Basic Environmental Engineering and Pollution Abatement
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Lecture 12
Environmental Quality and Standards - 2

Hello everyone. Now, we will discuss on the topic Environmental Quality and Standards, Part 2. In the Part 1 of this topic, we have discussed on the ambient air quality standards and then water quality parameters.

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Now, will continue this and we will cover water quality standards, industrial effluents and emissions and standards, noise pollution standards and vehicular pollution and standards in this class.

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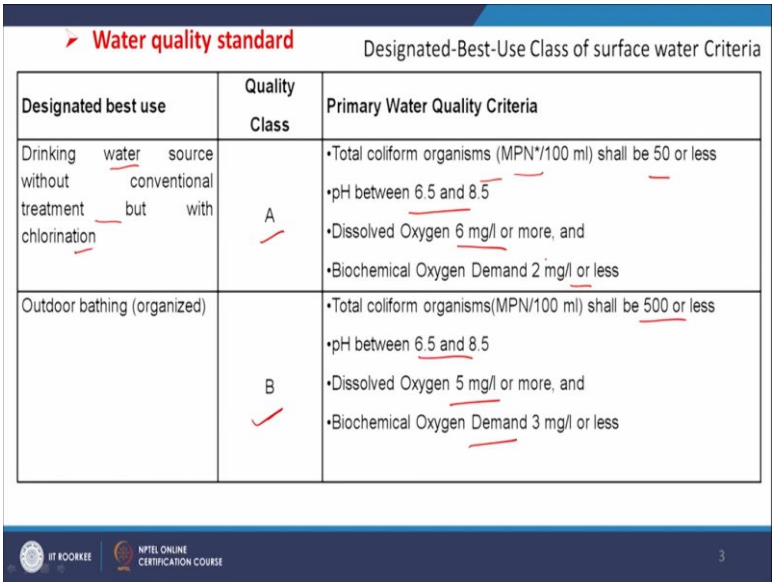

So, we have seen that TDS, TSS, etc. are some important parameters of water. Now, we will see on the basis of application, how the water can be classified and how the different quality parameter values are necessary for these applications. For example, we can classify the water into category A, B, C, D and E even less than E also. So, A category that is drinking water source without conventional treatment but with chlorination. So, this water does not require any conventional treatment except the chlorination. So, that is A class we can get it.

And in this case primary water quality criteria is total coliform organisms that is most probable number MPN per 100 ml shall be 50 or less, pH 6.5 and 8.5 in between this and dissolved oxygen 6 mg/L or more and biochemical oxygen demand 2 mg/L or less. So, this is category A. Similarly, category B that is for outdoor bathing, then it has total coliform 500 or less pH 6.5 and 8.5, the same and then dissolve oxygen 5 mg/L. So, it is lesser than that and BOD is also more than the category 1 or category A.

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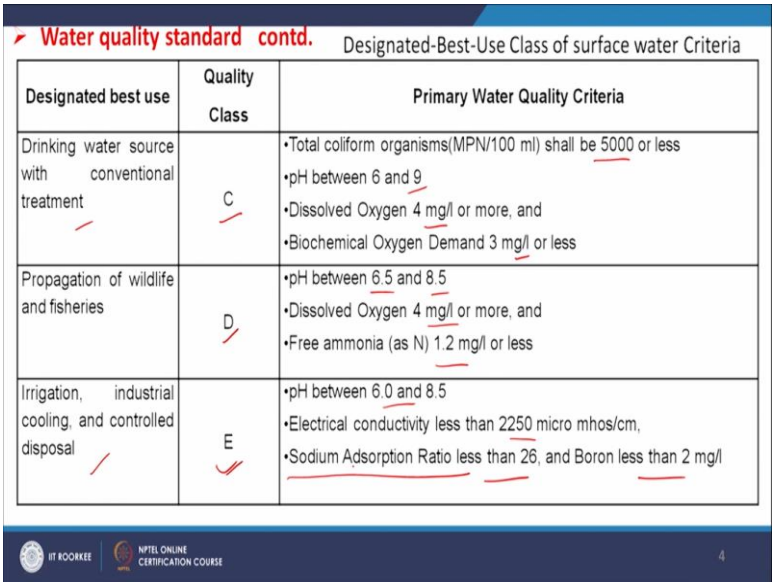

Similarly, for C category, drinking water source with conventional treatment. So, here total coliform is 5000 or less, pH between 6 and 9 and dissolve oxygen 4 mg/L and BOD 3 mg/L or less. And then category D, that is propagation of wildlife and fisheries that can be used for these applications. So, pH 6.5 to 8.5 and dissolve oxygen 4 mg/L or more and then free ammonia 1.2 mg/L or less.

Similarly, for E type, which is used for irrigation, industrial cooling and controlled disposal, is necessary for this. So, here pH is in between 6 and 8.5 and then sodium adsorption ratio less than 26 and boron less than 2 mg/L. So, these are important parameter of the E type of water. Now, one interesting point we have come to know that is sodium adsorption ratio. Now, let us see what this is.

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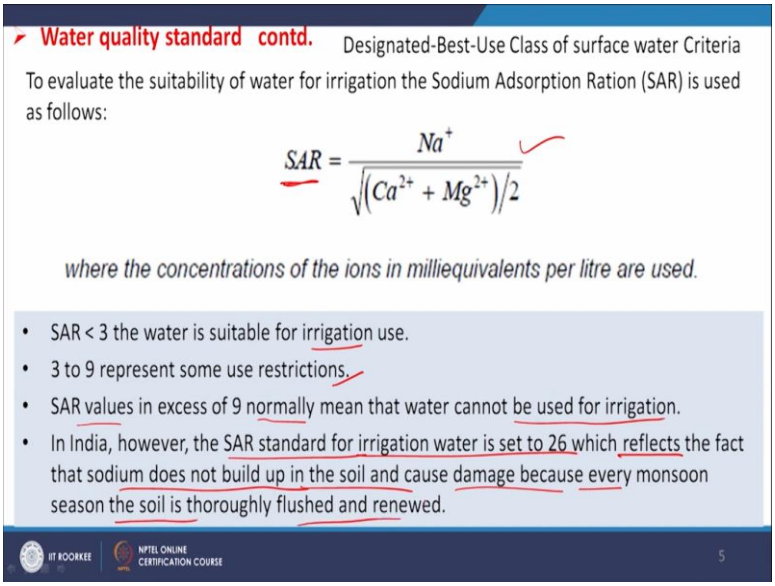

So, sodium adsorption ratio or SAR, we can mentioned here, so, this can be calculated by the formula

$$SAR = \frac{Na^+}{\sqrt{(Ca^{2+} + Mg^{2+})/2}}$$

That means the average concentration of these two, if we take the root and if we divide any plus concentration by these values then we will get the SAR or sodium adsorption ratio.

To make the water suitable for agricultural application, this SAR value should be below certain limit and that is SAR less than 3, the water is suitable for irrigation use. But if it is 3 to 9 represent some use restrictions. But SAR values in excess of 9 normally mean that water cannot be used for irrigation. However, in India SAR standard for irrigation order is set to 26. How it is possible? Because, this reflects the fact that sodium does not build up in the soil and cause damage, because every monsoon season the soil is thoroughly flushed and renewed.

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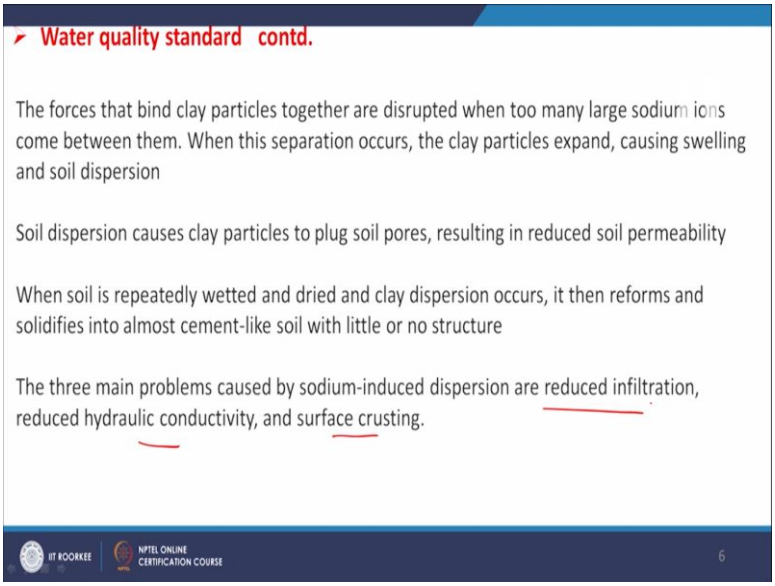

So, if sodium is present in the water, so, that will be giving some negative impact to the soil. Its electrical conductivity will be reduced. Its hydraulic conductivity will be reduced. Surface crusting can happen and infiltration property will be reduced, water penetrations will be reduced.

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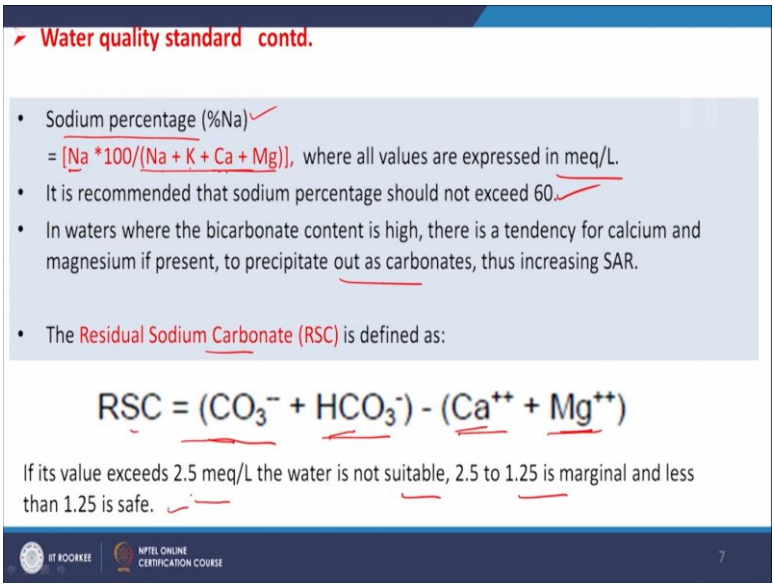

So, SAR, sodium adsorption ratio is very very important parameter of water for its agricultural application. And this term that is sodium percentage (%Na) is calculated and it is defined as

= [Na *100/(Na + K + Ca + Mg)],

and this is expressed meq/L. And this value sodium percentage value should not be more than 60.

Now, in waters where the bicarbonate content is higher then bicarbonate reacts with calcium, magnesium, etc. and precipitate out as carbonates. As a result what happens? In this formula, if calcium, magnesium is removed then this sodium percentage will increase. The residual sodium carbonate, how much sodium carbonate residual is there another parameter is also defined accordingly.

$RSC = (CO_3^- + HCO_3^-) - (Ca^{++} + Mg^{++})$

That means equivalent amount of calcium and magnesium will consume equivalent amount of these two, remaining will be available and that is called residual sodium carbonate. So, by that way also we can say how much sodium is present in the water and different parameters we are getting.

One is your sodium adsorption ratio, one is percentage of sodium another is your RSC or residual sodium carbonate. So, if its value exceeds that is RSC value exceeds 2.5 meq/L, the water is not suitable and 2.5 to 1.25 is marginal and less than 1.25 is safe. Now, we will see drinking water quality standards.

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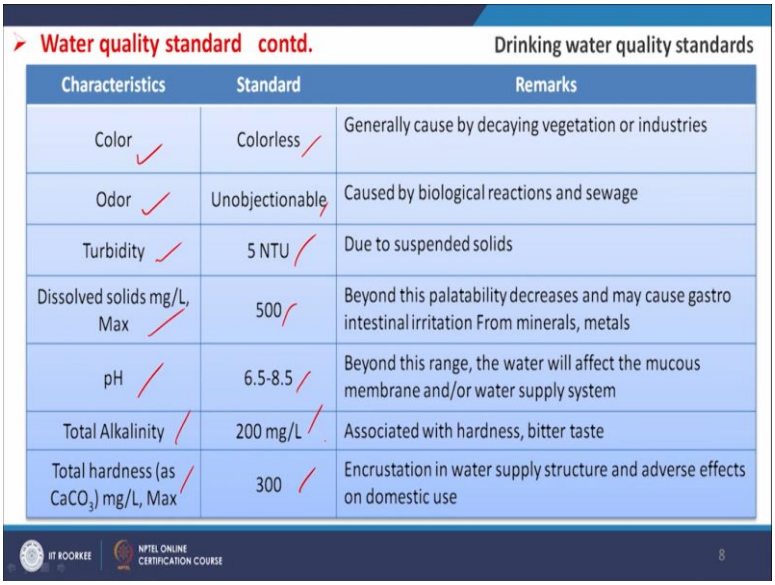

So, there are number of parameters which are considered for defining the quality of drinking water like say color, odor, turbidity, dissolved solids, pH, alkalinity that is total alkalinity,

total hardness and these are the values. So, color should be colorless, odor should not be objectionable, unobjectionable, turbidity 5 NTU and dissolved solids 500 and then pH 6.5 to 8.5 and total alkalinity 200 mg/L and total hardness 300 mg/L.

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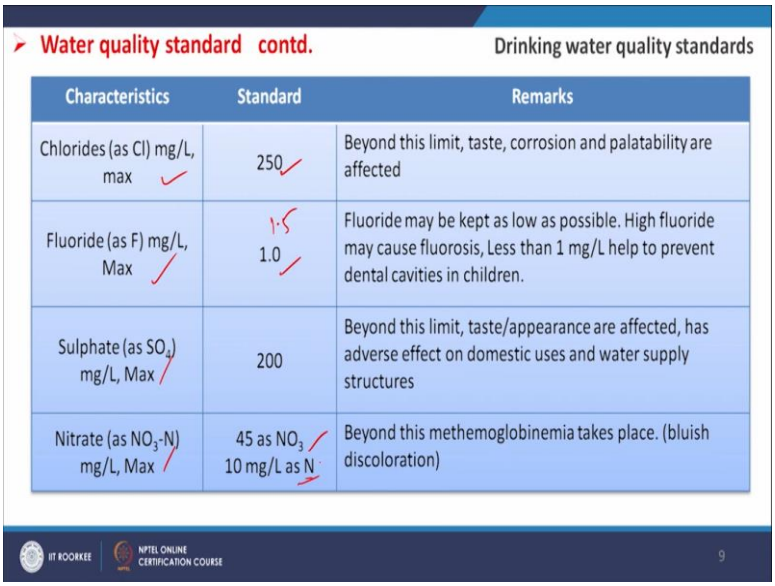

And then chlorides, fluoride, sulphate, nitrate and the values are chloride is 250 mg/L fluoride 1.5 mg/L and 200 mg/L for sulphate and nitrate as nitrate or as nitrogen. So, 45 as nitrate and 10 mg/L as nitrogen.

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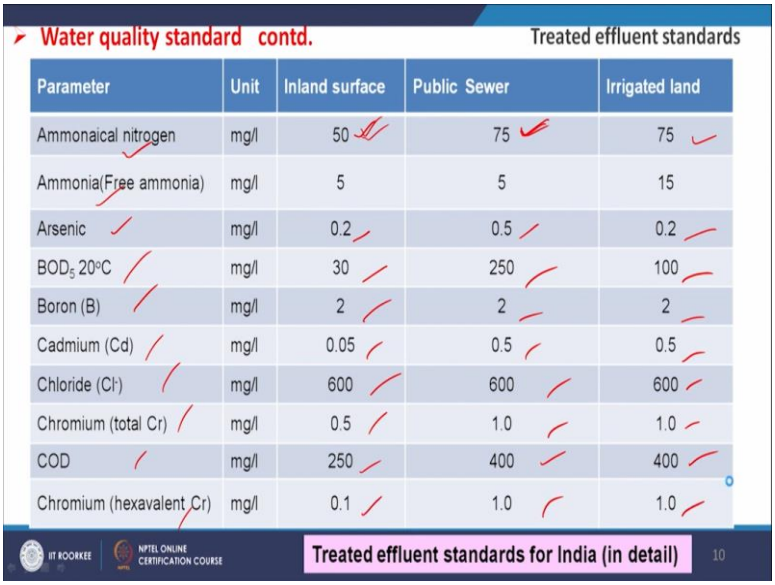

So, these are the different quality parameters of drinking water. Now, for treated effluents means any wastewater after treatment when it will come into the surface water then what will

be the quality parameters that is provided in this table. That is ammoniacal nitrogen, ammonia, arsenic, BOD5, boron, cadmium, chloride, chromium total, COD and then chromium hexavalent, so, all in mg/L and these are the values like say ammonaical nitrogen 50.

Here, we are saying that three different options for its disposal after treatment. May be inland surface water or maybe public sewer or may be irrigated land. So, public sewer means the after initial treatment the water is going to the public sewer. So, that will be further treated. So, that is why its value are quite higher, slightly higher than the inland surface water disposal.

Inland surface water means directly it is going to the river. So, here when it is going to public sewer that means it will be getting another opportunity to be treated. So, that is these values are relatively higher than this you see here. And irrigated land also the quality requirement is different with respect to inlet surface water.

So, these are the different parameter values like say arsenic 0.2 here and this is 4.5 this is 0.2 again mg/L. BOD 30, 250, 100 and boron 2, 2 and 2 mg/L, cadmium 0.05, 0.5 and 0.5 mg/L, chloride 600 in all the cases and chromium 0.5 and then 1 and 1. And then COD here 250 and public sewer 400 again it is 400 for irrigated land and chromium, hexavalent chromium 0.1, 1 and 1.

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Similarly, for copper this DO, dissolve oxygen, electrical conductivity, total dissolved solids, fluoride, sulphide, iron, total kjeldahl nitrogen, lead, manganese and mercury, the values are also provided here you see. Copper 0.5, 3 and 3. So, when it is dissolved oxygen 4.5 to 8, 4.5 to 8, 4.5 to 8. So, that is constant, the same for all the cases.

And electrical conductivity is also same for all the cases. And dissolved solids is also same for all the cases. And then fluoride, it is 7, it is 15, it is 10 and then sulfide 1, 2 and 2 mg/L, iron 2, 2 and 2. And then kjeldahl nitrogen 100, 100, 100 and lead 0.1, 0.1, 0.1 and manganese 5, 5, 5 ppm and mercury also 0.01, 0.01, 0.01 mg/L.

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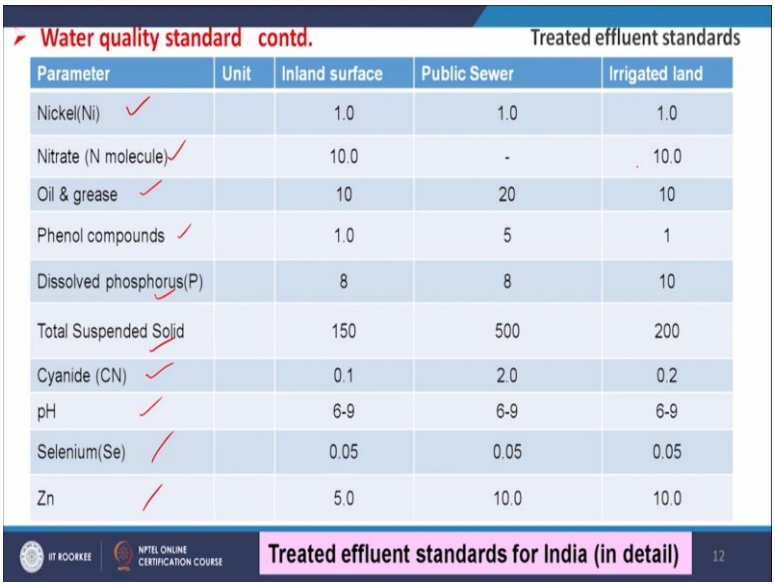

Similarly, nickel nitrate, oil and grease, phenolic compounds, dissolve phosphorous, total suspended solid, cyanide, pH, selenium, zinc, all parameters are measured and as mentioned here in this table, we will go through.

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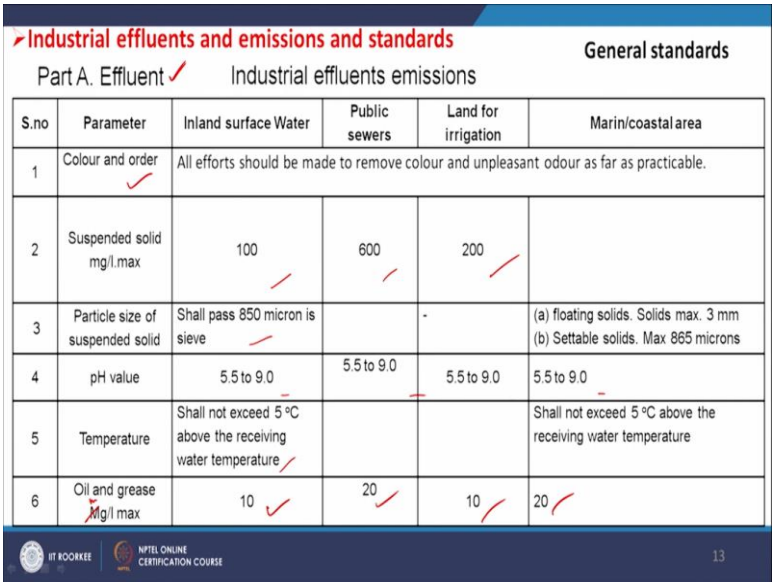

S.no	Parameter	Inland surface Water	Public sewers	Land for irrigation	Marin/coastal area
1	Colour and order	All efforts should be made to remove colour and unpleasant odour as far as practicable.			
2	Suspended solid mg/l.max	100	600	200	
3	Particle size of suspended solid	Shall pass 850 micron is sieve		-	(a) floating solids. Solids max. 3 mm (b) Settable solids. Max 865 microns
4	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
5	Temperature	Shall not exceed 5 °C above the receiving water temperature			Shall not exceed 5 °C above the receiving water temperature
6	Oil and grease Mg/l max	10	20	10	20

Now, we are going to discuss about the quality parameters and the values for industrial effluence emission. So, which emissions are come from industry basically effluent here we are talking about effluent. So, what effluent is coming from the industry after treatment in the industrial premise, it is getting entry into, similar way it may be discharged to the river through canal or it may be discharged to the public sewer for further treatment and it may be land for irrigation or it may be possible that this is available in the marine or coastal area. So, directly can go to sea.

So, that way different options are available for industrial effluents and emissions particularly the effluents. So, here the parameters are like say colour and odor. So, all efforts should be made to remove color and unpleasant odour as far as practicable. So, this is CPCB standard. We should take upmost care to remove all objectionable odor and the colours should also be acceptable.

And suspended solid that is equal to 100 for inland surface water and 600 mg/L for public sewers and 200 for land for irrigation. And particle size of suspended solids shall pass 850-micron sieve and pH 5.5 to 9 for all the cases. And temperature shall not exceed 5 ^{o}C above the receiving water temperature.

So, that we should not allow the discharge in such a way that the receiving body temperature increases more than 5 ^{o}C. I have solved one numerical problems in the previous class as well. Oil and grease that is 10 mg/L, 20 mg/L, 10 and 20 mg/L, respectively.

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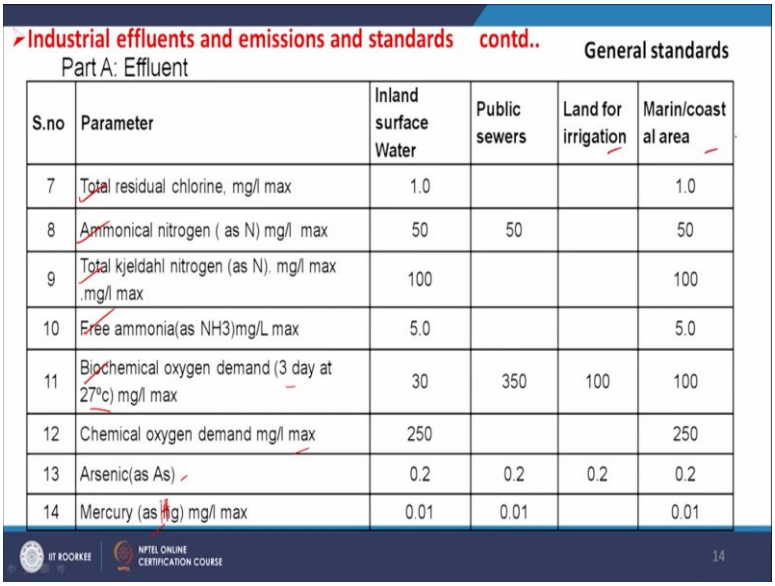

Some other general standards like say total residual chlorine, ammonaical nitrogen, total kjeidahl nitrogen, free ammonia, biochemical oxygen demand that is 3 day at 27 ^{o}C or 5 day and 20 ^{o}C whatever you can consider, chemical oxygen demand mg per liter and then arsenic and mercury as hg. So, these are the values for different disposal like say inland surface water, public sewers, land for irrigations and marine and coastal area.

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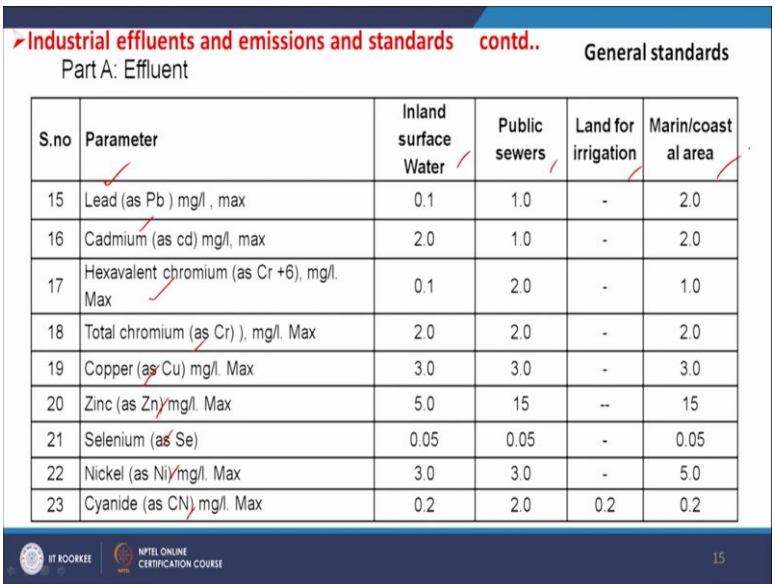

We may have lead, also cadmium, hexavalent chromium, total chromium, copper, zinc, selenium, nickel, cyanide. So, all the values are provided here for inland surface water, for public sewers, for land irrigation and then marine or coastal area.

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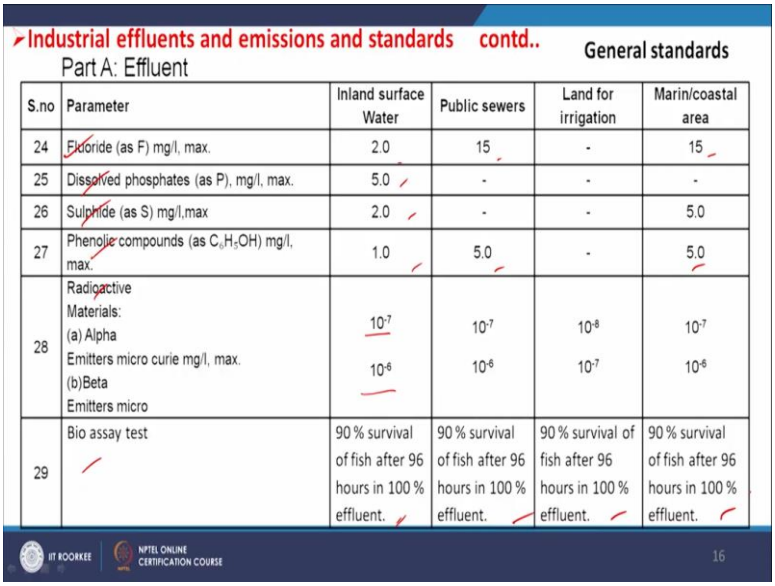

Now, again we can have others also that is fluoride, dissolved phosphates, sulfide, phenolic compounds, radioactive materials like alpha, beta, emitters materials may be present in it and bio assay test. So, these are also necessary for industrial effluents from case to case basis. In some facilities the nature of the wastewater is like this.

So, we need to ascertain that these qualities are also being satisfied. So, fluoride here 2 and it is 15 and 15 and then dissolved phosphate is 5, sulfide 2 and 5, Penelope compounds 1, 5 and 5 here. So, these radioactive materials 10^{-7} and 10^{-6} mg/L. So, this is the permissible limit and bioassay test 90 % survival of fish after 96 hours in 100 % effluent. So, this is one indication that my water is of good quality.

My fish is surviving means the water quality is good. So, automatically it gives indications that there is no problem with the water. So, that is the concept the 90 % survival of fish after 96 hours in 100 % effluent. The same is applicable for all type of discharge locations.

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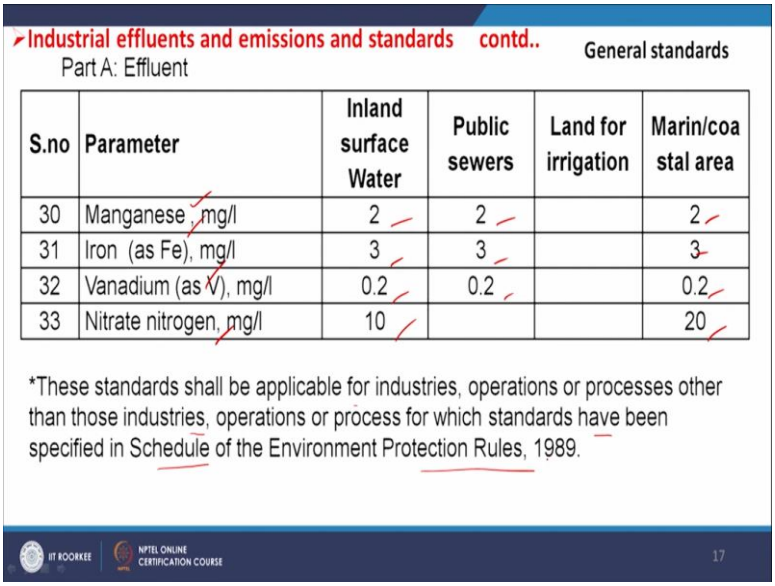

Now, we will see some other parameters also that is manganese, iron, vanadium, nitrate, nitrogen. So, here these values are from again is 2 here 2 and 2 and then iron also 3, 3 and 3 and vanadium 0.2, 0.2, 0.2 mg/L and nitrate 10 and 20, in case of marine 20 and in case of.

So, these are the general standards and these standards shall be applicable for industries, operations or processes other than those industries, operations or processes for which standards have been specified in schedule of the environmental protection rule 1989. As I mentioned you that industries produce different type of pollutants and which enter into the wastewater stream and the effluent stream. So, special treatment is needed for those industries.

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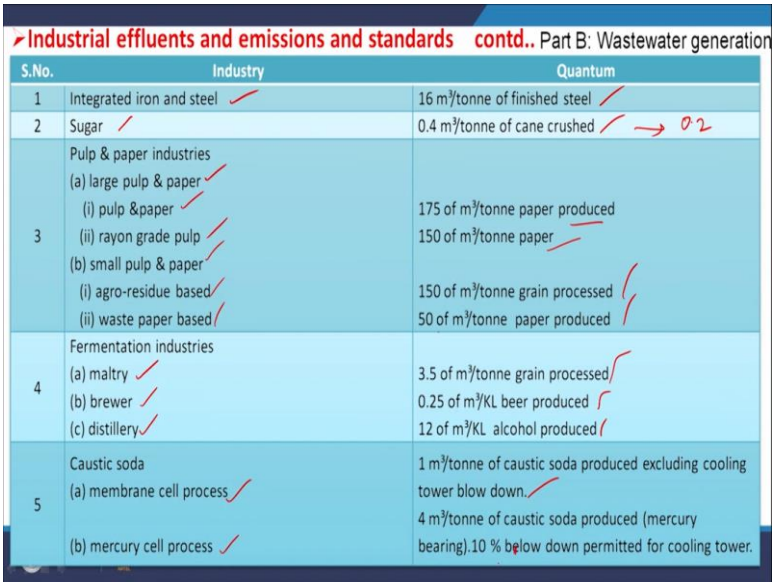

So, that way these are the, those are described for industry specific and mentioned in the CPCB and this which you have discussed. Now, that is generally applicable for all type of industries. And now, we will see some wastewater generation.

There are for industry some restriction is also there. Any type of industry, one is your quality of waste water that standard what will be the values of the quality parameters that is there, another is per production of unit amount of product, what is the water requirement or utilization, that is also given by the CPCB, that guideline is also given.

Like example say, integrated iron and steel plant if we consider. So, the quantum of water use will be 16-m^3/tonne of finished steel. Similarly, if you consider sugar then 0.4- m^3/tonne of cane crushed. Now, this value has changed now and this values changes from time to time by CPCB. It is around 0.2 now.

And then pulp and paper industries that may be large pulp and paper, pulp and paper, rayon grade pulp, small pulp and paper also, agro-residue based and waste based. So, for all these different cases we have different amount of water can be allowed. So, like for this case 175 of m^3/tonne of paper produced. Here 150- m^3/tonne that is way on like this.

And in this case, we are having for agro-residue 150- m^3/tonne of grain processed. And for waste paper based 50- m^3/tonne of paper produced. So, these are also one way of presenting the standards or the guidelines to maintain the environmental quality. And for fermentation industries, it may be maltry, brewer and distillery.

So, their water consumption are also different as prescribed by CPCB. If we consider the caustic soda then it may be membrane cell process or may be mercury cell process. So, their water requirement is also different, 1 m^3/tonne of caustic soda produced, excluding cooling tower blow down and here 4 m^3/tonne of caustic soda produced mercury bearing and 10 % blow down permitted for cooling tower.

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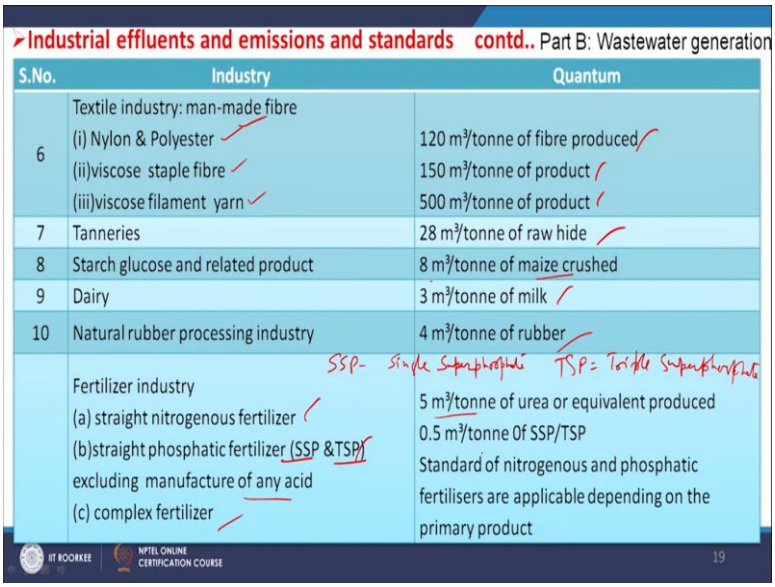

So, these are the some quantum of water use for the production of different products in these different types of industries. Now, for textile industry, it may be man made fiber, say nylon and polyester, viscose staple fiber and viscose filament yarn. So, in that case, you see, the different water requirement is recommended or guidelines has been given.

Similarly, for tanneries, it is 28- m^3/tonne of rawhide and starch glucose and related product; again, it is 8- m^3/tonne of maize crushed. And dairy, 3 m^3/tonne of milk produced, and natural rubber processing industries 4 m^3/tonne of rubber, and fertilizer industry that may be straight nitrogenous fertilizer, it may be straight phosphatic fertilizer that is single super phosphate SSP and triple super phosphate TSP.

So, here SSP single super phosphate, and TSP. For the production of these two, SSP and TSP, chemicals are different. For SSP, we can use sulphuric acid, for TSP, we use phosphoric acid and so, their water requirement is also may be different to some extent. And that is why you see here, straight phosphatic fertilizer excluding manufacture of any acid and then complex fertilizer. So, here the recommended water requirement are different.

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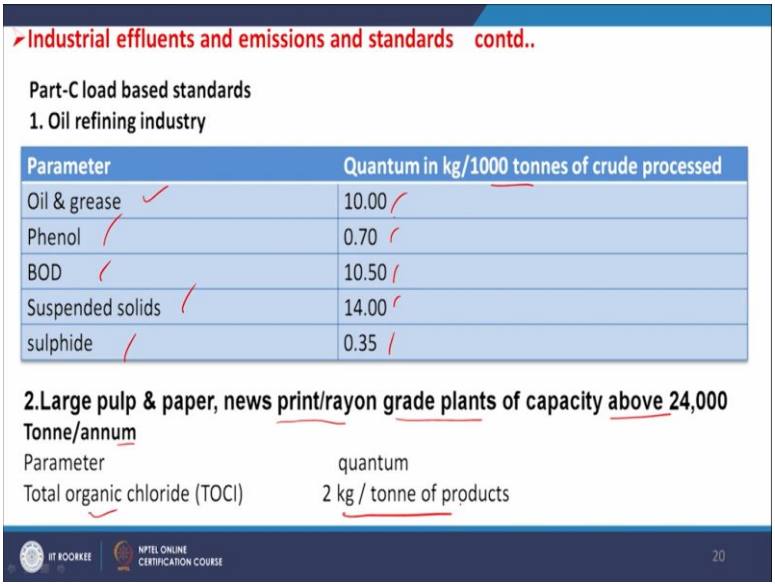

Now, we will see load based standards. So, we have seen the general standard then we have seen that the another type of standard that is per product how much water can be used, so, that way or can be generated, waste water can be generated that way. And this is load-based standard. That is say oil refinery industry. So, oil and grease, phenol, BOD, suspended solids and sulfide. So, we have seen that for wastewater, general standard will be applicable.

Apart from that, quantum in kg per 1000 tons of crude process that also be applicable for this type of industry. Like say oil-refining industry. So, oil and grease 10 kg per 1000 tonne of crude processed. Phenol 0.70, BOD 10.50, suspended solids 14 and sulphide 0.35. So, these are on load-based standards. Similarly, large pulp and paper, newsprint, rayon grade plants of capacity above 24000 ton per annum, in that case, total organic chloride TOCL that is 2 kg/ tonne of products. So, these are also some load-based standards given for different types of industries.

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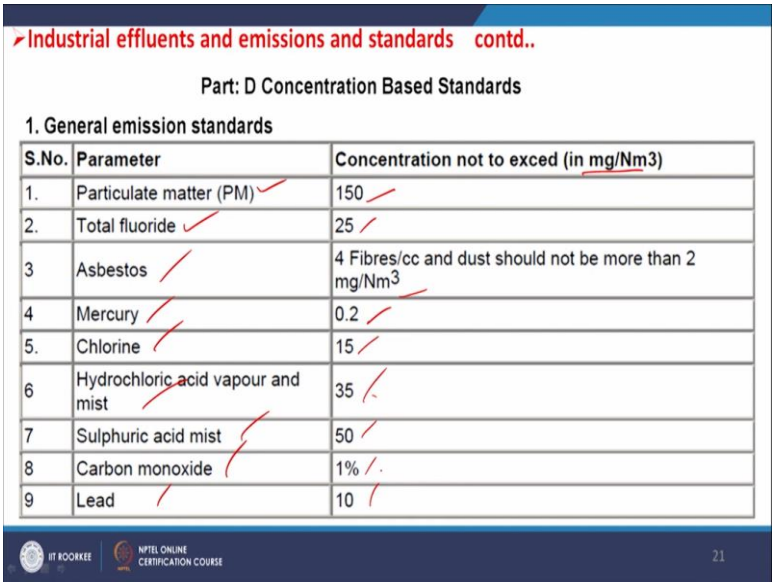

Now, we will be discussing on the emission that is concentration-based standards, general emission standards. It is shown here, the different parameters that is particulate matter, total fluoride, asbestos, mercury, chlorine, hydrochloric acid vapor and mist and then sulphuric acid mist, carbon monoxide, lead.

So, you see the values here. So, that is in mg/Nm^3. The concentration should not be more than that. That is, for particulate matter should not be more than 150 mg/Nm^3. So, total fluoride should be less than 25 mg/Nm^3 or equal to and then for asbestos 4 fibers per cc and dust should not be more than 2 mg/Nm^3.

Mercury 0.2 mg/Nm^3. Chlorine 15 mg/Nm^3. Hydraulic acid vapor 35 mg/Nm^3 and sulphuric acid mist 50 mg/Nm^3 and carbon monoxide is 1%, lead 10 mg/Nm^3. So, this is we are talking about the emission, the concentration of these pollutants in the air.

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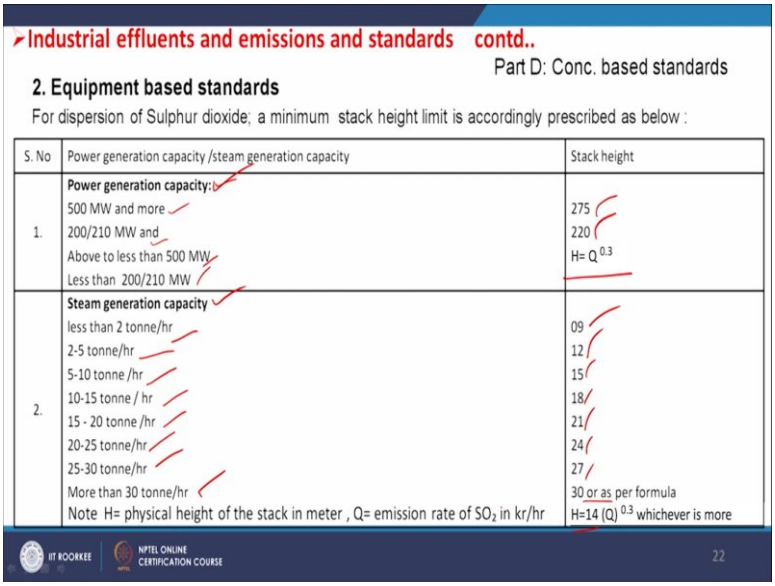

And equipment based standards are also available. For example say, power generation capacity, say, power generation capacity, steam generation capacity will help to decide the stack height. For example, if 500 MW plant or its more than 500 MW. So, stack height is 275 and then here 200 to 210 MW and above or less than 500 MW, it is 220. It is less than 200 or 210 MW. So, that can be determined by H equal to Q to the power 0.3, where Q is emission rate of SO_2 in kg/h.

So, similarly, steam generation. This is power generation capacity, similarly, for steam generation capacity, less than 2 tonne/h, less than 2 to 5 tonne/h, 5 to 10 tonne/h, 10 to 15 tonne/h, 15 to 10 tonne/h, 20 to 25 tonne/h and 25 to 30 tonne/h, more than 30 tonne/h.

So, here the heights are also given that is 09. So, 12, 15, 18, 21, 24, 27 and 30 or as per formula, this formula we can use. Whichever is more that we have to use. When H, is the physical height of the stack in meter and these are all in meter and Q is the emission rate of sulphur in kg/h.

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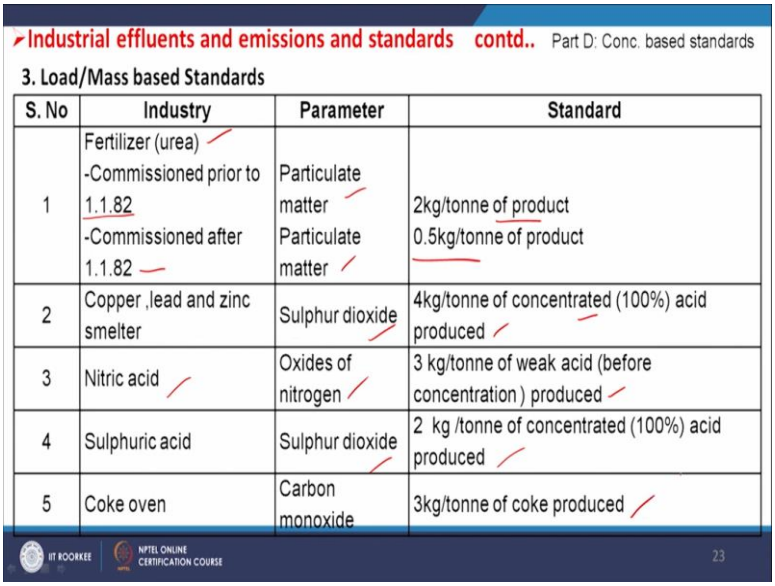

Then load or mass based standards are also available. So, that is fertilizer urea plant, which is commissioned prior to 1st January 1982 and somewhere which is commissioned after this time period. So, particulate matter, particulate matter are parameter for consideration and in this case 2 kg/tonne of product or here 0.5 kg/tonne of product.

Similarly, for copper, lead, zinc, smelter, sulphur dioxide is our parameter and 4 kg/tonne of concentrated acid produced. Similarly, for nitric acid, oxides of nitrogen is of quality parameter and 3 kg per tonne of weak acid produced and sulfuric acid, sulphur dioxide and here standard 2 kg per ton of concentrated acid produced. And coke oven that is carbon monoxide and 3 kg per ton of coke produced. So, these are the standards.

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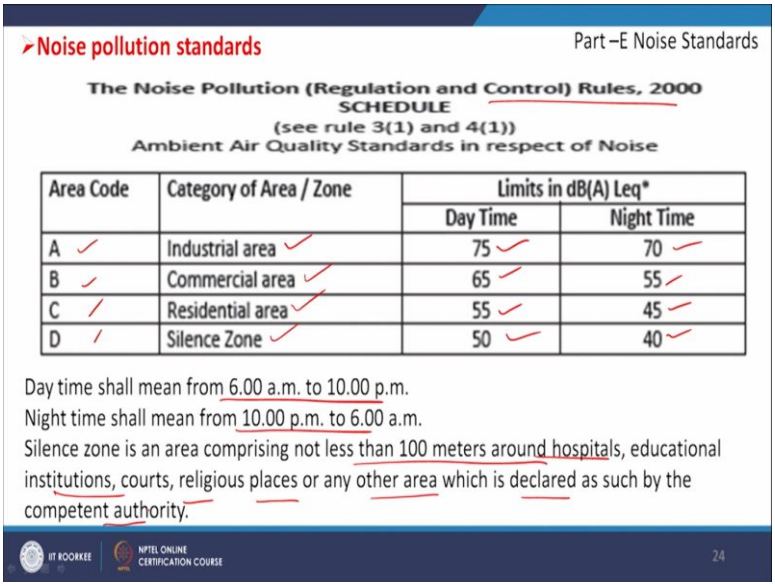

Now, we will see the noise standards. So, The Noise Pollution Regulation and Control Rules 2000. As per this rule say, industrial area, commercial area, residential area and silence zone has been identified, say area code A, B, C, D and for this day time and night time noise level is defined.

For A daytime 75, nighttime 70, for B that is commercial area, it is 65 and 55, and residential area 55 and 45, and the silence zone 50 and 40. So, this is, now, this daytime and nighttime. What is daytime? The daytime is 6 am to 10 pm and nighttime 10 pm to 6 am. And silent zone is an area comprising not less than 100 meters around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority. So, this is the standard of noise pollution.

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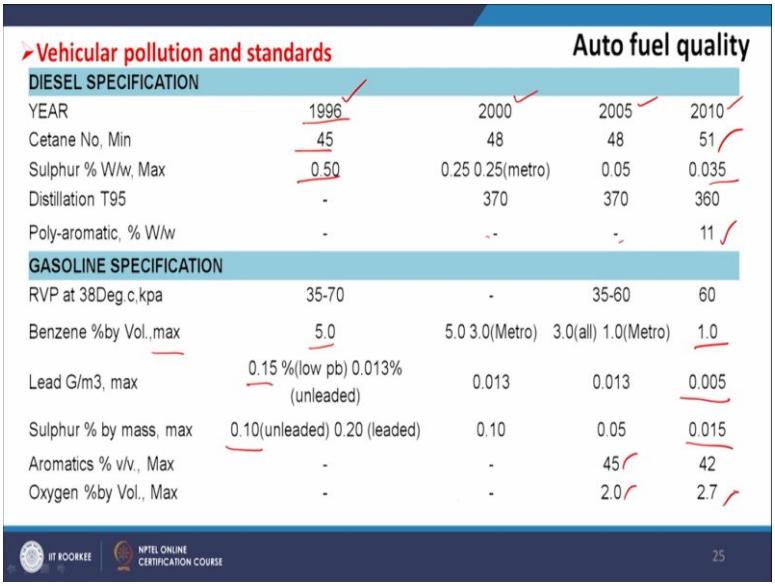

And now, we will see the auto fuel quality standard. So, if we see the diesel specification and gasoline specification, so, in 1996, we had one specification, 2000, it was modified, 2005, it is modified, 2010, it is modified. So, what we see here, the quality parameters are becoming more stringent. So, 1996, you see cetane number 45.

Now, it has increased to 51 in 2010 and sulphur was 0.5 %. Now, it has been reduced to 0.035 at 2010. And then poly aromatics was not considered at that time but 2010, it is considered, that is 11 %. So, that is for diesel. And similarly for gasoline also. You see benzene, it was 5 in 1996, it has reduced to 1 in 2010.

Lead, it was 0.15; it has been 0.005 in 2010. Sulphur 0.1. Now, it is reduced to 0.015. So, aromatics and oxygen were not there. So, these were introduced in 2005, with higher value and 2010, these values are also changed. So, this is the fuel quality standard. Now, vehicular emission norms are also available in the country.

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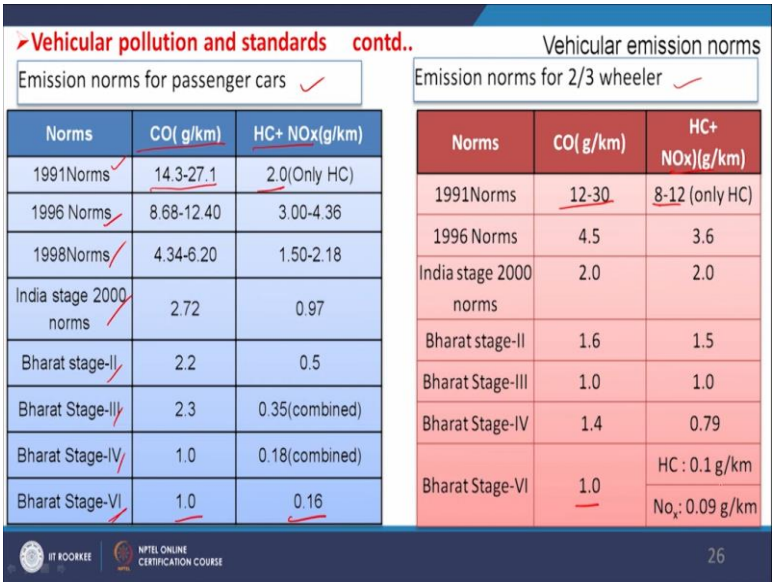

These norms are applicable for cars, for two-wheeler, three-wheeler and for buses, heavy vehicles that is called and those standards are different. So, 1991 the first norms, we had on this. Then 1996 norms, 1998 norms, 2000 norms. Now, we have after 2000, we have Bharat stage II, stage III, stage 4 and directly stage 6. It is implemented is 2021.

So, you see here, carbon monoxide generation in gram per kilometer of travel was 14.3 to 27.1 in 1991, but now, it has reduced to 1. So, drastically changed, the rules have, the regulation had changed. Similarly, hydrocarbon and NOx, it has been changed from say 2 to 0.16. So, you see how drastically the changes have been made in the quality, to regulate the air quality.

And for two three wheelers also here like this. So, again also you see 12-30, 12 to 30 CO g/km, here it is 1 and here is hydrocarbon plus NOx g/km, it was a 8 to 12. Now, here only hydrocarbon 0.1 g/km and NOx, 0.09 g/km. So, extremely the values have been reduced to maintain the air quality.

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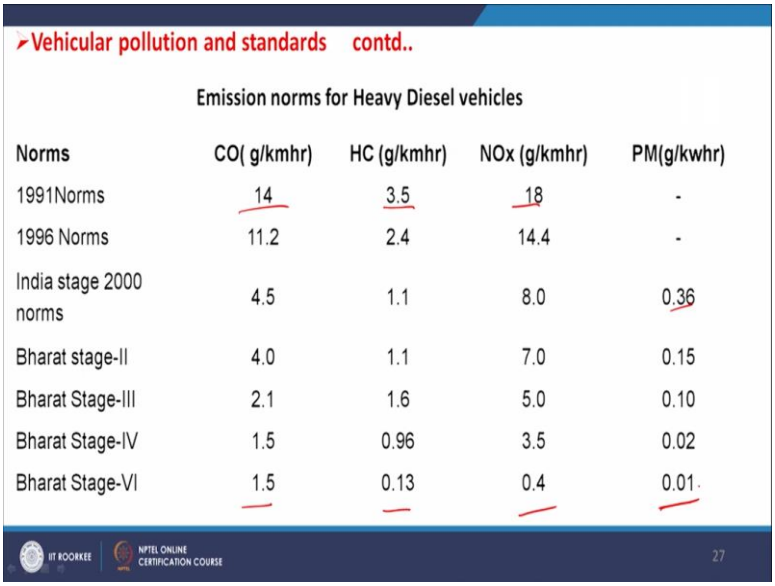

And here, emissions from the heavy diesel vehicles like say buses, trucks, etc. Here also the norms had changed. You see, how drastically it had changed. So, hydrocarbon also changed, NOx had changed and PM was not there included at that time, it has been included midway and now, it has been reduced to a very lower value. Up to this in this class, and thank you very much for your presence.