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Developments in Nuclear Energy Power Plants-A Review

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ABSTRACT

The paper posits that nuclear energy is energy from the nucleus of atoms that binds neutrons and protons together and can be released by bombardment and can be exploited for electricity generation. The paper reviews literature on nuclear power plants and positions it as a viable substitute for replacing fossil fuel generation in order to avoid and avert emission of greenhouse gases which results in global warming and consequent climate change. The paper defines nuclear power and describes how nuclear power stations operate.

The paper also describes the disadvantages and advantages of nuclear electricity generation. It compares nuclear power plants with fossil, solar and wind power plants. The paper says current nuclear power plants are mainly based on nuclear fission as nuclear fusion is still in experimental stage. Nuclear fission particularly of uranium-235 is a mature technology. If successful, nuclear fusion will provide electricity for thousands of years as nuclear fusion material are plenty whereas nuclear fission material is scarce, depletable and estimated to continue to last for the next 50 years only. The paper posits that nuclear power stations need less geographical space than solar or wind energy power stations per given MW output.

The paper concludes by recommending nuclear power stations for countries like Zimbabwe with energy shortfalls.

Introduction

Nuclear energy is a realistic option for decisively replacing fossil fuel generation and hence curb greenhouse gas emission and climate change (Fernandez-Arias et al (2020)). The expected phasing down of fossil fuel power plants in the next decade is anticipated to witness an increase or surge in the numbers of nuclear power stations. According to Hashemian (2011) nuclear power plants can operate upto 60 years or more. According to Zinkle and Was (2013), power generation mainly from fossil fuel is responsible for 66 % of greenhouse gas emissions worldwide. Brook et al. (2014) says that there is a compelling need to convert fossil fuel power plants to nuclear fission plants. Wind and solar electricity generation are intermittent, variable and unpredictable and need to operate in conjunction with nuclear power plants. According to Mathew (2022), nuclear fusion can provide unlimited, clean, safe and affordable energy but unfortunately is still at experimental stage. According to National Geographic Society Education (2024), nuclear energy is the energy in the nucleus or core of an atom, which can be exploited for electricity production and generation in nuclear power plants. The mentioned energy requires first to be emitted or let loose from the atom's nucleus. National Geographic defines an atom as small entities that make up all matter in the universe and unites entities such as protons and neutrons i.e. kept together in the atom's nucleus by binding energy. There exists huge amount of energy in the atom's dense nucleus (National Geographic Society Education (2024)).

According to ForoNuclear (2024), atoms are the smallest particles into which a chemical element can be divided and still maintain its properties. An atom consists of its core or nucleus consisting of neutrally charged neutrons and positively charged protons. Circulating around the nucleus are negatively charged electrons in various shells. The force that binds the nucleus even overcoming the electrostatic repulsive forces of one proton against another is called nuclear force or nuclear power. ForoNuclear says that nuclear energy is power normally resident in the core or nucleus of an atom. ForoNuclear (2024), says that the mass of the nucleus is less than the sum of the mass of its parts. The disparity between the mass of the nucleus and the mass of its components is termed mass defect (m) and the energy that binds the components is calculated from Einstein Equation

$E=(\Delta m)c^2$, where c=light's speed
According to International Atomic Energy Agency (2024), the energy in the nucleus of an atom can be emitted in two ways (1) nuclear fission –when nuclei of atoms split into several parts and (2) nuclear fusion –when nuclei fuse together. Production of energy through nuclear fission is mature and to produce electric energy through nuclear fusion is still at Research and Design phase.

According to National Geographic Society Education (2024), a series of machines which can control or regulate nuclear fission to generate electricity is called a nuclear reactor or nuclear power plant. The pellets of uranium-235 are the fuel employed in nuclear reactors to result in nuclear fission. The atoms of uranium are compelled to break apart in nuclear reactors and release products of fission. Products of fission force the splitting of other uranium atoms initiating a chain reaction. The power from this chain reaction generates thermal energy. Water, which is normally the reactor's cooling agent is heated by the thermal energy created from nuclear fission. Other reactors employ liquid metal or molten salt as cooling agent.

The steam that is produced under pressure by the nuclear fission is heated up to produce rotation of the turbine-generator set thereby producing electricity.

According to National Geographic Society Education (2024), rods of material known as nuclear Poisson can adjust how much electricity is produced. Xenon element is an example of nuclear Poisson material that absorb products of nuclear fission. If more rods of the nuclear poisson are available during the dynamics of the chain reaction, the less speed and the more restricted the chain reaction. Removing the rods will facilitate a faster chain reaction and produce more heat and therefore more electricity.

According to Britannica (2024), nuclear power is electricity generated by power plants that derive their heat from fission in a nuclear reactor. The role of a boiler is played by the reactor.
Nuclear power provides approximately 15 % of the world's electricity according to Britannica (2024).
ForoNuclear(2024) says that nuclear fission and nuclear fusion are the two major types of nuclear reactors.

When light weight atoms have nuclei that are combined to result in a stable and heavier atom nuclear fusion releases energy e.g. two hydrogen atoms are combined to create one helium atom as what happens in the sun. Nuclear fusion is the source of heat from the sun. It is still at experimental stage here on earth.

Nuclear fission occurs when heavy atoms' nuclei are bombarded with neutrons and decompose into smaller and lighter nuclei emitting energy that normally keeps their protons and neutrons together and releasing three or two neutrons. According to ForoNuclear (2024), these can then subsequently produce more fissions by interacting with new heavy nuclei that will emit new

neutrons and so on such that a chain reaction sustains itself. ForoNuclear (2024) calls this multiplying effect ‘nuclear fission chain reaction’.
According to Britannica (2024), in nuclear fission the nucleus of an atom such as that of plutonium or uranium breaks up into two lighter nuclei of approximately equal mass. The process may be spontaneous in some cases or induced by the excitation or bombardment of the nucleus with a variety of particles (e.g. neutrons, protons, deuterons or alpha particles) or with electromagnetic radiation in the form of gamma rays (Britannica (2024)). A huge amount of energy is emitted in the process. A tiny uranium pellet the size of a peanut has potential to produce as much power as 800kg of coal according to EDF website (2024).

The huge amount of thermal energy produced during the chain reaction of nuclear fission is exploited by nuclear power plants to produce electricity via steam production.

To start the process of fission reaction, normally radium, polonium, beryllium or other alpha emitter are used. Alpha particles emanating from the disintegration results in the ejection or release of neutrons from beryllium as it transforms into carbon-12.

WHAT IS NUCLEAR FISSION?

Nuclear fission is a reaction whereby the nucleus of a heavy atom splits or fragments into two or more tinnier nuclei releasing energy in the process. A uranium-235 atom fragments into two smaller nuclei e.g. barium nucleus and krypton nucleus and two or more neutrons when bombarded by a neutron. (International Atomic Energy Agency (2022)). Other nearby uranium-235 atoms are hit by these extra neutrons and this will result in it the further splitting to produce additional neutrons thus providing a multiplying effect resulting in a chain reaction during a split of a second.in the process (International Atomic Energy Agency (2022)).

During every time that the reaction above happens, there occurs a release of radiation and thermal energy. Thermal energy can be transformed into electric energy in an identical manner to coal power generation.

According to National Geographic Society Education (2024), nuclear energy can also be generated through nuclear fusion or fusing or joining together of atoms e.g. in the sun where hydrogen atoms fuse to form helium atoms.

DESCRIPTION OF THE FUNCTIONALITY OF A NUCLEAR POWER STATION

Nuclear reactors and their equipment inside nuclear power plants has inside them and regulate the chain reaction normally powered by uranium-235 to generate thermal energy via fission. The thermal energy produced heats the cooling agent in the reactor which is normally water. This water vapor is subsequently directed to rotate the turbine-generator set directly or through a gearbox to generate electric energy.

Mineral Extraction, Enrichment and Getting Rid Of Uranium

Uranium is a substance or element that is found in rocks almost everywhere in the world. It has several isotopes. Two isotopes of uranium which are primordial are uranium238 and uranium-235. Uranium-238 constitute the majority of uranium found inside planet earth and uranium-238 cannot produce fission reactions like uranium-235 which contribute less than one % of all uranium in the world. According to National Geographic Society Education (2024), the frequently used fuel to generate nuclear energy is uranium due to the fact that uranium atoms split apart easily comparatively. According to TEPCO (2024), uranium-235 acts as a fuel for nuclear power plants. TEPCO (2024) says that naturally occurring uranium has only approximately 0.7 % uranium-235 which needs concentration of this ratio to about 2 % or 4 %. It is then baked into pellets after undergoing various processes. TEPCO (2024) says that the pellets have an approximate diameter and height of 1 cm each.

To make naturally occurring uranium more readily undergo fission, it is imperative that we increase the quantity of uranium-235 within a given sample via a process known as enrichment of uranium. Uranium needs to get extracted from other minerals after it is mined.

The following generation after the current generation of nuclear power stations will produce far less nuclear waste compared to today's reactors (Galindo (2022)). They could be under construction by 2030.

According to ForoNuclear (2024), the most common uses of nuclear power is electricity production although it has many applications in sectors such as medicine, hydrology, agriculture and food, mining, industry, art, the environment, space exploration and cosmology.

According to Gov.UK (2024), a recent report by the U.N. Economic Commission, it is impossible to meet the World's climate change targets if nuclear technologies are excluded from future efforts of the de-carbonization of the power industry.

According to National Geographic Society Education (2024), nuclear material such as uranium and plutonium are also used to make nuclear weapons.

DISCOVERY

In 1911, Ernest Rutherford discovered the core of atoms called the nucleus soon after observing and studying $\propto$ particles released by atoms. The neutrons were discovered by James Chadwick and its reaction dynamics were done by Jolliot Currie couple. Friz Strassman and Otto Hahn found out reactions of fission in 1939. Enrico Fermi is given the credit of developing the chain reaction. A nuclear power station is also called an atomic power plant. The source of thermal energy in nuclear reactors are atoms and hence the name. Heat is employed to produce steam that turns or rotates a steam turbine-generator set to generate electricity.

According to ForoNuclear (2024), the water for cooling is obtained from the sea, river or lake and exploited for liquefying the water vapor contained in the condenser. ForoNuclear (2024) highlights the components of a Nuclear power plant as follows: -

- Uranium-235 fuel ore
- Reactor vessel
- Pressurizer
- Control rods or control bars
- Vapor generators
- Containment building-normally a meter-thick concrete and steel structure
- Turbine
- Alternator or generator
- Transformer
- Cooling tower
- Condenser.

According to ForoNuclear (2024), the main components of a Nuclear Reactor are as follows: -

1. **Fuel**-normally the dioxide of enriched uranium 235. Employed as a source of heat and also at the same time as a source of neutrons needed to sustain the chain reaction of uranium. Uranium dioxide is in a solid state in cylindrical pellet form encapsulated into metallic rods a few meters long (ForoNuclear (2024)). According to World Nuclear Association (2024), fuel is normally uranium oxide pellets tubes configured as fuel rods. These rods are configured in assemblies of fuel in the reactor.
2. **Moderator Water**- Water retards the fast neutrons produced by the fission chain reaction, which results in new nuclear fissions and sustainability of the reaction which is in a form of a chain. According to World Nuclear Association (2024), the moderator is normally water but maybe graphite.
3. **Cooling water**-The same water that is used as a type of moderator now also functions as a heat extractor which heat is produced by nuclear fission of the fuel which is uranium-235.
4. **Control rods**- They are the regulating entities within the reactor. The control rods behave in the absorption of neutrons. These rods are manufactured from indium-cadmium or boron carbide and facilitates constant control of the neutron population whilst keeping the reactor stable (Foronuclear (2024)). They also enable the stopping of the chain reaction whenever necessary. According to World Nuclear Association (2024), control rods are normally made from boron, hafnium and cadmium to regulate reaction rate or even to halt it.
5. **Shielding** –according to Foronuclear (2024), they prevent leakage of radiation and neutrons from inside the reactor to outside. The shielding is normally made up of lead, steel or concrete.
6. **Safety Considerations**-all power stations of the nuclear type incorporate many safety schemes for preventing the leakage of the radioactive material to the surroundings. These schemes also comprise of including the ‘containment building’ as part of the design.

ForoNuclear (2024), says that nuclear power generates heat through nuclear fission chain reactions in the nuclear reactor vessel which heats water to produce superheated steam under pressure which is used to rotate or spin a turbine-generator set and the generator produces electricity.

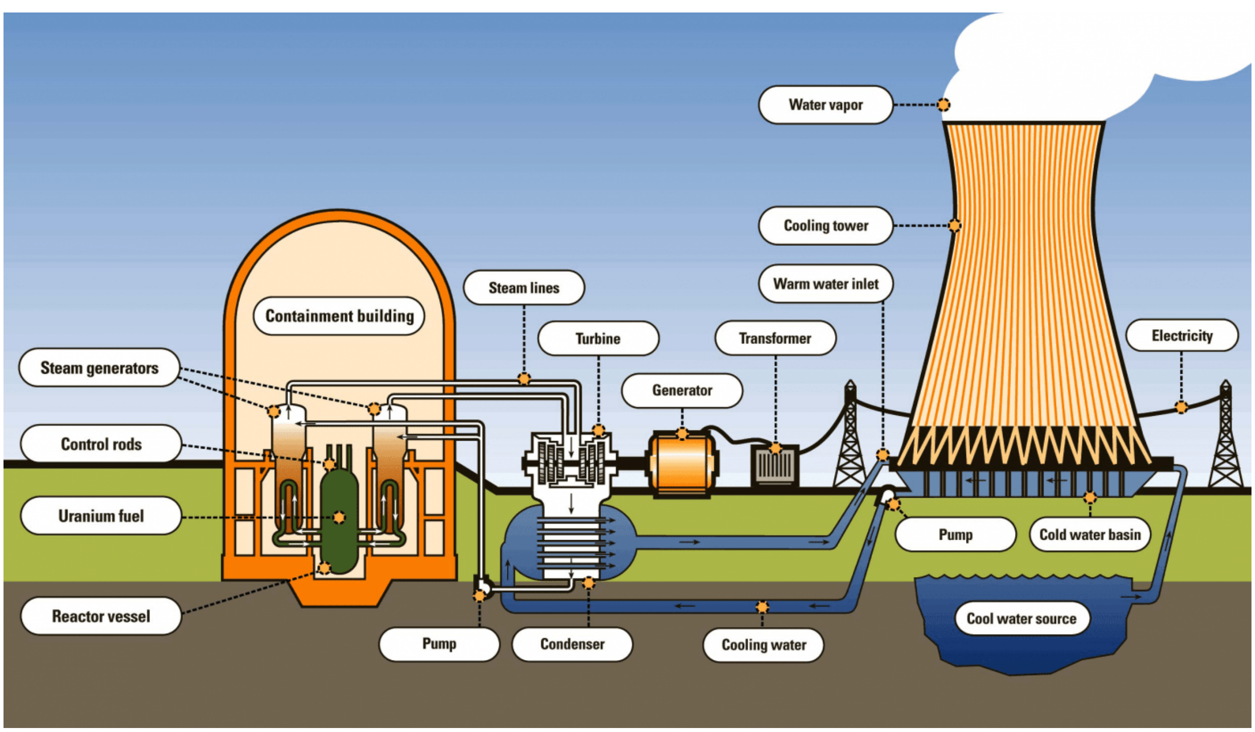
One of the major components of a nuclear power station is the nuclear reactor. It normally includes uranium which is the atomic and nuclear fuel. Its system is able to initiate, sustain or even halt the nuclear chain reaction in a control system or regulated manner. A nuclear power station operates in an identical manner to a conventional coal power plant except that the nuclear reactor with uranium fuel replaces the coal fuel as a heat source. Heat is obtained from the nuclear fuel which is uranium 235 through a chain reaction. The heat is employed to raise the temperature of water under elevated temperatures and elevated pressure conditions until it turns to water vapor. The water vapor rotates a turbine-generator set which converts rotational mechanical energy to electricity.
Inside the reactors construction materials encounter stress, corrosion and radiation

TYPES OF REACTORS (Fernandez-Arias et al. (2020)

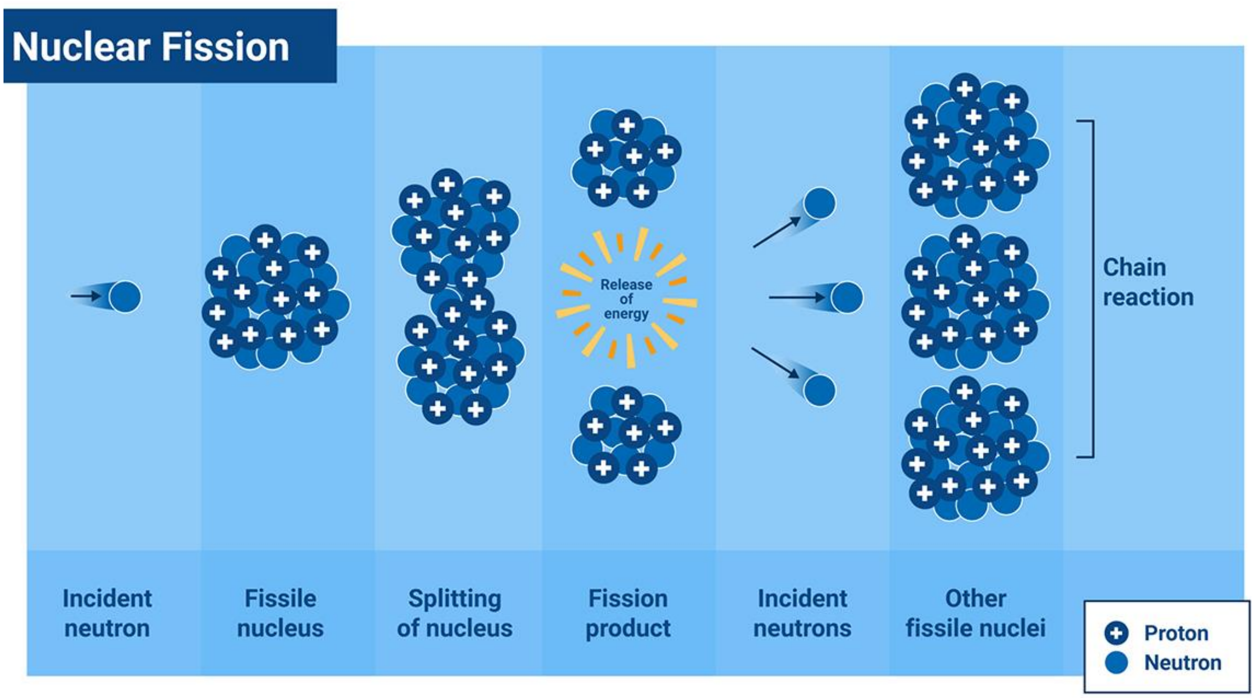
- Pressurized Water reactors(PWR)-two thirds of installed output capacity in the world
- Boiling Water Reactors(BWR)-twenty-one percent of installed capacity
- Pressurized Heavy Water Reactors (PHWR)-fourteen percent of installed output capacity
- Gas Cooled reactors-5 % of installed capacity

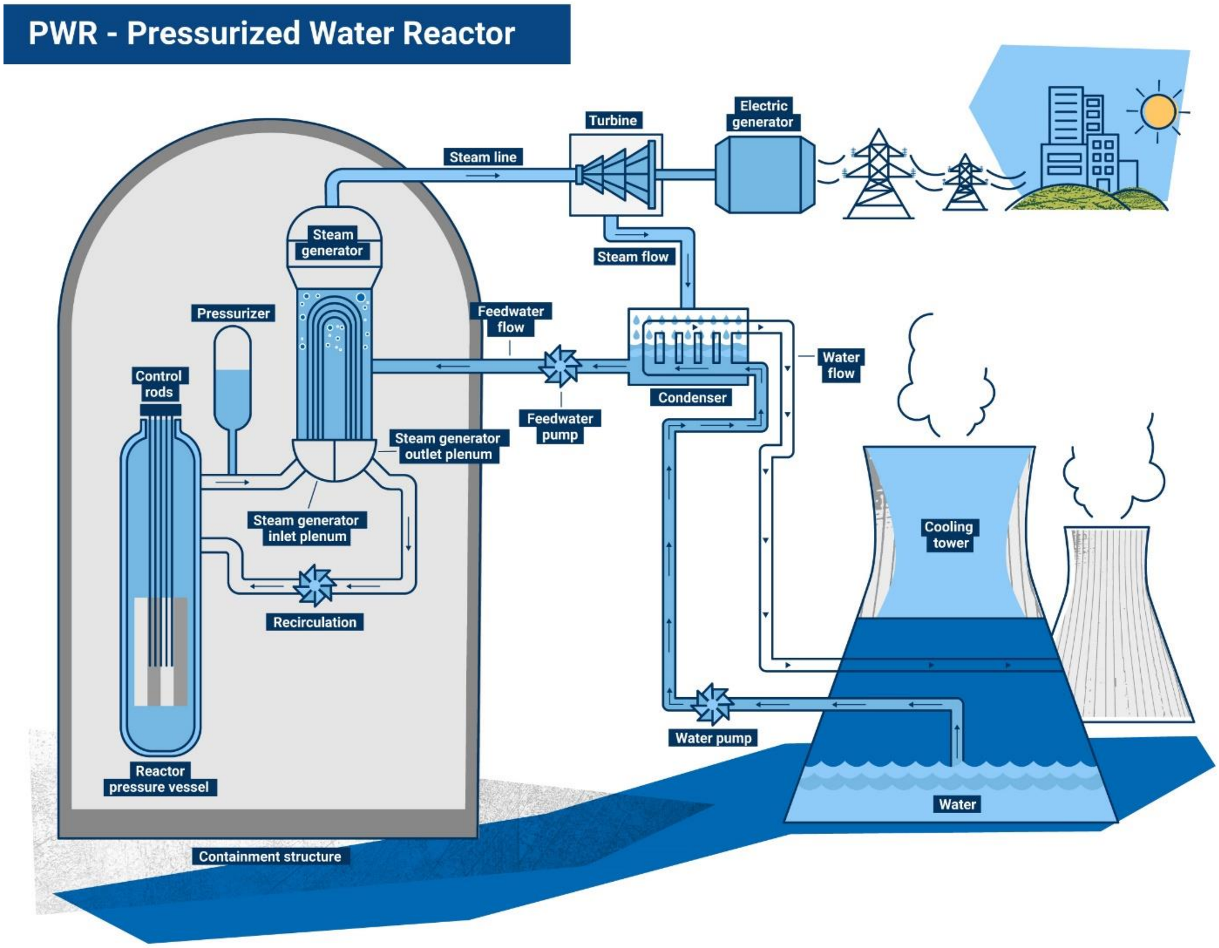
Two frequently used kinds of nuclear reactors are: -

- Pressurized Water Reactor (PWR) and
- Boiling Water Reactor (BWR) and

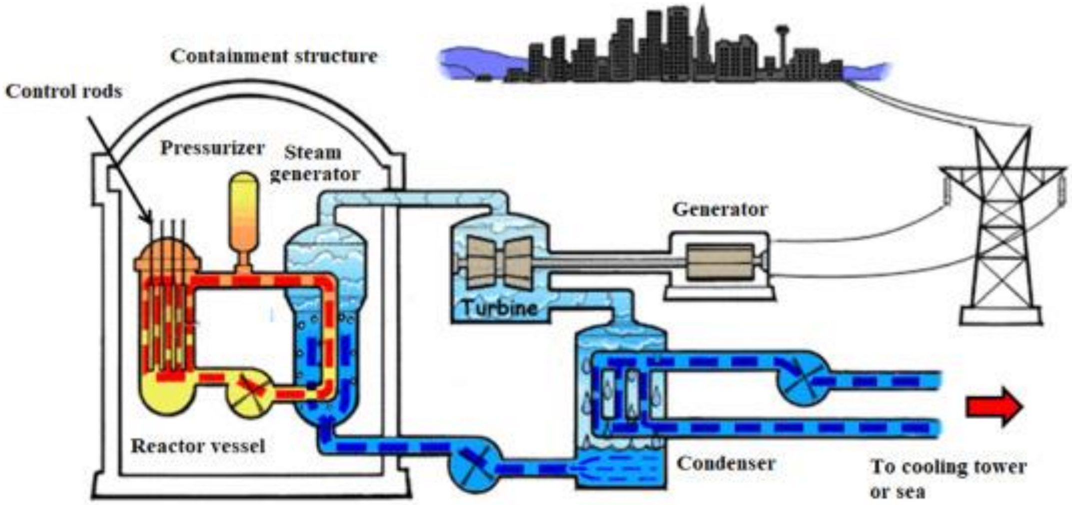


URANIUM DIOXIDE NUCLEAR FUEL




PWR - Pressurized Water Reactor
Turbine
Electric generator
Steam line
Steam generator
Steam flow
Pressurizer
Feedwater flow
Water flow
Control rods
Condenser
Feedwater pump
Steam generator outlet plenum
Steam generator inlet plenum
Cooling tower
Recirculation
Water pump
Reactor pressure vessel
Water
Containment structure

PRESSSURIZED WATER COOOLED NUCLEAR REACTOR



OPERATIONS OF A PRESSURIZED WATER REACTOR

It must be remembered that nuclear fission involves heavy atoms' nuclei being hit by neutrons which then disintegrate into lighter and smaller nuclei. They emit heat energy in this process from the energy that binds protons and neutrons composing them and emit two or three neutrons. More fission is produced as they interact again with new heavy nuclei which subsequently release fresh and new neutrons etc. in such a manner that there is sustenance of the reaction by the process itself. The chain reaction of nuclear fission is the multiplying effect. Pressurized Water reactors are the most widely deployed technologies in the world of nuclear power plants (Fernandez-Arias et al. (2020). According to Zinkle and Was (2013), pressurized water in the primary circuit enters the reactor core at 275 ^{O}C and has a core exit temperature of 325 ^{O}C. Low alloy or low carbon steel is employed to construct boundary of pressure components (pressurizer, reactor pressure vessel, condenser, turbine, steam lines and steam generator). Austenitic stainless steels make the core structural materials and also as cladding material inside of the reactor pressure vessel and pressurizer according to Zinkle and Was (2013). Nickel-based alloys make springs and fasteners.

According to Mathew (2022), water cooled reactors have been the major source of nuclear energy in the 20th century.

Was et al. (2019), says that materials for future nuclear power plants will need to operate under more extreme conditions of higher temperature and corrosive environment.

What differentiates Boiling Water Reactors (BWR) and Pressurized Water Reactors (PWR) is that Boiling Water Reactors comprises of one water circuit crafted for boiling to happen in the centre with directly flowing steam to the turbine blades which removes the need for pressurizer and steam generator that exists in Pressurized Water Reactors (Zinkle and Was (2013)). The operating temperature for both are comparable about 300 ^{O}C with comparable radiation environment and stress. According to Zinkle and Was (2013), the major difference is the zirconium alloys which is employed as fuel rod cladding, with BWR fuel cladding optimized for resistance to hydrogen absorption in the low potential environment of the core.

Pressurized heavy water reactors are also in high use word-wide. It employs heavy water as the primary coolant and controller passing thermal energy to light water through a steam generator

5 STEPS THROUGH WHICH A NUCLEAR POWER STATION WORKS

1. Uranium nuclear fission occurs in the nuclear reactor vessel. This emits large quantities of heat energy that raises the temperature of the water coolant that circulates at very huge pressures. The primary circuit transports water through to a heat exchanger also called steam generator which produces water vapor. According to World Nuclear Association (2024), temperatures of approximately 325 ^{O}C is reached by water in the reactor and need to be kept below 150 times atmospheric pressure to avoid a situation where it would boil.
2. A secondary circuit transports this steam to a turbine-generator set.
3. The vanes or blades of the turbine rotate the turbine-generator set and rotational kinetic energy is converted to electricity by the generator or alternator.
4. After the steam passes through the turbine's blades, it is passed on to a condenser for cooling so that it becomes water liquid again.
5. According to ForoNuclear (2024), this water is then subsequently carried to the steam generator so that it becomes steam again inside a closed circuit.

According to TEPCO (2024), condensers are used to cool the steam after it has been exploited to spin the turbine and return it to water. TEPCO (2024) further says that condensers have 40 000 to 50 000 cooling pipes having a thickness of about 3 cm via which seawater flows, functioning to make the steam cool as the seawater never mixes with the hot steam. In addition, condensers help to enhance turbine efficiency because converting steam to water reduces the volume, forming a high vacuum which results in enhanced steam flow.

The cooling towers cools the steam.

The nuclear fission chain reactions can be started, sustained and stopped in the nuclear reactor in a regulated and determined way. There is enough capability to extract thermal energy from the nuclear reactor vessel.
According to Britannica (2024), a typical nuclear power plant has a generating capacity of nearly one gigawatt (GW) of electricity.

The major part in a nuclear power station is called the reactor that is the location that houses the uranium nuclear fuel.

According to Britannica (2024), the busbar costs of a nuclear power plant are sensitive to construction costs and interest rates. Stricter laws and carbon taxes on carbon pollution could definitely raise costs of running coal power plants and make nuclear generation more competitive.

ADVANTAGES OF NUCLEAR GENERATION

1. It is highly efficient- a tiny amount of nuclear fuel is needed to produce lots of electricity (BBC Bitesize (2024)).
2. Nuclear is a carbon-free electric energy source and can limit the emission of greenhouse gases. Nuclear power stations produce low carbon unlike gas, oil and coal power stations. They do not emit CO_2 during operational activities and they are critical in satisfying the goals of climate change.
3. It can be used as a supply to base load and is important for energy security. Nuclear power plants produce electricity 24/7
4. Its output can accurately be predicted
5. Britannica (2024) highlights that the cost of nuclear fuel is substantially less than the cost of fossil fuel per kilowatt-hour of electricity generated due to enormous energy content of each unit of nuclear fuel compared to fossil fuel.
6. According to Chu (1982), nuclear electricity generation is not only safe and reliable but also highly economical. It has low ongoing running costs and produces reliable electricity. Running costs are small once set up.
7. Nuclear energy is a carbon-free, renewable and clean source of energy.
8. Do not radically change the surroundings
9. Can be constructed in rural and urban areas according to National Geographic Society Education (2024)).
10. Nuclear power plants can produce more energy with less fuel compared to any other technology today and use very little fuel (Climate Portal (2024).
11. Has the highest capacity factor
12. Cleaner than fossil fuel
13. Plants need less maintenance

DISADVANTAGES OF NUCLEAR POWER

1. Danger of radioactive leaks-i.e. safety risks to humans, flora and fauna. The byproducts of nuclear generation are radioactive. According to National Geographic Society Education (2024), radioactive material is very toxic and causes risk of cancer, bone decay, blood diseases and causes burns. The products of radioactive waste lasts for a long time. Radioactive waste may pollute the groundwater in the soil that will be close to the plant posing risk to people or organisms in the area.
2. Costly-The maintenance and operational costs of nuclear power stations are above those for coal fuel stations due to complexity of nuclear generation stations and legal issues which pop-up during the station’s operational activities.
3. Disposal of radioactive waste is a challenge which is risky to the environment and general public -geological disposal.
4. Danger of the development of nuclear weapons
5. During the occurrence of an accident, nuclear generation plants could be considered the most dangerous plants due to radioactive activities. It could result in harmful outcomes passed on from one generation to another over a large geographical area. Nuclear power stations must therefore be crafted and designed securely and robustly.

6. Can be used to manufacture nuclear weapons
7. Constructing nuclear reactors need or demands a high level of technological prowess and therefore only regions which will have pended their signature to the Nuclear-non-Proliferation Treaty could have access to uranium or plutonium that they require according to National Geographic Society Education (2024)). Because of the reasons above, majority of nuclear stations are in the developed world.
8. Need huge upfront investment –Nuclear power plants are highly expensive and complex to build (Greenpeace (2024)).
9. Nuclear fuel is not renewable and is a finite resource of energy (BBC Bitesize (2024))
10. Very high setup costs. Takes many years to construct.
11. Nuclear power plants are favorite targets to terrorist attack and sabotage.
12. The uranium in the world may run out in approximately 50 years

According to Koning and Rochman (2008), if nuclear generation is to be successful as a sustainable energy source, 5 crucial issues require to be addressed: -

1. Safety Issues
2. Inhibition of Proliferation
3. Production of minimum radioactive material waste
4. Access to natural resources e.g. uranium-235
5. Economic competitiveness

The interactions between particles normally neutrons and uranium-235 nuclei results in radioactivity, decay heat and finally electricity generation.

USES OF NUCLEAR ENERGY

- Electricity production
- Medical purposes to help in control of the proliferation of illnesses, in disease treatment or diagnosis.
- Energizes greatly ambitious exploration missions in space.

Reasons for the Opposition of Nuclear Energy by Environmentalists and Governments (Brook et al (2014):

- Unsafe
- Connection to the spread of nuclear weapons
- Uneconomic
- Unsuitable

According to Brook et al. (2014) sustainable means meeting current needs without compromising the ability of future generations to meet their own needs. There is need for sustainable use of uranium-235 resources if electricity production is limited to only nuclear fission.

According to World Nuclear Association (2024) 70% of electric power in France comes from nuclear generation. 50% of electricity in Ukraine, Slovakia, Belgium and Hungary comes from nuclear power and zero percent (0%) in Zimbabwe.

According to Britannica (2024), the first nuclear power plants were built in the 1960s. National Grid ESO (2024) says that the pioneering nuclear power generation plant on planet earth was built in Great Britain in 1956. They were prototypes that enabled the laying of groundwork for the construction of better energy reactors that were to follow. More than 400 nuclear reactors in the year 2012 were operational in 30 countries worldwide. Britannica (2024) says that the United States has the largest nuclear power industry with more than 100 reactors followed by France with more than 50.

According to World Nuclear Association website (2024), the first commercially operated nuclear plant began operational activities in the 1950s. Nuclear energy contribute 10 % of the world's electricity from about 440 power reactors according to World Nuclear Association website (2024), but Zinkle and Was (2013) puts the contribution from nuclear energy worldwide at 13 % and Mathew (2022) puts it at 11 % of global electricity generation. It is a dependable source of baseload electricity. According to Fernandez-Arias et al. (2020), as of 2020 there were 447 nuclear reactors operating in the world. Thirty-one (31) countries (plus Taiwan) have operational nuclear power plants. Commercial nuclear power industry began in the 1960s. According to National Geographic Society Education (2024), by 2011 the contribution to electricity generation from nuclear power plants was 15 % of total and nations such as France, Slovakia and Lithuania produce almost all of their electricity from nuclear power plants (National Geographic Society Education (2024)).

According to Koizumi and Morooko (2023), the history of nuclear electricity generation began with the discovery of radioactivity by Becquerel in 1896. The first production of electric power using nuclear worldwide occurred in the year 1951 in Idaho U.S.A at EBR-1

According to Fernandez-Arias et al. (2020), nuclear power plants were initially designed for a lifespan of 40 years which can be extended to 60 years and construction and commissioning period is 68 months (i.e. about 6 years).

According to Mathew (2022), New Innovations in Nuclear Energy include the following: -

1. Developments in big reactors
2. Emerging technological breakthroughs like small modular reactors or advanced fuel
3. Engineering advances in prolonging life span of existing nuclear reactors
4. Improved management of waste
5. New innovations and discoveries in materials

The demonstration of fusion reactors has been done successfully. According to Mathew (2022), the world's largest fusion reactor facility called ITER is at an advanced stage of construction to demonstrate the scientific and technological success of the fusion energy research for commercial production. The advantage is that fusion materials which is the fuel is accessible easily and widely available. Mathew (2022), says that it is believed that fusion energy is the pathway to energy security for thousands of years.

According to Mathew (2022), fusion reactor technology is very complex but promises unlimited energy potential. For reactions involving fusion to occur, there is need for collisions to happen between the atomic nuclei which could only occur at elevated temperatures surpassing millions of degrees Celsius (Mathew (2022)).

Conclusions

Supply inadequacy and rampant load shedding in countries like Zimbabwe, calls for innovation in electricity generation methods. There in need for Nationally ventilating knowledge of alternative generation methods to coal.

Nuclear energy generation will be quite exciting for countries like Zimbabwe who are not yet members of the nuclear club. There is information that there are uranium deposits in Kanyemba area which have not yet been exploited. There are also uranium claims in Shamva in Zimbabwe according to a geologist who is a Director in the Ministry of Mines in Zimbabwe. The risks of nuclear leakages and diseases like cancer that radioactive material causes also acts as a deterrent. Care has to be taken if Zimbabwe is keen in joining the nuclear club. Since nuclear power stations are linked to nuclear weapons proliferation, there is need for commitment on the part of Zimbabwe to only use nuclear energy for powering our industries and not for producing nuclear weapons.

There is also need for studies in uranium-235 enrichment which is a critical step in effective and efficient nuclear power generation in Zimbabwe.

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