COURSE CODE: *MCE 516*

COURSE TITLE: *Energy Technology*

NUMBER OF UNITS: *3 Units*

COURSE DURATION: *5 hours (Two hours Lecture, three hours for Practical) per week*

COURSE DETAILS:

Course Coordinator: **KUYE, S. I.** *B.Eng, M.Sc*
Email: ibiyemikuye@yahoo.com
Office Location: **COLENG**
Other Lecturers: **None**

COURSE CONTENT:

Energy and society. Sources of energy. Energy demand, supply and forecasting. Conventional and unconventional (renewable) energy. Energy conversion systems and devices for oil, gas, coal, heat, wood, solar, wind, biomass, tidal geothermal, etc. Renewable energy from the global environment perspectives; global warming potential of fossil fuels. New energy sources such as hydrogen. Energy conservation.

COURSE REQUIREMENTS:

READING LIST:

1. Streeter, V. L. and Wylie E. B. Fluid Mechanics, 1st Metric Edition. McGraw Hill.
2. Kumar, K. L. Engineering Fluid Mechanics. S. Chand.

LECTURE NOTES

1.0 ENERGY AND SOCIETY

Energy is conventionally defined by physicists as a measure of a system's ability to do work, and is conventionally classified into so many forms:

(a) Mechanical Energy
(b) Kinetic "
(c) Potential "
(d) Thermal "
(e) Magnetic "
(f) Electrical "
(g) Radiation "
(h) Nuclear "
(i) Chemical "

1.1 Economics

Production and consumption of energy resources is very important to the global economy. All economic activity requires energy resources, whether to manufacture goods, provide transportation, run computers and other machines, or to grow food to feed workers, or even to harvest new fuels.

1.2 Environment

Consumption of energy resources, (e.g. turning on a light) requires resources and contributes to air and water pollution. Effect of green gas emission on the environment can not be overemphasized.

2 SOURCES OF ENERGY

Energy is ultimately derived from three sources:
(i)Radiant energy from the sun
(ii) Geothermal energy from our own earth
(iii) Human-initiated nuclear processes.

2.1 CONVENTIONAL AND UNCONVENTIONAL ENERGY

(a) Solar energy
(b) Energy from fossil fuels
(c) Energy from biomass
(d) Wind energy
(e) Geothermal energy
(f) Tidal energy

2.2 CLASSIFICATION OF FUELS

Fuels are classified in three different ways

- Whether renewable or non-renewable
- Level of technology involved in production and use
- Physical state

3 ENERGY DEMAND, SUPPLY AND FORECASTING

3.1 ENERGY DEMAND

Majority of people in developing countries live in villages or small towns: more than 90 percent in many poor African nations, four-fifths in China and in India, some 60 percent in Turkey. For this set of people, energy demands can be satisfied with a small-scale, labour-intensive approach.

In the well-off nations of Europe and in Australia, New Zealand and Japan the energy consumption per capital exceeds 5 tonnes of coal equivalent per year, and in North America it is more than double this.

Furthermore, the world population is set to grow in the next few decades. Studies predict that by 2050 the energy demand will increase by a factor of 2.3 to 4 compared with 1990. This will intensify the problems of today's already high energy consumption and its consequences.

3.2 WORLD ENERGY SUPPLY

This gives the combined resources by which the nations of the world attempt to meet their energy needs.

Estimating energy supplies requires geological knowledge, economic calculation, and technological know-how. All three contain varying degrees of uncertainty.

4 ENERGY CONVERSION SYSTEMS AND DEVICES

4.1 Type of input and energy conversion system

4.2 Combustion

(a) Gaseous fuels
(b) Liquid fuels
(c) Solid fuels
  (i)Pulverized fuel combustion
  (ii) Combustion on grate
  (iii) Fluidized bed combustion
(d) Stoichiometric method of combustion
  (i) Mol method
(e) Analysis of flue gas produced
  (i) Volumetric analysis
  (ii) Mass of flue gas produced
(iii) Analysis of the actual air used
(iv) Composition of fuel from flue gas analysis
(v) Incomplete combustion
(vi) Volumetric fuel blend
(vii) Gravimetric fuel blend

4.3 Solar radiation

Solar power is energy from the sun and without its presence all life on earth would end. Solar energy has been looked upon as a serious source of energy for many years because of the vast amounts of energy that are made freely available, if harnessed by modern technology.

The Sun & Energy.
The sun is a star. It is the largest object in our solar system and one of the larger stars in our galaxy. The source of energy in the Sun is at its core where hydrogen is converted to helium in a thermonuclear reaction. This energy travels from the core to the surface of the Sun and is released into space primarily as light. The energy that comes to the Earth is in 2 main forms, heat and light.

Every hour, enough sunlight energy reaches the Earth to meet the world's energy demand for a whole year.

--- U.S. Department of Energy ---

The amount of energy from the Sun that reaches the Earth annually is 4×10^{18} Joules.*

4×10^{18} Joules/ Year ÷ 365 Days/ Year = 1×10^{16} Joules/ Day

1×10^{16} Joules/ Day ÷ 24 Hours/ Day = 4×10^{14} Joules/ Hour

The amount of energy consumed annually by the world's population is about 3×10^{14} Joules.

Speed of Light Energy from the Sun to Earth.

The earth is the third planet from the sun at a distance of about 93,000,000 (93 million) miles. If you could pitch a fast baseball to the sun at 100 miles per hour (mph) it would take the ball over 100 years to get there. On the other hand, it only takes light energy 8½ minutes to reach the earth from the surface of the sun, traveling at the speed of light of course.

Pitching a Baseball at 100 mph to the Sun***

93,000,000 miles ÷ 100 miles/ hour

= 930,000 hours to reach the Sun.;

930,000 hours ÷ 24 hours/ day

= 38,750 days to reach the Sun;

38,750 days ÷ 365 days per year

= 106.16 years to reach the Sun.

Light Energy traveling to Earth***

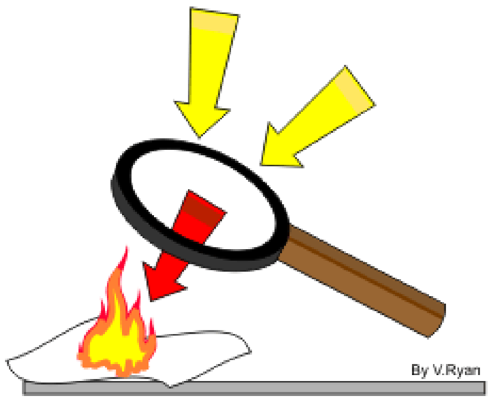
The speed of light is equal to about 11,000,000 (11 million) miles/ minute.

93,000,000 miles ÷ 11,000,000 miles/ minute

= 8.45 minutes for light to travel from the Sun to Earth.

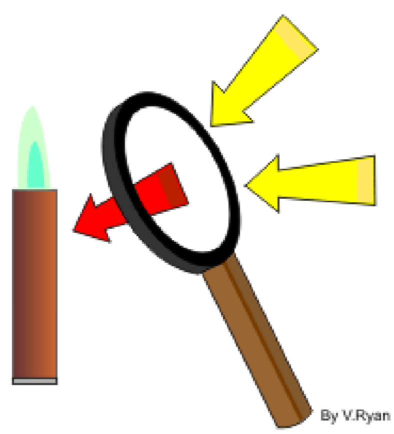
***Calculations are rounded for simplicity.

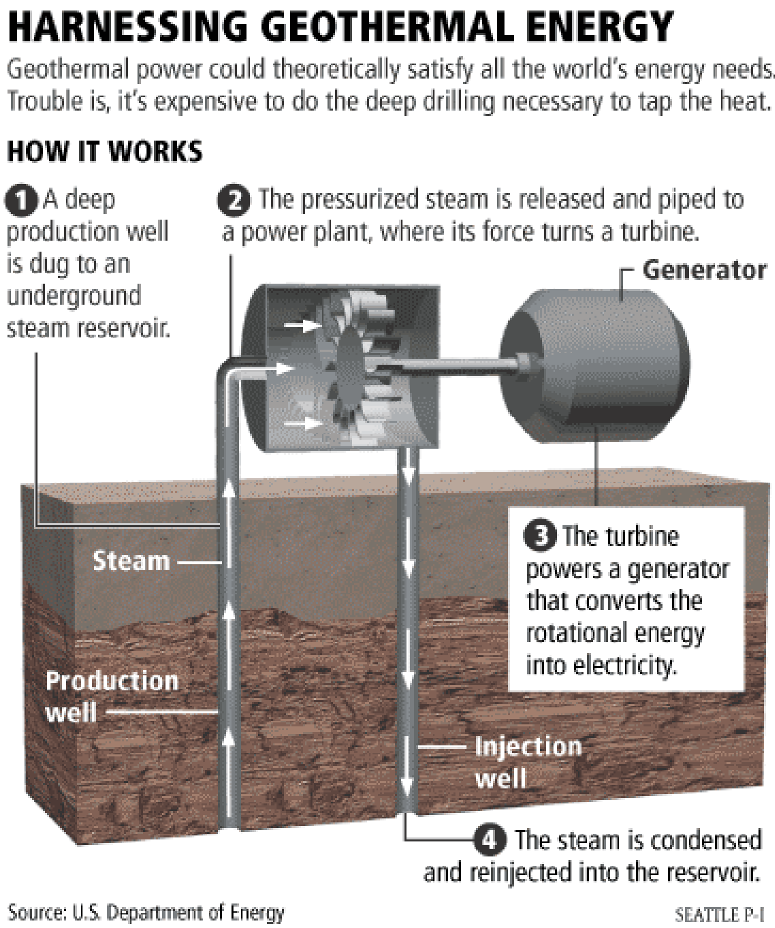
A simple example of the power of the sun can be seen by using a magnifying glass to focus the suns rays on a piece of paper. Before long the paper ignites into flames.



This is one way of using the suns energy, but flames are dangerous and difficult to control. A much safer and practical way of harnessing the suns energy is to use the suns power to heat up water.

A magnifying glass can be used to heat up a small amount of water. A short piece of copper tube is sealed at one end and filled with water. A magnifying glass is then used to warm up the pipe. Using more than one magnifying glass will increase the temperature more rapidly. After a relatively short time the temperature of the water increases. Continuing to heat the water will cause water vapour to appear at the top of the tube. In theory, with enough patience, several magnifying glasses and very strong sun light enough heat should be generated to boil the water, producing steam. This is one way of harnessing solar power.





Introduction

Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is energy that determines the temperature of matter. Earth's geothermal energy originates from the original formation of the planet, from radioactive decay of minerals, from volcanic activity, and from solar energy absorbed at the surface. The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface.

From hot springs, geothermal energy has been used for bathing since Paleolithic times and for space heating since ancient Roman times, but it is now better known for electricity generation. Worldwide, about 10,715 megawatts (MW) of geothermal power is online in 24 countries. An additional 28 gigawatts of direct geothermal heating capacity is installed for district heating, space heating, spas, industrial processes, desalination and agricultural applications.[1]

Geothermal power is cost effective, reliable, sustainable, and environmentally friendly,[2] but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

The Earth's geothermal resources are theoretically more than adequate to supply humanity's energy needs, but only a very small fraction may be profitably exploited. Drilling and exploration for deep resources is very expensive. Forecasts for the future of geothermal power depend on assumptions about technology, energy prices, subsidies, and interest rates.

The adjective *geothermal* originates from the Greek roots *geo*, meaning earth, and *thermos*, meaning heat.

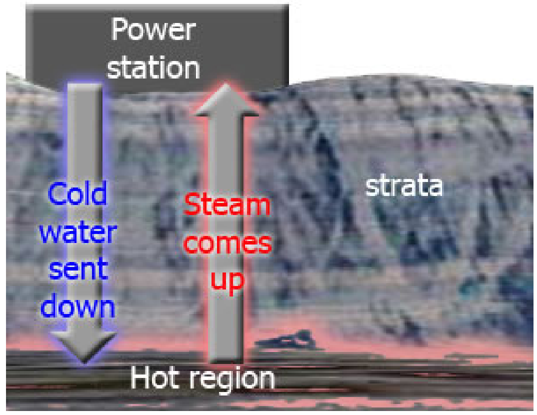
The centre of the Earth is around 6000 degrees Celsius - easily hot enough to melt rock. Even a few kilometres down, the temperature can be over 250 degrees Celsius if the Earth's crust is thin. In general, the temperature rises one degree Celsius for every 30 - 50 metres you go down, but this does vary depending on location

In volcanic areas, molten rock can be very close to the surface. Sometimes we can use that heat.

Geothermal energy has been used for thousands of years in some countries for cooking and heating.

The name "geothermal" comes from two Greek words: "geo" means "Earth" and "thermal" means "heat". (Energy Resources Geothermal power, 2011)

How it works



Hot rocks underground heat water to produce steam. We drill holes down to the hot region, steam comes up, is purified and used to drive turbines, which drive electric generators.

Advantages

- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.
- The power stations do not take up much room, so there is not much impact on the environment.
- No fuel is needed.
- Once you've built a geothermal power station, the energy is almost free. It may need a little energy to run a pump, but this can be taken from the energy being generated. (Energy Resources Geothermal power, 2011)

Disadvantages

- The big problem is that there are not many places where you can build a geothermal power station.
  You need hot rocks of a suitable type, at a depth where we can drill down to them.
  The type of rock above is also important, it must be of a type that we can easily drill through.
- Sometimes a geothermal site may "run out of steam", perhaps for decades.
- Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose of. (Energy Resources Geothermal power, 2011)