

Transcript BLOSSOMS

Thermodynamics: Energy Conversion in Generating Electricity

Hayati

Hi everyone. I am Hayati and i teach thermodynamics at the Faculty Mechanical Engineering, Universiti Teknologi Malaysia. Today we are going to learn about Energy Conversion in Generating Electricity. First, lets take a look at this scene of shadow play. For your information, Shadow play or also known as shadow puppetry is an ancient form of storytelling and entertainment, which uses flat articulated figures (shadow puppets) to create the impression of moving humans and other three-dimensional objects. The name Wayang Kulit is also the name by which shadow puppetry is known in Malaysia. In this country, such puppetry usually features mythical stories and tales of morality. Malay shadow plays are quite often considered the earliest forms of animation and almost always have an educational moral that is deduced through a battle. Various effects can be achieved by moving both the puppets and the light source. There is a strong association between shadow play performance and our lesson of energy conversion. We shall discuss the association after watching this scene.

Voiceover of girls from the previous scene

Girl #1: Eh, why is it suddenly dark?

Girl #2: Ishh..what happen to the show?

Girl #3: Laa..why did the lights go off?

Girl #4: Oii..can somebody turn on the lights?

Hayati

Can you tell me what just happened to the boy and his friends?

It seems that the boy does not have enough energy to light up the bulb for their play. Do you think we can help them?

Hayati

If you think this is part of the process of generating electricity, then you are right. From Physics, we know that during an interaction, energy cannot be created or destroyed, but is actually being converted from one form of energy to another form of energy. In generating electricity, there is a consecutive process of energy conversion taking place, before we get to the end product. This is the topic of today's lesson: Energy Conversion and Conservation of Energy.

Later in this lesson, we will present an animation of energy conversion and take you to a power station to see the actual running of a power plant. For now, let us identify the various stages of energy conversion involved in the video earlier. Why don't you discuss with your friends beside you and your teacher, to identify the energy involved in the short play earlier. What is the form of energy that is being converted, and how is that energy being transferred?

Hayati

I hope you were able to discuss and differentiate the various energy conversions. Now let us look closer at the animation, taken from processes in the previous segment.

Voice over

To put it simply, the boy uses biochemical energy in his body when cycling the bicycle and converts it to mechanical energy. This mechanical energy causes the wheel to spin. The spinning of the wheel provides for the rotation of a magnet in the dynamo that is conversion to kinetic energy. The turning magnet creates disturbances in the electromagnetic field, which produces alternating current or electrical energy. That electricity is then 'used up' or converted to light.

Hayati

We will see this similar process again during our visit to a power station later in the video. One point to take note is that, throughout these processes there is another form of energy in conjunction with the energies that I have stated. It is heat energy. Heat energy occurs at various point of energy conversion too; see if you can identify its existence. Check your answer with your teacher later.

Hayati

For now, let us take a look at simple systems. In my absence, your teacher will assist you to do some activities and a simple experiment on energy conversion. Go on and do the activities, discuss the type of energy involved and the energy required that allows them to work.

Hayati

Hello again.

From the activity you did with your teacher, I hope you are able to understand the concept of energy conversion by identifying specific conversion process, the work done and any 'waste energy' by product.

Take note that conversion of energy may be from kinetic to potential, electromagnetic to kinetic, electrical to kinetic, in reverse of those mentioned or in any other form of energy such as heat, light and biochemical. In the experiment, you had actually done a simple energy conversion. Remember, in a complex system such as a system for generating electricity, the energy is converted and re-converted through a chain of processes. Follow the energy path and you will get to the end product.

Hayati

For the purpose of calculating the amount of energy available and converted, which we will discuss in another video, these chains of energy conversion may be identified with system boundaries. You can then apply the relevant thermodynamics principles to determine the amount of energy being converted and the efficiency of the system.

Hayati

Let us do an activity before I take you to visit a power station. Have a class discussion with your teacher. Try and identify activities around you that you normally find, and specify the energy and its conversion process that is required to gain an end product. Go from a simple conversion system to a more complex

system with multiple conversion processes. See if you can understand and identify system boundaries too.

I will meet you at the power station.

Hayati

Hello again. Now we are at the YTL Pasir Gudang power station which is a combine cycle power plant. So now let us go in and meet the power plant Engineer, Mr. Mohamad Zaki Ramlee.

Hayati

Hello, welcome to the YTL Pasir Gudang power station. My name is Mohamad Zaki Ramlee and I am a Mechanical Engineer in charge of plant operations of this power station. This YTL Pasir Gudang power station is a 404 megawatt combined cycle power plant located in Pasir Gudang adjacent to strait of Johor in southern Malaysia. This plant consist of two 134 megawatt gas turbine, two heat recovery steam generators, and one 136 megawatt steam turbine. For your information, the main component in generating electricity is the generator for this is where electricity is produced before it is step up via a transformer for transmission to business and housing areas. Energy for the generator is from the turbine such as this. Turbines are rotated by a continuous flow of high pressure steam from the boiler. The boiler used in this combined cycle power plant is a heat recovery steam generator in which the steam is heated up by exhaust gas from the gas turbine. Other components of the power plant include the condenser, sea water cooling pump, water treatment plant, and electrochlorination plant.

The operation of the power plant is carried out from the control centre located in the administrative building. This operation include starting up and shutting down of the machine, monitoring of processes and communication with the national load dispatch centre. Although the concept of electricity generation is the same, each power plant has its own characteristic depending on its basic fuel and energy cycle. This YTL power plant uses natural gas as its source of fuel which is supplied by national petroleum company also known as Petronas.

Voice over

An animated power plant will indicate the workings and the inside of each system especially the boiler and turbine.

Hayati

Notice the energy used to turn the turbine. The turns that it makes is used to cut through a magnetic field. The principle is very much like a bicycle dynamo, only bigger.

Before I go, I want to point out something. If you have not already realized it, take note, the mechanics of generating electricity is very much alike, be it a gas turbine power plant, a nuclear power plant, coal power plant, or hydro power plant. The major difference in these power plants is the type of fuel that it uses as a source of energy to turn the turbine. Of course the process flow, building and

safety requirements will also be at different levels, but that will be another topic of discussion. For now we are focusing on the flow of energy. The flow remains similar in these various power stations, only the fuel differs.

Hayati

I will leave you again so that you can discuss the workings of the power generation plants, its similarities and differences. Your teacher will demonstrate the generation of electricity. So, have fun exploring it. Also, in view of the impending shortage of fossil fuel in the future, you may want to discuss on current issues like, what are the alternative sources of fuel? How can we harvest these fuel for use?

Hayati

We are at the end of our session. I hope you have gained enough information on what energy conversion is about, how it takes place all around us, and why it is important for us to learn about energy conversion. The law of conservation of energy states that energy is neither created nor destroyed. It is merely being transformed from one form to another. We also noted that there could be several end products of energy at each stage of conversion, as in usable energy (the energy required to run a system) and waste energy (typically as heat, sound and light). You need to fully understand this concept for further application in thermodynamics.

Hayati

We have also learned that through various processes of energy conversion, we are able to get electricity. Depending of the origin of fuel, be it coal, gas, or oil that fuel can undergo a process of energy conversion to get electricity as an end product. However, we did not touch on the amount of required energy produced nor the quantity of fuel required. That will be in another lesson.

Hayati

Finally, we had the opportunity to visit a power station and realize its function in providing continuous energy to meet demand. For that we are able to use our cell phones, TV, air conditioners and heaters. As of year 2013, the optimum and most favorable fuel for generation of electricity in Malaysia, are coal and gas. This may differ in other regions around the world. As an exercise, with respect to your location and the most favorable fuel in that location, try and discuss this scenario. In the event of that fuel being depleted, what other forms of fuel or energy can be used to replace it? How economical are they? What do you envision the source of energy for the future? How effective and reliable are they? And, most importantly, why should you, as future engineers, care about these issues and what is YOUR role? These are some of the questions that you can think of as future engineers. Thank you.

Hayati

Good day to you. This video was designed for first year engineering students taking courses in Thermodynamics. It may also be applicable to physics students

who have a general background in various forms of energy and energy conversion processes.

In activity one, teachers should take the time to let students understand that Shadow Play is a form of entertainment and one of Malaysia's heritage cultures. A group of friends were seen trying to re-enact a play using an old bicycle, a bedsheet and several self-made characters.

The objective of this segment is to understand the concept of energy and its source. The concept presented here are the various forms of energy. You may want to get your students to enlist the various forms of energy, not just from the video but from their everyday activities. Depending on the heat of discussion, you may want to extend the discussion further to differentiate between force, energy and work done and its respective S.I units.

It is prudent that we let students understand the forms of energy and its source or how it is being produced. This comprehension will take them to activity two, where the objective is realizing the process of energy conversion.

In activity two, teachers may do any forms of activity that would allow your students to connect that activity with conversion of energy. We provide several suggestions for your use.

Suggestion 1 is a physical activity, such as a walk across the room, dropping a ball, and holding a cloth to a fan. There are usable energy around us that your students can identify and discuss its conversion processes.

Suggestion 2 is through the utilization of stored energy in a battery. Teachers will need two brand new batteries of size AA, a short copper wire coiled or shaped as in Fig 1, a magnet (the more powerful the magnet the better). Stack them as in Fig 2. The wire will rotate indicating there is a flow of electrical energy from the battery through the copper wire and cuts through a magnetic field.

Your students need to understand that energy is utilized to get things done and by virtue of such conversion, there are energy that is considered waste or undesired output such as excessive heating, light and sound.

Segment 3 reviews the chain conversion process of generating electricity. For the activity, teachers should get students to present the chain of processes to assess their understanding of the concept. Students are encouraged to identify the energy being converted, its processes and what are needed for the process to occur.

The visit to a power station is another way of providing students the connection between concepts learned to real world application. Just like a dynamo, the generator is the main converter of energy to electricity; the other energy conversion processes are means to an end product. Although the concept of electricity generation is the same, there exist issues that need special

considerations for each type of power plant, be it a thermal plant, a combined cycle, a hydro plant or a wind farm.

By now, we've learned what energy conversion is about. We now know that energy neither created nor destroyed. It is merely being converted from one form to another. We've also learned the importance of energy conversion in the generation of electricity and in our lives. It is hoped that this concept has been fully understood for further application in Thermodynamics. I hope you have enjoyed the video. Thank you, have a great day.