LW on the subject *Power Supply and Nuclear-Powered Submarines*

Let's revise vocabulary

1. Find synonyms

- room, appropriate, to construct, element, rigorous, safety, environment, vapour, widely, to necessitate, to enhance, ultimately, to provide, shielding, liquid, to verify, generation

- surrounding, reliability, to ensure, steam, fluid, to build, broadly, harsh, to force, applicable, in the end, compartment, component, protection, production, to check, to increase

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2. Find antonyms

- Solid, inside, thick, rapidly, harsh, low-pressure, internal, to permit, the worst, to include, to heat, less, usually, advantages, to low

- Thin, to elevate, to exclude, the best, to cool, rarely, disadvantages, more, high-pressure, mild, outside, liquid, slowly, external, to forbade

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3. How are the words formed?

Experimentally, strength, exchanger, activation, reliability, remove, superheated, recirculation

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4. Find abbreviations in the text. What do they mean? What type of reactors are the most spread in the world?

HTGR, RPV, e.g., PWR, LWR, BWR

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5. What are forms of verbs?

realized been have, developed have, may designed be, produced is, rugged be must, existed has

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6. Find in the text:

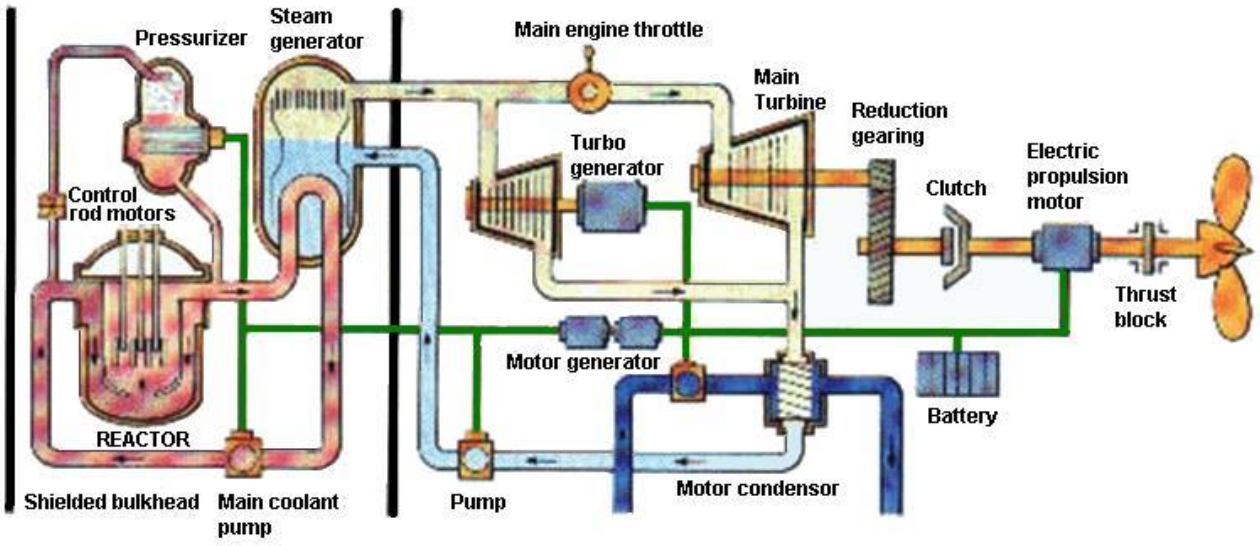
Атомные подводные лодки и военно-морские суда, теплоноситель и замедлитель нейтронов, водо-водяной энергетический реактор сверхкритического давления, обогащенный уран, поглощает слишком много нейтронов, процесс обогащения урана, упаковывается в топливные стержни, собираются в топливный пучок, расположены вертикально, плотность постепенно увеличивается, образуются небольшие пустоты, напряжение в трубках, накопление продуктов деления, вероятность разрыва, относительно высокое поглощение нейтронов, важное значение для безопасности, авария с потерей теплоносителя, нижняя часть активной зоны реактора, не выкипая в пар, более высокий тепловой КПД, стабилизирует изменения давления, поступает в реактор, упрощается система управляющих стержней, перевернутые U-образные трубки.

7. Read and translate the text

The pressurized water reactor (PWR) is a type of nuclear reactor used to the generate electricity and propel nuclear submarines and naval vessels. They make use of light water (ordinary water, as opposed to heavy water) as their coolant and neutron moderator. It is one of three types of light water reactors, with the others being the boiling water reactor and the supercritical water cooled reactor.

It is the most widely used reactor in nuclear power plants; with 297 in operation around the world as of 2018. This makes them by far the most dominantly used reactor in the world, with the second most (the boiling water reactor) having only 80 in operation.

Pressurized-water Naval Nuclear Propulsion System

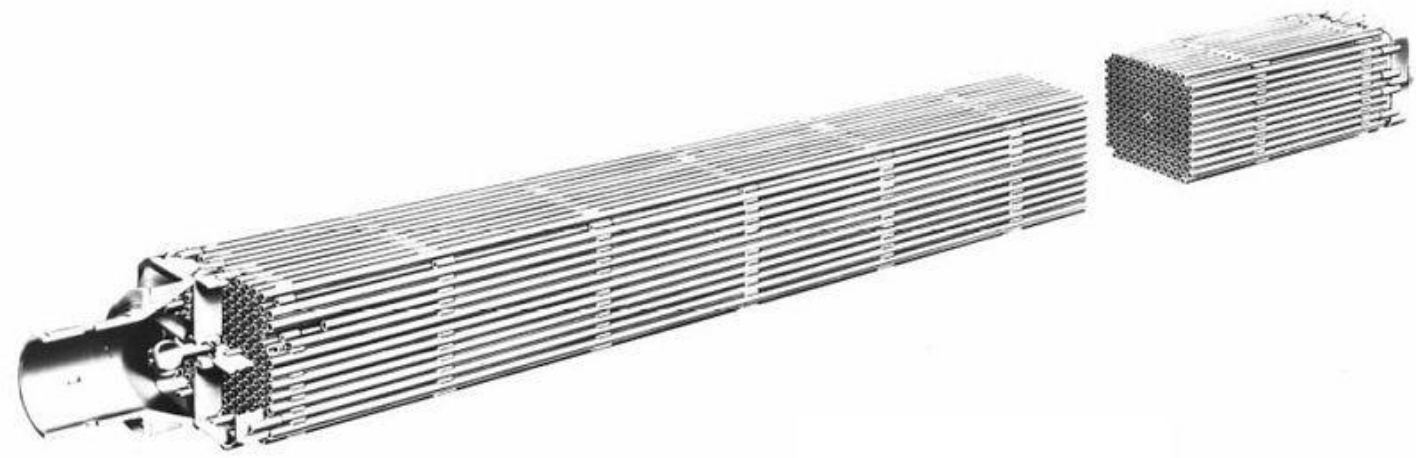


Fuel

Pressurized water reactors must use enriched uranium as their nuclear fuel, because of their use of light water. This is because light water would absorb too many neutrons if natural uranium was used, so the fuel content of fissile Uranium-235 must be increased. This is done through a uranium enrichment process, in which the concentration of Uranium-235 is increased from 0.7% to around 4%.

The enriched uranium is packed into fuel rods which are assembled into a fuel bundle, as seen in Figure 3. There are about 200-300 rods in each bundle for a PWR, with a large reactor containing 150-250 bundles in their core. This corresponds to about five cubic meters of uranium, or 80-100 tons of uranium.

The bundles are arranged vertically in fuel tubes within the core. As the fuel is "burned" in the reactor, its density gradually increases, resulting in small voids to develop inside the fuel tube. These void spaces can cause a problem because high pressures could cause stress to the tubes, increasing the likelihood of a rupture. To avoid this problem, the tubes are pressurized with helium at about 3.4 MPa. As fission gas products accumulate over the fuel's lifetime, the pressure gradually balances with the high pressure of the core.



A nuclear fuel bundle for a PWR

Coolant and Moderator

As mentioned before, light water is used as the coolant and moderator for a pressurized water reactor. Light water is much more abundant than heavy water, as it makes up 99.99% of natural water.

Light water does not make as good of a moderator as heavy water or graphite as a result of its relatively high absorption of neutrons. However, its use as a moderator makes for an important safety feature; if there is a loss of coolant accident (LOCA), there will also be a loss of moderator causing the nuclear chain reaction to stop. Also if the moderating water overheats and becomes

steam inside the bottom reactor core, there will be less moderator and therefore the chain reaction will stop.

The inverted U-tube bundle in the steam generator of a PWR

Pressure, Temperatures and Water flow

As the name implies, the water in the reactor is pressurized. This is due to the fact that as the pressure gets higher, the boiling point of water increases with it. This means that at high pressures the water can operate at extremely high temperatures without boiling to steam. This is important for the reactor as higher pressures allow for greater power output and higher thermal efficiency.

The pressure is maintained by the "pressurizer", which acts to stabilize pressure changes caused by changes in electrical load.

Water enters the reactor at 290°C, and by the time it exits it is at around 325°C. In order for it to remain a liquid at these temperatures, the pressure must be 15 MPa, or about 150 times atmospheric pressure. By keeping the water in liquid form, the control rod system is simplified as they are able to be placed in from the top, rather than from the bottom like in a boiling water reactor. Therefore, if the power is lost in the plant, the electromagnetic system holding the rods will give out, and gravity will cause the rods to fall into the core, stopping the reaction.

The hot water flowing from the reactor flows through inverted U-tubes which acts as a heat exchanger, heating up a secondary loop of water in what is called a "steam generator". This secondary loop is at a lower pressure so it is able to boil to steam, which then passes through turbines in order to generate electricity. Large reactors have up to 4 steam generators, each of which may be larger than the reactor itself.

Video

Hello I am Adam Sedgwick and today I will be presenting a slide-cast on pressurized water reactors.

A _____ _____ _____ is a type of nuclear reactor that creates nuclear power. Throughout the United States today there are currently 100 _____ _____ _____ providing roughly 20% of the nation's electrical needs. That's a really big thing. That's a lot of a lot of electricity that these nuclear power plants are producing. And most of these power plants are pressurized water reactors. Also the _____ _____ use nuclear power

technology in the form of pressurized water reactors to _____ _____ _____. This could be said to be one of the primary foundations for nuclear power in the United States starting with _____ _____.

Now let's look at the nuclear reactor and discuss how it works. It starts with the process called _____ _____. A _____ is fired at a uranium-235 isotope atom and is a strike C atom. It creates a lot of intense energy and it creates a reaction. This _____ _____ causes the uranium-235 isotope atom to split into two separate atoms causing a large amount of energy to form and additional neutrons just split off from these atoms. These _____ moving at high speeds hit other uranium-235 isotope atoms and this _____ _____ begins that creates and continues to create lots of energy and the _____ _____ will go on for a long period of time if not stopped.

So pressurized water reactors are developed in order to contain this reaction in order to transform that energy into _____ _____ _____. Quite simple very effective but very, very important that the design is very important.

So let's start with the first part. This is _____ _____ where the reactor sets, pump sets an additional component sim. So within this _____ _____ water is heated by the nuclear reaction and is pumped through the system.

A _____ Pressure rises the water up to 15.5 bar which is roughly 50 times the amount of pressure that's in your car tire and remove the water moves through the system. Now the reason why the water _____ _____ so high is so that the water when it's heated up to temperatures of 600 degrees Fahrenheit it won't boil. So as it flows to this system still _____. It comes in contact with a separate system known as the _____ _____ or the _____ _____. This the water in this system is not pressurized so income when it comes in contact with that very hot water. Through conduction the water is heated and it boils.

This _____ _____ is known as _____ flows through additional piping where it runs through a _____. It is pressurized and as it goes to this _____ it spins a _____ and electricity is formed. And this is what we use as an energy that it provides the 20% of our energy is through

the electrical energy. And so it's been very effective and very useful and for the most part very _____.

Now the _____ _____ within the system is connected to condenser: There's a reservoir of water that is connected to pipes and this cold water flows through. And the purpose is to cool down the _____. So the steam comes down, hits a turbine, flows down next to _____, condenses back to _____ _____, cools and then is pumped back through by the via feed water pump. Through the _____ _____ again is heated, flows through and it continues this process in a cycle.

So this _____ continues continuously and this reaction continues until you know we have lots of lots of energy formed and stored.

Thank you for listening to my presentation.

Write an essay on topic:

What makes the pressurized water reactor the most dominantly used reactor in the world?

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Self-working paper

1. Put in missing words on the base of the text

1. A reactor pressure vessel (RPV) in a nuclear power plant is the pressure vessel containing the nuclear reactor _____, core _____, and the reactor _____.

2. Of the main classes of reactors, the _____ _____ _____ is the most widely used.

3. A _____ is a central region that contains the fuel, fuel cladding, coolant, and sometimes _____.

4. A _____ _____ _____ power plant is smaller than the _____ _____ _____ power plant.

5. The internals of the _____ _____ _____ power plant are simpler than the internals of the _____ _____ _____ power plant.

6. A section of the ship with the nuclear power plant inside is called the _____ _____.

7. Grids for holding the reactor core and solid reflectors are within _____ _____.

8. The water in the _____ _____ upon absorbing heat from the _____ _____ becomes saturated and ultimately slightly superheated.

9. The pressure vessel of _____ _____ _____ must be built to a larger diameter to have the same reactor power as the _____ _____ _____.

2. Underline the grammatical structure of the sentences and define verb's form. Change Voice of the Verbs. Don't forget to change structure of the sentences.

1. An electric motor drives the same shaft when docking or in an emergency.

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2. The batteries power electric motors driving the propellers.

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3. This water is pumped through the steam generators and back into the reactor for re-heating.

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4. After passing through the turbines, the steam is condensed into water.

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5. Naval reactors undergo repeated power changes for ship maneuvering.

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6. Nuclear engineers have developed reactors with solid and liquid fuels.

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