Urban Services Planning
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Lecture 37
Waste to Energy Part II: Refuse Derived Fuel

Welcome back in lecture 37, we will talk about refuse derived fuel this is waste to energy part 2.

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The different concepts that we will cover are on refuse derived fuel, solid waste management rules 2016 in context of refuse derived fuel, then the RDF production process RDF utilization process and then we will talk about some case studies.

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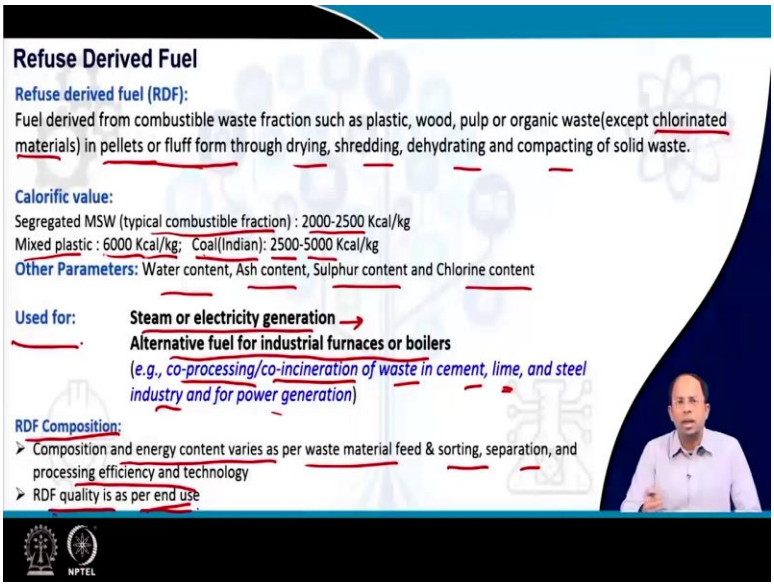

Now, refuse derived fuel, we have already discussed the basic concept what it is and to define it further, it is the fuel derived from combustible waste fractions such as plastic, wood, pulp or organic waste in pellets or fluff form. So, this is important through drying, shredding, dehydrating and compacting of solid waste.

Now, we have to be careful that we should not take chlorinated materials because that will create problems other than that anything which can be burned after recycling after composting whatever is left whatever material is left that can go for we can use those material for refuse derived fuel and we have to use it in first we cannot use the waste directly we have to process it.

So, that is where we have to convert it in either into pellets form or in fluff form pellets are particle form and fluff are more in 2D form. So, pellets is 3D whereas fluff's in 2D format. So, and this is achieved by drying, shredding, dehydrating and compacting of solid waste.

Now, the calorific value of segregated municipal solid waste the portion which is typically combustible the one which should go for RDF that comes to around 2000 to 2500 kilocalories per kilograms. So, this is what is acceptable because this is more than 1500 kilocalories per kg as specified in software management rules 2016.

But at the same point of time even though a typical combustible fraction is of this value, but the waste received by different this RDA plants actually is not of this quality, usually it we ended up

getting waste of much lower calorific value because of moisture contained because of many other materials or some form of contamination of the waste.

Now, mix plastic waste usually if we just use plastic, then the kilo calorie per kilo grams is around 6000. And to give you a reference coal in produced in India or we that we use in India is gives us around 2500 to 5000 kilocalories per kilograms. So, you can understand that if we can replace coal because with segregated MSW, then that means in processes where we require coal to burn coal to generate energy instead of that we can burn MSW to also generate energy as well.

So, some of the other parameters that we should be also concerned about is the water content, the moisture content the ash content, the sulfur content and the chlorine content of this particular material. So, this is what influences what would be the final output of or the RDF material that will generate.

So, how is RDF used? RDF could be used to generate steam or electricity that means, either you generate steam and use it directly for some sort of heating purposes or you can use the steam to in a boiler and then using the boiler, you sorry using the boiler we can generate steam and then using that steam we can drive a turbine and using that we can generate electricity or this that is we are generating using this waste directly or indirectly. For example, we use RDF as an alternative fuel for industrial furnaces or boilers.

So, usually in production of cement, production of some certain other lime and so on. We require large furnaces where we you typically use coal and other fuels. So, instead of that we can use RDF as well. So, that means, here we can group process or co-incineration, this can be taken can be done of waste in cement, lime and steel industry and for power generation.

So, in all these cases in addition to existing coal and other fuels we can add RDF as the say a secondary fuel, which will help in incineration process. So, the RDF composition the final form in which the industry or the furnace will receive the RDF. That means, it depends on each furnace is different, we use different kinds of technologies in different kinds of furnaces different kinds of like cement production will require a certain furnace configuration whereas, lime production will require different furnaces per configuration along with different kinds of fuel requirements.

So, what is the characteristics of the RDF? What properties of the RDF should be? It depends on the RDF quality that is required is dependent on the end use, that means, where we are going to utilize the RDF that will determine what sort of quality of the RDF that we required. Now, composition and energy content of waste material varies that we know and we have to sort, separate and process this waste material in such a way so, that we arrive at a waste a feed stock content, which will result in the kind of RDF that we want to generate.

So, that means, definitely the composition and energy content will vary, but we have to adjust our processes or sorting in such a way so that eventually we end up with RDF, which matches the quality that we require at the end use, that will in whatever form it is going to be utilized, it has to match the characteristic that is required for that particular use.

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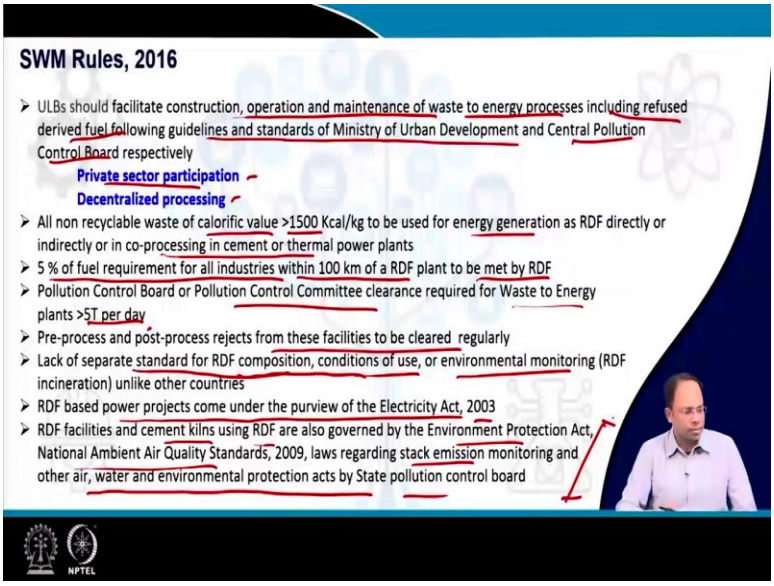

Now, coming to software management rules 2016. We have already gone through the basics, but we can in regards to RDF there are certain segments of the rules which are very very relevant. For example, ULB's should facilitate construction operation and maintenance of waste to energy processes, including refuse derived fuel, following guidelines and standards are ministry of urban development and central pollution control board.

Now, the rules also say suggests that utilization of private sector as well as decentralized processing of waste for to generate this kind of energy. Now, private sector participation is very, very important. Why? Because these are high technology processes, there has to be and usually

the ULP does not either have the capacity or neither a trained manpower to run this kind of system.

So, these kinds of processes, so it is better to engage some private companies who already have got some experience in this particular sector, maybe in PPP mode or maybe in some other (())(07:52) demonstration mode to do this to demonstrate or set up this kind of waste to energy plants. At decentralized processing, the reason is same the transportation cost would be lessened. So that is why decentralized processing is always favored.

So, the other rule that you we already have been discussing the calorific value has to be greater than 1500 kilocalories per kg for the waste that will be used for energy generation, either directly or indirectly or in co-processing in cement or thermal power plants. Now 5 percent of the now the how do you facilitate use of RDF in the industry because we may produce RDF but there may be no takers for that.

So, to facilitate use of RDF government has suggested 5 percent of fuel requirement of all industries within 100 kilometer of RDF plant has to be made via RDF. So, that means that ensures that there is a ready market for RDF near urban areas. Now, pollution control board or pollution control committee clearances are required to set up this waste to energy plants which are greater than 5 tons per day which utilizes waste more than 5 tons per day.

And pre-process and post process rejects from these facilities has to be cleared regularly because as we know that in RDF we have to pre-process we have to sort we have to further categorize the waste and that will generate a lot of rejects. So, not only the waste has to be processed that are w waste to energy plant, but also the regions that are generated over there has to be transported to the landfill site. So, this is what is also part of the software management rules. Then, there is no separate standard for RDF composition, conditions of use, or even environmental monitoring standards when we burn RDF it generates a lot of emission.

So there has to be certain standards for that. So eventually, there are standards set for incineration and all which are given by the software management rules. But there is no standard there for from the CPCB which is required. So, that and then because there is no standard for RDF composition the product that is prepared that may not meet certain standard quality standards which are required by the industry and so on.

So, these kind of standards needs to be set so that we get uniform quality and also the industry are aware that this would be the standard of the RDF and accordingly they can design their processes. RDF based power projects comes under the purview of the electricity board Electricity Act 2003.

And RDF facilities and cement cleans use using RDF are also governed by environmental protection act, national ambient air quality standards and laws regarding stack emission of from coming out of this particular plant, what kind of smoke they release, or emission they release, and other air water and environmental protection acts by the state pollution control board. So, all these adherence to different standards and laws has to be there, when you set up this waste to energy process of plants.

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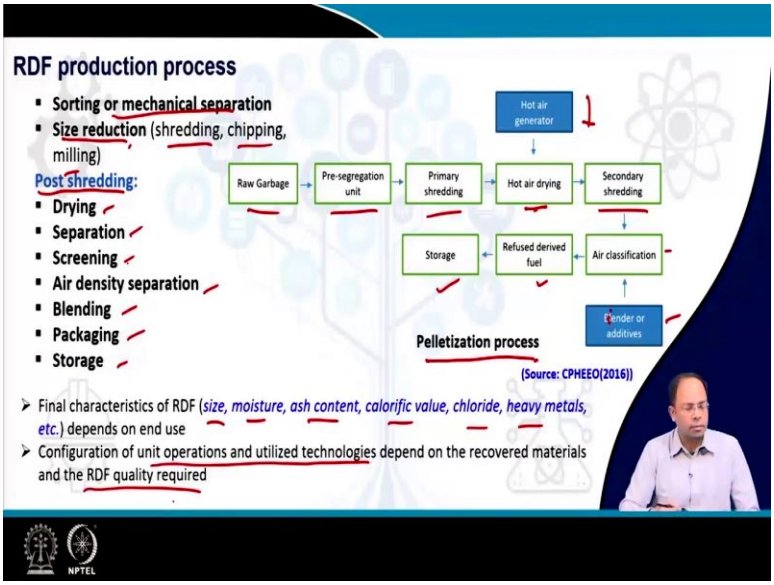

Now, just to give you a brief idea about this process, these are technical processes. So, maybe it is not part of it is we cannot discuss in detail in this course, but we will just tell you take you through the basics. For example, before we even start the process of actual creation of RDF, we have to first sort or manually or using mechanical means, we have to sort the waste which will go for the RDF palletization process, then we have to reduce it in size, because when we reduce it in size, all the material becomes homogeneous of uniform size and it is easier to further use it in further in mechanical systems downstream.

So, that means if the waste is of uniform size and all further mechanical processes would be facilitated. So, we have to shred the waste or chip or mill the waste we can say it, what it means is we will reduce the size of the waste to manageable forms. The next steps are post-shredding that means, once we have done this shredding operation, we have now reached uniform size, then the steps are drying of the waste.

So, that moisture is removed some separation again some sort of screening is done so, that we separate different types of waste or different size of waste based on size, then separation once it is done separation screening then we can even go for air density separation, so that we can have different waste of different weighted weights separated and maybe we will get rid of some of the sand or inert material in this process, then blending of waste we mix up the entire waste together packaging and finally storage.

So, this is where basically we are creating pellets of fuel, which is the refuse derived fuel and we would be further utilizing this pellets in industries for incineration. So, this is the palletization process you can see raw garbage comes in pre-segregation unit, then after it goes to the pre-segregation unit we shred it its primary shredding, then we dry the waste we using hot air generators and after that there could be a secondary shredding.

So, we can do the shredding in two steps. And then finally, using air classification, we can get the refuse derived fuel out of the waste stream and we can get the inert and all out of that and we can also add some binders or this would be binder not binder or additives into the waste so that eventually it could becomes pellets and then finally we will store this particular pellets.

So, this is the palletization process and the final characteristics of RDF or this particular pellets depends on induce as we have already discussed, but what are those properties that we are concerned with we are concerned with size of the particles because different furnaces will take particles of different sizes, moisture content of that particular in that particular pellet, ash content, calorific value chloride, heavy metals and so on.

So, these are the different criteria which has to be checked and then wherever as per the required criteria at the induce site, we will use that RDF. So, the configuration unit operations and utilize technologies depend on the recovered materials and the RDF quality required. So, we have to create our plant in such a way so, that it depends we consider what we are getting in the plant

accordingly we have to set up a sorting, drying and other facilities and similarly, the packaging pellet checking a final quality has to be determined based on what is the final quality of fuel or refuse derived fuel that we are going to deliver.

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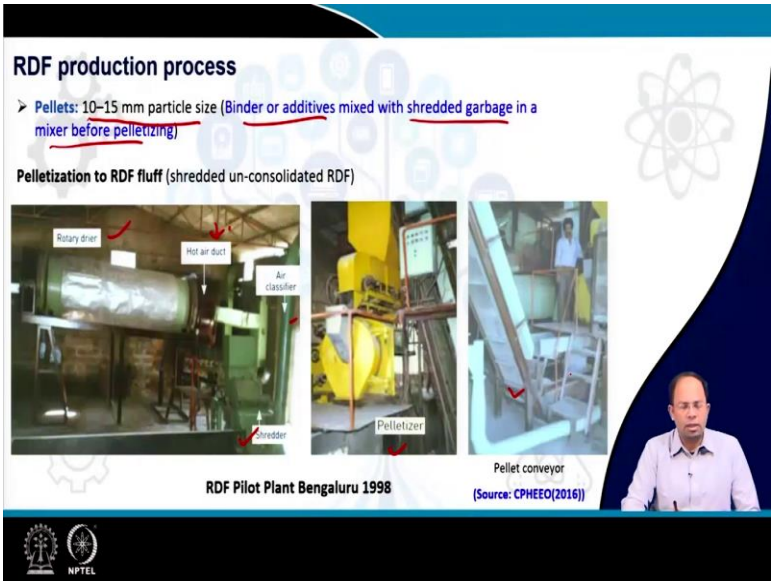

So, here in this you can see the palletization process, pellets are obtained to 50-millimeter particle size we use binders or additives mixed with shredded garbage in mixture before palletization. So, here you can see a rotary dryer then there is this hot air duct which introduces hot air, this is the air classifier, this is where the shredding is happening. And finally, this is the pelletizer machine where it is becoming pellets by using of additives with the shredded waste and finally, the pellets could be sent by a conveyor belt and eventually packed that means we put them in bags and then we can send it for to the final destination.

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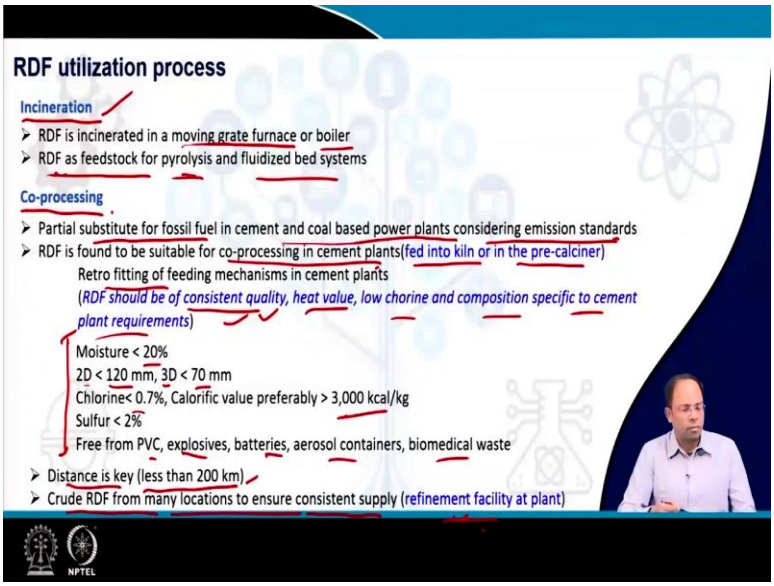

So, RDF now once we have produced the RDF next comes the steps of RDF utilization that means how do I use the RDF. So, the first utilization is of course incineration of RDF directly. That means, we can incinerate RDF and in a moving great furnace or a boiler in a boiler system, so that directly we can generate electricity.

So, that means in when we will learn about incineration later on, in incineration is burning of waste. So, instead of burning up waste, we can burn pellets to also generate energy. Otherwise a RDF can use as a feedstock for pyrolysis and fluidized bed system. So these are other forms of incineration, not exactly incineration this there are pyrolysis, gasification different kinds of techniques are there which are we will also learn about that later.

So there also RDF can be used as a feedstock instead of using direct waste we can use RDF as the feedstock. Like for example, pyrolysis will take in plastic waste, so we can create plastic pellets and then we can utilize it by burning it directly. Now, this is incineration is burning RDF directly, whereas co processing is we are using replacing existing fuel use in certain other sectors or certain other companies or certain other furnaces, whichever way you want to put it so that we reduce the use of fossil fuels and we can use RDF in its place.

So, it is a partial substitute for fossil fuel in cement and coal based power plants. Considering emission standards. Of course, you have to be careful that whatever emission comes out of burning RDF, it should also adhere to the existing emission standards. And RDF is found to be

suitable for co-processing in cement plants, particularly because the cement furnace designed or is in such that even though the waste is of not that uniform quality, you still it usually does not create too much of a problem.

So that is why it is found that out of all the different options of using RDF using it as a co-processing in cement plants, this is the best possible option. So, in cement plants, the RDF is fed into the kiln or the furnace or in the pre calciner and then it is utilized. But to do this, the existing cement plants needs to be retrofitted. The feeding mechanism particularly has to be retrofitted. And that actually creates certain kinds of problems because already the plant is set up. It is running, it is operating smoothly.

Now, suddenly I introduced by law that okay, you have to utilize RDF. So, they have to do some changes in the plant, maybe the plant is not designed to introduce this kind of changes, maybe they do not have adequate area. So that is one of the issues. The other issue is RDF should be of consistent quality, heat value, low chlorine and composition specific to cement plant requirements. Now, I said that the waste can be a little bit varying the RDF quality can be a little varying in cement plant. That is why cement plants are suitable. But still there is a certain range within which we have to be.

So, this consistency in quality. It is difficult because the RDF is produced from municipal waste, and municipal waste quantity and quality varies all throughout the year. So that is the problem. So how to use standardize? So that is one of the biggest challenges in this waste RDF process. Additionally, moisture should be less than 20 percent that 2D, pellets and 3D at the pellets 2D at the fluff. So 2D means it is a flat surface 3D is it is a solid surface. So, here you can see the 2D size should be less than 120 mm, the 3D size should be less than 70 mm.

So, this is the standard size of pellets or fluff that is accepted by the cement plants. Chlorine content should be less than 0.7 percent calorific value should be around greater than 3000 kilocalories per kg. That means of course, the waste has to be dried resorted and a lot of inert material has to be removed so that we improve the calorific value.

Sulfur should be less than 2 percent and it should be free from Poly benign chloride plastics, explosives batteries, aerosol containers biomedical waste and so on. So, this is some of the composition characteristics that we should be aware of for the waste that goes into the cement

plant whereas, the other issue is the distance that means, we cannot send spent too much money on the transportation cost that means, we are producing pellets and it is supposed to be also economical to use this in the industry.

So, if it is more than 200 kilometers neither it is economical neither it is environment friendly because we will be spending too much amount on the fossil fuel to transport the waste. So, it should be as specified should be less than 200 kilometers but as SW of rules specify it has to be utilized in plants which are within 100 kilometer of a RDF plant. So, the other option could be that crude RDF from many locations in the city can be taken up and once it is brought to the facility then it is refined so, that we get a consistency supply as well as consistent quality of the RDF.

So, that means different plants may have different quality output different quantity output some plants may send something other plants may fail to send something at certain times. So, it is better to take supply from multiple plants together and also do the processing or refinement at the facility itself where it would be utilized so, that we get uniform quality as well as quantity.

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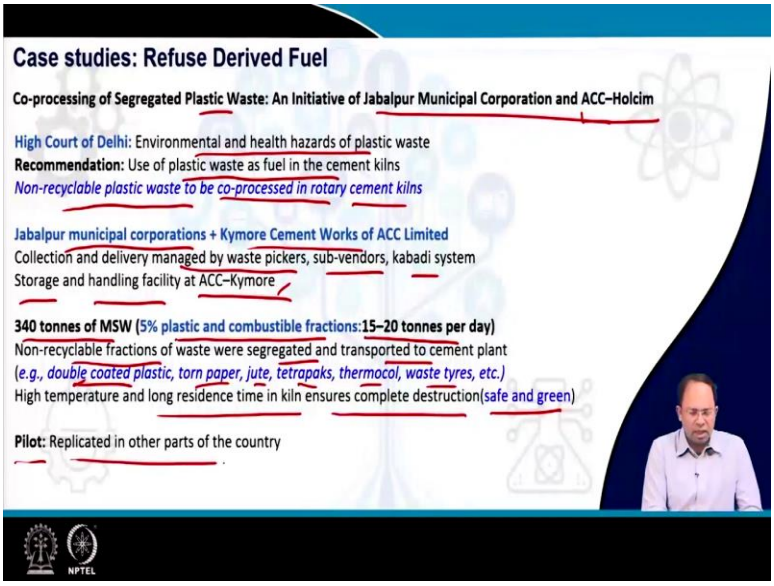

Now, we will talk about a few case studies on refuse derived fuel, first of all co processing of segregated plastic wastes. So, that means we are using plastic waste as a refused derived fuel and this initiative is at Jabalpur municipal corporation and the co-processing plant is ACC Holcim and so it is a cement plant of ACC group and this was initiated when high court of Delhi really

talk was concerned about the environmental and the health hazards resulting from plastic waste in the city.

And the recommendation committee actually recommended the use of plastic waste as fuel in the cement kilns initially and then it was suggested that non recyclable plastic waste in Delhi to be co-processed in rotary cement kilns. So, that means plastic waste is a menace it should not go to the landfills.

So, better way to utilize is to utilize it as fuel or as RDF and where in the cement plants then probably environmental standards would also be within limits as well as the quality and all these issues should be not be a problem. So accordingly Jabalpur municipal corporation and Kymore Cement Works of ACC Limited tied up and the collection delivery of waste is managed by waste pickers sub venders in the kabadi system in Jabalpur of course facilitated by the Jabalpur municipal corporation.

So, they supplied collected segregated and again then supplied the waste to the cement plant whereas storage of the waste in the cement plant the handling facility or processing it all this is responsibility of ACC Keymore. So, that is how the the collaboration happened and eventually out of 340 tons of MSW generated 5 percent was plastic and other some combustible fractions which was utilized.

So, eventually the plant got around 15 to 20 tons of waste per day. And this is the non recyclable fraction of waste where and this were segregated and transported to the cement plant. It included double coated plastics torn paper, jute, tetra packs, thermocol waste tyres and so on. So, it was a mixed waste, but of course plastic was there and the high temperature and long residence time in kiln ensures complete destruction of the plastic and other material.

So, that means that is also one of the reasons why cement co processing using RDF in for co processing in cement plants is also good. And the end products or usually this entire process is safe and also green. So, it is a good utilization of the plastic waste compared to alternatives. So, this is a pilot project and this is supposed to be replicated in other parts of the country.

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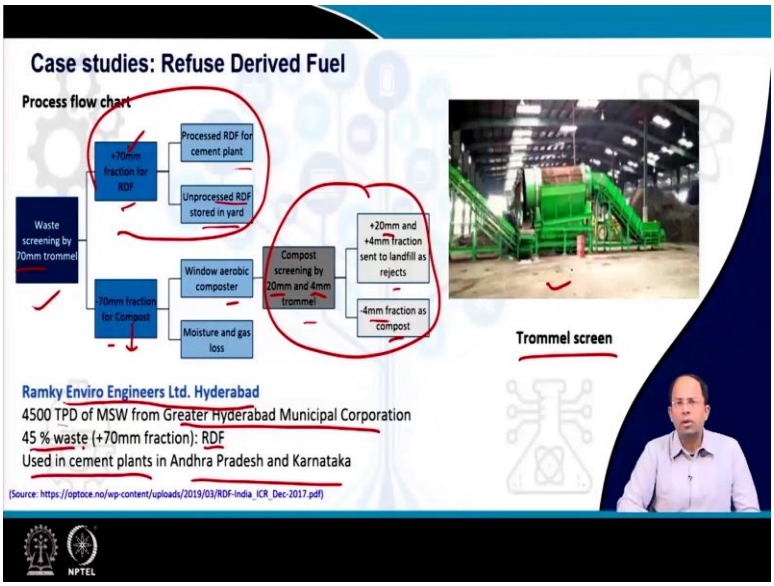

And now we see similar kinds of projects also coming up. And as you can see over here, this is Ramky Environmental Engineers limited Hyderabad their they have collaborated with the greater Hyderabad Municipal Corporation, where around 4500 tons per day of municipal solid waste is generated out of that 45 percent of the waste is utilized for generation of RDF. Now, where how do I get this 48 percent? If you follow this process, the waste is screened using us 70-millimeter trommel screen.

So, we have discussed how trommel screen operate. It is a inclined rotating a cylinder with screens at the side, so that the particles which are larger in size will tumble down and then get out. So, the particles which are bigger than 70 mm remained for RDF whereas the particles which are lesser than 70 mm when went for the compost plant and this 70 mm particle processed apart in RDF for cement plant and unprocessed RDF was stored in the local yard.

Whereas, the compost one went for window aerobic composter and some amount of moisture and gas was lost in the process. And then finally, compost was screened by using 20 millimeter and 4-millimeter trommel the 4-millimeter fraction became compost eventually, the 20 plus millimeter and 4 mm fraction rejects were sent to the landfill.

So, that is the standard composting process that we have discussed earlier. But this is what we are interested in and the initial segregation was done via 70-millimeter trommel. So, the finally

the RDA produced was used in cement plants in Andhra Pradesh and Karnataka. So, there you can see the image of the trommel.

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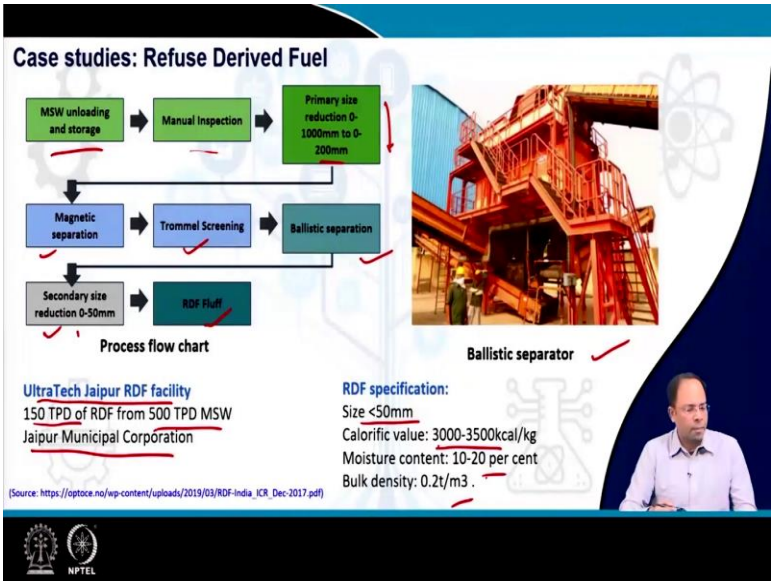

Then, coming to the second third case study actually, this is UltraTech Jaipur RDF facility. So, this is UltraTech Cement as well what they have tied up with Jaipur Municipal Corporation and 150 tons per day of RDF is generated from 500 tons per day of municipal solid waste and you can follow the process here MSW is unloaded then manually it is inspected, then we the initially primary shredding operation happens the size reduction is roughly from 1000 mm to 200 mm.

The range is 0 to 200 mm size then magnetic separation that means ferrous separation was conducted ferrous materials were taken out, then trommel screen was used to further segregate. Finally, ballistic separation occurred this is the ballistic separator, this is also a very large scale separator of solid waste and finally, this secondary size reduction occurred from 0 to 50 millimeter size pellets where fluff was formed and this RDF fluff was actually utilized.

So, RDF specification size is less than 550 millimeter. As we obtained from the secondary reduction calorific value obtained was 3000 to 3500 kilocalories per kilograms moisture content was 10 to 20 percent and bio density was 0.2 tons per meter cube. So, this is how these are two case studies of RDF which has been successful in India.

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So, these are some of the references you can study.

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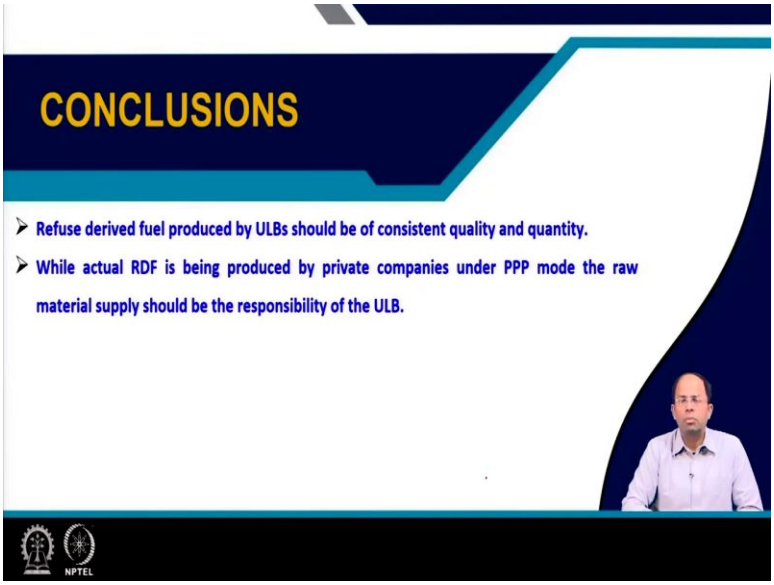

And to conclude, refuse derived fuel produced by ULBs should be consists of should we have consistent quality and quantity. And while actual RDF is being produced by private companies under PPP mode, the raw material supply should be the responsibility of the ULB. Thank you.