Basic Principles and Calculations in Chemical Engineering

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Lecture # 17
Principles of Energy

Welcome to massive open online course on basic principles and calculations in chemical engineering. So, in this module you have energy and its forms will discuss about the principles of energy in the previous.

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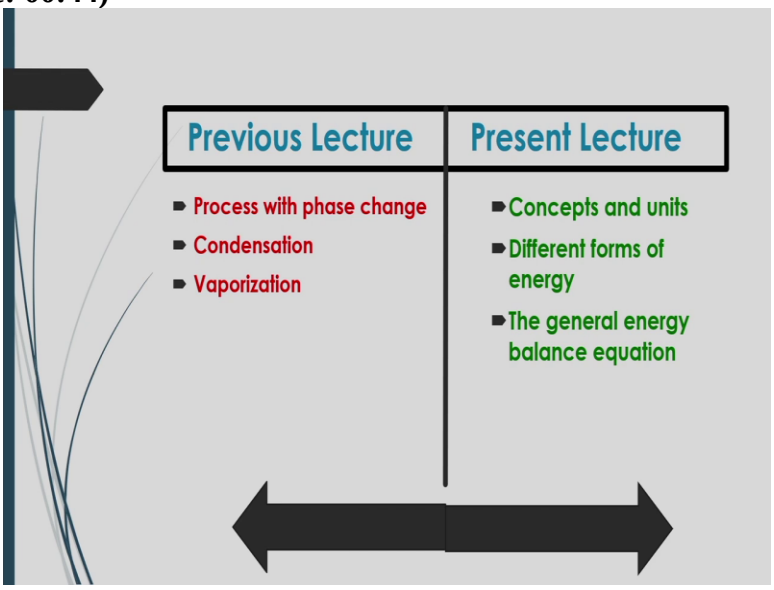

Module in lecture 16 we have discuss about the process with phase change and also based on that principles of the you know p change, we have discussed about you know different laws of you know that equilibriums when there is a change of phase, especially for condensation and vaporization process they are also have described how to do that material balance with those, you know that principles, laws of that condensation and polarization.

And those are actually based on the, you know, vapor pressure concept at equilibrium conditions and also the partial pressure which is depending on that, you know vapor pressure as well as you know that mole fractions of the components in the liquid phase which are in equilibrium with the vapor pace and also we have described that different phenomena of you know that process

variables for this you know, equilibrium condition or during the phase change like humidity, dew point, even bubbled point temperature.

Relative humidity saturation, unit volume enthalpy, absolute humidity, how to calculate all those things who have described to there. In this lecture, we will discuss the concept and units of you know, that energy system and how to do that, you know, energy balance and what are the basic equations for that, you know, energy balance in this module. We will start this energy balance in this lecture especially for the you know that how that energy has been defined and also what are the units.

And how that energy balance can be done in open system and close to the system and based on this, you know energy conservation law will be doing, you know that energy balance for the process systems in successive lectures of this module and so, we can first.

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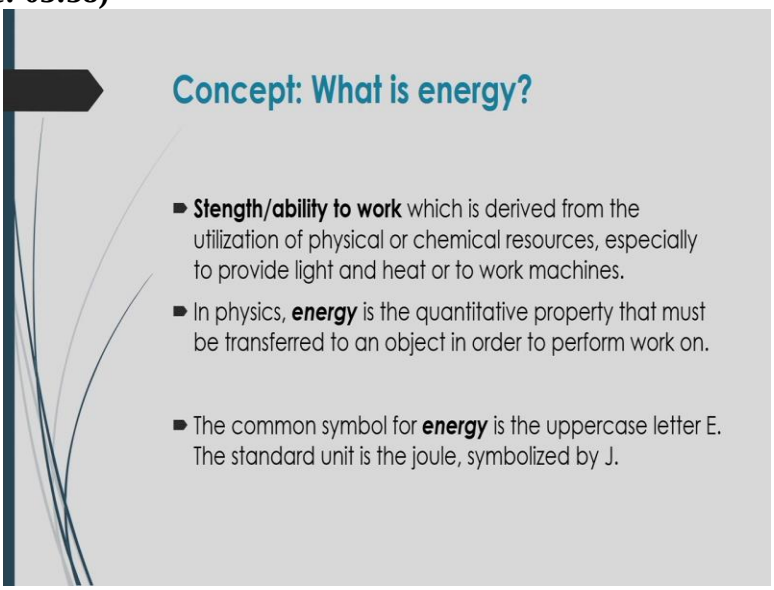

talk about that concept of that energy what is that energy that we have to know fast, how it can be defined basically, this energy is represented by the phenomenon of you know that ability of work. All you can say that for the strength of you or particular system or any you know process equipment or you can see that there will be a you know execution of any plant, what should be the overall strength or power you can see that ability of that you know, overall plan to give you certain you know it. So, in that case, we can say that that energy can be you know, defined as the term is strength or ability to work.

Which is basically derived from the utilization of physical and chemical resources and this especially, to provide, you know, light and heat or to work machines there. And in overall based on this, you know that heat or work of the machines will be you know, regarded to you know assets that whole process plant and adjust systems and also we can say that this energy is basically a quantitative property that must be transferred to an object in order to perform work on.

So, in physics generally, this energy is the actually considered as a quantity to property and this quantity poverty must be transferred to an object in order to perform some work on the system. In this case, you will see that whenever you are going to you know assess some you know process stem based on the quantity of energy you have to express this energy by a certain symbol. Generally, the symbol for energy is represented by E.

And of course, you have to express this quantity by a certain unit that is basically in SI system is you know Joule. So, the common symbol for the energy is you know used by the later you know that he and standard unit is generally considered as you know, joule there.

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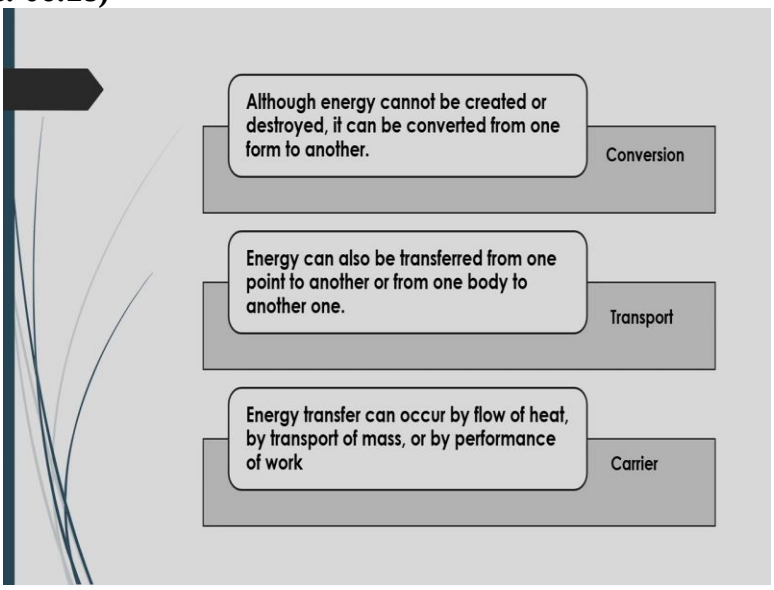

And you will see that whenever we are talking about that energy, you cannot actually destroy or create that energy who said you know universally available their only thing is that this energy whatever available that you can you know that convert this from one form to another form And

this energy can also be transferred from one point to another or from one body to another body, like any heat object is in tossed with record object what will happen you will see that heat energy will be transferred from these hot body to the cold body.

So, this heat energy is transferring from one body to another body and it can be also transport from point to point like in a same object already or in the same material. If there is a temperature you know difference between 2 points you will see that the temperature will be you know moving from higher temperature to the lower temperatures. So, in that way you can say that the heat energy will be you know transport from one point to another point.

And also this energy transport, you can say, it will occur by flow of heat or by transport of mass or by performance of work like suppose, if any heat is supplied to any object you will see that that object or material will be heated with respect to time and it will be you know changing its temperature from you know higher temperature to the lower temperature or cold body may be transporting from lower temperature to the higher temperature.

So, in that case the flow of heat is the main unit carrier for the transporting of energy In that case, sometimes you will see in the convective mode if suppose fluid element if it is heated and if it is you know flowing with a certain velocity or at a certain flow rate, you will see that the mass of this fluid will be you know carrying that heat energy from one location to another location. And this you know transport of this you know heat by this mass flow rate will be you know that enhanced by just you know changing each saw you know flow rate.

You can you know transport that heat energy at a certain rate based on the fluid properties and also you can transfer this energy by part 4 minutes of work also if suppose any uniform is you know that transferring any liquid from one position to another position you will see that there will be a you know certain heat energy will be generated because of that friction of that fleet to the you know surface of the that is conduit to his that flow to be moving.

So, because of that to discuss effect or fiction of that fluid element over this you know solid surface you will see there will be some frictional energy that friction analogy will be converted

into heat energy. So, in this case, you can see that how much work is done by that farm to transferring this fluid from one position to another position. They are according to that, the heat energy will be produced another system like you know that.

If suppose any closed system if you know that increase the movement of the molecules just by you know doing some work on the system, you will see that the closed system will be heated up because of that internal friction of that fluid element or you know the carious element in the close to B cell just by changing the temperature, and also you can say that, this change of this energy by raising this temperature because of that work done on the system, you will see there will be increasing energy and that increasing an energy will be called as internal energy increased.

So, in that case, you can say that you can increase the heat energy or internal energy or you can say that if you are working on a particular system like flash on at a certain pressure and if you decrease the volume or increase the volume just by you know, increasing the pressure and lowering the pressure respectively, you will see that the systems will be you know generating some you know energy that energy change will be considered as that internal energy.

So, in this way the heat may be you know that produced or you know generated or by transport by the you know performance of the work.

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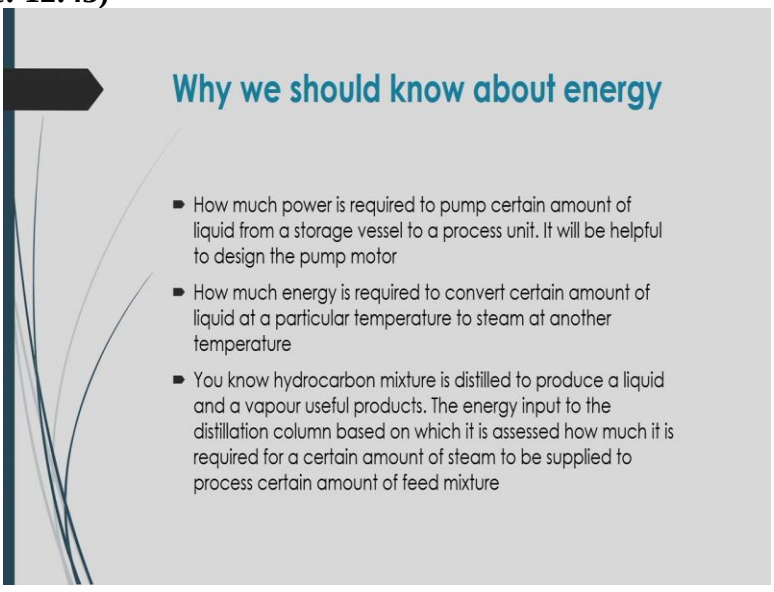

Before going to that, you know performance and analysis of the system. You have to know that why we should know that about energy. We should be you know, required for that particular system. Now, we have to know you know certain energy systems, how much energy is being consumed, how much energy is supplied there in a particular system. So, before going to you know analyze that you have to design that system and after designing that system, you will see that this mass of energy will be released or consumed.

But, that design of course, will be related to that you know, energy consumption and that you know that energy you know, utilization there, so, how much energy will be required for the operation of particular systems based on who is that you know design system will be designed or unit will be designed so far that the knowledge of that you know energy to be required for the design of the process unit. Like it will be you know helpful to design pump motor, you know that if you suppose supply some electrical energy.

and this motor will be you know rotating and based on which you will see that some energy will be produced and based on his that energy will be transferring to another pump to you know, do some work that will be you know, some, you know useful you know to produce some you know that valuable products. So, in that case, you know, the designing of that pump motor or some other process unit that will be requiring.

how much energy to be required or power to be required, that is basically especially for that pump to pump certain amount of liquid from a storage vessel to a process unit also how much energy is required to convert certain amount of liquid at a particular temperature to you know that Steam at another temperature. So, it is also required and also you know that hydrocarbon mixture is you know distilled to produce a liquid and vapor useful products in that case some energy is required to distill that you know hydrocarbon mixture.

Because any way you have to you know heat up that hydrocarbon mixture and based on the boiling point of that hydrocarbon mixture components, you know that lower boiling point liquidity will be you know, vaporized easily and it will be you know, coming off to that column and it will be separated from that liquid phase and then it will be you know collected as a you

know liquid after you know condensed session and for boiling off you need some you know boiler.

And they are also you know that heat is required so, for this boiler you need heat energy and also condensation you need also that some external work to be done they are. So, for this operation of distillation to you know get this useful productive liquid and vapor they are energy will be required and this energy input to that you know distillation column based on who is it will be assessed how much it is required for a certain amount of steam that is to be supplied to the process a certain amount of you know hydrocarbon mixture.

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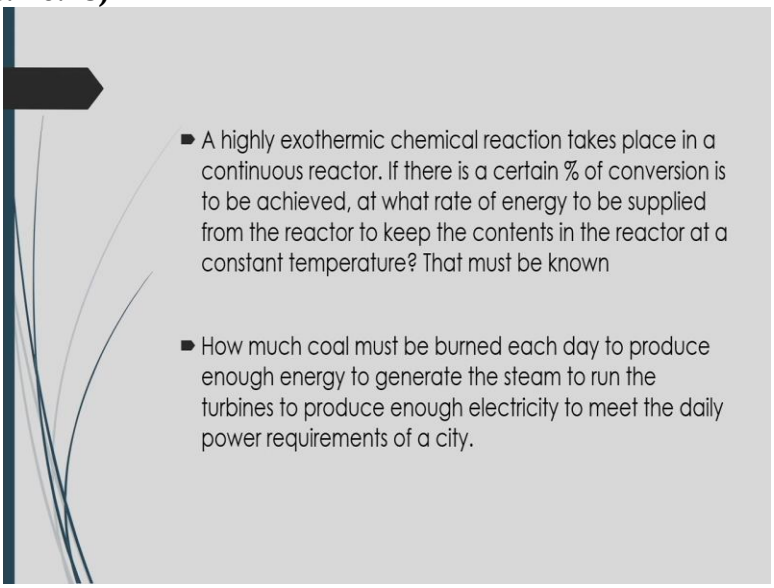

Also you will see that some other aspects also the heat energy or some energies required they are supposedly highly exothermic chemical reaction that is takes place in a continuous reactive now, if there is a certain percentage of conversion is to be saved by that reaction. Now you have to you know supplying some energy. Now, you have to know what rate of energy to be supplied from the reactor. So, that you can keep that you know reactor at a constant temperature.

Because whatever energy will be you know released by that reaction you have to remove that energy now, to removing that energy you have to do you have to use some you know that process unit like heat at here or you can see that some other cooling you know or device by who is you can you know that he moved that heat energy which is produced by the reaction now, in

that case, you have to know what will be the amount of heat to be you know that required to be you know removed to keep the contents in the reactor at a constant temperature.

Another important aspects where the energy is required to know that how much coal must be burned each day to produce enough energy to generate the steam, we know that particular energy we are getting maximum energy is coming from burning of coal by producing different valuable you know, gases mixture and from which we are separating and then we are getting different type of useful products and daily life.

Now, also you will see that whatever electricity we are using, that is actually being produced based on burning of coal. Now, in this case, how much coal will be banned to produce this type of this mass of energy support that you need to know that how much energy to be required for each of kind enough to generate the steam to around the turbines to produce you know enough electricity to meet the daily power requirements of a particular city or some other you know, that other required mercury.

So, in that case, you will see that whenever coal burn that coal will give you a certain amount of you know, gases mixture and that is that gases mixture you will see that will give you know or will be used to you know, that are rotating that turbine or that gases mixture can be used to synthesize some hydrocarbon mixture that will be useful for our daily life and also coal is also used to you know, that generate the steam from the water.

So, that heat energy is produced by simply you know burning of coal. So, burning of coal will give you the heat energy and that heat energy will convert that liquid water to steam and then the steam to be you know supplied to the turbine. And whenever turbine will be rotating that rotates the rotating turbine will generate that electricity. So, this a how much you know electrical energy will be produced by you know burning the coal and when you burn coal will be burned.

How much energy will be produced and also what will be the amount of coal will be supplied based on who is what will be their energy will be produced that should be you know, known for that operation.

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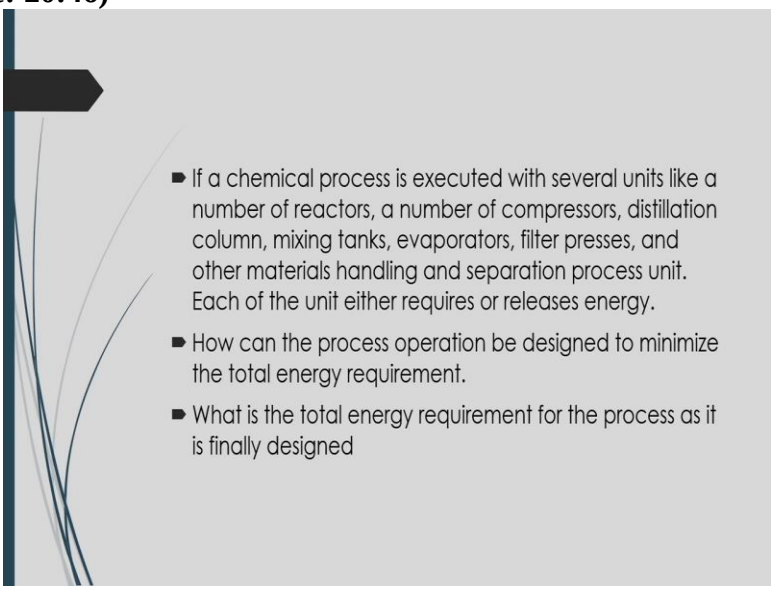

Another important you know, aspects of that chemical processes which are being executed and also, you know, those are required for their operation several units and like a number of reactors in number of compressors, distillation column mixing tanks evaporators filter precious and other you know materials that handling and separation process unit ease of the unit either recourse or releases some energy. So, that amount of energy to be calculated and also that should be controlled based on that you know among which are being coming as per calculation as per requirement.

Also how can the process operations can be designed to minimize the total energy requirement. So, that also can be assessed based on that energy balance and also how much energy to be required for that and also overall process plant analyzes whether it will be economic or not, that is actually SS based on that you know, energy requirement for the whole plant for you know, producing certain, you know useful products there. So, that is why we need to.

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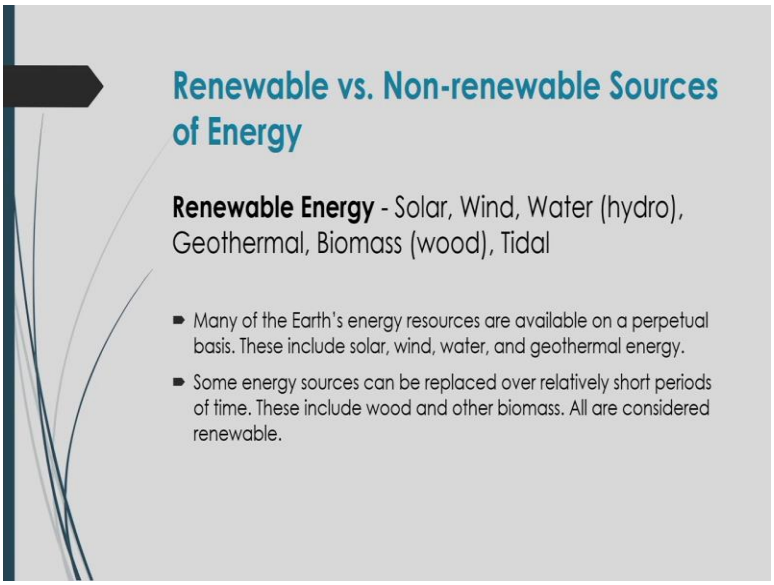

You know, that energy and it is also importance of that balance they are now, before going to that energy balance equation again you have to know what are the different types of energies also they are and what are the sources of that energy, you know that there are 2 types of energy one is called renewable energy another is called non-renewable energy. Now, renewable energy is called what is that? The solar wind water hydro geothermal biomass who title this type of energy is called renewable energy.

And this case, many of the arts energy resources are available on a you know, perpetual basis. So, these include these solar, wind, water, geothermal biomass and these are these energy are called you know renewable energy and some energy sources can be replaced over relatively short periods of time and this includes wood and other biomass all are considered as a renewable energy.

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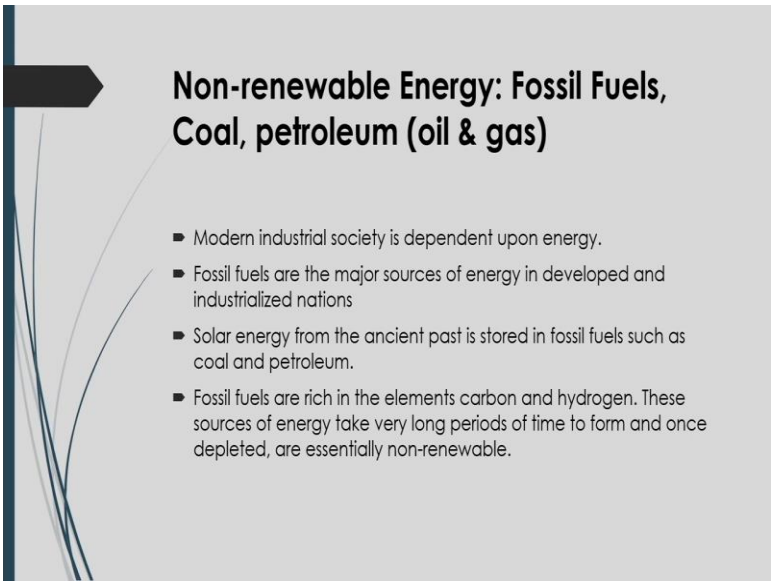

Whereas, you will see that in our modern you know industrial society, which are dependent upon for the energy and those energy comes from you know that, just by you know come from that, you know, natural resources like fossil fuels coal, petroleum, oil and gas like this, that case, fossil fuels are the major sources of energy in developed and industrialized, you can see that nations solar energy from the ancient past is stored in fossil fuels such as coal and petroleum and fossil fuels are released in the elements of carbon and hydrogen.

And these sources of energy take very, you know, long period of time to form and once depleted are essentially non-renewable. So, these are non-renewable, you know that necessarily occurring you know, sources from which you can get this energy.

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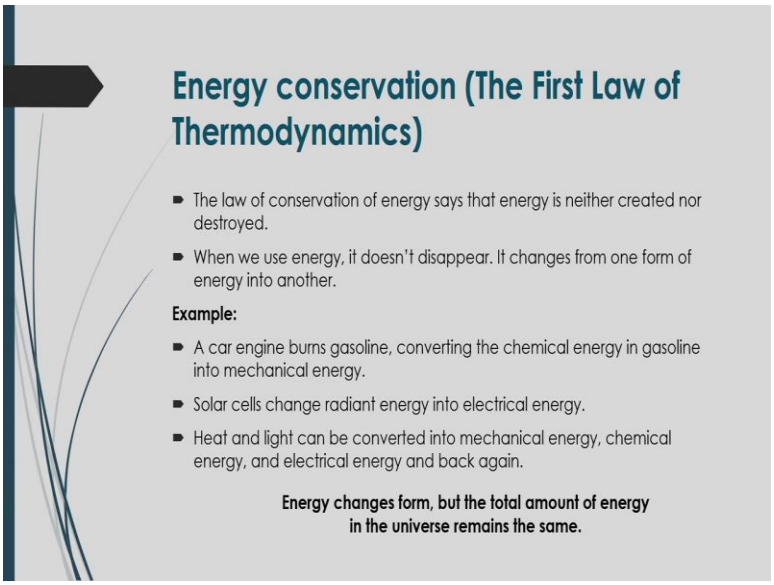

Now, we have to know that the different forms of energy and also what are the energy conservation law. So, energy conservation law is sometimes called this past law of thermodynamics. In this case this law says that you cannot create or you know, destroy the energy only, you can change this energy from one form to the another energy into another form like you can say that a car engine that bonds gasoline, that will convert the, you know, chemical energy in gasoline into mechanical energy.

And solar cells, the change radial as a radiant energy into you know that electrical energy and also heat and light energy can be, you know, converted into mechanical energy, chemical energy and electrical energy and back again. So, energy, you know, changes, it is form but the total amount of energy in the universe remains the same. So, this is called that energy conservation law and this law is sometimes referred to as First Law of thermodynamics.

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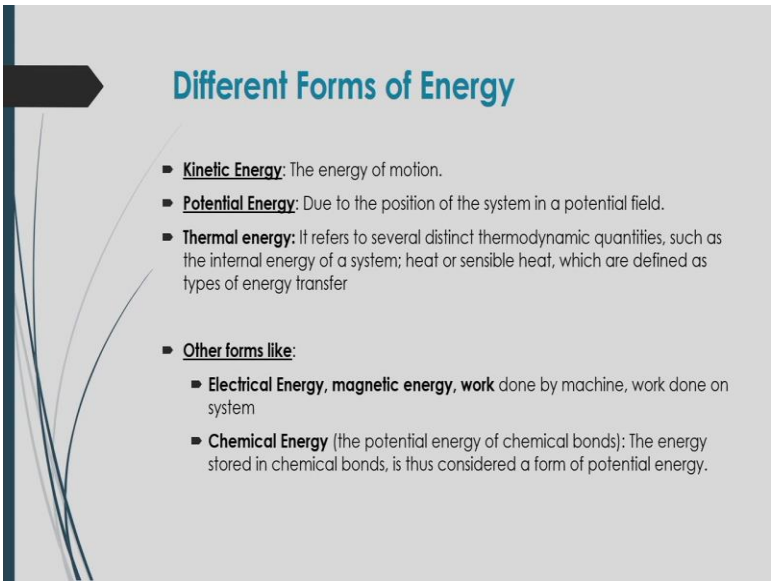

Now, what are the different forms of energy there may be you know, there is some kinetic energy that will be potential energy, thermal energy, electrical energy, magnetic energy work and also energy, chemical energy. Even you can see that some other different types of energy you can have like you know nuclear energy, fusion energy, all those different types of energy.

Now, kinetic energy is basically the energy of motion whenever to the element with change, it is you know, kinetic from one you know, quantity to another quantity, you will see that the motion of this fluid at each different, you know, flow rate will have some your own energy. So, this is called kinetic energy and potential energy is basically due to the position of the system in a potential field to anybody any object it is change its position, you know particularly or you can see at an inclined to another position you will see there will be a change of potential energy.

And you will see that this potential energy maybe of different types like gravitational energy or gravitational due to the gravitation and also due to some you know that chemical bonding of the, you know, atoms and also some other you know, forms like, if suppose the spring needs, change its location, there will be you know that, you know, that potential energy will be you know, really there. So, that is why how can say that her potential energies basically due to the opposition of the system in a you know potential field.

And thermal energy it refers to several distinct thermodynamic quantities, whereas the internal energy of the system, heat or sensible heat, you can see, who said defined as the types of you know that energy transfer other forms like electrical energy magnetic energy work, which are done by machine work done on system like this chemical energy or this is basically a potential and achieve up chemical bonds. The energy that is stored in chemical moles is does considered a form of you know potential energy.

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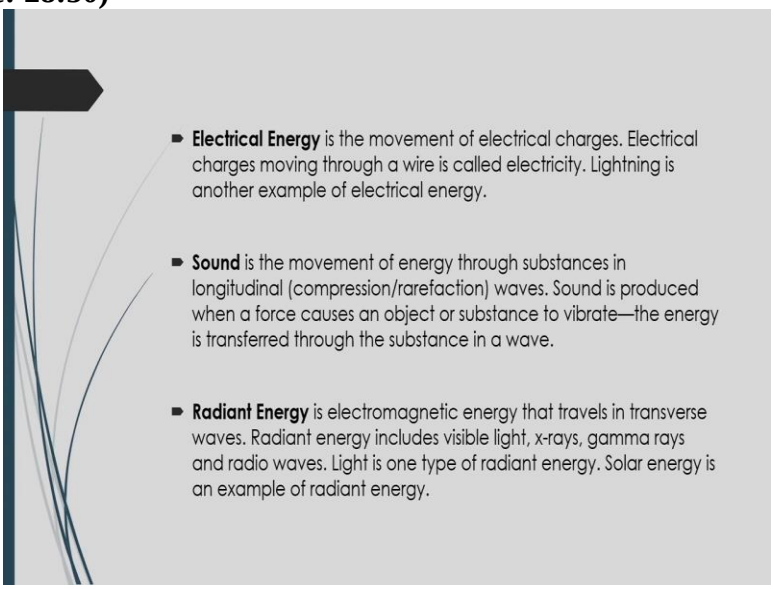

Electrical energy is the movement of electrical charges moving to a wire that is called electricity and lightning is another example of electrical energy you can say. Sound is also regarded as an energy basically, the movement of energy is through substance in longitudinal are based on compression or rare fraction waves. And, this sound energy is produced when a you know, force causes an object or substance to vibrate.

The energy is transferred from the substance in a wave and radiant energy. It is basically a you can see that electromagnetic energy that traverse in transports waves and this radiant energy includes, you know some visible light X ray gamma rays and you can see radio waves and light is one of one of the you know, the top radiant energy and solar energy is an example of radiant energy you can say.

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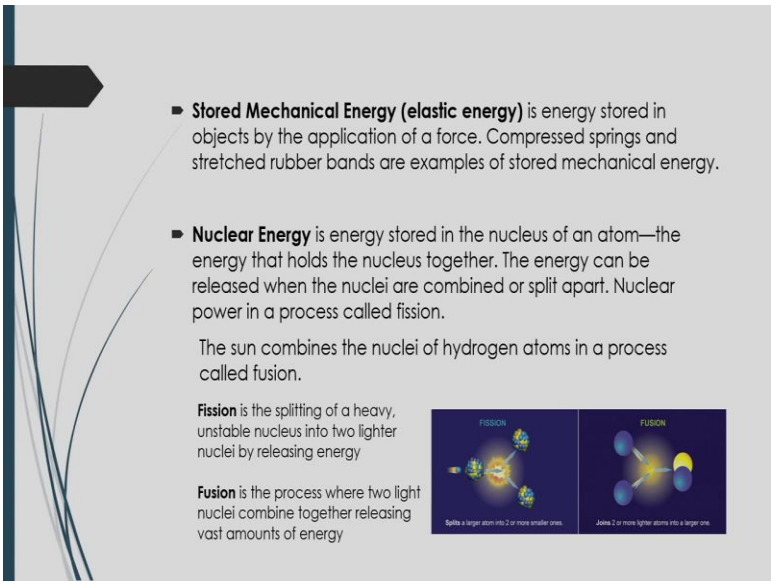

Sometimes you will see that some energy will be you know that stored as a mechanical energy that is called elastic energy. And this is stored in objects by your application of stored compressed speeds there and stressing use and also stressing a proper bands are some examples of stored mechanical energy. Nuclear energy this is also one type of energy which is being stored in the nucleus of an atom. In this case the energy that holds the nucleus together and the energy can be you know released.

When the nuclear combined or split apart and nuclear power in a process that will be called as efficient process you will see that the sun that combines the nuclei of hydrogen atoms in a process which is called you know fusion. So, fusion is the process where 2 light you know nuclei that combines together releasing past the amount of energy and fission, this is a splitting of heavy you know unstable nucleus into 2 lighter nuclei by reusing each energy.

So, that is fusion is one process by which you can have some energy just by splitting of a heavy unstable nucleus into, you know, 2 light a nuclear whereas as fusion is the process for the releasing of energy by you know, that combining, you know 2 light a nuclei together into, you know, a combination to release this past amount of energy.

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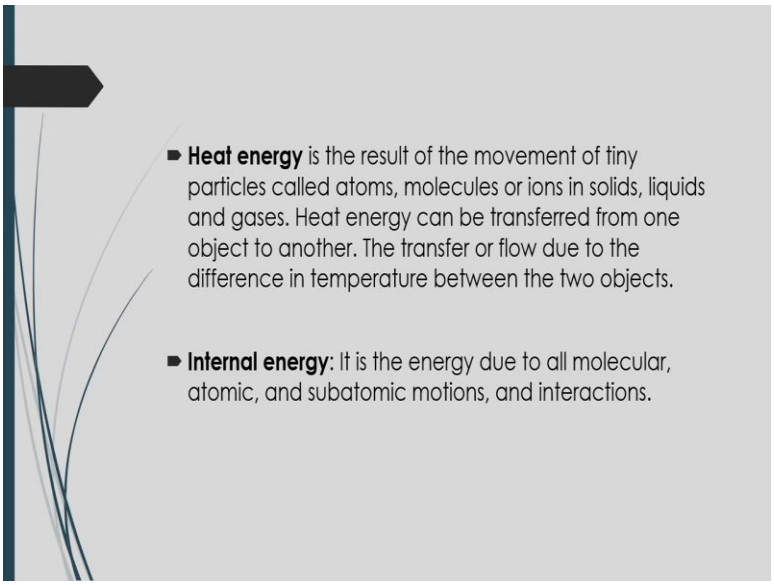

and heat energy is the result of that movement of the in particles that is called atoms, molecules or ions in the solids, liquids and gases and heat energy can be transferred from one object to another the transfer or flow due to the difference in transfer between the 2 objects and you will see that due to the you know, molecular or atomic or some subatomic, you know motions and also that interactions among the molecules you will see that there will be you know energy released and this energy release will be called as internal energy.

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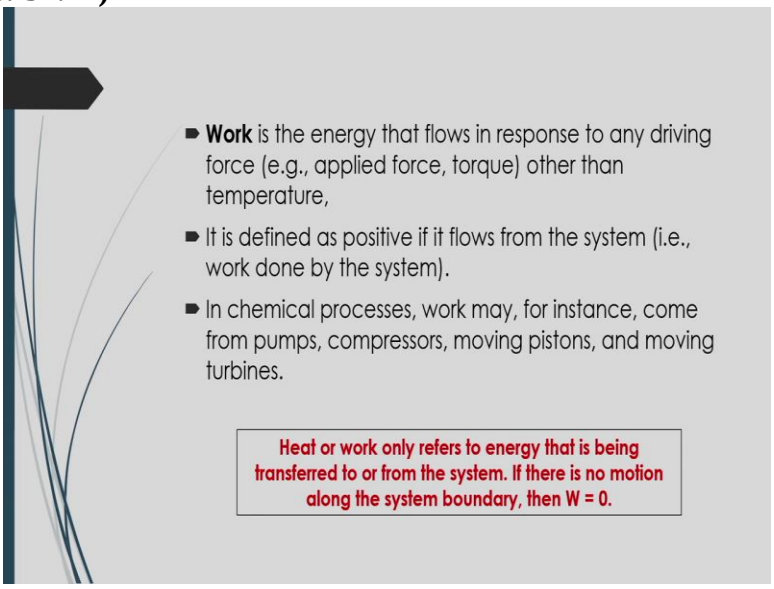

And this internal energy you can you know produced by you know supplying some, you know, extra work on this. So, that will be called as work energy and that work is actually regarded as energy that flows in response to any driving force they are like applied force torque other than

temperature you can say and it is defined as the positive for if it flows from the system that is work done by the system in chemical processes work may for instance come from pumps, compressors moving pistons and other moving you know turbines.

So, in that way you can you know, get this work for you know chemical processes just by you know pumps compressors moving pistons and moving turbines and also you can you know get this type of work based on that you know, applied force as a torque or some pistons or you can see less thick, you know, forces there. And these, you know work, energy will be utilized for transporting of fluid from one position to another position or you can use this work energy to change the internal energy or enthalpy of the systems to you know that particular process prior.

You can get that useful products by its processing and so, we can see that what about heat or work that will be refer to the energy that is being transferred to or from the system and based on who is that you know, that process would be you know, assist and you can see that performance of the process will be analyzed. And if there is no motion along the system boundary for a particular process that you can say that, that work done will be you know non or negligible there.

So, basically 2 things are here heat and work that will be supplied or it will be you know that released from the system and based on based on which you can say that what will be the you know process out and order the efficiency the process that can you can assist based on this and because this you know supplying up work to the system or by the system, you know or you can see that supplying of heat to the system or releasing from the system.

you will see that there will be change of internal energy, kinetic energy and also potential energy and based on who is you know, case to case that different chemical engineering processes to be assessed based on that you know, based on each process you need, how it is being used based on this energy supply.

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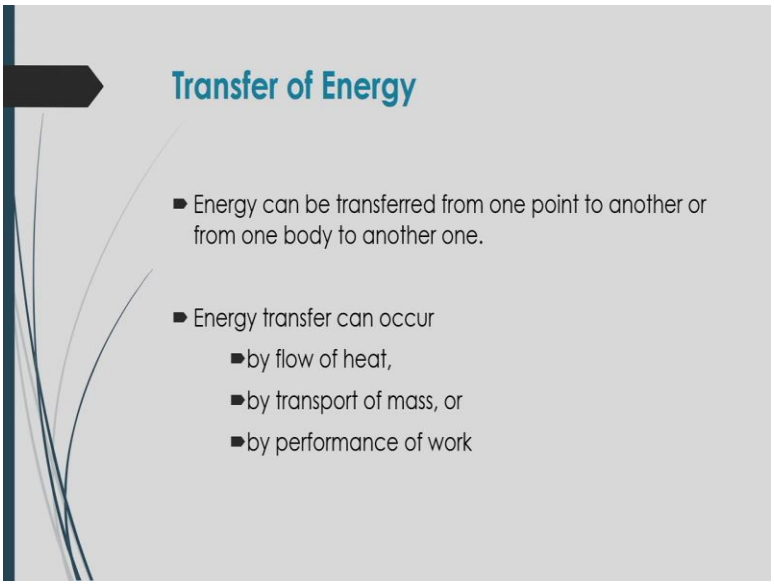

Now, we know that how that energy can be transferred to you know utilize it for you know getting that useful products that energy whatever heat or work can be transferred by flow of heat by transport of mass or by performance of work.

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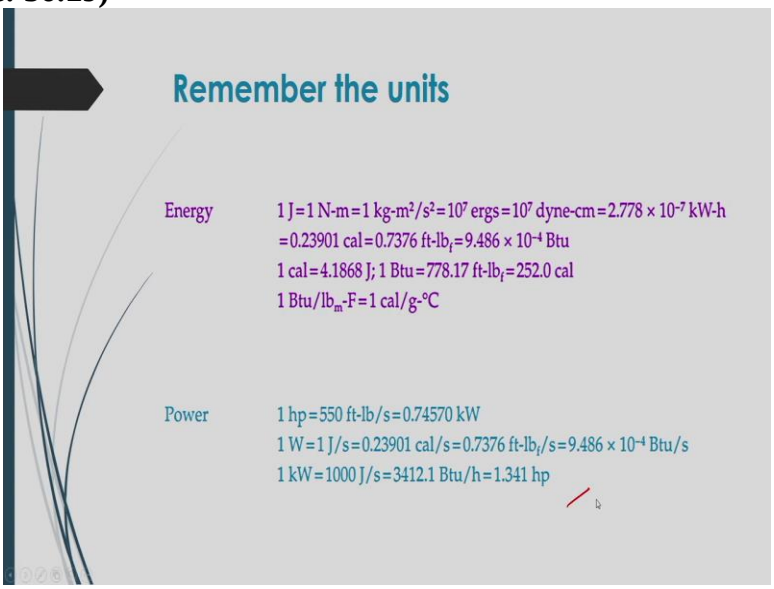

In this case, you have to remember what are the units generally being used for these energy and also the rate of energy which is called power what will do what should be the units that also to be you know are required to know, because, different systems are you know they are to be used or to be you know that access based on this you know, system of units and based on which you will see that quantity of the heat indifferent systems will be different. So, in this case, generally the unit for energy is actually denoted by joule and it is basically that Newton meter.

So, 1 joule is equal to 1 Newton meter, where you can see that 1 kg of you know mass of any object anywhere it will be accelerated at a certain you know value like kg per meter is a meter per second described then you can say that there will be 1 joule of energy is produced or work done will be produced to there. So, we can regarded this joule as a unit of you will see that energy and in British thermal unit it is you know that.

BTU and this you know that what will be the you know conversion factor for this dual to you know that British thermal unit and also to the calorie also another important unit by which you can you know access these are quantified this that is energy. So, that will be joule calorie when British thermal unit here in the slides, this unit conversion of this energy from one system to another system is given also the units for power also given in this slides.

It is regard it is generally regarded as you know that horsepower or kilo watt. So, one horsepower is basically 0.74570 kilowatt and also 1 kilowatt joule 1000 joule per second that means, the how much energy is released or work done per unit time that will be called as power. So, here the slides the unit for power at different, you know systems is given.

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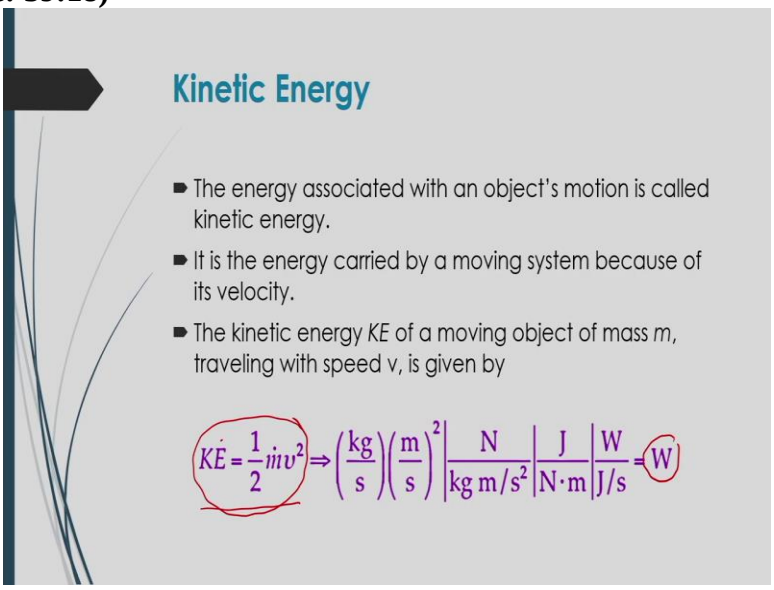

Let us talk about the different forms of energy and how it can be calculated. Now, we have truly described regarding that, different forms of energy like kinetic energy potential energy, internal energy, heat energy, electrical energy all those. So, what is that kinetic energy, this is basically

associate with an object saw motion and it is the energy that is carried by your moving system because of its velocity and the kinetic energy of a moving object of mass m traveling with this speed suppose p can be you know defined as like half of a mv square.

If it is regarded as a rate then you can say that it will be you know that rate of kinetic energy they need to be you know defined as the rate of kinetic energy to go to hop into m dot into p square your m dot is you know mass flow rate and p is the velocity. So, half into m dot into v square it will be you know called as kinetic energy and this unit you need to be you know that joule per second. So, simply to come as you know that watt is watt is the power unit are as joule per second it will be the energy per unit time. So, what is regarded as watt now, let us do an example for this.

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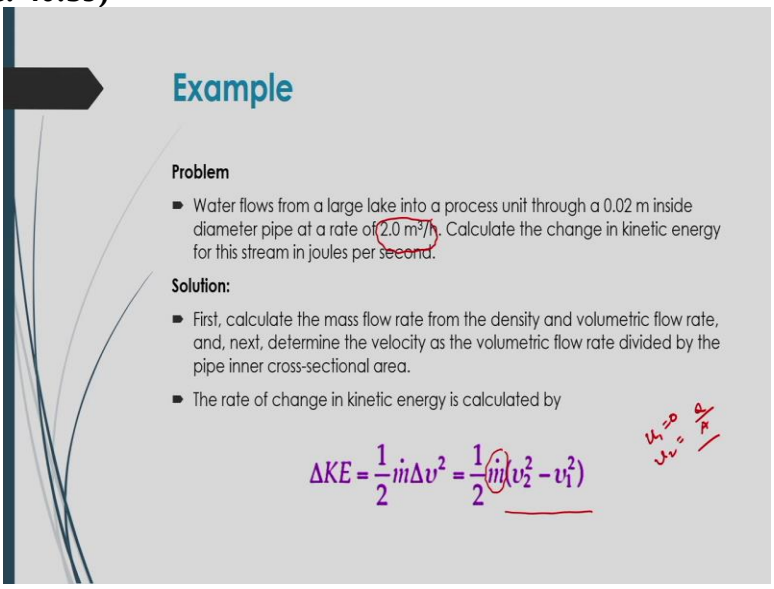

Suppose water flows from a large tank into a process unit to a 0.02 meter inside diameter pipe at a rate of 2 meter cube or work calculate the change in kinetic energy for this stream in joules per second. So, in this case, you will see that it is given that what will the volumetric flow rate here, this volumetric flow rate at this flow rate you will see that water is flowing through the pipe for us inner diameter of the pipe is given to you that is 0.02.

So, what we the velocity of the fluid that is flowing through this pipe first of all you have to calculate since volumetric flow rate is given to you can get these you know velocity just by dividing the volumetric chloride by its cross sectional area you have to calculate first cross

sectional area since its diameter is given. So, what should be the cross sectional area simply volumetric flow divided by you know volumetric cross section area to be simply you know that by the square by four is the diameter.

And if you know that cross sectional area, then you can easily calculate watts velocity simply volumetric floated by cross sectional area, so, here you can get this velocity. Now, these velocity will be you know that through the, you know, pipe from each, you know initial condition initially that fluid was, you know, at rest. So, initial velocity of that fluid will be, as you know that 0. So, you can say initial velocity, u1 = 0 or 1 will be = 0.

And the final velocity as you know that u2 that will = just simply queue by cross sectional area. So, you can get it and you can say, after that you can calculate what should be the you know the kinetic energy. So, kinetic energy that will be half into m dot into v2 square – v1 squared. So, v2 is known to you as part this problem u2 0 here u1 0 here but again you have to calculate what to the mass flow rate.

Since you are you have given only you know that volumetric fluoride of the fluid. So, you can get the mass flow rate just you know that multiplying this volumetric flow rate with rage say density then you can get the ah mass flow rate since era the fluid is water. So, density of the water is 1000s. So, we can say that the master it will be equal to this 2 into 1000. So, it will be coming as you know that 2000 you know, Kg per work here. So, if you substitute here this mass flow rate.

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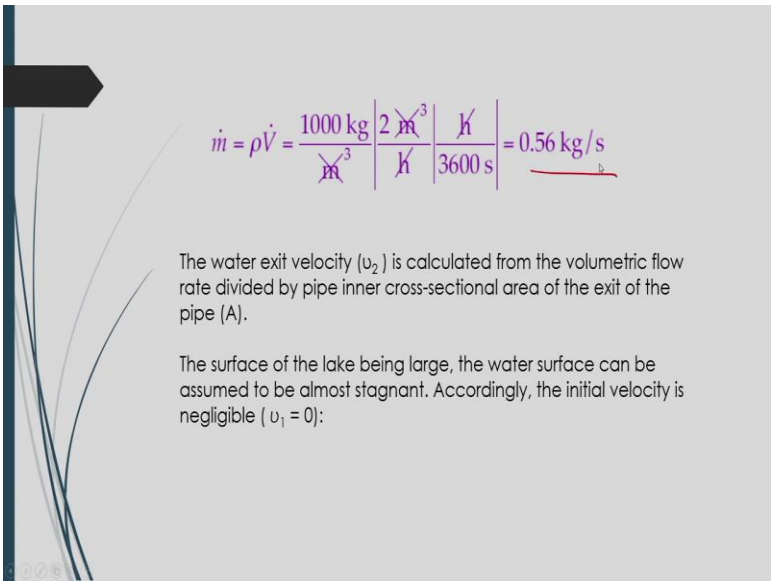

You can get this kinetic energy finally, after substitution.

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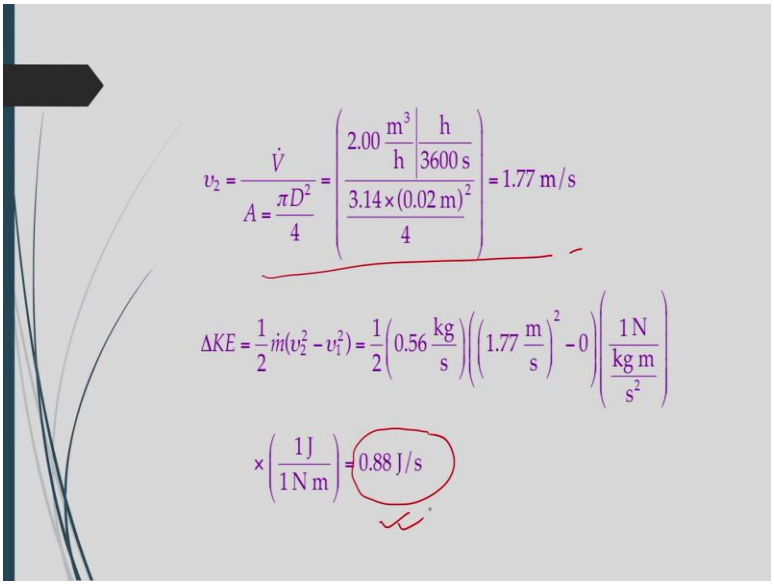

Then you can get this kinetic energy as here 0.88 joule per second. So, from our 2 second you have to then multiply you know that this you know kinetic energy you know they are second to hour are hour 2 second that you have to you know conversion factor of 603 we have to use there So, finally here in the slides, it is given the details calculation of these V2 and also mass flow rate also which is given here as it is 0.56 and then finally, this kinetic energy is like this.

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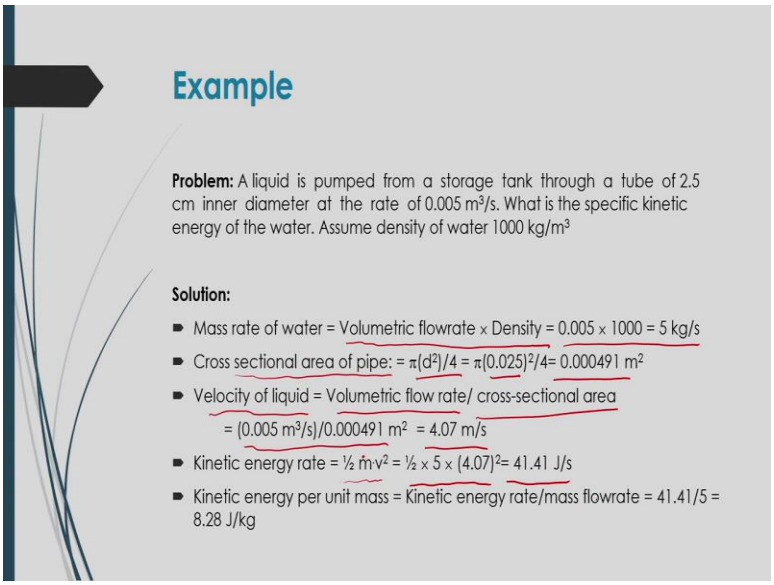

Let us do another example here. Suppose a liquid is pumped from his storage tank to a tube of 2.5 centimeter in diameter at the rate of 0.005 meters joule per second, what is the specific kinetic energy of the water here, density of the you know liquid as water you can say it is given 1000 Kg per meter cube. In this case you have to find out what should be the specific kinetic energy. Now, this specific kinetic energy basically the kinetic energy per unit of mass you can calculate here.

First of all you have to calculate it is kinetic energy based on then you know, velocity change. So, to calculate that, first of all you have to calculate or to the mass flow rate of that water, this is basically volumetric flow rate into density then it will be coming as your 5 kg per second and then calculate the cross sectional area of the phi it will be you know quiet discouraged by for here d is given to you, then after calculation, you will get this cross sectional area of 0.00491 meter squared.

And then velocity of the leakage you can get it volumetric flow rate divided by cross sectional area then after substitution of those values, you can get this velocity as 4.07 So, kinetic energy rate will be equal to half mv squared. So, after substitution of this, you know, value of this.

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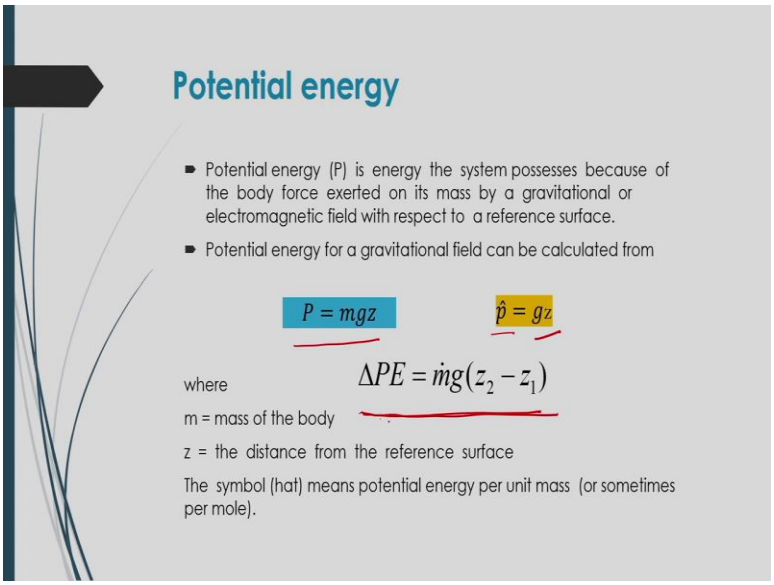

You know mass flow rate even you know that velocity, they are and finally you can get this you know kinetic energy rate as 41.41 joule per second. Now kinetic energy per unit mass that will be regarded as that specific kinetic energy. So, that can be calculated just by dividing this kinetic energy by you just you know mass flow rate, then it will be coming as 8.28 joule per kg, here, now what is potential energy, the potential energy is energy by the system, that is possesses.

Because of the body force that exerted on its mass by a gravitational or some other you know that field force field you can see with respect to a reference surface, now this potential energy for a gravitational field can be calculated by this equation per field called potential energy. M is the mass of that you know object or material you can say and g the gravitational isolation and z is te for that height of that you know object from the star reference surface and the specific potential energy can be regarded as we had that is basically this us potential energy per unit mass, then i will becoming as simply g z.

So, potential energy change you can calculate what should be the, you know, height change based on which you can calculate its change. It is basically in m dot g into z2 – z1 here z is the distance from the reference surface and at 2 locations if it is there then you can see that z 2 are from the different subjects surface z1 also from the references and then you know subtracting it will give you that change of you know potential energy based on this equation given in the slide.

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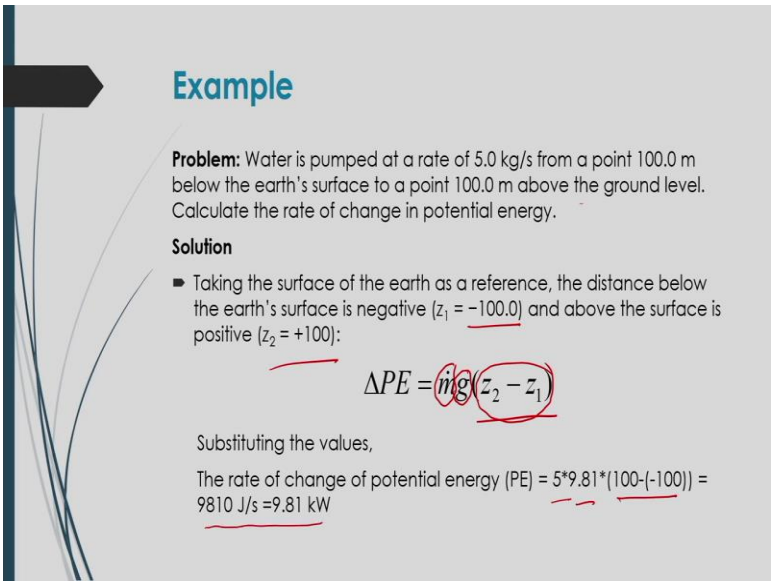

Now, let us do an example here this case again that water is pumped at a rate of 5 kg per second from a point 100 meters below the earth surface to a point of 100 meter above the ground level. So, in this case, you have to calculate the rate of change in the potential energy. So, simply here m dot is given to you g is the gravitational acceleration that is 9.81 here, this saw you know that level change like this z2 to z1 here in the load, z1 into z2.

This is basically this difference is coming as you know that here, z1 is - 100 meter and z2 is + hundred so, we can say that this difference will be 100 - of - 100. So, it will be coming as 200 here. So, if you multiply this with this mass flow rate and this gravitational isolation, we can have this rate of change of potential energy as you have 9.81 kilowatt.

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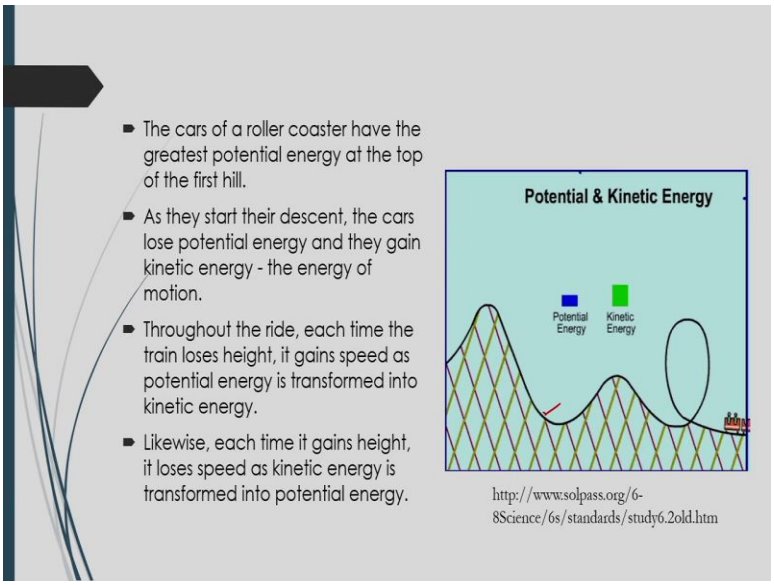

Now, if we you know compared this potential and kinetic energy and how it is actually changing, just converting this potential energy to the kinetic energy. Now, let us see this discuss of a roller coaster have the you know greatest potential energy at the top of the first hill here. Now, as they start their descent, the curse, loss potential energy and they gained their kinetic energy, the energy of motion there, here seen this video in the slides here throughout the ride is time for the you can see that discuss or train loss height it gains the speed as a potential energy.

and then it is transferred into kinetic energy here and then is transferred into again ah kinetic energy just by changing it is different you know height of this you know hill like this time it gains height it losses to speed as kind of energy is transformed into potential energy there so based on whose we saw in the bar it is the same g you know a location you will see that this potential energy will change and whenever it is changed, you know this velocity its kinetic energy will change.

So from that you know that changing its position by its changing its velocity how these potential energy and kinetic energy will be changed and this converting this energy from potential to kinetic to potential that you can easily you know, has is based on this you know preview or you can understand this.

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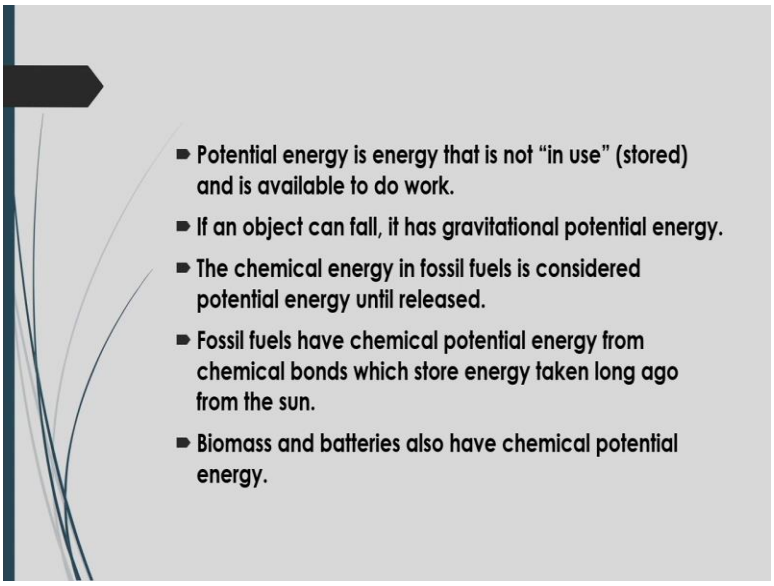

Now potential energy is energy that is not in us that is physically installed and is available to do work and if an object can fall it has gravitational potential energy, the chemical energy in ah you will see that in fossil fuels is considered potential energy until released. Fossil fuels have chemical potential energy, you know from chemical bonds with stored energy taken long ago from the sun. And also you can see that biomass or batteries have also chemical potential and achieve here also.

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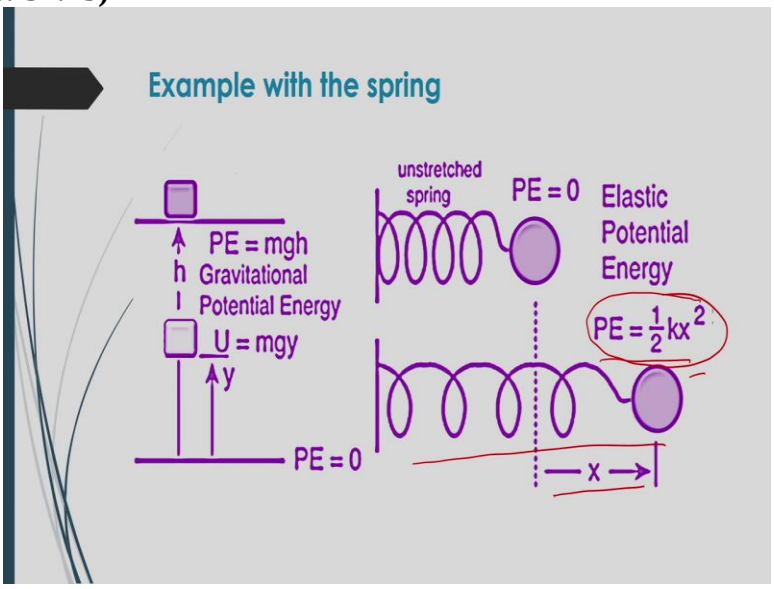

The spring energy is shown the slides that how this potential energy is changed whenever, you know that expand this spring at a certain link takes there. So, therefore, that potential will become potential energy will be calculated based on this expansion of this unstretched spring

here So, it will be simply half of k into x squared here case called here some constant that is you know less g constant here. So, based on PC you can calculate what the potential energy.

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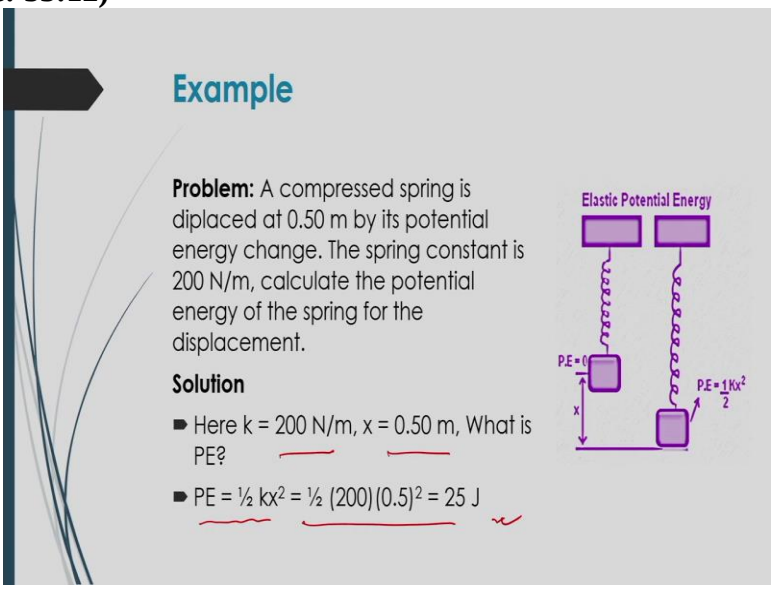

Like here example is given here a compressed spring is, you know displaced at 0.5 kilometer by each potential energy change, the spring constant is given 200 newton per meter in this case what should be the potential energy that you have to calculate based on this displacement of this spring here K is given here 200 newton per meter x is given .5 meter then potential energy will be equal to half of k into x squared that simply you know half into 200 into .5 squared that will come 25 of Joule.

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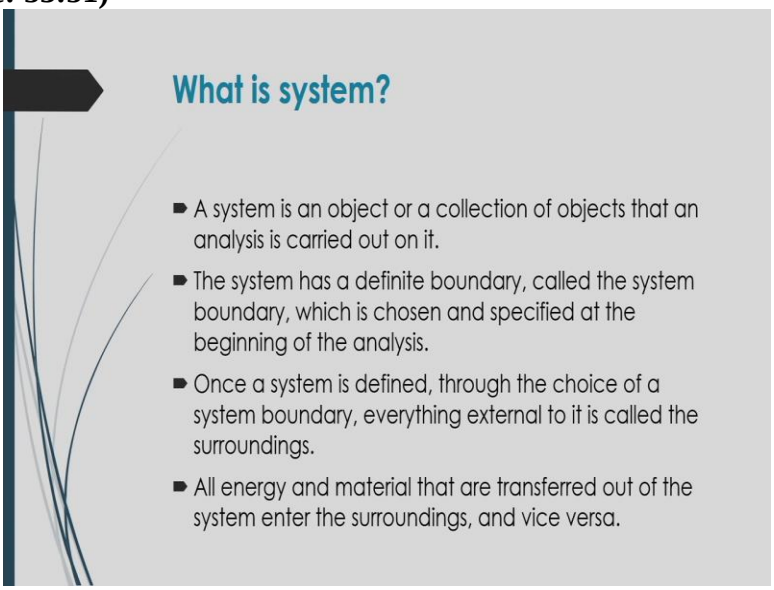

So, we have discussed here regarding that you know concepts of energy and how different forms of energy is converting from one form to another form. Now, in this case before going to that balance of energy in a particular system, you have to know that what is that particular system in this case the system generally is an object or a collection of object that and you know analyze is carried out on each the system has a definite boundary called the system boundary.

Which is so then and is specified at the beginning of the analysis. Once the system is defined to the size of a system boundary everything external to eat to be called as the surroundings and all energy and materials that are transferred out of the system entered the surroundings and vice versa and based on this.

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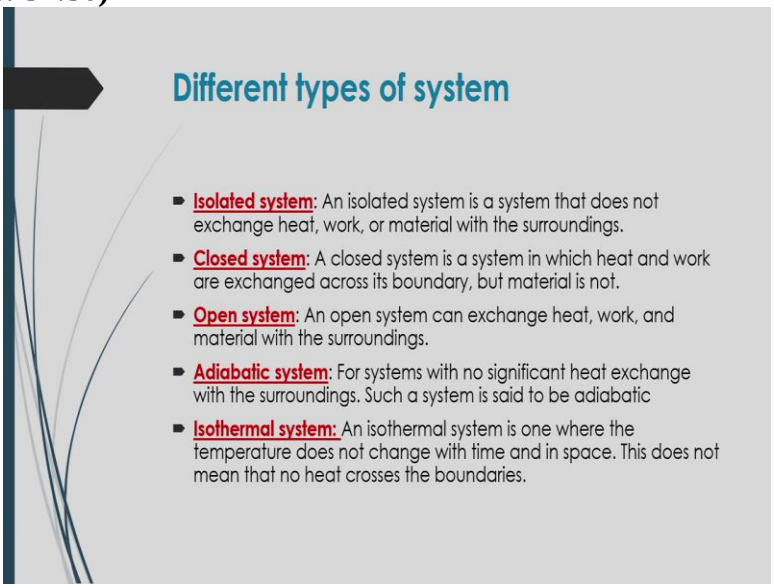

You have to analyze that you know, our system energy which is coming out which is coming in and also what are the change of internal energy you know enthalpy potential energy kinetic energy inside the system, there are different type of system you will see that some systems will be isolated, some systems will be closed some systems will be open some systems will be eidetic some systems will be isothermal.

Isolated system there are that does not exchange heat work or material with the surroundings and closed system they are in which heat and work are exchanged across its boundary, but material will not be open system will be defined as the system by our you know that heat work and

materials would be you know, extends to the surroundings and adiabatic systems in that case most significant heat exchange with the surroundings will be happened.

And such a systems is said to be sometimes eidetic and whenever the systems will be operated at an you know constant temperature and also you know that there will be a certain time and for a particular you know a special coordinates, then you will see that heat crosses the boundary will not happen. So, in that case it will be regarded as you know isothermal system.

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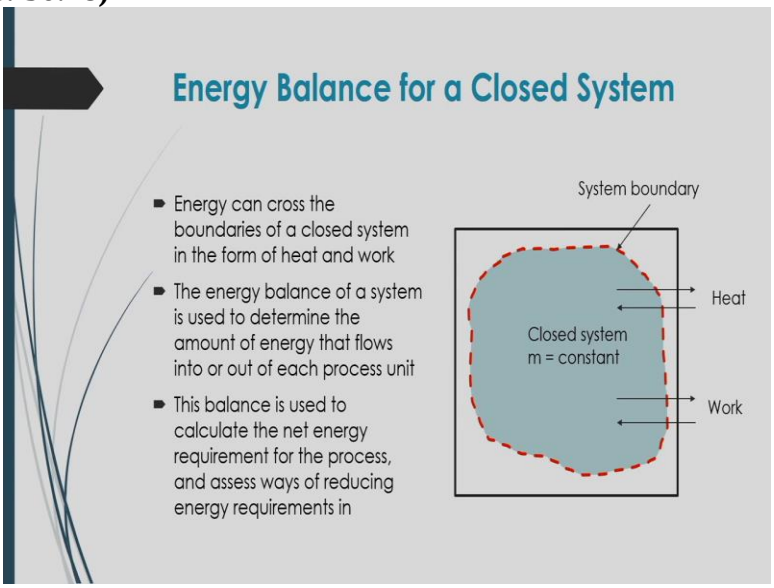

So, here one system here is given this is the closed system and here red dotted line is regarded as boundary and outside the boundary it will be called a surroundings. Now, to these closed systems will be heat will be in and out there simulate what can be done on the system and work will be done by the system also. So, energy can cross this boundary of a closed system in the form of heat and work and the energy balance of the system will be used to determine the amount of energy that flows into or out of his process unit.

So, these systems can be regarded as one processing unit also and the balance, which would be you know, that used to calculate the net energy requirement for the process and they need to be assets as ways of reducing energy requirements in the systems.

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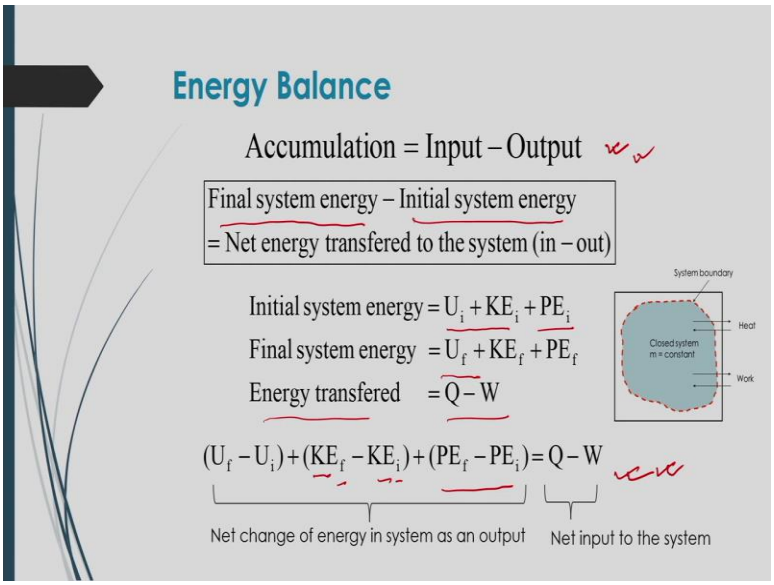

Then, after doing that system or defining that system boundary, you have to do that balance energy balance now, to do that energy balance, you have to you know that basic energy balance equation. Now, ask for this you know that conservation of this energy we can you know formulate this energy balance equation as like it is anesthetic that heat is there gaining and it is losing and also you can see that there will be accumulation of some heat energy.

So, if there is unsteady state operation, so, based on which you can see that there will be some accumulation there will be some energy there will be some output of energy. So, based on this you know concept of this energy equation, we can say that there will be some accumulation of energy based on you know, what will be the energy in the final system and what will be the energy that in the initial system and also what would be the net energy that is transferred to the system to change the spinal system energy from its initial system energy.

So, we can then represent it as the accumulation as final system energy - initial system energy and it will be then equals to that input - output like this and that what will be the net energy here input - output that is transferred to the system like maybe you know that some heat energy or you know that work done by the system or work, heat energy to be supplied to the systems there. So, based on which there will be changed on that system energy.

It may be gaining its final system energy from its initial system energy they are now, initial system energy can be regarded as you know that a summation of internal energy, kinetic energy and potential energy final system and it will be regarded as that you again that internal energy of that final state or final condition, kinetic energy and funded into potential energy and net energy transport that will be q - w.

So, if you substitute this, you know, quantities here in this you know energy balance equation, we can write this energy balance equation here, we can see that that net change of energy in the system as an output or you can see that that will be changed by that you know supplying of energy or losing its energy from the system here. So, based on this net input to the system that may change these you know that system energy from its initial to each final stage.

So, based on this, we can then formulate this you know energy balance equation. So, here Uf - Ui, the analogy is you know that internal energy change from its initial to final and kinetic energy as KE this kinetic energy, this is a favorer final and kinetic energy that is i for initial to this kinetic energy will be changing from initial to the final similarly, potential energy also may be changed from initial to the final.

So, to be the total change of the saw submission of internal energy change, kinetic energy change, stage potential energy change, all those will be coming based on that net energy supplied to this you know system. So, we have we are, you know described this energy balance based on the system boundary and also how that unnatural within more details of this energy balance will be, you know, described in the, you know, next 2 lectures there.

So, the next lecture will describe this, you know more details of this energy balance and also other, you know, conditions of this energy balance equation and based on base will, you know, do some, you know calculations based on this energy balance. So, thank you for giving attention for this lecture.