansion and modernization of activities and respective local bodies are the main responsible for day-to-day operation and maintenance of the slaughterhouses.

(Refer Slide Time: 01:57)



So, now in the slaughter houses various operations are performed and wastewaters are released. So, you can see here in the picture that this is the place where for a simple case the slaughtering may be done. So, wastewater will be generated here. So, you can see the wastewater generated, it is some amount is accumulated here. Certainly, it will be bloodish in nature or reddish in nature and thereon then certainly skeletons and bones etc. which are there.

(Refer Slide Time: 02:27)

### Classification of Slaughterhouses

❖ At present, there are no official norms for the classification of slaughterhouses. However, depending upon the type of animals slaughtered, the slaughterhouses are classified into:

- Large animal (i.e., cattle, buffalo, etc.) slaughterhouse
- Goat and sheep slaughterhouse
- Pig slaughterhouse
- Poultry slaughterhouse

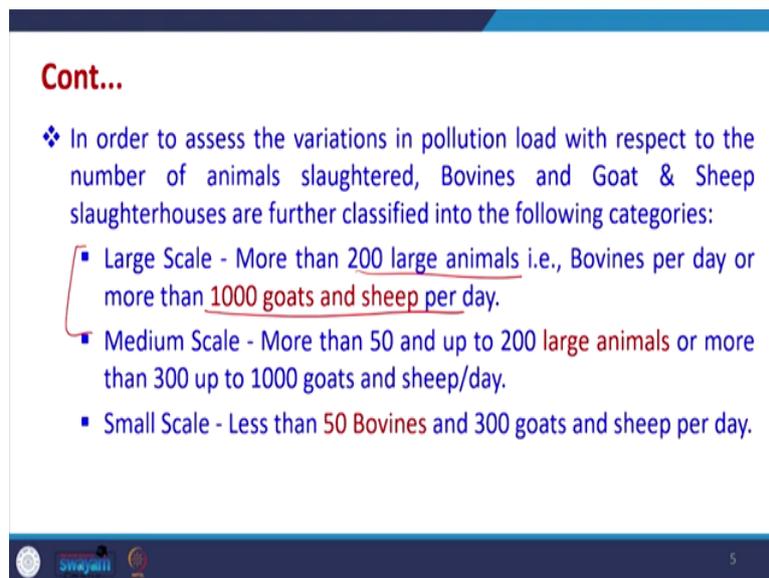
4

So, slaughtered houses are classified also, but there is no official noun for the classification of slaughter houses. So, however, depending upon the type of animals being slaughtered, the slaughtered houses can be classified into large animal slaughterhouse, goat and sheep's

slaughterhouses, pig slaughterhouse, and poultry slaughterhouses. So, there could be four different, but mostly the large animal slaughter houses, we are will be concerning here.

So, where the cattle and buffaloes are slaughtered and the wastewater gets generated during the process various operations which are there. Now in order to assess the variations in the pollution load with respect to the number of animals slotted, bovines, goats, sheeps slaughter houses are further classified into following categories.

(Refer Slide Time: 03:27)



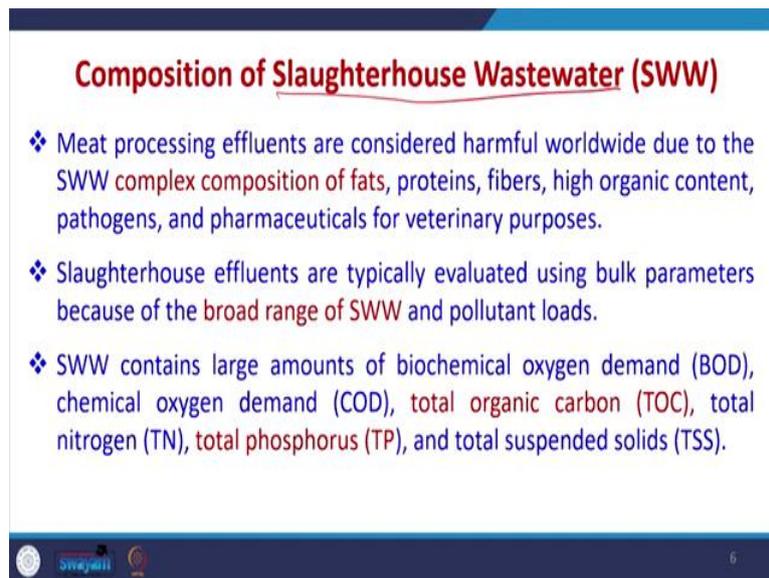
**Cont...**

- ❖ In order to assess the variations in pollution load with respect to the number of animals slaughtered, Bovines and Goat & Sheep slaughterhouses are further classified into the following categories:
  - Large Scale - More than 200 large animals i.e., Bovines per day or more than 1000 goats and sheep per day.
  - Medium Scale - More than 50 and up to 200 **large animals** or more than 300 up to 1000 goats and sheep/day.
  - Small Scale - Less than **50 Bovines** and 300 goats and sheep per day.

swayam 5

So, large scale more than 200 large animals slaughtered per day are more than thousand goats and sheep slaughtered per day. So, they will fall into the category of large-scale slaughterhouse. Medium scale the one where 50 to 200 large animals are more than 300 to 1000 goats are slaughtered per day. Similarly, small scale where less than 50 bovines and 300 goats and sheeps are slaughtered per day.

(Refer Slide Time: 03:52)



**Composition of Slaughterhouse Wastewater (SWW)**

- ❖ Meat processing effluents are considered harmful worldwide due to the SWW complex composition of fats, proteins, fibers, high organic content, pathogens, and pharmaceuticals for veterinary purposes.
- ❖ Slaughterhouse effluents are typically evaluated using bulk parameters because of the broad range of SWW and pollutant loads.
- ❖ SWW contains large amounts of biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS).

swayam 6

Now, composition of slaughter houses wastewater. Now meat processing effluents are considered harmful worldwide due to the complex composition of fats, proteins, fibres and high organic content pathogens, pharmaceuticals present in the wastewater, which is generated in the slaughterhouse or meat processing industry.

Slaughterhouse effluents are typically evaluated using bulk parameters because the broad range of slaughterhouse wastewater and pollutant loads. SWW, which is the slaughterhouse wastewater contains a very high amount of BOD, COD large amount of total organic carbon total nitrogen, total phosphorus and total suspended solids.

So, that means SWW the slaughterhouse wastewater will contain high BOD, COD, TOC, total nitrogen, total phosphorus, etc. So, they will require lot of biological treatment in a way.

(Refer Slide Time: 04:58)

Parameter	Range	Mean
BOD (mg/L)	150–8500 ✓	3000
COD (mg/L)	500–16,000 ✓	5000 ✓
TOC (mg/L)	50–1750	850
TN (mg/L) ✓	<u>50–850</u>	450
TP (mg/L) ✓	<u>25–200</u>	50
TSS (mg/L)	0.1–10,000	3000
K (mg/L)	0.01–100	50
Color (mg/L Pt scale)	175–400	300
Turbidity	200–300	275
pH	4.9–8.1	6.5

Source: Adeshiyani et. al., 2010

The typical characteristics of actual slaughterhouse wastewater could be like this. So, BOD in the range of 150 to 8500, COD in the range of 500 to 16000, with average of 5000. Similarly, TOC will also be high 50-750, then total nitrogen in the range of 50 to 850, total phosphorus in the range of 25 to 200.

Similarly, we can have TSS, potassium, colour, turbidity, pH, etc. So, these may vary, but all these parameters are important to be analysed for understanding how the treatment has to be done for slaughterhouse wastewater.

(Refer Slide Time: 05:43)

### Regulations for Slaughterhouse Wastewater Management

- ❖ Regulations are necessary to mitigate the environmental impact of slaughterhouses, and the treatment methods are used as the main regulatory requirement.
- ❖ Current regulations and discharge limits (for organics and nutrients in SWW for an adequate release to the environment) are different worldwide, including the Indian Central Pollution Control Board, the World Bank Group, the Council of the European Communities, the US EPA, the Environment Canada, the Colombian Ministry of Environment and Sustainable Development Colombia, the People's Republic of China Ministry of Environmental Protection, and the Australian and New Zealand Environment and Conservation Council.

Now regulation for slaughterhouse wastewater management, there are certain regulations. Regulations are necessary to mitigate the environmental impact of slaughterhouses and the

treatment method that have to be used are regulatory requirement. Current regulations and discharge limits are different worldwide.

That means different industries like Indian Central Pollution Control Board, World Bank Group, then the European Community, the US EPA, Environment Canada, Colombia Ministry, also the People's Republic of China Ministry of Environmental Protection, Australian and New Zealand Environmental agencies, all have different discharge standards.

(Refer Slide Time: 06:24)

**Depiction the comparison of standard limits of slaughter house waste water in different jurisdiction worldwide**

Parameter	World Bank	EU ✓	USA ✓	Canada ✓	Colombia ✓	China ✓	India ✓	Australia ✓
BOD (mg/L)	30 ✓	25	16-26	5-30	50	20-100	30-100	5-20
COD (mg/L)	125 ✓	125	N.A.	N.A.	150	100-300	250	40
TN (mg/L)	10 ✓	10-15	4-8	1.25	10	15-20	10-50	10-20
TOC (mg/L)	N.A.	N.A.	N.A.	N.A.	N.A.	20-60	N.A.	10
TP (mg/L)	2	1-2	N.A.	1.00	N.A.	0.1-1.0	5	2
TSS (mg/L)	50	35-60	20-30	5-30	50	20-30	100	5-20
pH	6-9	N.A.	6-9	6-9	6-9	6-9	5.5-9.0	5-9
Temperature (change, °C)	N.A.	N.A.	N.A.	<1 °C	N.A.	N.A.	<5 °C	<2 °C

Source: Adeshiyar et. al., 2010

So, are these discharge standards are compared here with respect to slaughter houses and these are the places where actually the slaughter houses are more present in nature. So, World Bank limits are like 30, 125, 10, with respect to BOD, COD and total nitrogen. Similarly, TOC is mostly limited in the case of China.

So, we can see the different standards which have been given by different countries including European Union, USA, Canada, Colombia, China, India, Australia, etc., and these regulations are similar in nature, but they have some variation with respect to discharge limits.

(Refer Slide Time: 07:04)

**Environmental Impact and Health Effects of Slaughterhouse Wastewater**

- ❖ The discharge of raw SWW to water bodies affects the quality of water particularly by causing a reduction of dissolved oxygen (DO), which may lead to the death of aquatic life.
- ❖ Moreover, macronutrients, such as nitrogen and phosphorus, may cause eutrophication events.
- ❖ The discharge of these nutrients triggers an excessive algae growth and subsequent decay.
- ❖ Thus, the mineralization of the algae may lead to the deterioration of aquatic life due to the depletion of DO levels.

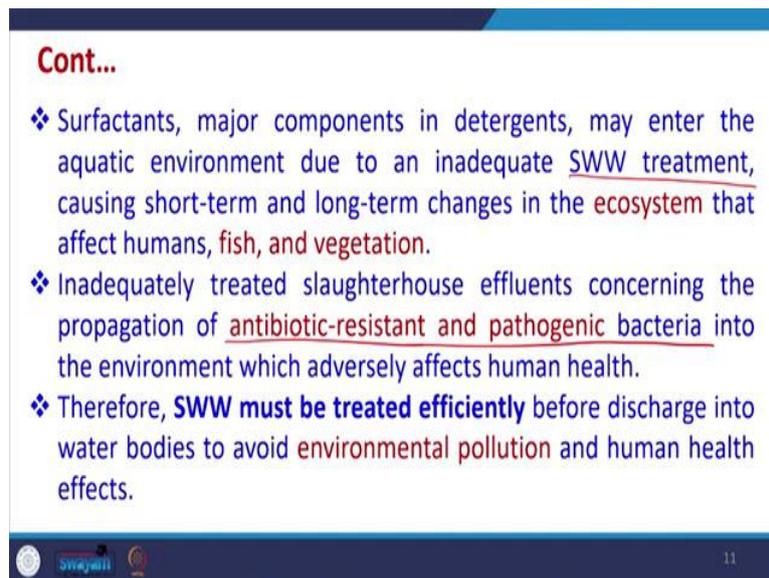
swayamii 10

Now environmental impact and health effects of slaughterhouse wastewater. The discharge of raw a slaughterhouse wastewater to water bodies will affect the quality of water particularly by causing a reduction of dissolved oxygen and which may lead to death of aquatic life. So, certainly, it will cause lot of effect.

Moreover, lot of micronutrients are present in the slaughterhouse, like nitrogen and phosphorus and which will cause lot of eutrophication. So, if untreated slaughterhouse wastewater is discharged to any river. So, the river flow will be stopped in a way because the eutrophication will happen at the place where the discharge happens and that causes lot of problem.

So, it is mandatory for the Municipal Corporation, etc., to check that there should be no raw slaughterhouse wastewater discharge to any aquatic body, otherwise that aquatic body may die because of eutrophication very soon. The discharge of these nutrients' triggers and excessive algae growth and subsequent decay. And thus, the mineralization of algae may lead to the deterioration of aquatic life due to depletion of dissolved oxygen levels and slowly and slowly that aquatic body will die.

(Refer Slide Time: 08:31)



**Cont...**

- ❖ Surfactants, major components in detergents, may enter the aquatic environment due to an inadequate SWW treatment, causing short-term and long-term changes in the ecosystem that affect humans, fish, and vegetation.
- ❖ Inadequately treated slaughterhouse effluents concerning the propagation of antibiotic-resistant and pathogenic bacteria into the environment which adversely affects human health.
- ❖ Therefore, **SWW must be treated efficiently** before discharge into water bodies to avoid environmental pollution and human health effects.

swayam 11

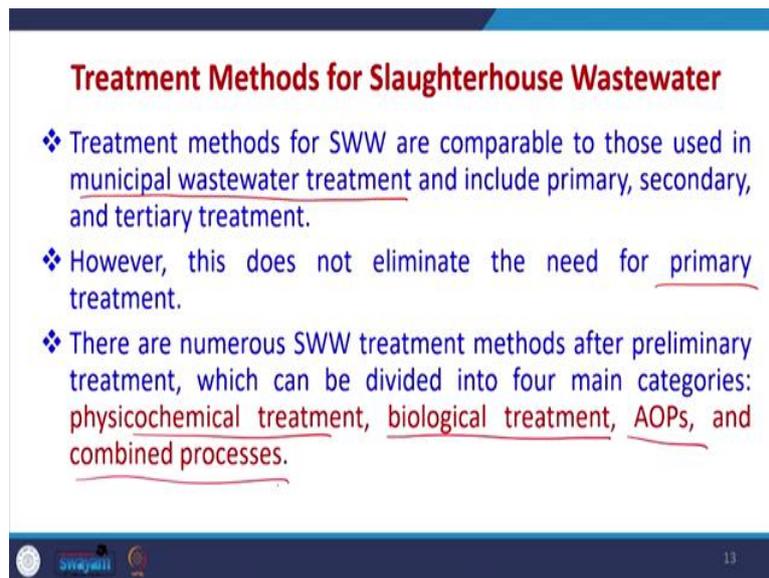
The surfactants, major components in detergents, may also enter the aquatic environment due to inadequate this slaughterhouse wastewater treatment, causing short term and long-term changes in the ecosystem that can affect humans, fish, vegetations, everybody. Inadequately treated slaughterhouse effluents concerning the propagation of antibiotic resistance and pathogenic bacteria into the environment also is a major challenge.

Because these animals may have some antibiotic resistance and they may also contain some pathogenic bacteria itself, etc. So, the wastewater which is generated from slaughterhouse is a must for treatment and it has to be treated very well. So, it must be treated efficiently before discharged into the any water bodies. Actually, it should be mostly recycled but there are certain challenges with respect to recycling of treated wastewater.

So, it can only be used in the gardening. So, in the process it is very difficult to use the recycled water. So, that means the slaughterhouse should have a very large amount of gardening area, etc., where this treated water may be used. It will be very difficult to discharge the water also into the aquatic bodies.



(Refer Slide Time: 11:27)



**Treatment Methods for Slaughterhouse Wastewater**

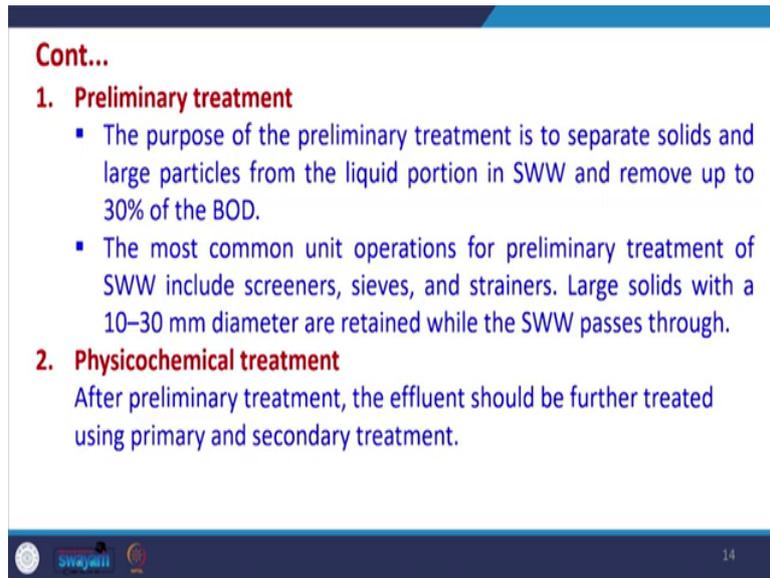
- ❖ Treatment methods for SWW are comparable to those used in municipal wastewater treatment and include primary, secondary, and tertiary treatment.
- ❖ However, this does not eliminate the need for primary treatment.
- ❖ There are numerous SWW treatment methods after preliminary treatment, which can be divided into four main categories: physicochemical treatment, biological treatment, AOPs, and combined processes.

swayam 13

Now, what are the treatment methods for wastewater, this slaughterhouse wastewater and this will be similar to the municipal wastewater treatment and they will include primary, secondary, and tertiary treatment. However, this does not eliminate the need for primary treatment. So, primary treatment will always be required because it is very difficult wastewater to be handled because there may be hair may be present in the slaughterhouse wastewater, there may be bones which may be present.

So, the slaughterhouse wastewater is difficult to be treated and it will require all stages of treatment including AOPs and combined processes. So, there are numerous treatment methods after primary treatment, which can be divided into four categories: physicochemical treatment, biological treatment, AOPs, and combined processes.

(Refer Slide Time: 12:21)



**Cont...**

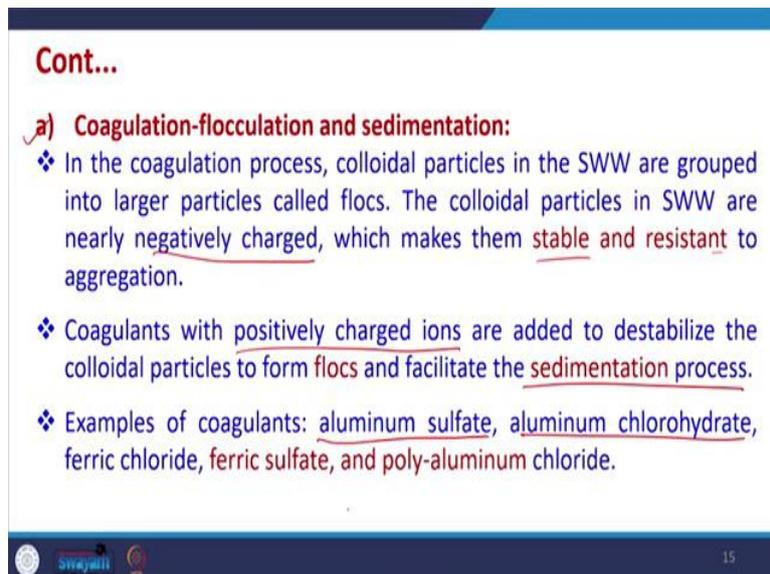
- 1. Preliminary treatment**
  - The purpose of the preliminary treatment is to separate solids and large particles from the liquid portion in SWW and remove up to 30% of the BOD.
  - The most common unit operations for preliminary treatment of SWW include screeners, sieves, and strainers. Large solids with a 10–30 mm diameter are retained while the SWW passes through.
- 2. Physicochemical treatment**

After preliminary treatment, the effluent should be further treated using primary and secondary treatment.

14

So, we will try to see. So, preliminary treatment the purpose of treatment is to separate solids and large particles from the liquid portion and in the case of slaughterhouse screener, sieves, strainers, etc., have to be used. We have to remove the skins, we have to remove the hair, we have to remove the partials, bones, etc., also during the primary treatment. Then physicochemical treatment after prevent treatment, the effluent should be further be treated using primary and secondary treatment.

(Refer Slide Time: 12:54)



**Cont...**

**a) Coagulation-flocculation and sedimentation:**

- ❖ In the coagulation process, colloidal particles in the SWW are grouped into larger particles called flocs. The colloidal particles in SWW are nearly negatively charged, which makes them stable and resistant to aggregation.
- ❖ Coagulants with positively charged ions are added to destabilize the colloidal particles to form flocs and facilitate the sedimentation process.
- ❖ Examples of coagulants: aluminum sulfate, aluminum chlorohydrate, ferric chloride, ferric sulfate, and poly-aluminum chloride.

15

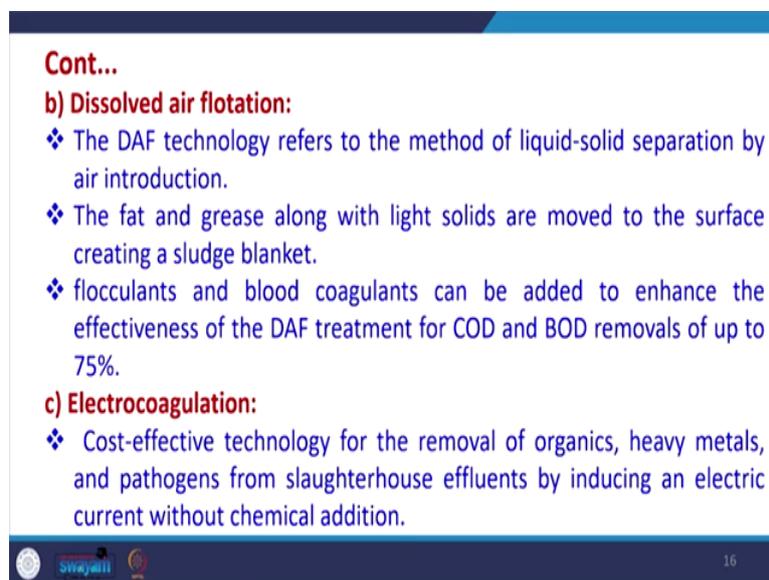
So, this primary physicochemical treatment may include coagulation, flocculation and sedimentation. So, in the coagulation process collide particles in the SWW are grouped into

larger particles called flocs. The colloidal particle in SWW are nearly negatively charged, which makes them stable and resistant to aggregation.

So, coagulants with positively charged ions are added to destabilize the colloidal particles to form flocs and facilitate the sedimentation process. Examples of coagulants include the aluminium sulphate, aluminium chloralhydrate, ferric chloride, ferric sulphate, and poly-aluminium chloride. So, we can use any one of them for the coagulation process.

We can use the dissolved air flotation also in the physicochemical treatment, that in fact, it is used very often in the slaughterhouse industries.

(Refer Slide Time: 13:47)



**Cont...**

**b) Dissolved air flotation:**

- ❖ The DAF technology refers to the method of liquid-solid separation by air introduction.
- ❖ The fat and grease along with light solids are moved to the surface creating a sludge blanket.
- ❖ flocculants and blood coagulants can be added to enhance the effectiveness of the DAF treatment for COD and BOD removals of up to 75%.

**c) Electrocoagulation:**

- ❖ Cost-effective technology for the removal of organics, heavy metals, and pathogens from slaughterhouse effluents by inducing an electric current without chemical addition.

swayam 16

The DAF technology refers to the method of liquid-solid separation by air introduction. The fat and grease along with the light solids are moved to the surface creating a sludge blanket. Flocculants and blood coagulants can be added to enhance the effectiveness of the DAF treatment for COD and BOD removals up to 75 percent.

Electrocoagulation can also be used for the removal of organic, heavy metals, pathogens from slaughterhouse effluent by inducing an electric current without chemical addition. So, this process can also be applied.

(Refer Slide Time: 14:24)

**Cont...**

- ❖ The EC process generates  $M^{3+}$  ions, mainly  $Fe^{3+}$  and  $Al^{3+}$ , using different electrode materials.
- ❖ Other electrode types, including Pt,  $SnO_2$ , and  $TiO_2$ , can interact with  $H^+$  or  $OH^-$  ions in acidic or alkaline conditions, respectively.
- ❖ removal efficiencies of up to 80, 81, 84, 85, and 96% can be achieved for BOD, TSS, TN, COD, and color, respectively.

**d) Membrane processes:**

- ❖ Different membrane processes, including microfiltration (MF), ultrafiltration (UF), nanofiltration (NF), and reverse osmosis (RO), have been used for SWW treatment to remove particulates, colloids, macromolecules, organic matter, and pathogens with overall efficiencies of up to 90%.

www.ijer.in 17

The EC process generates the metal ions, mainly iron or aluminium ions using different electrode materials. Other electrode materials using platinum,  $SnO_2$ ,  $TiO_2$ , can interact with  $H^+$  and  $OH^-$  ions in the acidic and alkaline medium, separately. Removal efficiency is up to very high can be achieved with respect to BOD, COD during electrocoagulation process.

Similarly, membrane processes, different membrane processes including micro filtration, ultra-filtration, Nano-filtration, RO, can be used for SWW treatment to remove the particulates, colloids, macromolecules, organic matters, pathogens, etc., so, these processes are also very common.

(Refer Slide Time: 15:09)

**Cont...**

**3. Biological treatment**

Biological processes include lagoons with anaerobic, aerobic, or facultative microorganisms, trickling filters, activated sludge (AS) bioreactors, and constructed wetlands (CWs) for organic and nutrient removal efficiencies of up to 90%.

**(a) Anaerobic treatment:** ✓

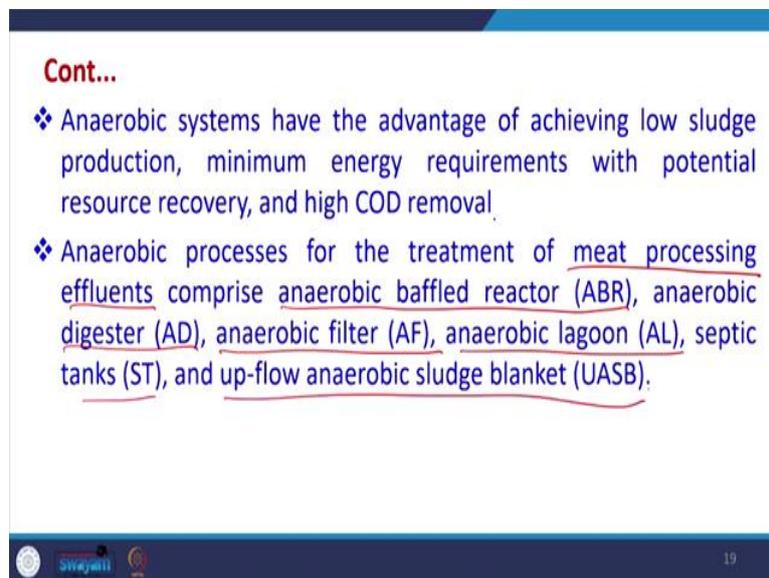
- ❖ Anaerobic digestion is the preferred method for SWW treatment due to its effectiveness in treating highly concentrated industrial effluents since organic compounds are degraded by anaerobic bacteria in the absence of oxygen into  $CO_2$  and  $CH_4$ .

www.ijer.in 18

Then we have to adopt the biological treatment also for SWW. The biological processes can include the lagoons with anaerobic, aerobic, or facultative microorganisms. Then we can use trickling filters, activated sludge bioreactors or constructed wetlands. So, any of these techniques can be used.

Broadly we can use anaerobic aerobic treatment methods, in the anaerobic digestion is preferred method for sewage for SWW treatment, due to its effectiveness in removing or treating highly concentrated effluent. So, in the organic compounds are degraded by anaerobic bacteria in the absence of oxygen to CO<sub>2</sub> and H<sub>2</sub>O.

(Refer Slide Time: 15:56)



**Cont...**

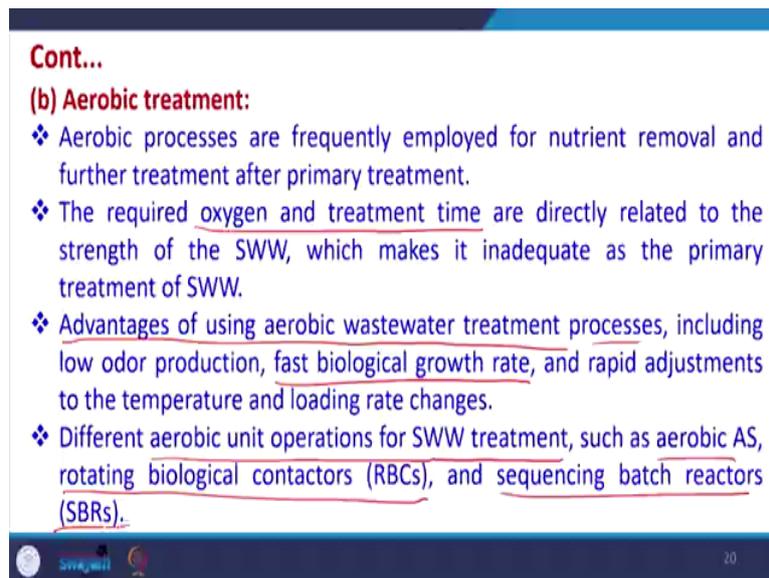
- ❖ Anaerobic systems have the advantage of achieving low sludge production, minimum energy requirements with potential resource recovery, and high COD removal.
- ❖ Anaerobic processes for the treatment of meat processing effluents comprise anaerobic baffled reactor (ABR), anaerobic digester (AD), anaerobic filter (AF), anaerobic lagoon (AL), septic tanks (ST), and up-flow anaerobic sludge blanket (UASB).

19

Now, anaerobic systems, they have the advantage in achieving low sludge production, minimum energy requirements with a potential resource recovery and high COD removal. They can be used for the treatment of meat processing effluents and anaerobic process which can be used include anaerobic buffer reactor, anaerobic digester, anaerobic filters, anaerobic lagoons septic tanks and UASB reactor.

So, any of these techniques depending upon the characteristic of wastewater can be used for treatment of meat processing effluent, or slaughterhouse effluent. Now, similarly, various aerobic processes can also be used for treatment of such wastewater.

(Refer Slide Time: 16:43)



**Cont...**

**(b) Aerobic treatment:**

- ❖ Aerobic processes are frequently employed for nutrient removal and further treatment after primary treatment.
- ❖ The required oxygen and treatment time are directly related to the strength of the SWW, which makes it inadequate as the primary treatment of SWW.
- ❖ Advantages of using aerobic wastewater treatment processes, including low odor production, fast biological growth rate, and rapid adjustments to the temperature and loading rate changes.
- ❖ Different aerobic unit operations for SWW treatment, such as aerobic AS, rotating biological contactors (RBCs), and sequencing batch reactors (SBRs).

20

And they are frequently implied for nutrient removal and further treatment of the primary treatment. So, the required oxygen and treatment time with respect to aerobic treatment is directly related to the strength of the SWW. So, depending upon the strength, what is the characteristic, whether it is low BOD, high BOD and that itself will depend upon that how much water is being used during the cleaning?

If more amount of water will be used, then certainly, the wastewater characteristics will be diluted. But there are certain regulations also with respect to that how much amount of water can be used in the, per animal slaughtered in the slaughterhouses. So, depending upon the characteristics of the Wastewater, the oxygen and treatment time will vary.

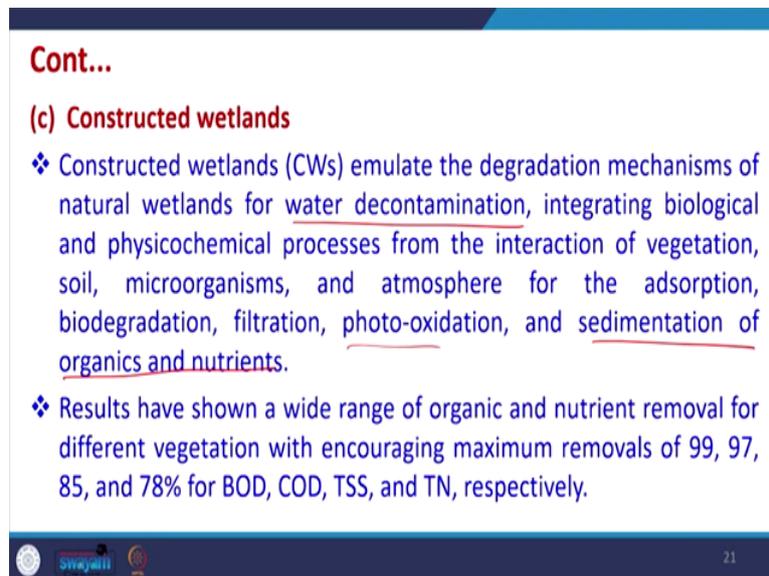
And the advantage of using aerobic wastewater treatment processes include low odor production, because in the anaerobic process odor may also get produced. So, H<sub>2</sub>S production may happen. So, the people may not feel well. So, the odor will be less produced in the case of aerobic treatment.

Fast biological growth rate can be achieved and rapid adjustment to the temperature and loading rate changes can be done. So, if the loading rate is changing in the wastewater treatment plant of slaughterhouse, then it is very difficult to take care. And also remember, slaughter houses have variable load. So, they always have to use the equalization tank otherwise the treatment system may not work well.

So, in the slaughterhouses equalization tanks are always present for maintaining a constant composition which is fed to the actual treatment system. Different aerobic unit operations of

SWW treatment include like aerobic activated sludge process, then rotating biological contractors RBCs, then SBRs can also be used for the treatment of SWW, the slaughterhouse wastewater. We can also use the construct wetlands for treatment of wastewater which is generated in the Slaughterhouse.

(Refer Slide Time: 19:05)



**Cont...**

**(c) Constructed wetlands**

- ❖ Constructed wetlands (CWs) emulate the degradation mechanisms of natural wetlands for water decontamination, integrating biological and physicochemical processes from the interaction of vegetation, soil, microorganisms, and atmosphere for the adsorption, biodegradation, filtration, photo-oxidation, and sedimentation of organics and nutrients.
- ❖ Results have shown a wide range of organic and nutrient removal for different vegetation with encouraging maximum removals of 99, 97, 85, and 78% for BOD, COD, TSS, and TN, respectively.

21

The constructed wetlands emulate the degradation mechanisms of natural wetlands for water decontamination and they integrate biological, physicochemical processes from the interaction of vegetation, soil, microorganism's atmosphere for the adsorption biodegradation, filtration, photo oxidation, and sedimentation of organics and nutrients.

So, constructed wetlands can be used, but they should be used after all the treatment has been done. So, that whatever residuals are remaining they can be further be taken care of. So, results have shown that wide range of organic and nutrients removal may happen. For a proper industry, slaughterhouse industry, where the frozen foods are also being made.

It is always suggested to have a full treatment plant which will include an equalization tank followed by all primary, secondary, tertiary treatment. Tertiary treatment may also be requiring including AOP methods and after that the water should be discharged into construction wetlands and there the treatment may further happen, then it may be used in the gardens etc., So, that all the water is used inside the industry itself.

As I told the advanced oxidation processes have many a times have to be used for treatment of slaughterhouse wastewater. So, AOPs are highly diverse and there are many methods which are present you can refer to my another set of lectures on physical chemical treatment

of wastewater where AOP methods have been described in very detail. So, you can refer to that.

(Refer Slide Time: 20:54)

**Cont...**

**4. Advanced oxidation processes**

- ❖ AOPs are diverse and include gamma radiation, ozonation, ultrasound technology (UST), UV/H<sub>2</sub>O<sub>2</sub>, UV/O<sub>3</sub>, and photocatalysis, among others, for the oxidation and degradation of organic matter.
- ❖ Main advantage of the AOPs is the high reaction rates as well as very low treatment time.
- ❖ Removal efficiencies of over 90% can be achieved for SWW secondary effluents in terms of TOC and COD as a post-treatment method.

22

There are various type of AOP methods including gamma radiation, ozonation, ultrasound technologies. Then we can use UV with H<sub>2</sub>O<sub>2</sub>, the hydrogen peroxide. We can use UV with ozone or we can use photocatalysis among others for oxidation and degradation of organic matter. So, because different types of fat, proteins, blood related materials are present in the wastewater generated from the SWW.

So these compounds are difficult to degrade because they may be aromatic in nature. So, we have to use advanced oxidation methods, so as to instigate the oxidation of all these organic matters. So, whatever residual organic matter is present after all the primary, secondary treatment that can be taken care of in the advanced oxidation process where oxidation and degradation of organic matter happens.

The main advantages of the AOP is the high reaction rates as well as very low treatment time. So, certainly the oxidation processes in the AOPs are very fast, thus, the treatment time is less, but the cost will also be higher maybe as compared to the biological treatment. The removal efficiency is more than 90 percent can be achieved for SWW in terms of secondary effluents in terms of TOC and COD as the post treatment method.

So, we always treat the secondary effluent in the AOP method to further reduce the load and after that the water may be taken to the constructed wetlands. We can use combined processes also for the treatment of wastewater which is generated in the SWW.

(Refer Slide Time: 22:50)

**Cont...**

**5. Combined processes**

- ❖ The implementation of combined processes is operationally and economically beneficial for SWW treatment since it couples the advantages of different technologies to treat high-strength industrial wastewaters.
- ❖ The combined ABR-AS-UV/H<sub>2</sub>O<sub>2</sub> system is recognized as a cost-effective solution for SWW treatment with removal efficiencies of over 95% for organics and nutrients at optimum operating conditions.

(Adeshiyani et al., 2010) 23

The implementation of the combined processes is operationally and economically beneficial for SWW treatment. Since it couples the advantage of different technologies to treat high strength industrial wastewater. Now, as I told earlier that the SWW is very complex wastewater. So, treatment technique may also require complex processes, which have to be combined together in a proper way.

So, the combined ABR-AS-UV H<sub>2</sub>O<sub>2</sub> system is recognized as a cost-effective solution for SWW treatment with removal efficiencies of 95 percent of, for organics and nutrients removal at optimum operating additions. So, the combined processes of activated sludge, then the equalization tank, then UV H<sub>2</sub>O system where we are using hydrogen peroxide along with UV for oxidation of compounds.

So, such combinations can be thought of and they may have to be used for treatment of wastewater which is generated in the slaughterhouse.

(Refer Slide Time: 24:05)



Now we can see here some processes. So, we can see here the equalization tank which is there. So, wastewater is coming here where it is being kept here for some time. We can perform the aeration within this tank itself. So, this is being performed, then we can have some aerobic treatment processes like one which is being shown here.

So, we have activated sludge process where the treatment is happening. Then we certainly will have the sedimentation process which is working out for treatment of this wastewater. We have to remove the sludge. So, for this industry because it contains lot of different types of materials including the skin or the hair, etc.

So, we have to use the filter press many times for removal of sludge from wastewater. So, a filter press is present here. Further treatment may also be requiring AOP process, wetland, etc. So, there are different technologies that have to be adopted together for treatment of wastewater which is generated in a slaughterhouse. Slaughterhouse as I told, it is a complex nature and we have to very carefully treat the wastewater.

(Refer Slide Time: 25:27)

**Waste Recovery**

- ❖ There should be separate drains/tanks for blood recovery, bone, fur, flesh, feather, or paunch content trapping, feed, or manure trapping available. The unavailability of such tanks constitutes over a 50% increase in the waste load.
- ❖ Contaminated cooling water from rendering activities should not be deposited directly into the waste stream without fat/solid particles/flesh recovery; this also increases the waste load.
- ❖ Trapping, segregating, and keeping solid particles out of the waste load reduces the biological load of wastewater and serves as a good housekeeping measure and engineered management technique for the control of wastewater from slaughterhouses because it eliminates excessive surface and groundwater pollution as well as eliminates the necessity for expensive wastewater treatment cost.

(Adeshiyani et al., 2010)

Now, the Waste Recovery. There should be separate drains are tanks for blood recovery, bone, fur, flesh, feathers, paunch, content trapping, feed, or manure trapping available. So, there are different ways which may be generated in the slaughterhouse and all have to be recovered, reused in some way or another. The unavailability of such tanks will constitute 50 percent increase in the waste load. So, this will happen if you are not able to remove.

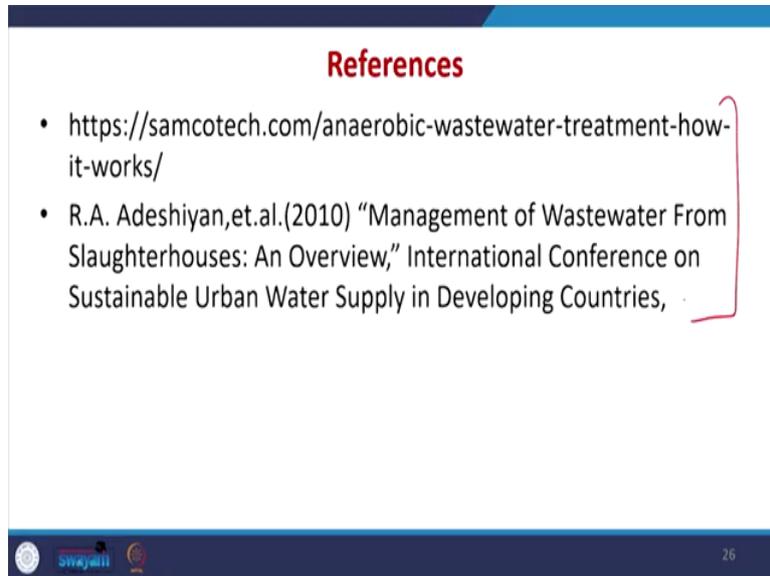
So, we can have the feathers also, we can have the skin also, we can have the hair also. So, all these things are there. Contaminated cooling tower from rendering activity should not be deposited directly into the waste stream without fat and solid particulates and flesh recovery. So, we have to see that we should be able to recover fat, solid particles, flesh beforehand the wastewater is generated. So, this is very important.

Trapping, segregation, and keeping solid particles out of the waste load reduces the biological load of the wastewater and serves as a good housekeeping measure. And thus, it will help in the engineering management technique for the control of wastewater from slaughterhouse because these are present. And slaughterhouse operations are difficult to be taken care of and many times many of them are manual in nature.

So, certainly it is problematic for the persons who are working there and also the machines though they are getting developed is still not well used in the industry. So, we have to take care of all these segregations, trapping, and keeping solid waste out of the waste load of the effluent, and that must be taken care of, otherwise the characteristics may go abundantly very high, and all the treatment system will fail in case if it is not done.

So, waste recovery is very important if we have to properly treat the wastewater generated from slaughterhouse.

(Refer Slide Time: 27:44)



**References**

- <https://samcotech.com/anaerobic-wastewater-treatment-how-it-works/>
- R.A. Adeshiyani, et al. (2010) "Management of Wastewater From Slaughterhouses: An Overview," International Conference on Sustainable Urban Water Supply in Developing Countries,

26

We have used lot of references. Some of the references are shown here. So, you can always refer to these references for further studying the treatment of management of wastewater from slaughterhouse. We will further study in the next lecture the, how the CETP works. So, we will study the common effluent treatment plant in the next lecture. Thank you.