Renewable and Non-Renewable Sources of Energy :-

Energy sources are classified as renewable and non-renewable sources based on replenishment

Renewable sources of energy are normally replaced or replenished by natural processes eg: Solar energy, wind energy, tidal energy etc

Non renewable sources of energy are those which are not replaced or replenished by natural processes at a rate comparable to the use of energy. In otherwords these resources get depleted or exhausted by use eg. coal, petroleum, natural gas, nuclear power etc.

currently, fossil fuels (Petroleum, Natural gas and coal) provide about 95% of all commercially used energy in the world. Sustainable or renewable energy resources such as hydroelectricity, Solar, biomass and others provide 2.5% of power demands. Nuclear power contributes the balance 2.5%

energy requirements. Though nuclear power potential is quite high, safety concerns makes this option environmentally unacceptable.

Non renewable energy resources

coal

coal is formed when plant material is buried deep inside the earth and compacted by geological forces and condensed into a carbon-rich fuel. coal takes a very long time to form hence it is a non-renewable resource. Quantity of coal deposits is 10 times greater than oil and gas resources combined. However, coal mining is a hot, dirty and dangerous activity with adverse impacts. Strip mining or surface mining and underground mining are the two methods of mining. Significant impacts of underground mining are accidents (mostly due to accumulation of poisonous or explosive gases, ground water intrusion, mine collapse etc), respiratory diseases (mainly black lung disease ~~XXXX~~ which is caused by accumulation

of fine coal dust in the lungs and respiratory tracts).

Surface mining leads to ecological destruction, erosion and acid mine drainage (Sulphur and other acidic and toxic compounds dissolve in runoff water and reach water bodies) lead to adverse impacts on aquatic ecosystem.

Toxic metals and radioactive substances absorbed by plants and concentrated during process of coal formation are not destroyed when coal is burnt but released into the atmosphere as air pollutants. which in turn lead to acid rain, global warming, Severe impacts on human health etc.

Oil

Crude oil is a naturally occuring yellow to black colour liquid found in geologic formations beneath the earth's surface which is commonly refined into various types of fuels. It consists of hydrocarbons

and organic compounds. The name petroleum covers both naturally occuring unprocessed crude oil and petroleum products that are made up of refined crude oil. Petroleum is formed when large quantities of dead organisms are buried underneath sediment and rock and subjected to intense heat and pressure.

Petroleum is recovered through oil drilling It is refined and separated most easily by distillation into a large number of consumer products, from gasoline and kerosene to asphalt and chemicals used to make plastics and pharmaceuticals.

Environmental effects

Ocean acidification :— It is the increase in the acidity of the earth's oceans because of release of carbon dioxide into the atmosphere by usage of petroleu This increase in acidity inhibits life in the oceans.

Global warming :— green house gases released into the atmosphere by usage of petroleum increases the temperature around the earth surface and leads to various effects like melting of glaciers and rise in sea level.

Extraction :→ Oil extraction operation causes certain damage to the surrounding environment.

Oil spills → Crude or refined oil spilled from tanker ship accidents have damaging effect on the natural ecosystems. The quantity of oil spilled during accidents has ranged from a few hundred tons to several hundred thousand tons. Oil spilled at sea can cover very large surface area of sea as a thin oil slick. This can kill various organisms living in sea

Natural gas

Natural gas is a fossil fuel formed when buried plants and animals are subjected to anaerobic decomposition. Natural gas is a hydrocarbon gas consisting mainly of Methane It has lesser content of Nitrogen and Hydrogen Sulphide. It is a energy source used for heating, cooking, electricity generation and as a fuel for vehicle. It is convenient, cheap and results in relatively clean business.

Environmental effects

combustion of Methane releases carbon dioxide into the atmosphere which is a green house gas leading to global warming.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Other pollutants released from natural gas combustion are carbon monoxide, Sulpher dioxide and nitrogen oxide

Nuclear Power

In India, about 3% of the national energy requirement is contributed by nuclear power. Nuclear power technology includes the use of controlled nuclear reactions (fission and fusion) to generate steam, that turns a turbine which is connected to generator. During fusion, two small atoms combine to form a larger atom of different element. In fission, a large atom of one element is split to produce two smaller atoms of different elements. In both fission

Nutron + U_{235} $\xrightarrow{\text{Fission}}$ Barium + krypton + Free neutrons + Energy

Hydrogen + Hydrogen $\xrightarrow{\text{Fusion}}$ Helium + Free neutron + Energy

The most commonly used fuel in nuclear power plant is U_{235}. The fission of 1 gram of U_{235} produces the same amount of energy as the combustion of 3 tons of coal. Heavy construction cost, environmental impacts and safety concerns limits the

use of nuclear energy.

The disposal of wastes from the nuclear reactors is a major problem. The end products of the nuclear fission reactions will be continuously emitting high energy radiations which have damaging effect on the living tissues of the living organisms. Persons subjected to these radiations are prone to cancer. The end products of nuclear reactions are disposed by either by burying deep inside the ocean or deep inside the land in thick walled metallic containers.

Renewable Energy Resources

Solar energy

Thermonuclear fusion reaction occurring in the sun result in solar energy. The amount of solar energy reaching the earth is vast. Approximately, 30 days of solar energy is equivalent to the total energy

that can be derived from all the fossil fuels on the earth. All the polluting byproducts of nuclear fusion reaction remain in the sun while only pure energy reaches the earth's surface. solar energy can be used for various purposes like heating water, heating space, generation of electricity etc

The disadvantages associated with solar energy are, ① collection, conversion and storage of solar energy

② Sun does not shine consistently

③ solar energy is a diffuse source In order to use it must be concentrated

Hydro power

Force of falling or flowing water is used to run turbines and hence produce electricity. Turbines are generally Hydroelectric projects involves the construction of dam, construction of

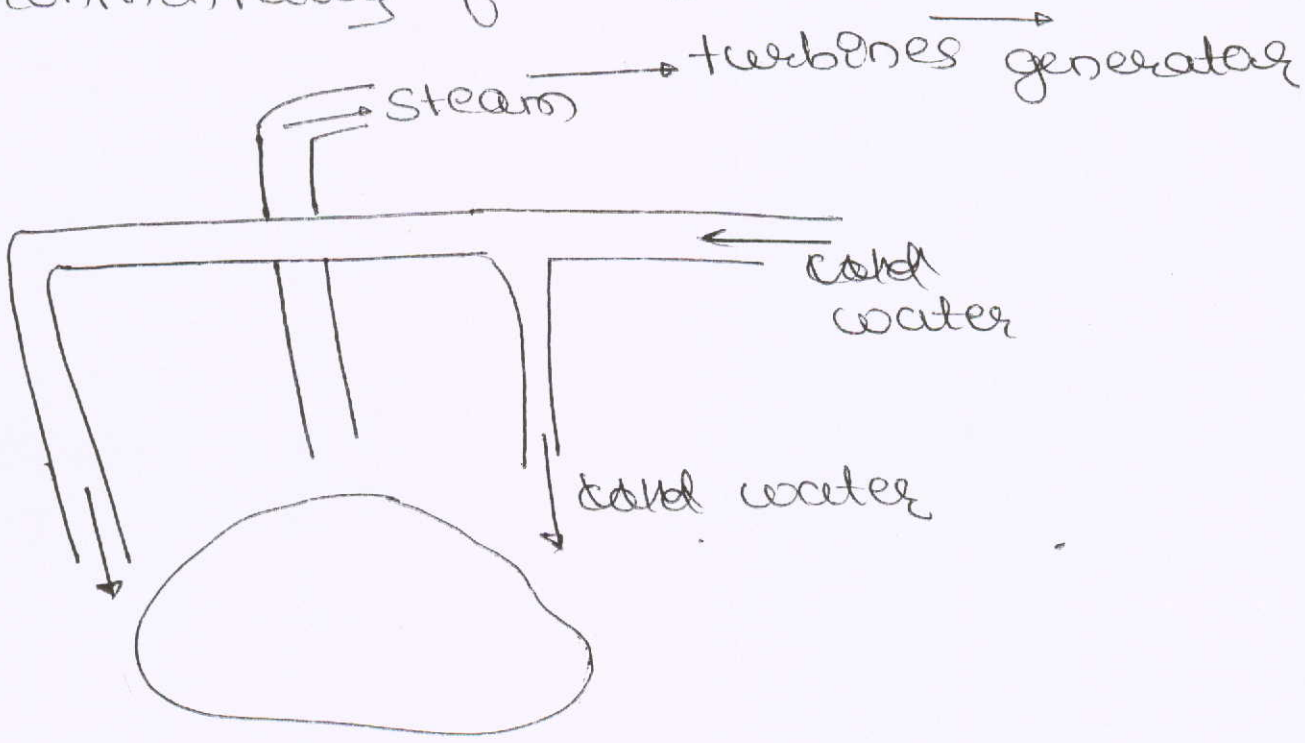
power house, transmission lines for power distribution and Roads in the project areas. The various impacts on the environment due to construction of dam are flooding of upstream lands, change in regime of natural streams, severe risks of land slides, destruction of flora and fauna, health hazards, Submergence of mineral deposits, distruction Submergence of properties and historical and cultural moncements, water logging etc

Wind Power

Wind power is the conversion of wind energy into a useful form of energy such as wind turbines, to produce electricity, windmills for mechanical power, wind pumps for water pumping & or sails to propel ships. Its effect on the environment are less as compared to other sources of energy

Geothermal energy

The high temperature in the earth's crust can be used to generate steam which is used to run turbines connected to a generator and hence produce electricity. geothermal power is cost effective, reliable, sustainable and environmentally friendly.



Steam coming out to the surface carry a mixture of CO_2, H_2S, CH_4, NH_3 etc These pollutants contribute to global warming, acid rain and noxious smells if released. construction of

geothermal power plant ~~eff~~ effect the land stability

Tidal power

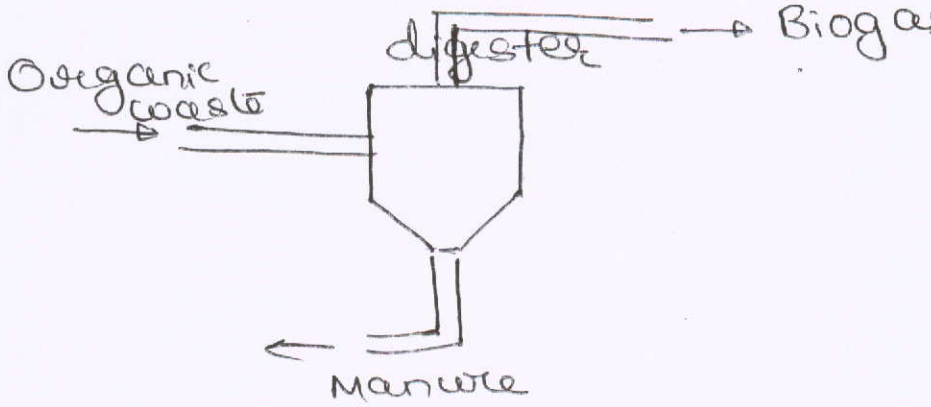
Energy available in the ocean's tides and waves can be used to ~~obtain~~ elec generate electric power.

Biomass

It is the energy obtained due to the anerobic decomposition of the organic matter such as plants, animal ~~residue~~ waste, crop residue etc

The major byproduct of this decomposition is Methane which is good combustible gas.

Biogas plants are more suitable in rural areas.



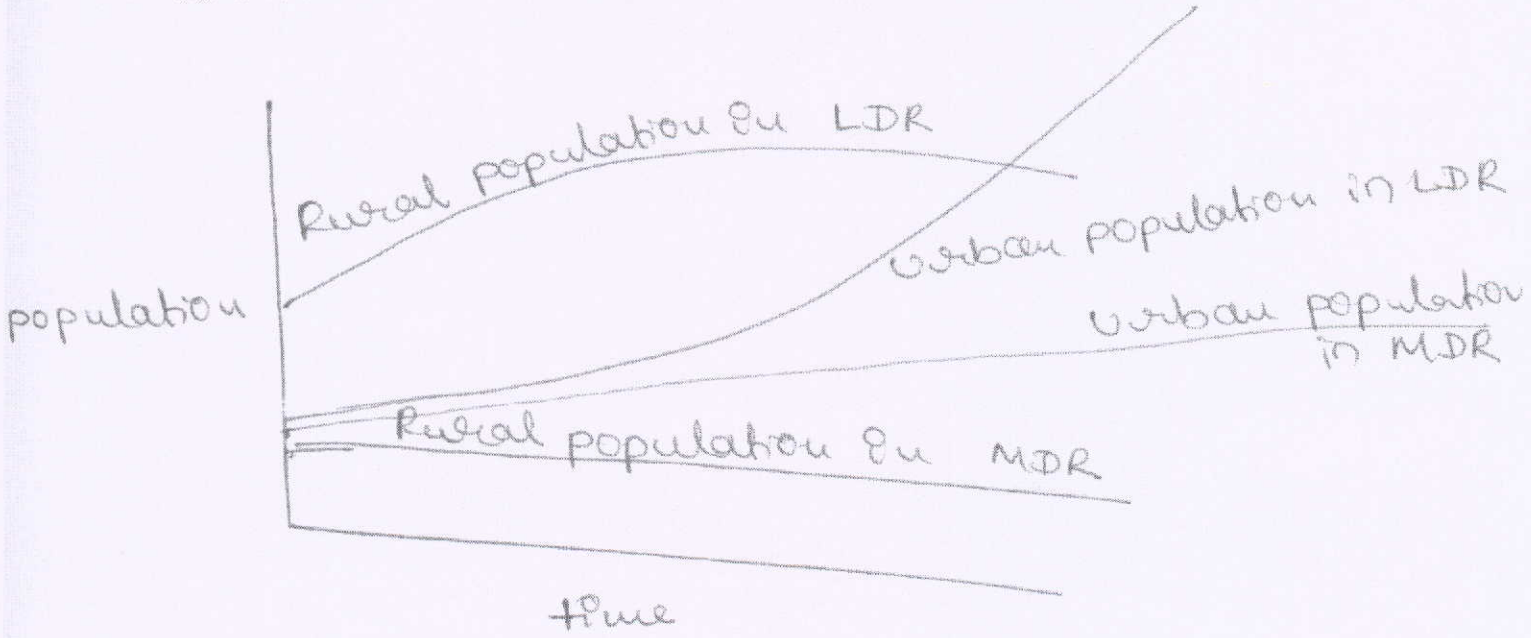
Urbanization

Concept of Urbanization started when men began to lead settled life. With the agricultural revolution, the nomadic hunters and food gatherers started settling down to domesticate animals and grow food. In this developed They soon developed devision and specialization of labour among themselves This in turn led to the concept of what is known as urban area.

Environmental factors played the largest role in the development of Urbanization. There was a need for flat land, and rich fertile soil necessary for cultivation and also easy access to readily available water. This is the reason for developmentment of ancient urbanization near rivers.

Its difficult to demarcate b/w rural and Urban area. The definition of Urbanization varies from country to country. For eg in Sweden, If the distance b/w 2 houses is less than 200m, then such area is called Urban area. In India, places having a population density of not less than 1000

persons / km^2 where at least 3/4th of the male adult population is employed in non-agricultural work are called Urban areas. Most often, a population of 20,000 is used as the size above which an area is called Urban. (14)



The rate of increase in the Urban population in case of Less developed region is more as compared to more developed region. This is because of the very less facilities being available in the rural areas of less developed region as compared to more developed region, people try to migrate from rural to urban areas in search of better facilities

Rural area → a region where most residents depend on agriculture or other ways of harvesting natural resources for their livelihood

Urban area → a region where majority of the people are not directly dependent on the natural resource based occupation.

Village → A part of rural area with a collection of households characterized by similar culture, tradition, and family ties and association with land

City → An urban area ~~that offers residents specialized services~~ with better facilities that helps in the development of individual

Causes for Urban growth

Urban populations grow for two reasons, natural increase and migration. Natural increase is caused by improved living conditions, facilities, medical care, education etc.

in the urban area. Immigration to cities is caused by several reasons like employment, education, industrialization etc. Many times people migrate to cities in search of jobs, food and housing. In some places, economic forces, racial or religious conflicts drive people from rural to urban. Large cities attract the people by opportunities, entertain-ment and freedom from constraints of village traditions. Modern communications also draw people to cities by broadcasting images of luxury and opportunity. Developing countries, commonly spend most of the budgets on improving urban areas by providing better facilities than rural areas. As a result, increased number of people leave rural areas to become part of large urban work force, keeping ~~wages~~ wages down and industrial production high

Environmental Impacts of Urbanization

① depletion of energy resources

changing life styles in urban areas leads to ever increasing demand for energy resources.

Alteration of land → Loss of agricultural land, loss of forests, loss of wild life, loss of biodiversity, etc

More energy consumption → depletion of energy resources, increasing air pollution

Hard surfacing upsetting the water cycle → increasing runoff, flooding, degrading water quality, decreased infiltration, depletion of water resources, land subsidence etc.

② Air pollution:- Automobile often is responsible for major contributions of pollutants while industry is another source of air pollution in urban area. global warming, ozone layer depletion, and rain are the important implications in addition to effects on human health, animals, plants and animals

③ Traffic and congestion

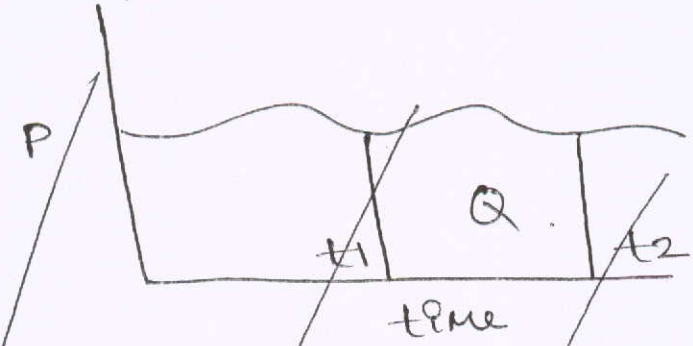
mainly, In developing countries, the city streets are overcrowded with pedestrians and vehicles of all types. The noise, congestion and confusion of traffic creates unhealthy atmosphere on roads

④ water pollution

Many of cities in developing countries can don't have proper sewage and water treatment system for their rapidly increasing urban population

Resource consumption

Resource produced = Resource consumed



where P is production rate eg tonnes/of

$$dQ = \int P \cdot dt$$

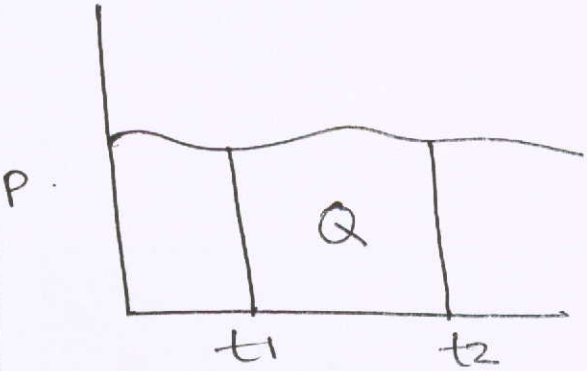
$$Q = \int_{t1}^{t2} P \cdot dt$$

Resource consumption

To maintain human life on earth, we depend on a steady flow of energy and materials to meet our needs. Some of the energy used is renewable but most comes from non-renewable fossil fuels. The minerals extracted from the earth's crust such as copper, iron are also limited. Our future to the large extent depends on the availability of inexpensive, non renewable energy and materials. How long these materials ~~lasts~~ last, depends on their quantity that exists and our consumption rate. Two models are used for the study of resource resource consumption (1) exponential function (2) Bell shaped curve.

(1) exponential function model

Resource produced = Resource consumed



plotting the rate of production of a resource vs time, the area under the curve b/w

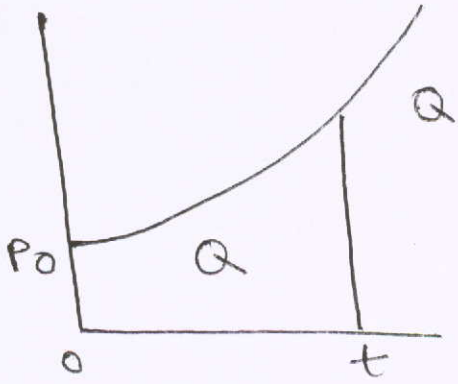
any two times will represent the total resource that has been produced during that time interval. That is, if P is production rate (eg. tonnes of Aluminium / year) and Q is the resource produced b/w times t_1 and t_2, then

$$Q = \int_{t_1}^{t_2} P\,dt$$

In other words, if the production rate and total material ~~produce~~ to be produced ~~then~~ ~~Ice~~ is known ~~the~~ then time required for its production can be calculated.

If the production rate is assumed to be exponential

$$P = P_0 e^{rt}$$



$$Q = \int_0^t P_0 e^{rt}\,dt = \frac{P_0 \cdot e^{rt}}{r}\Big|_0^t$$

$$Q = \frac{P_0}{r}\left[e^{rt} - e^0\right] = \frac{P_0}{r}\left(e^{rt} - 1\right)$$

where Q = total resource produced from time 0 to t

P_0 = initial production rate

r = exponential rate of growth in production

Rearranging the above expression

$$t = \frac{1}{r} \ln\left(\frac{rQ}{P_0} + 1\right)$$

where t is the length of time required to produce an amount Q.

(8) Coal production in 2005 ~~was~~ is 6.1 billion tons / year. The total coal reserves were estimated to be 1.1 trillion tons. How long could it take ~~to~~ to use up these reserves at current production rate.

$$t = \frac{\text{Reserves}}{\text{Production rate}} = \frac{1.1 \times 10^{12} \text{ tons}}{6.1 \times 10^{9} \text{ tons/year}} = 180 \text{ yrs}.$$

How long could it take if production continues to grow at 1.9 %.

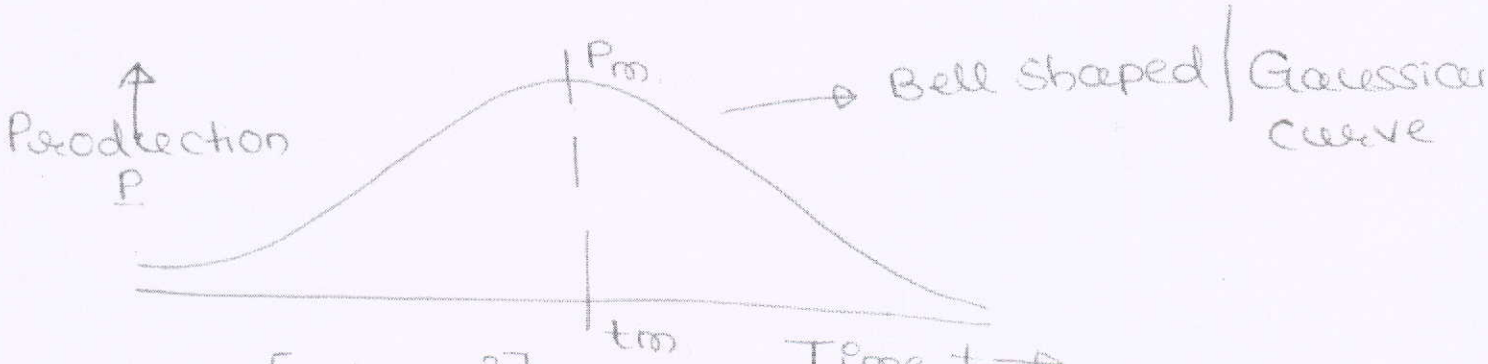
$$t = \frac{1}{r} \ln\left(\frac{rQ}{P_0} + 1\right)$$

$$= \frac{1}{.019} \ln\left(\frac{.019 \times 1.1 \times 10^{12}}{6.1 \times 10^{9}} + 1\right) = 78 \text{ yrs}$$

Bell Shaped Curve

According to M. king Hubbert, consumption of a resource may follow exponential growth when the resource is abundant and relatively cheap. As new sources get harder to find, prices go up and substitution would begin to take in the market. Eventually, the consumption rate would peak and the begin a downward trend as the combination of high prices and resource substitution would be predominant. The resource production would be stopped when the energy needed to extract and process the resource exceeds the energy derived from the resource itself. A graph of resource consumption rate verses time would start at zero, rise, peak and then decrease back to zero, with the area under the curve giving the total resource consumed

Hubbert Suggested the use of bell Shaped curve as shown below.



$$P = P_m e^{\left[-\frac{1}{2}\left(\frac{t-t_m}{\sigma}\right)^2\right]} \quad \text{—①}$$

where, P = the production rate of the resource

P_m = the maximum production rate

t_m = time at which maximum production rate occurs.

σ = standard deviation. (its unit is time)

total resource that can be produced is give

$$Q_\infty = \int_{-\infty}^{\infty} P\,dt = \int_{-\infty}^{\infty} P_m e^{\left[-\frac{1}{2}\left(\frac{t-t_m}{2}\right)^2\right]} dt$$

$$Q_\infty = \sigma P_m \sqrt{2\pi} \quad \text{—②}$$

The above expression can be used to calculate σ, if, the total resource reserve (Q_∞) and the maximum rate of producti (P_m) are known.

If we put $t = 0$ in ①

$$P_0 = P_m e^{\left[-\frac{1}{2}\left(\frac{t_m}{\sigma}\right)^2\right]}$$

From above expression, time to reach maximum production is given by (24)

$$t_m = \sigma \sqrt{2 \ln \frac{P_m}{P_0}}$$

5). The total coal reserves were estimated to be 268×10^9 tons. The coal production rate is 1×10^9 tons/year in 1995. How long would it take to reach a peak production rate equal to four times the 1995 rate if a gaussian production curve is used? also write the expression for production rate at any time t

$$\sigma = \frac{Q_\infty}{P_m \sqrt{2\pi}} = \frac{2 \times 268 \times 10^9 \text{ ton}}{4 \times 1 \times 10^9 \text{ tonn/year} \sqrt{2\pi}} = 53.5 \text{ yr}$$

$$t_m = \sigma \sqrt{2 \ln \frac{P_m}{P_0}} = 53.5 \sqrt{2 \ln .4} = 89 \text{ yr}$$

$$P = P_0 \cdot e^{\left[\frac{-1}{2}\left(\frac{t - t_m}{2}\right)^2\right]} = 4 \times 1 \times 10^9 e^{\left[\frac{-1}{2}\left(\frac{t-89}{53.5}\right)^2\right]} \text{ tons/yr}$$