Waste to energy conversion

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Lecture – 06
Tutorial on characterization of waste

Hi friends. Now we will start discussion on Tutorial on Characterization of Wastes under Waste to Energy Conversion course. In this module we will discuss on characterization of waste and solve some numerical problems on the characterization of solid waste as well as waste water.

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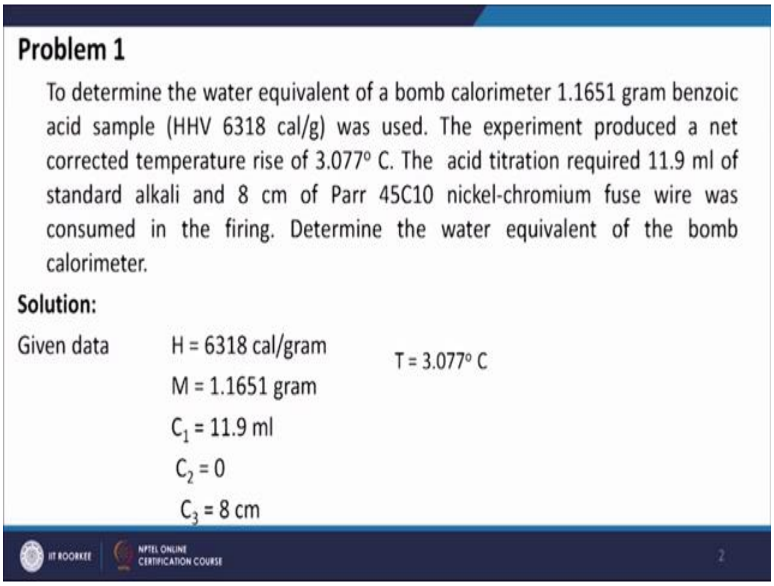

So, the first problem is to determine the water equivalent of a bomb calorimeter 1.1651 gram benzoic acid sample high heating value of 6318 calorie per gram was used, the experiment produced a net corrected temperature rise of 3.077 degree centigrade, the acid titration required 11.9 milliliter of standard alkali and 8centimeter of Parr 45 C 10 nickel chromium fuse wire was consumed in the firing, determine the water equivalent of the bomb calorimeter. So, this is the problem statement: so we have to determine the water equivalent of the bomb calorimeter.

So, how to solve this problem? In the previous module we have discussed that in bomb calorimeter the certain amount of fuel is used and it is combusted under high oxygen pressure, and the released heat is taken up by the bomb and the water in the bucket, and the temperature rise is determined then heat balance equation is applied to calculate the heating value of the material. And when the heating value of the material is known then we can get the value of water equivalent.

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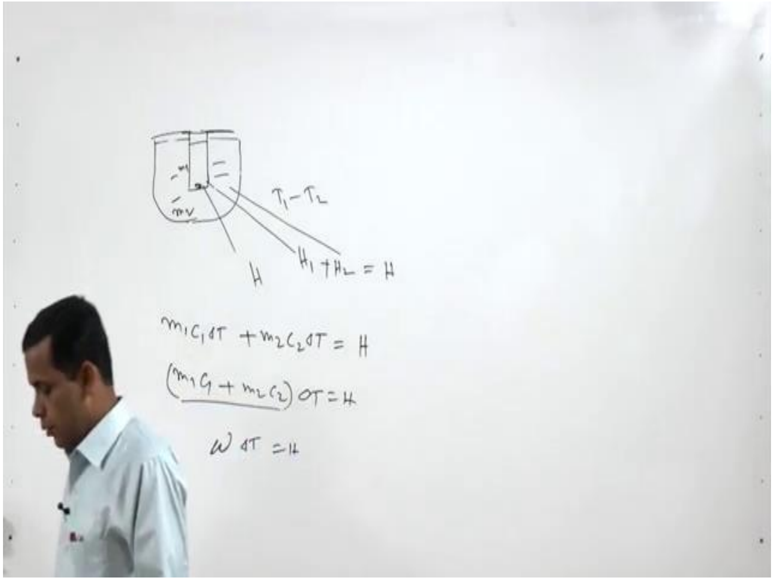

So, what happens in case of bomb calorimeter see this is the bucket say 200 to 2 liter volume inside this we have 1 bomb, and inside this we have some certain amount of solid waste or any fuel. So, this is combusted temperature increases from say T 1 to 2 T 2, T 1 is the ambient temperature and then T 2. So, heat released by this that is H is taken up by the water here as well as the bomb the whole bomb is in the water; so heat taken up by this bomb plus heat taken up by the water; so H 1 plus H 2 that is equal to heat released by the solid material.

Now, H 1 H 2 will be m 1 C 1 into del T, and m 1 is the mass of this bomb and C 1 is the heat specific heat of this, and then m 2 C 2 del T, and m 2 is the mass of water here and this is the m 1 is the mass of this bomb, and the C 2 is the specific heat of this water; so del T. So, this is the total heat that is equal to H which is generated due to the combustion of this. Now m 1 C 1 plus m 2 C 2 into del T or we can write equal to H or we can write that is equal to W del T equal to h. So, then m is equal to this one. So, there is water equivalent of the bomb calorimeter; now for the determination of water equivalent of this value we need H we need del T.

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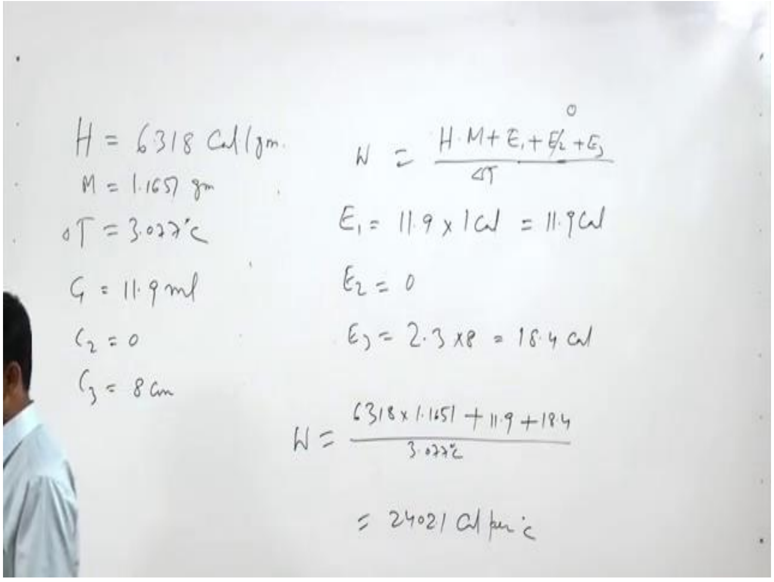

In this case H is equal to 6318 calorie per gram and then m is equal to m is the mass in this case this is 1.16 1.1651 gram; del T is equal to a cap T is equal to 3.077 degree centigrade this is del T, and C 1 is equal to what that is standard a alkali required for acid correction that is 11.9 ml, and C 2 is equal to 0; sulfur percentage of sulfur that is equal to 0 and C 3 is equal to 8 centimeter that is the length of the fused wire. So, if we want to get the value of water equivalent water equivalent W c. So, that W is equal to into m that is the mass of the fuel which is taken, and then divide by del T and it will be requiring some correction. So, some correction that is heat released due to this E 1 that is due to the acid correction and E 2 plus E 3; now E 2 is equal to 0 H s is equal to 0.

Now, what is E 1? E 1 is the error associated with the acid formation. So, this E 1 is equal to we can get ml of standard alkali required in milliliter that is 11.9 into 1 calorie. So, that is equal to 11.9 calorie. What is equal to E 2? 0; E 3 is equal to 2.3 into C 2, C 2 into centimeter. So, C 2 in this case is equal to 8 centimeters. So, we will multiply it into 8. So, that is equal to 18.4, so 18.4 calories.

So, now will we having the value of W is equal to H is equal to 6318 into m 1.1651 plus E 2 is equal to 11 point a 1 is equal to 11.9, plus C to equal to 0 and E 3 is equal to 18.4 divided by del T is equal to 3.077 degree centigrade. So, then W is equal to we are getting to 4021 24.21 calorie per degree centigrade. So, this is the water equivalent of the bomb calorimeter.

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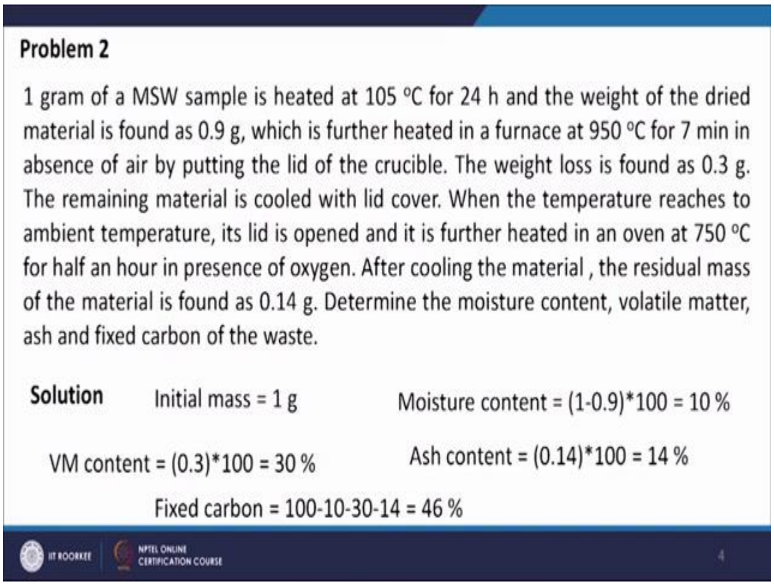

Now, let us go to next problem. So, another problem statement is 1 gram of a MSW sample is heated at 105 degree centigrade for 24 hour, and the weight of the dried material is found at 0.9 gram, which is further heated in a furnace at 950 degree centigrade for 7 minute in absence of air by putting the lid of the crucible. The weight loss is found at 0.3 gram, the remaining material is cooled with lid cover when the temperature reaches to ambient temperature, its lid is opened and it is further heated in an oven at 750 degree centigrade for half an hour in presence of oxygen. After cooling the material the residual mass of the material is found at 0.14 gram, determine the moisture content volatile matter ash and fixed carbon of the waste.

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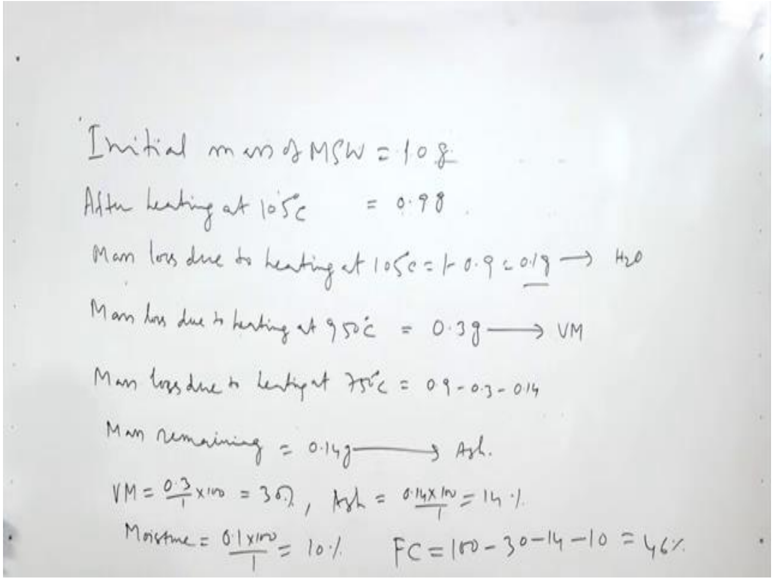

So, in this statement when we apply sheet to the waste at 105 degree centigrade, it losses some mass that is due to the moisture. So, initial mass is equal to 1 gram of MSW, 1 gram after heating at 105 degree centigrade this is equal to 0.9, gram mass loss due to heating at 105 degree centigrade is equal to 1 minus 1 gram; this is because of H 2 O this is because of water moisture. Now this remaining mass 0.9 gram is heated at 950 degree centigrade for 7 minute. So, mass loss due to heating at 950 degree centigrade is equal to directly the loss is given that is 0.3 gram. So, 0.3 gram this is corresponding to VM volatile matter and in the hard space when the lid is opened and oxidation takes place and the mass loss is related to ash present in it.

So, mass loss due to heating at 750 degree centigrade is equal to 0.9, minus 0.3, minus 0.14, but this is not required we need mass remaining mass remaining is equal to 0.14. So, that mass remaining this will give us ash content, this will give us ash contained therefore, what is the percentage of volatile matter? Volatile matter is equal to 0.3 divided by 1 into 100 that is equal to 30 percent. What is the ash content? Ash content is equal to 0.14 into 100 divided by 1 that is equal to 14 percent, and then moisture content is equal to mass loss that is 0.1 gram. So, 0.1 into 100 divided by 1 is equal to10 percent then the rest is fixed carbon. So, fixed carbon we can calculate differentiating 100 by this. So, 30 minus 14 minus 10 that is equal to 46 percent.

Now, we have been able to calculate the moisture fixed carbon ash content and volatile matter content of the solid waste.

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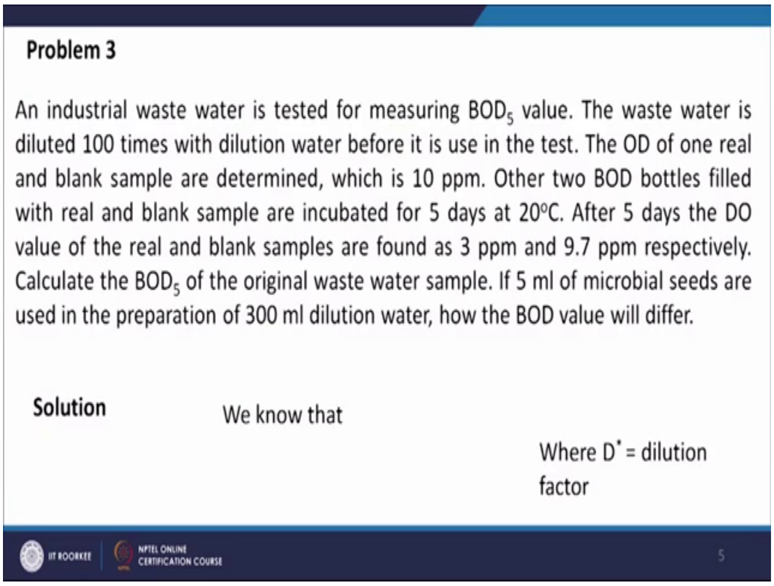

Now, we will go to next problem; the statement is an industrial waste water is tested from measuring BOD 5 value the waste water is diluted 100 times with dilution water before it is used in the test, the DO dissolved oxygen of 1 real and blank sample are determined which is 10 ppm other 2 BOD bottles filled with real and blank samples are incubated for 5 days at 20 degree centigrade, after 5 days they do value of the real and blank samples are found as 3 ppm and 9.7 ppm respectively; calculate the BOD 5 of the original waste water sample if 5 ml of microbial seeds are used in the preparation of 300 ml dilution water how the BOD value will differ. So, this is the problem statement.

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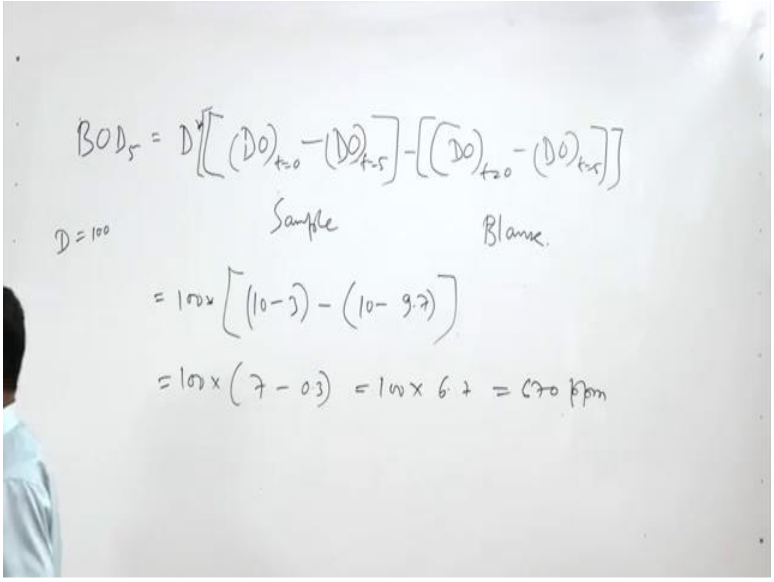

Now, the BOD 5 this value will depend upon the dissolved oxygen remaining after 5 days, and what is the dissolved oxygen has T equal to and T equal to 0 and blank test is also done to get some correction if there is any error due to the presence of dilution water. So, the expression is BOD 5 in mg per liter is equal to dilution factor into do T equal to 0, minus do T equal to 5 is equal to for sample minus do T equal to 0, minus do T equal to 5 for blank. Now D is the dilution factor in this case d is equal to 100. So, this value is equal to 100 into do T equal to 0 for sample that is 10 minus do T equal to 5 for sample that is equal to 3, minus do T equal to 0 for blank time minus 9.7 that is equal to 100 into 7 minus 0.3, 7 minus 0.3. So, that is equal to 100 into 6.7. So, it is equal to 670 ppm per mg per liter, so 670 ppm or mg per liter.

Now, the second part of this problem is if high ml of microbial solution is added the seeds is added in the dilution order, in that case the expression is this into f this is equal to f; fine f is ratio of the seed volume in dilution solution to seed volume in BOD test on seed.

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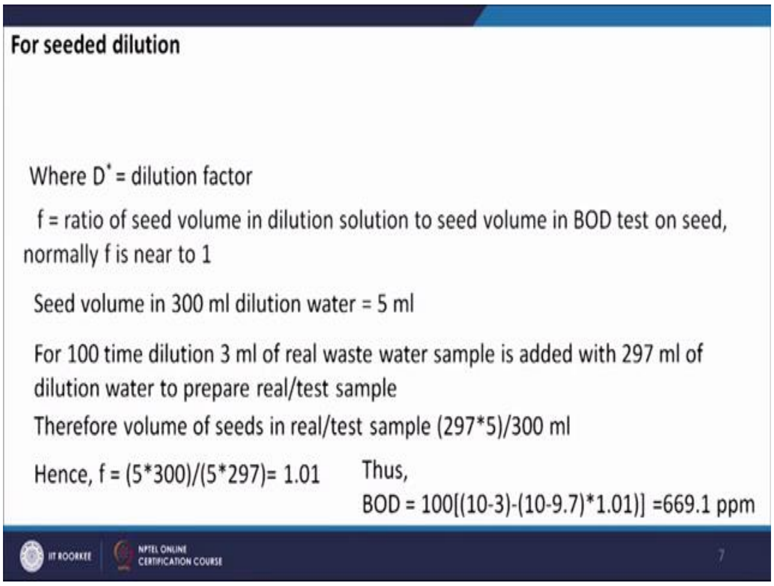

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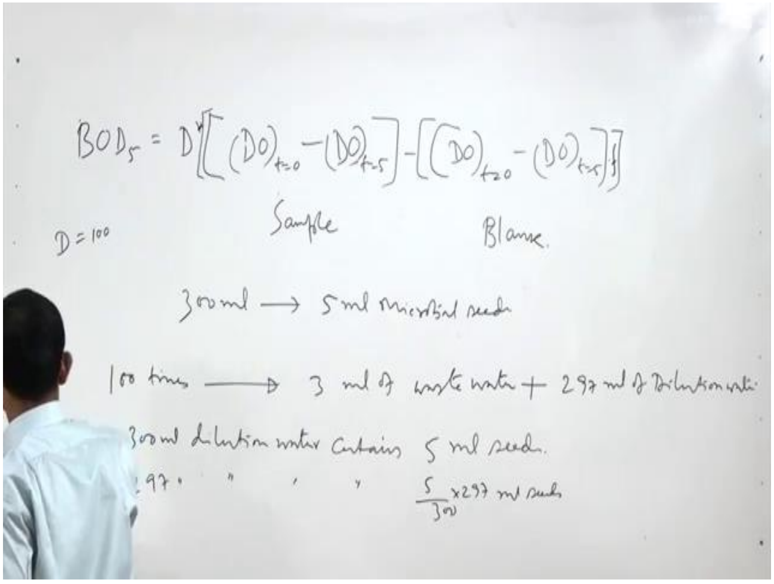

So, for the preparation of dilution solution 300 ml contains 5 ml of microbial solution; microbial seeds 5 ml, when dilution is 100 times means 3 ml of solution waste water plus 297 ml of dilution water, now 300 ml dilution water contains 5 ml of seeds. So, 297 ml dilution water contains 5 by 300 into 297 ml seeds then that is f; f is equal to f is equal to 300 into 5 divided by 5 into 297. So, that is equal to we are getting 1.01.

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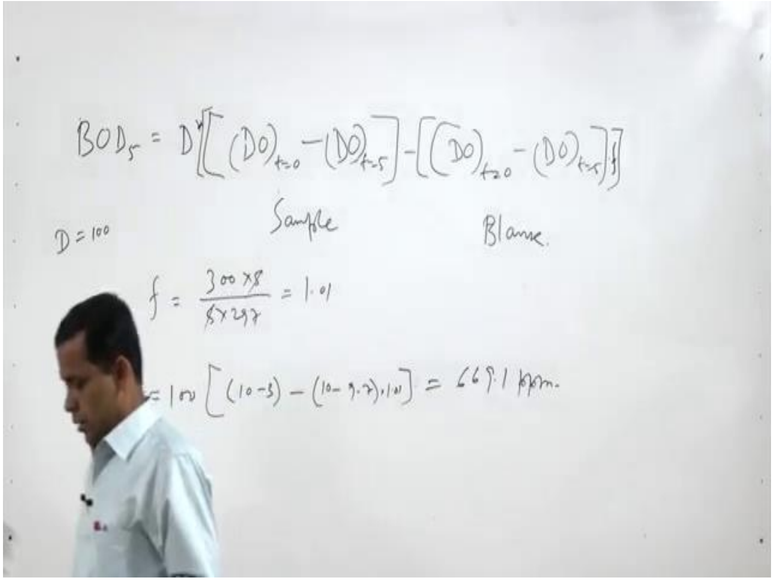

Therefore BOD 5 will be 100 into 10 minus 3 minus 10 minus 9.7 into 1.01, and that is equal to 669.1 ppm. So, there is slight difference that was 670 now 669.1 because f value is very near to 1.

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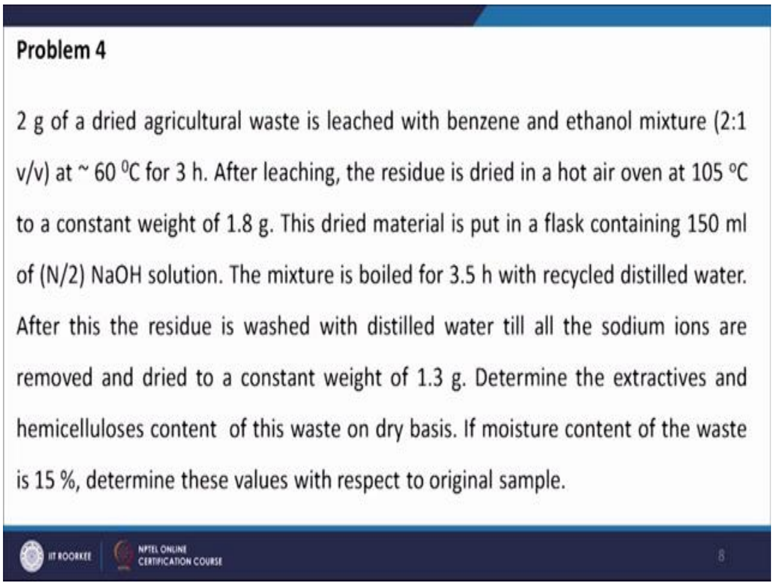

Next problem statement is 2 gram of a dried agricultural waste is leached with benzene and ethanol mixture. 2 is to 1 volume by volume ratio at 60 degree centigrade for 3 hours, after leaching the residue is dried in a hot air oven at 105 degree centigrade to a constant weight of 1.8 gram, this dried material is put in a flask containing 150 ml of n by 2 NaOH solution the mixture is boiled for 3.5 hour with recycled distilled water, after this the residue is washed with distilled water till all the sodium ions are removed and dried to a constant weight of 1.3 gram. Determine the extractives and hemicelluloses content of this waste on dry basis, if moisture content of the waste is 15 percent determine the values with respect to original sample.

So, in this case when solidified seeds list with this benzene and ethanol, extractives will come out. So, mass loss during this step will give us the amount of extractives and in the second case the hemicelluloses will be removed. So, the mass loss will be related to hemicelluloses.

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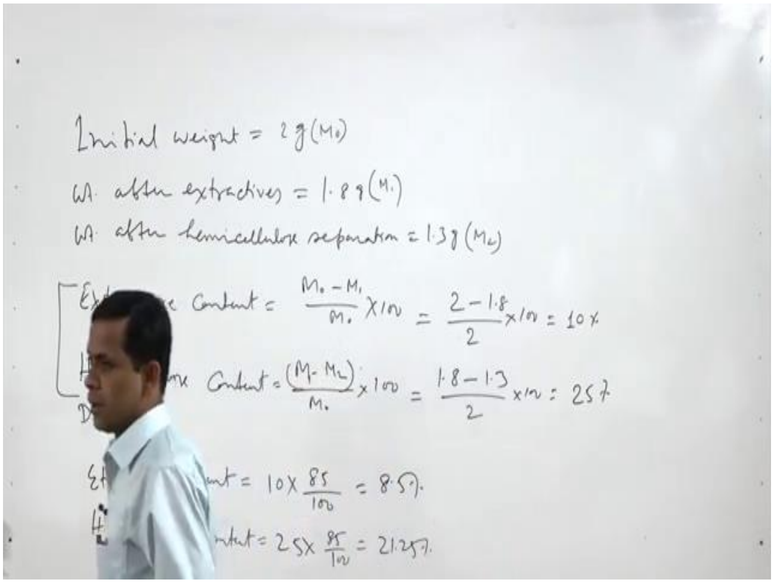

So, initial weight is equal to or mass we can write 2 gram. So, 2 gram initial is equal to you know weight is equal to 2 gram weight after extractives is equal to 1.8, then weight after hemicellulose separation weight after hemicellulose separation 1.3 gram. So, this equal to m 1, this equal to say m 2, and this is equal to m o. So, extractive content is equal to as discussed in the previous module that is equal to m o minus m 1 divided by m o into 100; into 100. Sort we are getting m o minus m 1, so 2 minus 1.8 divided by 2 into 100. So, that is equal to 10 percent. Hemicellulose: hemicellulose content is equal to m 1 minus m 2 divided by m o into 100. So, we are getting how much m 1 1.8 minus m 2 1.3 divided by 2 into 100 that is equal to 25 percent.

So, these values are in dry basis the last part of the question was if moisture content of the waste is 15 percent, then determine these values with respect to original sample. So, these values in original sample the extractive content will be 10 into 85 divided by 100, this equal to 100 minus 15. So, that is equal to 8.5 percent and hemicellulose content that will be 25 into 85 divided by 100. So, that is equal to 21.25 percent.

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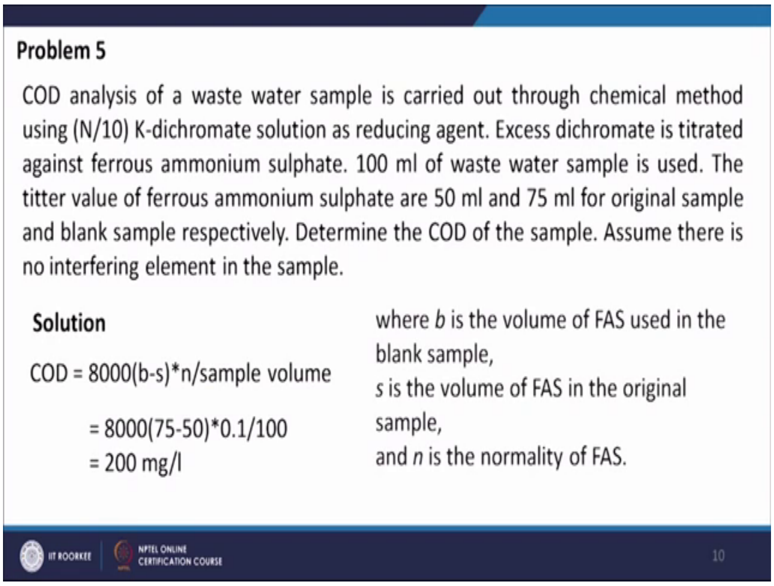

Next our problem statement is related to cod analysis. So, cod analysis of a waste water sample is carried out through chemical method using N by 10 potassium dichromate solution as reducing agent excess dichromate is titrated against ferrous ammonium sulphate, 100 ml of waste water sample is used the titter value of ferrous ammonium sulphate are 50 ml and 75 ml for original sample and blank sample respectively; determine the cod of the sample assume there is no interfering element in the sample.

Now, when you do cod analysis potassium dichromate is added in excess then it is the waste water contains some organics. So, those organic compounds are oxidized by this potassium dichromate, and blank sample does not contain any organic compounds. So, all the potassium dichromate remains as such. So, when we do the back titration we get the potassium dichromate presence in it. So, the titer value for blank and titer value for sample we get and obviously, the titer value for blank is more.

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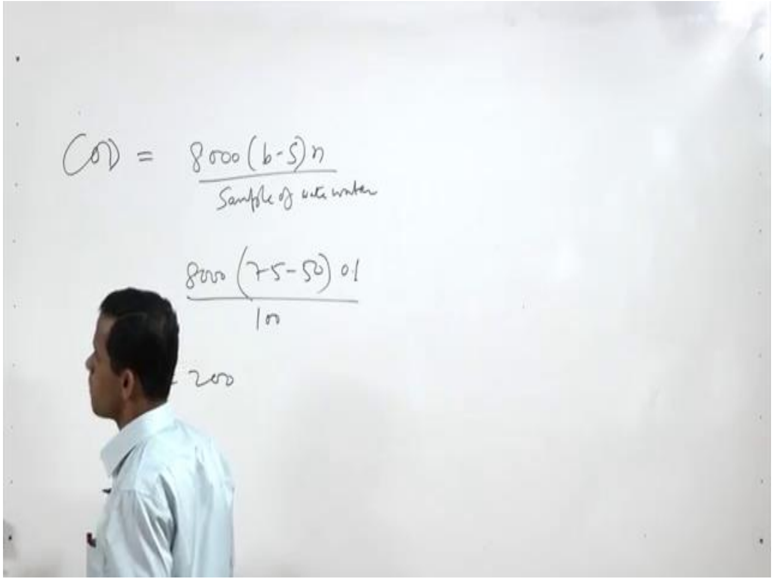

And in this case cod determination can be done when the titer values are in ml then the expression is 8000 into b minus 6 into n divide by sample of sample volume sample of waste water or sample volume.

See in this case 8000 into what is v and s, v value is given that is 75, n value is s value is given that is equal to 50, n is also given that is equal to N by 10 or 0.1 normal, and sample volume is equal to 100 ml. So, this is equal to it is giving us the value of 200 m g per liter. Next problem is 1.5 gram of solid waste is kept in the bomb of a calorimeter; the initial and final temperatures of water in bucket are 23 and 28 degree centigrade respectively.

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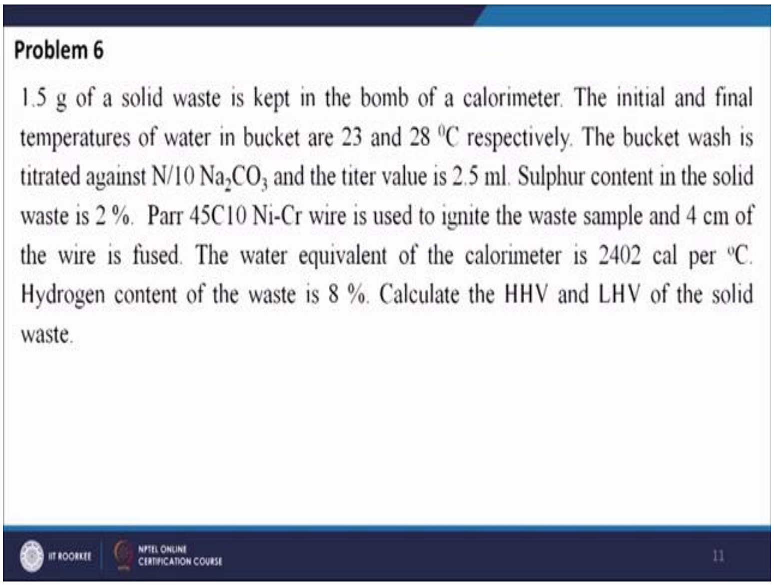

The bucket wash is titrated against N by 10 Na2CO3 and titer value is 2.5 ml sulphur content in the solid waste is 2 percent Parr 45 C 10 N i chromium wire is used to ignite the waste sample, and 4 centimeter of the wire is fused. The water equivalent of the calorie meter is 2 0 2402 calorie per degree centigrade hydrogen content of the waste is 8 percent; calculate the eight HHV and LHV of the solid waste.

So will stop here today and will go for next module in the next lecture.

Thank you.