1.1 Introduction

Energy and human progress

The last two centuries have seen remarkable changes across our world. The global population has increased from 1 billion to 7 billion people. At the same time, living standards have advanced dramatically in many parts of the world, supported by modern technologies and access to energy. People with the freedom to innovate and thrive in an environment of investment risk-and-reward led a burst of human progress, the pace and scale of which has been remarkable. As an indicator, energy consumption worldwide is now about 25 times higher than in 1800[1].

Expanding use of advanced technologies has also correlated with increasing demand for coal, oil, natural gas and electricity. As technologies and needs have evolved, people have naturally sought practical solutions with energy that are reliable, affordable and convenient. An often unrecognized sign of technology's progress over time is dramatic energy efficiency gains. For example, a steam engine in 1800 at 6 percent efficiency pales in comparison to a modern combined-cycle gas turbine with about 60 percent efficiency. It's no coincidence that people's quest to improve the use of their resources also extends to energy.

Together, technology and energy advances have helped bring about an unprecedented improvement in the key indicators of human well-being, including incomes, literacy rates and average life expectancy in many parts of the world.

Still, this dramatic progress has not been seen everywhere. According to the International Energy Agency (IEA), 1.3 billion people live without access to electricity, while 2.6 billion people rely on traditional biomass energy for cooking[1].

The global energy landscape is changing rapidly. And those changes will recast our expectations about the role of different countries, regions and fuels over the coming decades.

As the world's population approaches 9 billion people in 2040, we are challenged to not just meet basic needs, but also to improve living standards throughout the world.

In our view, meeting this challenge will require an increase in energy use worldwide of about 35 percent. The scale of the challenge may seem daunting, but history demonstrates a remarkable ability of people to overcome hurdles to progress. Fortunately, the world not only holds a vast and diverse array of energy resources, but we also possess increasingly advanced technologies that can safely and reliably supply this energy.

Another important aspect to improving standards of living concerns the environment. Perhaps most urgent are needs in many areas of the world for cleaner air and cleaner water. Nations around the world also need to continue to address risks associated with rising greenhouse gas (GHG) emissions. We expect advanced technologies and lower carbon fuels will help energy-related CO_2 emissions plateau around 2030.

In pondering our Outlook to 2040, we recognize that people's lives and those of their children are being transformed by access to energy and technology. Going forward, we expect people everywhere will continue to invent, innovate, work and deliver practical solutions to build a brighter future. Now, as always, that path to progress will be powered by human ingenuity and energy[1,2].

1.2Problem of the research

The real problem is that physicists think they understand well the mechanism of integration; In 1950 began research on the fusion, but the course of events suggest otherwise, it was the scientists expect that by the end of the twentieth century will be the production of fuel thermonuclear integrate widespread, but now the scientists expect that the commercial production of 40-year-old in front of him as the most optimistic estimates[2].

Core of the problem in how to bring two nuclei to the degree of integration, and control in the reaction product, which means within the means to provide tremendous energy to start the reaction by stimulating or rather forcing nuclei to the merger; for the transformation of one gram of fuel fusion to the case of plasma or gas high heat and is the fourth case of conditions Article three well-known solid, liquid and gaseous. Then fly nuclei of hydrogen superior speeds in plasma and approaching some to the degree of integration, while in 1991, the reactor Jet is the first of its kind that uses a mixture of deuterium and Turaetyawm, which demonstrated that fusion reactors can work, but unfortunately could not provide more than 70% of the energy needed to start the reaction fusion[2].

While says physicist Chris The goal was experimentally purely ability and size of the reactor ITER 10 times larger than Jet, and therefore needs to power 10 times that needed by the latter until it starts interacting fusion, and then the goal of these experiments control and watch the reactions going to learn from them is give us experience about how to control the super-hot gas. It is also a step to demonstrate that it is technically and scientific as possible the merger, however, some scientists who dismiss the idea of the world such as the British say John is ironic that much of the reactor building is funded for 40 years is a "very, very, very ambitious"[2].

1.3 Objectives of the research

Few of us – especially those of us living in advanced economies – ever pause to reflect on the pervasive importance of energy to our lives.

That’s only natural given the convenience and reliability of the energy we use. Consider electricity, for example. It flows when we flip a switch and suddenly there’s light. We turn on a cell phone and instantly connect with others around the world. It happens so automatically, that only disruptions get our attention.

At the same time, few of us ever get a glimpse of the energy being used miles away to produce this electricity for our benefit. Similarly, we expect our local service station will have fuel when we drive our car or truck in for a fill-up. Do we ever consider the energy it took to get the gasoline to the station, let alone the energy used to build our car[2].

Energy is a critical part of boosting prosperity and eradicating poverty.

Think about it. Energy is all around us. Vital in virtually every aspect of our lives, it’s remarkable that the value of energy doesn’t get broader recognition.

How are modern energy supplies paired with today’s technologies to improve your own life? You’re warmed in the winter and cooled in the summer, thanks to energy. Electricity powers your alarm clock, your television, and your cell phone. A refrigerator uses energy to keep your food safe to consume and your oven uses energy to cook it. And before that, your food was grown by farmers, then processed, packaged and transported to the grocery store from another part of the country or the world, using energy at every step along the way. Essentially every task you perform and every product you use throughout the day is made possible because of energy.

It raises the question: why energy? The answer is simple. Energy helps us survive and frees us to pursue fuller lives in thousands of ways.

Today, most people are fortunate to have energy supplies and clean water flowing directly to their homes. Modern appliances can handle tasks like cooking and laundry while we read an e-book, watch television, shop online, hit the treadmill, or challenge the kids to a video game, all in a temperature-controlled room.

We have unparalleled travel options. We can use a motorcycle, car, bus, truck, train, boat or plane.

We can dash to school, to work or to the grocery store in minutes. We can drive hundreds of miles to see family or fly across an ocean in hours. And we can trade goods with others thousands of miles away. Energy not only powers all of this travel, it helps us build the vehicles and infrastructure that it requires.

When our loved ones are sick, energy is integral to getting them to the doctor and restoring their health. From hospitals and urgent-care facilities, to basic pharmaceutical drugs, to materials that keep equipment sterile, to high-tech diagnostic tools such as MRIs, energy has a hand in producing and powering our health system[3].

Our lives are also affected by electric-powered devices that are transforming communications and computing. Today, we can be in touch with someone else basically anytime, anywhere in a matter of seconds. And with the Internet, we can transform the education of our children, telecommute to work, capture new trade opportunities, see distant friends and family, or attend online classes to improve our education.

These technologies are widely used today only because they provide practical value to people like you; value that would not exist without convenient access to modern and reliable energy supplies. This combination of technology and energy provides important synergies that improve human life. We can meet basic needs much more efficiently and in turn pursue more valuable activities, whether it’s time with family and friends, furthering our education, inventing a new medical treatment, building a business, playing or simply helping a neighbor[2, 3].

1.4literature of view

Some early and unsuccessful experiments were conducted in the Cavendish laboratory in Cambridge, UK, during the 1930s, but it was only after World War Two and the development of nuclear fission weapons that interest in fusion and nuclear technologies in general increased.

The original large-scale experimental fusion device was built in the late 1940s and early 1950s at Harwell in the UK. The Zero Energy Toroidal Assembly (ZETA) worked from 1954 to 1958 showing initial promise and producing useful results for later devices[1].

Research on fusion quickly became an international area of science with experimental devices developed in France, Germany, the Soviet Union and the US. Even during the depth of the Cold War, scientific exchange on fusion was encouraged. In 1958 an Atoms for Peace conference in Geneva formally sealed the start of truly international collaboration that would in time lead to today's ITER experiment in southern France.

A major step forward occurred in 1968 when the Russian scientists Tamm and Sakharov announced results from a new type of magnetic confinement device called a tokamak. It was able to run at temperatures ten times higher than other current experiments. Today, the tokamak is the dominant experimental technique for studying fusion.

In 1978 the Joint European Torus (JET) project was launched in Europe and came into operation in 1983, about the same time as the Tokamak Fusion Test Reactor (TFTR) in the USA. The Japanese tokamak JT-60 came online in 1985. In 1991, JET produced for the first time in the world a significant amount of power (1.7 megawatts-MW) from controlled nuclear fusion. Subsequently, in

1993 TFTR produced 10 MW of power. The current world record for fusion power was regained by JET in 1997 when it hit 16 MW.

The international project ITER will be the largest tokamak ever constructed and it will build on the experience and knowledge gained by its predecessors as it takes the next big steps on the road to fusion as a worldwide energy sourcesee table (1.2) below [1].

Figure (1.1) showing thessartingin 1999, a growing number of amateurs have been ableto fuse atoms using homemade fusors.

Figure (1.2)showingMagnetic mirrors suffered from end losses, requiring high power, complex magnetic designs, such as the baseball coil pictured here.

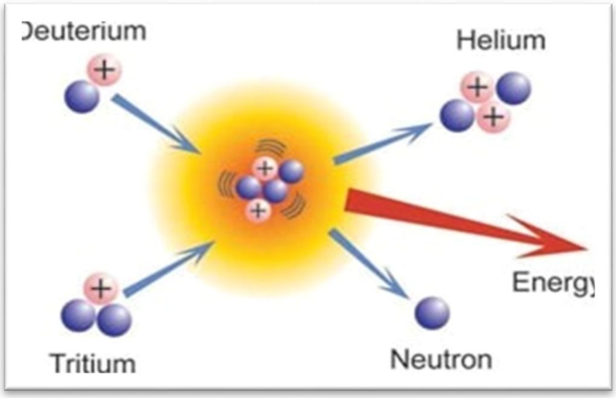
Table (1-2) showingliterature of view

1929	1939	1954	1976	1988	1993	2003
Prediction	Quantitative	ZETA	JET Project	Japanese	Princeton	ITER
using $e=mc^2$	Theory			Tokomak	Generates	
that energy	explaining				10	
from fusion is	Fusion				Megawatts	
Possible					of power	
					(cold	
					fusion)	

2.1 Introduction

In nuclear physics, nuclear fusion is a nuclear reaction in which two or more atomic nuclei collide at a very high speed and join to form a new type of atomic nucleus. During this process, matter is not conserved because some of the matter of the fusing nuclei is converted to photons (energy). Fusion is the process that powers active or "main sequence" stars.

The fusion of two nuclei with lower masses than iron (which, along with nickel, has the largest binding energy per nucleon) generally releases energy, while the fusion of nuclei heavier than iron *absorbs* energy. The opposite is true for the reverse process, nuclear fission. This means that fusion generally occurs for lighter elements only, and likewise, that fission normally occurs only for heavier elements. There are extreme astrophysical events that can lead to short periods of fusion with heavier nuclei.This is the process as shown in figure (2.1) that gives rise to nucleosynthesis, the creation of the heavy elements during events such as supernovae[4].



Picture (2.1) shows Fusion of deuterium with tritium creating helium-4, freeing a neutron, and releasing 17.59 MeV of energy, as an appropriate amount of mass changing forms to appear as the kinetic energy of the

products, in agreement with kinetic E = Δmc2, where Δm is the change in rest mass of particles.

2.2Controlled nuclear fusion

To maintain a sustained controlled nuclear reaction, for every 2 or 3 neutrons released, only one must be allowed to strike another uranium nucleus. If this ratio is less than one then the reaction will die out; if it is greater than one it will grow uncontrolled (an atomic explosion). A neutron absorbing element must be present to control the amount of free neutrons in the reaction space. Most reactors are controlled by means of control rods that are made of a strongly neutron-absorbent material such as boron or cadmium[4][5].

In addition to the need to capture neturons, the neutrons often have too much kinetic energy. These fast neutrons are slowed through the use of a moderator such as heavy water and ordinary water. Some reactors use graphite as a moderator, but this design has several problems. Once the fast neutrons have been slowed, they are more likely to produce further nuclear fissions or be absorbed by the control rod[6].

2.3Positives and Negatives of Nuclear Fusion

Nuclear fusion as anything in the world has positives and negativeswhich shown in the table (2.1).

Table (2-2) showing pros and cons of nuclear fusion

Positives	**Negatives**
Clean energy source that produces.no greenhouse gases.	Fusion can only occur at extremely high temperatures (1015 million K) making it difficult to contain.
Fusion, unlike fission, does not involve a chain reaction, so the process can be stopped eliminating the risk of a meltdown.	The energy required to make fusion work could be greater than the output of energy by fusion itself.
Fusion does not produce nuclear waste, only the core of the reactor remains radioactive and only for 100 years.	Current research and experimentation is going to cost billions of dollars, money that could be invested in renewable green fuels
Fusion has the potential to fuel the entire world for relatively low costs compared to today's fuels.	Cold fusion may be the only way to make fusion efficient, and cold fusion has yet to been successfully developed.

2.3Fusion power

Fusion poweris the generation of energy by nuclear fusion. Fusion reactions are high energy reactions in which two lighteratomic nuclei fuse to form a heavier nucleus. When they combine, some of the mass is converted into energy in accordance with Einstein's formula $E = mc^2$[8] This major area of plasma physics research is concerned with harnessing this reaction as a source of large scale sustainable energy. There is no question of fusion's scientific feasibility, since stellar nucleosynthesis is the process in which stars transmute matter into energy emitted as radiation.

In almost all large scale commercial proposals, heat from neutron scattering in a controlled fusion reaction is used to operate a steam turbine that drives electrical generators, as in existing fossil fuel and nuclear fission power stations. Many different fusion concepts have come in and out of vogue over the years. The current leading designs are the tokamak and inertial confinement fusion (laser) approaches. As of January 2016, these technologies are not yet practically viable, as they are not*energetically* viable—i.e., it currently takes more energy to initiate and contain a fusion reaction than the reaction then produces[9].

There are also smaller-scale commercial proposals relying on other means of energy transfer, mostly forms of aneutronic fusion—but these are largely considered to be more remote than the large scale neutron scattering approaches.

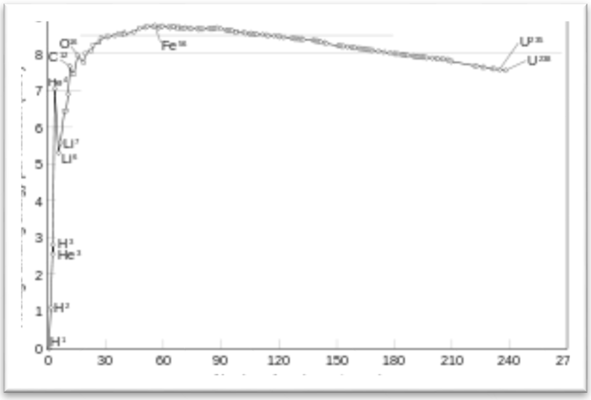


Figure [2.2] shows Binding energy for different atoms. Iron-56 has the highest, making it the most stable. Atoms to the left are likely to fuse; atoms to the right are likely to Split.

2.3.1Cross section

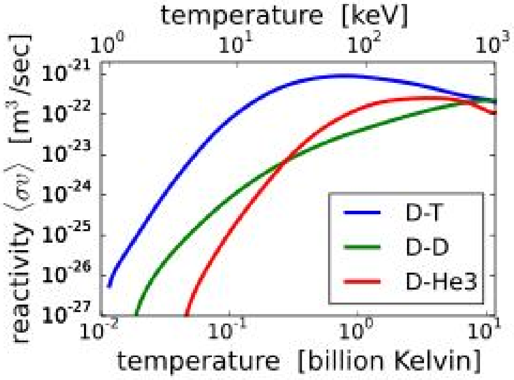
A reaction's cross section, denoted σ, is the measure of how likely a fusion reaction will happen as shown in figure (2.3). It is a probability, and it depends on the velocity of the two nuclei when they strike one another. If the atoms move faster, fusion is more likely. If the atoms hit head on, fusion is more likely. Cross sections for many different fusion reactions were measured mainly in the 1970s using particle beams [10]. A beam of ions of material A was fired at material B at different speeds, and the amount of neutrons coming off was measured. Neutrons are a key product of most fusion reactions.

In most cases, the nuclei are flying around in a hot cloud, with some distribution of velocities. If the plasma is thermalized, then the distribution looks like a bell curve, or maxwellian distribution. In this case, it is useful to take the average cross section over the velocity distribution. This is entered into the volumetric fusion rate[11].

$$P_{\text{fusion}} = n_A n_B \langle \sigma v_{A,B} \rangle E_{\text{fusion}} \quad (2.1)$$

where:

- P_{fusion} is the energy made by fusion, per time and volume
- n is the number density of species A or B, the particles in the volume
- $\langle \sigma v_{A,B} \rangle$ is the cross section of that reaction, average over all the velocities of the two species v
- E_{fusion} is the energy released by that fusion reaction.



Figure[2.3] showing cross section

The fusion reaction rate increases rapidly with temperature until it maximizes and then gradually drops off. The deuterium-tritium fusion rate peaks at a lower temperature (about 70 keV, or 800 million kelvin) and at a higher value than other reactions commonly considered for fusion energy.

2.3.2 Lawson criterion

This equation shows that energy varies with the temperature, density, speed of collision, and fuel used. This equation was central to John Lawsons' analysis of fusion power stations working with a hot plasma. Lawson assumed an energy balance, shown below[11].

Net Power = Efficiency * (Fusion - Radiation Loss - Conduction Loss)(2.2)

1. Net Power is the net power for any fusion power station.
2. Efficiency how much energy is needed to drive the device and how well it collects power.
3. Fusion is rate of energy generated by the fusion reactions.
4. Radiation is the energy lost as light, leaving the plasma.
5. Conduction is the energy lost, as momentum leaves the plasma.

Plasma clouds lose energy through conduction and radiation.[11] Conduction is when ions, electrons or neutrals hit a surface and transfer a portion of their kinetic energy to the atoms of the surface. Radiation is when energy leaves the cloud as light. This can be in the visible, UV, IR, or X-ray light. Radiation increases as the temperature rises. To get net power from fusion, you must overcome these losses.

2.3.2 Triple Product: Density, temperature, time

The Lawson criterion argues that a machine holding a hot thermalized and quasi-neutral plasma has to meet basic criteria to overcome the radiation losses, conduction losses and a power station efficiency of 30 percent.[11][12] This became known as the "triple product": the plasma density and temperature and how long it is held in [13]. For many years, fusion research has focused on achieving the highest triple product possible. This emphasis on $(nt\tau)$ as a metric of success has hurt other considerations such as cost, size, complexity and efficiency.This has led to larger, more complicated and more expensive machines such as ITER and NIF.

when it moves from a low to high density magnetic field[13].

2.4 Energy capture

There are several proposals for energy capture. The simplest is using a heat cycle to heat a fluid with fusion reactions. It has been proposed to use the neutrons generated by fusion to re-generate a spent fission fuel[14]. In addition, direct energy conversion, has been developed (at LLNL in the 1980s) as a method to maintain a voltage using the products of a fusion reaction. This has demonstrated an energy capture efficiency of 48 percent[15].

2.5Fusion importance

Fusion energy has the potential to provide a sustainable solution to global energy needs. In particular it can provide a continuous baseload power supply which is sustainable, large-scale and environmentally responsible, using fuels that are universally available.

Limitless fuel - The raw fuels for fusion are water and lithium. There is around 0.033 grams of deuterium in every litre of water. Tritium is not found on Earth but can be easily made from lithium - an abundant metal found in batteries that power mobile phones and laptops. Tritium can be made *in situ* in a fusion reactor by using the neutron released by the fusion reaction. If the neutron is absorbed by a surrounding 'blanket' of lithium then tritium is produced.

Inherent safety - The volume of gas in a fusion reactor will always be low, at around 1 gram of fuel in 1000 cubic metres. Any problem will always cool the plasma and stop reactions - so a runaway situation is impossible. Also the raw fuels for the reactor (deuterium and lithium) are not radioactive. Tritium is mildly radioactive but will be produced and used within the reactor. Consequently, no transport of radioactive fuels will be needed for a fusion power plant - and even the worst possible case accidents would not require evacuation of neighbouring populations.

Environmental impact - Fusion power will not create greenhouse gases, produce other harmful pollutants or result in long-lasting radioactive waste. Its fuel consumption will be extremely low. A 1000 megawatt electric fusion power station would consume 100 kg of deuterium and three tonnes of lithium a year to generate 7 billion kilowatt-hours of power. To do the same a coal-fired power station would need 1.5 million tonnes of coal.

The fusion fuels are not radioactive. The neutrons generated by fusion will interact with the materials close to the reactor, but careful choice of these materials will ensure that no long-term legacy of radioactive waste is produced by fusion power [15].

3.1Introduction

Nuclear Reactors

A nuclear reactor, formerly known as an atomic pile, is a device used to contain and control a sustained nuclear reaction. Nuclear reactors are used at nuclear power plants for electricity generation and in propulsion of ships. Heat from nuclear fusion is passed to a working fluid (water or gas), which runs through turbines. These either drive a ship's propellers or turn electrical generators. Nuclear generated steam in principle can be used for industrial process heat or for district heating. Some reactors are used to produce isotopes for medical and industrial use, or for production of weapons-grade plutonium. Some are run only for research. Today there are about 450 nuclear power reactors that are used to generate electricity in about 30 countries around the world[16].

3.2Mechanism

Just as conventional power-stations generate electricity by harnessing the thermal energy released from burning fossil fuels, nuclear reactors convert the energy released by controlled nuclear fission into thermal energy for further conversion to mechanical or electrical forms.

3.3 Methods for achieving fusion

3.3.1Thermonuclear fusion

If the matter is sufficiently heated (hence being plasma), the fusion reaction may occur due to collisions with extreme thermal kinetic energies of the particles. In the form of thermonuclear weapons, thermonuclear fusion is the only fusion technique so far to yield undeniably large amounts of useful fusion energy. Usable amounts of thermonuclear fusion energy released in a controlled manner have yet to be achieved. In nature, this is what produces energy in stars through stellar nucleosynthesis.

3.3.2 Inertial confinement fusion

Inertial confinement fusion (**ICF**) see the figure below is a type of fusion energy research that attempts to initiate nuclear fusion reactions by heating and compressing a fuel target, typically in the form of a pellet that most often contains a mixture of deuterium and tritium.

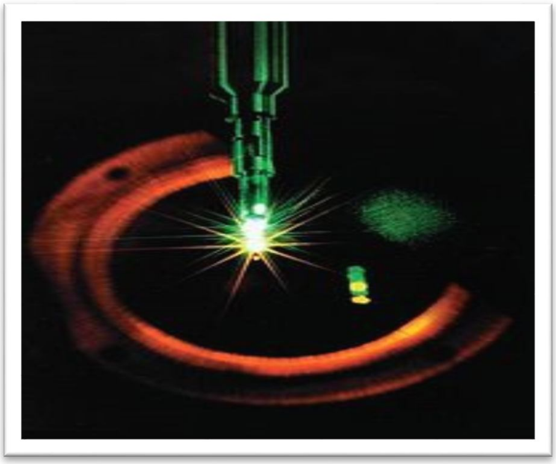


Figure (3.1) showing inertial confinement fusion implosion on the Nova laser during the 80's was a key driver of fusion development.

3.3.3 Inertial electrostatic confinement

Inertial electrostatic confinement is a set of devices that use an electric field to heat ions to fusion conditions. The most well-known is the fusor. Starting in 1999, a number of amateurs have been able to do amateur fusion using these homemade devices. Other IEC devices include: the Polywell, MIX POPS[16] and Marble concepts[17].

3.3.4 Beam-beam or beam-target fusion

If the energy to initiate the reaction comes from accelerating one of the nuclei, the process is called *beam-target* fusion; if both nuclei are accelerated, it is *beam-beam* fusion.

Accelerator-based light-ion fusion is a technique using particle accelerators to achieve particle kinetic energies sufficient to induce light-ion fusion reactions. Accelerating light ions is relatively easy, and can be done in an efficient manner—all it takes is a vacuum tube, a pair of electrodes, and a high-voltage transformer; fusion can be observed with as little as 10 kV between electrodes. The key problem with accelerator-based fusion (and with cold targets in general) is that fusion cross sections are many orders of magnitude lower than Coulomb interaction cross sections. Therefore, the vast majority of ions end up expending their energy on bremsstrahlung and ionization of atoms of the target. Devices referred to as sealed-tube neutron generators are particularly relevant to this discussion. These small devices are miniature particle accelerators filled with deuterium and tritium gas in an arrangement that allows ions of these nuclei to be accelerated against hydride targets, also containing deuterium and tritium, where fusion takes place. Hundreds of neutron generators are produced annually for use in the petroleum industry where they are used in measurement equipment for locating and mapping oil reserves.

3.3.5 Muon-catalyzed fusion

Muon-catalyzed fusion is a well-established and reproducible fusion process that occurs at ordinary temperatures. It was studied in detail by Steven Jones in the early 1980s. Net energy production from this reaction cannot occur because of the high energy required to create muons, their short 2.2 µs half-life, and the high chance that a muon will bind to the new alpha particle and thus stop catalyzing fusion[18].

3.5Cooling

A nuclear reactor coolant — usually water but sometimes a gas or a liquid metal (like liquid sodium) or molten salt — is circulated past the reactor core to absorb the heat that it generates. The heat is carried away from the reactor and is then used to generate steam. Most reactor systems employ a cooling system that is physically separated from the water that will be boiled to produce pressurized steam for the turbines, like the pressurized water reactor. However, in some reactors the water for the steam turbines is boiled directly by the reactor core; for example the boiling water reactor[19].

3.6 Electrical power generation

The energy released in the fusion process generates heat, some of which can be converted into usable energy. A common method of harnessing this thermal energy is to use it to boil water to produce pressurized steam which will then drive a steam turbine that turns an alternator and generates electricity[20].

3.7Reactor types

Classification by type of nuclear reaction

3.7.1Nuclear fission

All commercial power reactors are based on nuclear fission. They generally use uranium and its product plutonium as nuclear fuel, though a thorium fuel cycle is also possible. Fission reactors can be divided roughly into two classes, depending on the energy of the neutrons that sustain the fission chain reaction:

- Thermal reactors (the most common type of nuclear reactor) use slowed or thermal neutrons to keep up the fission of their fuel. Almost all current reactors are of this type. These contain neutron moderator materials that slow neutrons until their neutron temperature is *thermalized*, that is, until their kinetic energy approaches the average kinetic energy of the surrounding particles. Thermal neutrons have a far higher cross-section (probability) of fissioning the fissile nuclei uranium-235, plutonium-239, andplutonium-241, and a relatively lower probability of neutron capture by uranium-238 (U-238) compared to the faster neutrons that originally result from fission, allowing use of low-enriched uranium or even natural uranium fuel. The moderator is often also thecoolant, usually water under high pressure to increase the boiling point. These are surrounded by a reactor vessel, instrumentation to monitor and control the reactor, radiation shielding, and a containment building[21].

- Fast neutron reactors use fast neutrons to cause fission in their fuel. They do not have a neutron moderator, and use less-moderating coolants. Maintaining a chain reaction requires the fuel to be more highly enriched in fissile material (about 20% or more) due to the relatively lower probability of fission versus capture by U-238. Fast reactors have the potential to produce less transuranic waste because all actinides are fissionable with fast neutrons,[19] but they are more difficult to build and more expensive to operate. Overall, fast reactors are less common than thermal reactors in most applications. Some early power stations were fast reactors, as are some Russian naval propulsion units. Construction of prototypes is continuing (see fast breeder or generation IV reactors).

3.7.2Nuclear fusion

is an experimental technology, generally with hydrogen as fuel. Fusion power While not suitable for power production, Farnsworth-Hirsch fusors are used to produce neutron radiation.

3.8Fusion reactors

Controlled nuclear fusion could in principle be used in fusion power plants to produce power without the complexities of handling actinides, but significant scientific and technical obstacles remain. Several fusion reactors have been built, but only recently reactors have been able to release more energy than the amount of energy used in the process. Despite research having started in the 1950s, no commercial fusion reactor is expected before 2050. The ITER project is currently leading the effort to harness fusion power[22].

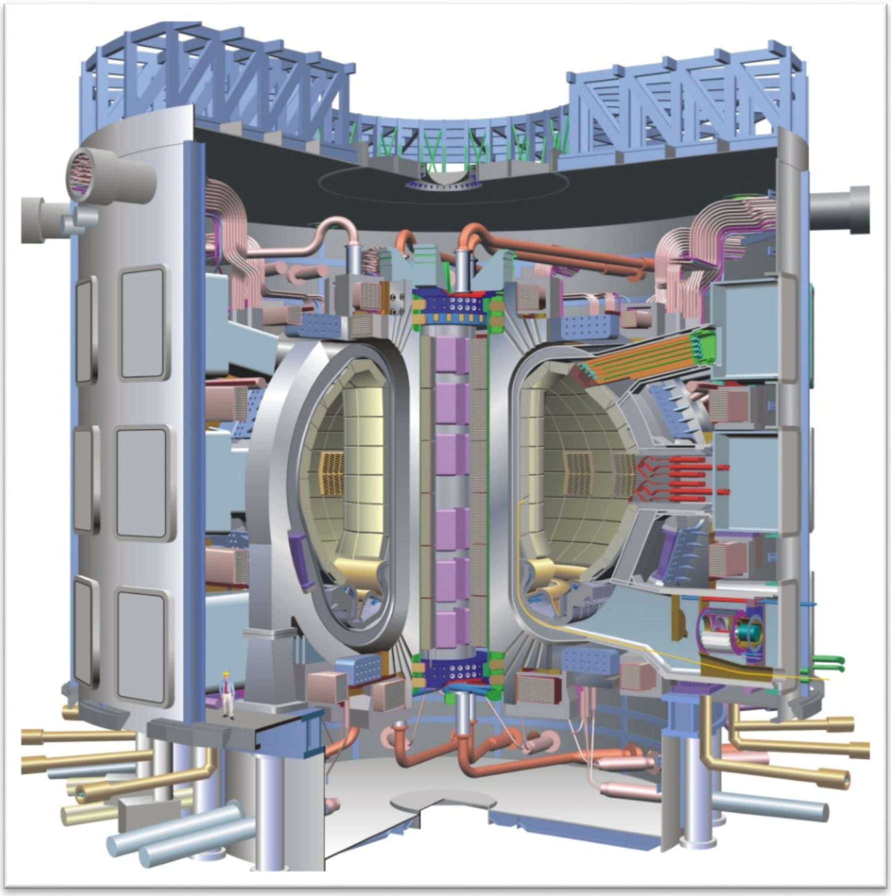
3.9International experimental thermonuclear reactor

ITER (Latin for "the way") is an international nuclear fusion research and engineering megaproject. It will be the world's largest magnetic confinement plasma physics experiment, housed in the world's largest experimental tokamak nuclear fusion reactor that is being built next to the Cadarache facility in the south of France[23].

The ITER project aims to make the long-awaited transition from experimental studies of plasma physics to full-scale electricity-producing fusion power stations. The ITER fusion reactor has been designed to produce 500 megawatts of output power while needing 50 megawatts to operate.[26] Thereby the machine aims to demonstrate the principle of producing more energy from the fusion process than is used to initiate it, something that has not yet been achieved in any fusion reactor.

The project is funded and run by seven member entities—the European Union, India, Japan, China, Russia, South Korea and theUnited States. The EU, as host party for the ITER complex, is contributing about 45 percent of the cost, with the other six parties contributing approximately 9 percent each [24,25,26].

Construction of the ITER Tokamak complex started in 2013[27] and the building costs are now over US$14 billion as of June 2015.The facility is expected to finish its construction phase in 2019 and will start commissioning the reactor that same year and initiate plasma experiments in 2020 with full deuterium–tritium fusion experiments starting in 2027.[27,28]If ITER becomes operational, it will become the largest magnetic confinement plasma physics experiment in use, surpassing the Joint European Torus. The first commercial demonstration fusion power station, named DEMO, is proposed to follow on from the ITER project[30].



Figure[3.1] showing ITER reactor from inside

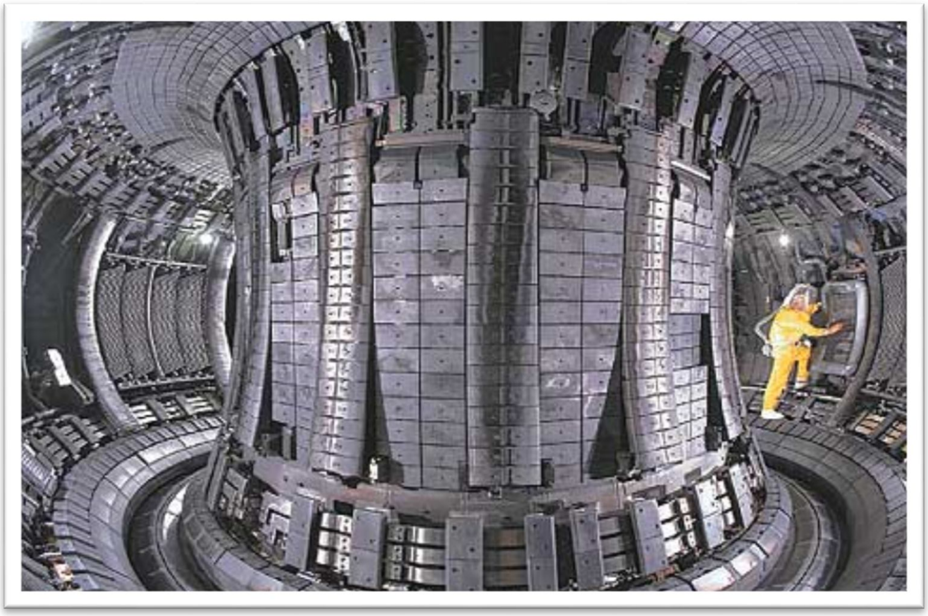


Figure [3.2] showing fusion reactor

4.1Result and discussion

In this thesis we found that the creation of combinatorial interaction requires the creation of certain conditions to overcome the repulsive forces between the atoms emerging if merged. These conditions are at high temperature is estimated at about one hundred million degrees Celsius, as well as high pressure pushes the atoms of adhesion in the distance of a portion of the million-billionth of a meter. Therein lies the obstacle in the design and construction of a nuclear reactor where combinatorial that so far there is no well-known on the surface of the planet can withstand so much heat the material.

However, this did not prevent the scientists to continue research to overcome those obstacles combinatorial design of a nuclear reactor capable of and access to bear on those with enormous power and control interactions. Where united teams of scientists from Japan, Russia, China, South Korea, India and the United States as well as countries of the European Union in a huge project under the name "International Thermonuclear Experimental nuclear reactor" (International Thermonuclear Experimental Reactor ITER). This project aims to develop a combinatorial design of a nuclear reactor being built near the city of "Cadarache" (Cadarache) in France and running by 2020.

In a major step towards achieving this dream team of scientists at the University of "Tennessee" in the United States was able to develop an experimental design for a nuclear reactor combinatorial. Where scientists test new technology designed to ensure isolation and stability of the central solenoid, which is the backbone of the nuclear fusion reactor. The central solenoid consists of six giant monolith files on top of each other - weighing up to 1000 Tun- working to ignite and turn the plasma - a hot gas of electrically charged works as a fuel for the reactor. The difficulty lies in the design of fusion reactors to achieve electrical insulation and thermal hot plasma inside the central solenoid to bring stability and consistency to the center of the reactor.

The solution to that problem lies in finding the right material that can be entered in all the necessary places in the central solenoid in order to ensure stability. Scientists have managed to find the right composition of this material through the mixing glass fibers with epoxy mixture to reach a chemical liquid at high temperatures turns solids have handled. It took two years almost to find those unique composition. In addition to this, scientists were able to determine the appropriate method for the introduction of this article to the central solenoid reactor over full control of pressure and temperature and the rate of pumping during this delicate process. Scientists have tested the so unique design to prove the validity of the application on a larger scale in the future.

TheInternational project (ITER) aims to build a nuclear reactor capable of combinatorial production capacity equal to 10 times the energy consumed. Thereby solving the anticipated energy crisis in the future, next to avoid the terrible environmental problems resulting from the combustion of fossil fuels for power generation, and the interesting thing is that the man is the only one who has a "crisis" in energy object; all living organisms live valuable consistency and harmony with nature, going energy in natural tracks without any crisis or shortage. Let us learn from nature how to manage their energy may be that guide us and to eliminate the "crisis" that we made!

4.3 Conclusion

We found that it is too early to tell if fusion power will ever be commercially viable. If it is, it will be a truly remarkable achievement, but it is more likely to be the miracle energy source of the next century rather not this one. In that sense, fusion as a solution to climate change or peak oil is a misplaced hope. Only time will tell if Iter's machine is a pioneering prototype or a $21 billion white elephant in the French woods – and time is one thing we don't have. A new generation of nuclear fusion power stations simply will not be ready in any time frame that realistically slows CO2 emissions, nor would it come online in time to replace fossil fuels. In the short term, there is still no alternative to renewable energy, and a drastic reduction in the amount of energy we use in the first place.

4.2Recommendations

Scientists had to overcome a number of difficulties before dawn fusion energy:

Temperature: The material should be in contact with the interactions able to withstand very high temperatures for many years.

Structure: neutrons, high-energy transmitting material to brittle materials.

Fuel: a fusion reactor that feeds itself Baltretyawm produced through a complex series of interactions.

Reliability: fusion reactors laser generates only intermittent explosions, while the reactors should contain magnetic fusion plasma for weeks, not for a few seconds.

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