Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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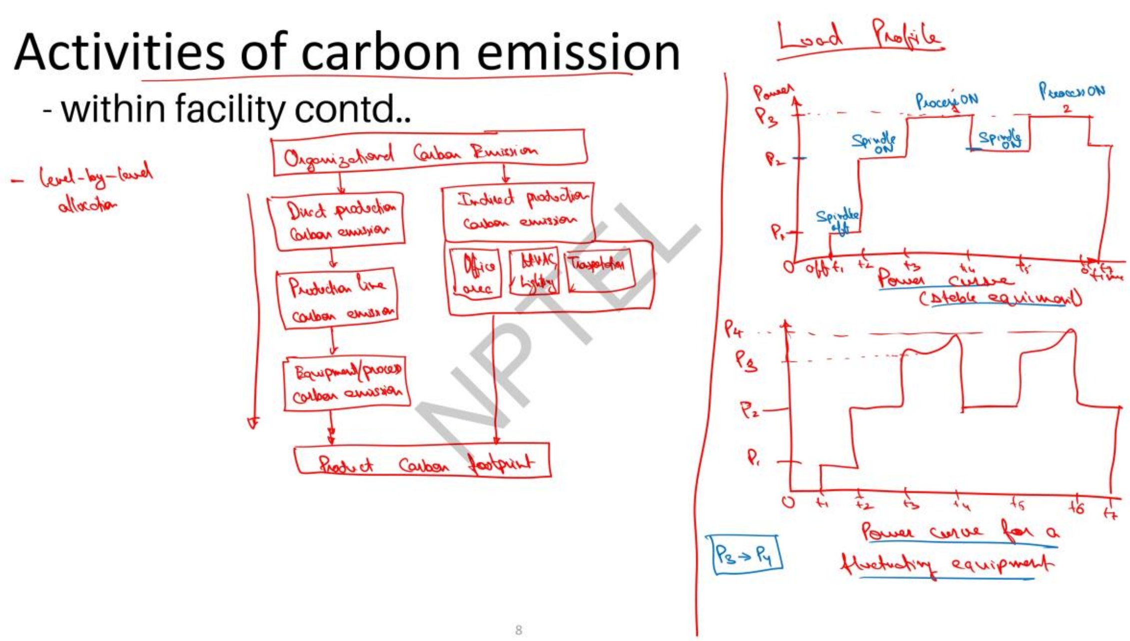
Week 06

Lecture 28

Activities of Emission (Part-2)

Welcome back to the next lecture in the course Carbon Accounting and Sustainable Designs in Product Lifecycle Management.



We are discussing about the Activities of Carbon Emission. We saw in the last lecture how an organization is having certain inflows of energy material and information that helps you to generate orders. Orders are also very important when we try to talk about the supply chain from a little upstream level. We also try to saw the temporal level and spatial level decisions and certain pointers in the previous lectures.

Here I would like to continue and try to talk about the carbon emissions, which was the last investigation that we took in the last lecture. The carbon emissions, which are there as an input to the system, that is, I call it as organizational carbon emission. That could be direct or indirect as Professor Deepu Philip also mentioned. I would like to talk about a little more detail in direct and indirect carbon emissions and these would be taken in the models that we try to see. So, organization carbon emission that is there, this could be either direct production carbon emission or indirect production carbon emission.

So, when we talk about the direct production carbon emission. This is majorly the direct manufacturing or processing of the products resulting in direct alteration of physical or chemical characteristics of raw material or semi-ferrous articles. Indirect production carbon emission cannot be seen directly or cannot be calculated directly. This is a range of activities that provides support or assistance to the direct production activities such as procurement, management, equipment maintenance, quality inspection functions and so. There are certain sources of information or certain intricate sources of information could be there which are contributing to the carbon emissions in direct manufacturing.

Because it cannot be ascertained at the supply chain level directly that is why we try to divide the facility level by level. We will put it as level by level allocation. Direct carbon emission or direct production carbon emission when we try to talk about it is coming from an organization, right. So, this direct production, carbon emission is coming from production line carbon emission. So, it could be production line or it could be maybe the process that is there, the equipment or process carbon emission.

When I am talking about the production line carbon emission or maybe equipment or process carbon emission, I can just suppose if I try to draw a power curve line, you see. So, this is my machine or a equipment that is there that is having a stable production, right. So, here I would try to plot a power curve for a stable equipment. So, what happens first equipment is off then at time this time is going right at the off position no power when the material is switched on at time t 1, there is a rise in power. So, this is my power in the y axis.

It is rise in power, it rises to only when the machine is switched on, but no load on the machine is there. That is the lighting in the machine is there, the motor has started rotating, but there is no load in the motor. So, the power rises to this level. I will call it as at time t1, the power is P1, right. So, then at certain level, when the main motor is still not working or off at pre-processing when we switch on the mate motor at time t2 the power rises to the level P2.

So, at this level we call it as the machine is now ready to work the process has not started, but when the process is started here and at this time the machining has started. So, here you see at time T3 the machining has started and the process has started here hill power rises to level P3.

I will try to bring a demonstration when I will try to show you a machine working machine switching on. I will try to see here the power is machine spindle starts rotating then the power rises to P2 then the machine starts cutting, That is the power rises to P3 till the time the cutting happens the power that is there in the stable machines is P3.

So, this is the power being consumed once this process is completed the machine is switched off. So, once this process is completed, the machine spindle stops the machining, but it is still rotating. Because it is still rotating, it comes out to level P2 only. So, here at time T4, the power is at P2. Again, what happened at this time from T4 to T5, I would say, the T processing is still there.

I will put it here. This is my T2, mean spindle off, this is spindle on, right. This is process on process on or process one is happening right here also process is off, but the spindle is on. So, what happens between T4 and T5 is that the machine has stopped its machining process. For instance, the machine was doing a drilling.

This drilling is now stopped. Now, once the drilling is stopped, but the spindle is still rotating. Because the spindle is rotating, the energy is being consumed here. The energy is still at level P2 here. Spindle is rotating, this is my setup time.

This work piece could be removed. Another work piece would come. This time, this power is at P2. When again the machine starts working, it will again rise to level P3. Provided that the machining, the hole, whatever you are doing is all similar.

It again rises to level P3 here. This is I would say process 1. This is process 2. And so on, it keeps on going till the point you switch off the machine. First you switch off the spindle, then you switch off the machine and it comes down at some point maybe I would say T6 and T7, the machine is off.

So, here it is again process on here. This is for a stable equipment. Let me try to see if the equipment is not stable, if the equipment is using variable power input. So, for a power curve for a fluctuating equipment. Here let me try to see what happens.

It is not always the constant power when the machine is on. The machine will still vary for a production system that is fluctuating or for a requirement of the machining dimensions which are fluctuating. The power will keep on changing. Here what happens? The power would rise at certain level.

Machine is switched on. Spindle is on. But the spindle is off. Here the spindle switch is on. The power resistors this level and this is my machine in the machining you could see certain.

For instance, if it is a milling machine, milling machine is what? You try to cut a profile. A profile where the material depth is higher, the more power will be consumed. When the depth is lower, the power consumed will be lower. Accordingly, this power might vary.

Here the spindle is again on, but machining is not happening. The second set of machining, if it is happening for the similar material, it will again follow this kind of path. It will keep on going. You can put the times similar to the above T1, T2, T3, T4, T5, T6 and T7. It could be power P1, P2 and I am putting a level power maximum P4 here and a minimum of this is minimum.

That is P3. That is for a fluctuating equipment the power remains between P3 and P4. Between P3 and P4 power remains and this is a fluctuating equipment that is there. But still this is our the power or the carbon emission that is there. Now the carbon that is obtained from this system is also variable.

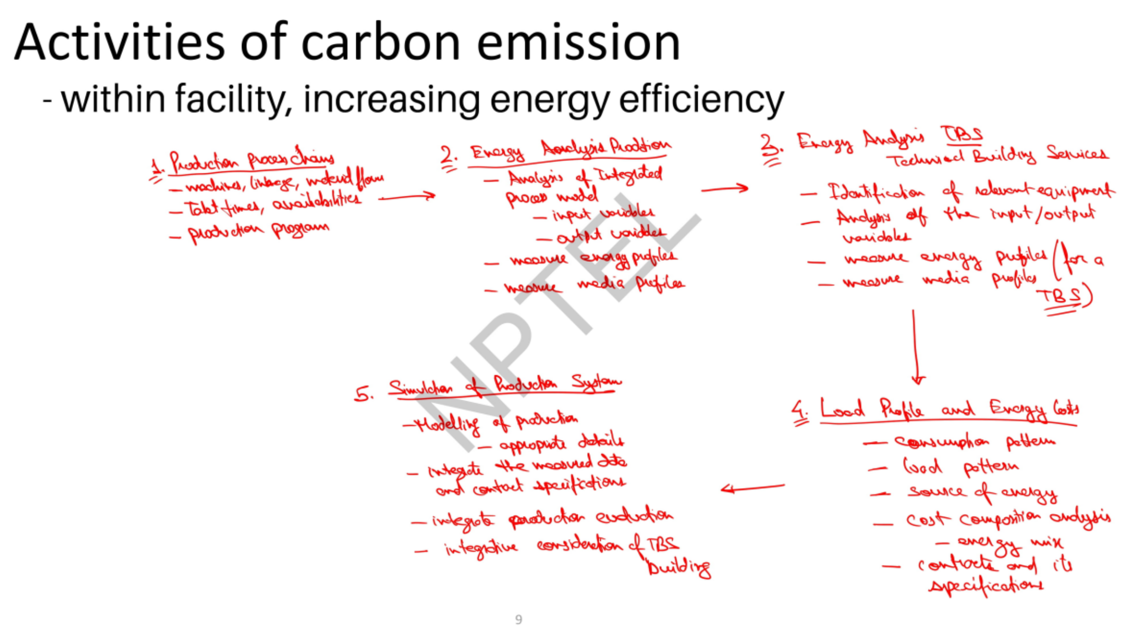
So, here this was all my product carbon footprint that I am mentioning here. Now, in the indirect production carbon emission system. So, what do we have? We have our office area or you call it as administrative area. We have our heating, ventilating, air conditioning systems or call it as the lighting systems.

That is the all the facilities, all the assistance that is being provided to direct production activities that is here. Whether it could be equipment maintenance, whether it is procurement, whether it is management in the offices and transportation is also part of it.

So, these are the sub areas of my indirect carbon emission, these also contribute to the carbon footprint. So, I am talking about the direct and indirect once again. Because, I will come up with a model with the whole connection, that is level by level from the system level to the facility to the production line to the unit level.

And try to see what are the different ERP system information flow, what are the different manufacturing education system. And I will also try to talk about SCADA and how the level by level allocation establishes a good carbon accounting model. So, in accordance with the allocation technique, the carbon emission resulting from direct production are initially assigned to the production line level. Subsequently, these emissions are transferred from the production level to the process level and ultimately those go to the product level. This is how it flows here.

The allocation of the indirect production carbon emission can also be ascertained in a single step. We try to take it as a percentage of the direct carbon from the history data or from the secondary data it could be taken accordingly. So, there are multiple ways to pursue in this direction with this, I will also like to now talk about certain strategies because we are talking about now a unit level. That is I try to talk about how the power curve is being developed let me also try to now suggest certain ideas or certain tips to increase the energy efficiency.



Increasing energy efficiency is very important, because with the degree of the detail of the process chain that includes cycle times and availability.

And further it needs an assessment of the energy and consumables input and output as well. Taking into consideration the factors such as cooling water, compressed air, heat, certain ideas could be put in. For instance, if I try to talk about the production process chains. Number one, here the parameters which are to be worked upon are machines, the linkages between the machines, the material flow, right. Then, because we are talking about a production process change, the multiple change we are talking about, not even one production line.

We need to talk about the allocation of the times between the chains, allocation of the manpower, allocation of the machines. That is we will talk about the touch times and availabilities, right. So, this all makes a production program. This is my production process chain. This now helps you to have an energy analysis of the production.

That is energy analysis production. That is a sustainable production, aware production that is we get to have an analysis of input, output. That is we have analysis of the variables that the input variables, output variables referring to the integrated process model. That is when processes are now taken together as a chain of reproduction lines. So, here we try to understand their input variables, output variables and so, like I mentioned, we need to measure the energy and media profiles.

Measure energy profiles will measure media profiles, right. This is second level, first was the production process chain, then energy analysis production, then we have energy analysis TBS. That is energy analysis technical building services parameters or the areas which are worked upon are identification of relevant equipment. Analysis of the input output variables referring it to a integrated process model.

The same part analysis of the input or output variables at a higher level than those who are in the energy analysis of production itself. And we have again measuring of energy media profiles measure energy profiles and measure media profiles for developing. Please note this word technical building services try to read about it and then we can discuss upon this. Then comes the next point that is load profile and energy cost and energy supply contract the load profile the profile which I showed you here is my load profile only. This is my load profile, is electricity load profile or you call it as power curve.

So, it is now load profile or and energy costs. So, here the consumption pattern, load pattern, consumption pattern, load pattern, right. Then the company from which the energy is coming that is the source of energy because we are talking about the energy course. We are talking about the source of energy which is procured. Or whether it is the inbuilt energy or generated energy within the organization.

Then analysis of the cost composition, this analysis is more important when we have energy mix. Energy mix example for heavy machinery you can take energy from the grid for the office operation of computers. You can take energy from the solar powered or other systems that you have within the organization. So, cost composition analysis then also we have the specifications of the contracts that you have contracts and its specifications. That is energy that you are getting from different government system, from the private organizations, what are the contracts, what are the loads that you have taken, so how are you paying for those loads.

So, those all are here pointers which are considered or taken into account when you try to talk about your energy efficiency increase. Definitely along with it I could also mention about now from left to right point number 5 which is the last point that is the simulation system. We have the integrated simulation and evaluation production system. We have simulation of production system like the Siemens PLM software. You can simulate your overall facility while designing the facility for the specific product or the set of the products and you try to model them.

So we have modeling of production this comes with the appropriate details. It depends whether you would like to have a complete model with the energy for each and every system. You have or you can have an energy analysis or the simulation for the specific set of equipment. And if those are similar systems being replicated in the other parts of organization, you can project the same results over there. So, depending upon the details or the expensive that you are spending on the simulation system that is also important.

Then we try to integrate the measured data and the contract specifications. So, in a way when you try to simulate a system and you try to understand that the load required for your factory or the facility that you are developing would be very heavy 50 megawatt, right. So, for this load what would you contract that you have with the company that is providing you energy or with the government from where you are getting the energy, right. The load that you will design for your own organization. So, then we have integrated evaluation of production.

The last but not the least we have our complete integrative consideration of TBS building, right. So, this is the last point for increasing the energy efficiency. So, when we talk about the increasing of energy efficiency and we try to implement any of these pointers. So, now to show you an example, I will have to show you a video of Toyota production systems itself. Where they will try to give you certain tips or the systems that you are using to get to the target of net zero by 2050.

And also we'll try to talk about the data mapping and data acquisition in the coming week. And then we'll try to see the models of carbon accounting level by level. How do we rise from the very unit level to the overall system to have a complete carbon accounting for the product? This is the Toyota Environmental Challenge 2050. Six goals for creating a positive impact on our planet.

By 2050, Toyota will eliminate almost all CO2 emissions from new vehicles. Reducing CO2 emissions by 90% from all new Toyota vehicles by 2050 will be a huge accomplishment for one of the largest car companies in North America. That's why we're working today to innovate and introduce next generation power trains and vehicles. Products like Prius Prime and Mirai will move us closer to a low carbon future. By 2050, Toyota will eliminate all CO2 emissions from the manufacturing of parts and materials used to produce Toyota vehicles.

To achieve Challenge 2, the manufacturing of the parts and materials we purchase to assemble our vehicles will no longer emit CO2. This goal requires close collaboration with suppliers and partners to scale up progress as we work toward Toyota's vision for a better planet. By 2050, Toyota will eliminate all CO2 emissions from Toyota facilities, logistics, and processes. Challenge 3 demands we rethink the way we power our facilities, especially our North American manufacturing plants, where we assemble Toyota vehicles. Because our region operates some of the largest auto manufacturing plants in the world, this is no small task.

So today, we are implementing projects that reduce our energy consumption, increase our use of renewable energy, and minimize CO2 emissions from logistics operations. By 2050, Toyota will ensure all Toyota facilities and processes conserve and protect water resources. Availability of clean water is increasingly important, especially to communities in water-stressed regions of North America. Toyota will continue to manage, protect, and conserve this critical resource. That's why Toyota is focused on reducing our water use and exploring options for reusing and recycling water, especially at our manufacturing facilities.

By 2050, Toyota will ensure all Toyota facilities and processes support a recycling-based society. Challenge 5 requires us to help establish a society where sustainable materials are used and waste becomes a thing of the past. That's why we continue to look for ways to keep materials circulating and out of landfills, taking reduce, reuse, and recycle to a whole new level. By 2050, Toyota will ensure all Toyota facilities and processes operate in harmony with nature. We know Toyota provides important benefits to the local communities where we live, work and play.

We also know that each location has a unique and important natural balance of plants, animals and ecosystems. That's why Challenge 6 supports our efforts to minimize the disruption of natural habitats as we plan, construct, and manage our facilities across North America. So, with this video we will discuss upon the certain other strategies in the coming week. Where we will discuss the data mapping and acquisition for developing a carbon accounting system.

Thank you.