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NUCLEAR ENERGY SUCH AS AN ALTERNATIVE ENERGY SOURCE

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ABSTRACT

Nuclear power is still an unknown subject to many and ends up being left out when it comes to alternative energy sources and environmental preservation. Unfamiliarity and the disclosures information that are not always correct end up not to show the public the true risks and benefits of this source. The strength of public opinion is the main barrier to the advancement of this technology. So, this paper aims to demystify the villain aspect of nuclear energy that could become a major source for power generation. For this, will be made a historical retrospective of the theories that enabled the field of nuclear fission, the authors and key points, such as will be described how nuclear fission reaction is produced, controlled and sustained and how energy is produced, will be also made an argument on key facts that lead public opinion to stand up against nuclear power, as the generation of radioactive waste and nuclear weapons. Are presented possible solutions beyond the learnings and improvements resulting from the occurred accidents. After these analyzes was observed that, besides being a potentially clean source for power generation, it can be safe in order that the waste generated are already safely managed and intelligence groups also monitor terrorist groups, seeking to ensure global security in relation to nuclear weapons and, at the issue of accidents, each event has brought learning and became the nuclear industry today, one of the safest.

1. INTRODUCTION

Global warming has become a featuring problem in recent times and has great prominence in the media [l] heading the discussion of its causes and ways to prevent environmental degradation. In this context, physics appear as a science that can man understand their problems and propose solutions.

The rapid development that has taken place in the emerging countries changed the political-economic picture drastically. These countries were suppliers of inputs to the great powers, but nowadays they have become competitors and produce at full capacity to remain competitive.

Today Brazil is an extremely promising country, with the spotlight overshadowed only by China. With its political, economic and growth rates relatively low compared to other developing nations Brazil still have time enought to develop a plan for energy infrastructure to support growth and avoid problems like the one that happens in 2001 when the lack of rain caused the low water levels in the reservoirs of hydroelectrics and almost left the country in the "dark."

Brazil has the 5th largest uranium reserves in the world and now dominates almost the entire cycle of nuclear fuel1. The thermonuclear plants represent today only 2.2% of the energy produced in the country, the package of nuclear power pretends to build four nuclear power plants until 2030. Other investments in alternative energy sources such as biomass (bagasse) and ethanol are the development package of the current government, but surely the most certain is nuclear energy due to the immense technological mastery over this source "inexhaustible" of energy [2].

Nuclear power is still a subject unknown to many and therefore ends up being left out when it comes to alternative energy sources and environmental preservation. The unknowing and the information is not always correct publicized by the media, not just to show the general public the true risks and benefits of this energy source. The resistance of public opinion has become the barrier main to the nuclear technologies advancement.

This work has as main purpose to demystify aspect of villain one of the sources of energy that may, in the near future, become a major alternative sources of power generation.

2. METODOLOGY

2.1. Nuclear Reactor

The nuclear reactor is the main equipment of a thermonuclear plant, it is inside of the nucleus that the nuclear fission process happens, this process releases the energy needed to move the turbines that generate electricity.

Less than a year after the discovery of fission, Enrico Fermi (1901-1954) realized that a chain reaction could be made if the uranium was separated into small pieces by a material and in 1942, Enrico and his team built the first reactor nuclear at the University of Chicago, who at the time was called atomic cell [2].

The main part of a nuclear reactor is its core where fission occurs. Within the core is located the fuel element which is separated in small amounts near by the moderator. The fuel element is the U^{235}, by absorbing a slow neutron the uranium atom gains energy exciting the uranium atom. The force that maintains the core cohesive is the strong interaction, this interaction is observed when nucleons are very close to each other. It is clear that the neutrons do not suffer nuclear repulsion, but rather the protons. It was expected that they repel away if approached, but the strong interaction is predominant in the nuclear level. There is no mathematical model for this interaction, but it is known that it exists only in nuclear dimensions, at larger distances the electromagnetic interaction is predominant [3,4,5].

After the absorption of a neutron, the core of the fuel element is excited by stretching and increasingly its diameter such that the strong interaction is no longer sufficient to maintain the electromagnetic repulsion, which began to be the predominant interaction at certain points of the core, thus causing its disruption into two other cores of approximately the same mass and releasing two or three neutrons, which makes possible the chain reaction.

In the uranium atom breaking it is released 200 MeV per nucleon and neutrons are ejected with energy of about 2 MeV, which hinders the capture of these neutrons by other U^{235} atoms,

since the cross-section between the core and a neutron is much larger at low energies it is just like neutrons with different energies sees different targets. The cross section is related to the allowed energy states for the nucleus whose excitation energy is approximately 0.04 eV, it means that the chain reaction is maintained only if the neutrons lose energy before leaving the reactor core. The material used in fission comprises 97% of non-fissile uranium, because of the insufficient energy of the neutrons to break the nuclear potential as they are absorbed, and 3% of fissile uranium. Neutrons are slowed down by elastic collisions with nuclei at rest, to respect the law of momentum conservation they transfer part of its kinetic energy to the core. The fissile element comes together with the U^{238}, and when it collides with the neutron just a little energy is transferred in the collision by the great size difference, just imagine the collision of a tennis ball with a golf ball that loses considerable speed, but if the collision is with a basketball there will be no change in its speed, therefore the U^{238} was not enough to slow the neutrons that there would continue with the chain reaction by excess energy. To solve this problem, fission is carried out with a material called a moderator. This material is used to slow down neutrons and by the fact that they have the nucleus much less massive than U^{238}, there is a considerable energy transfer in the shock, decreasing neutron energy and increasing cross section, so the fuel fissile performing chain reaction.

In order to keep the reaction under control, all nuclear reactors have control rods that absorb neutrons without fission and those are used to control the chain reaction, which does not occur in the nuclear weapons that only stop after the end of all fission material available [3, 4,5]. The Fig. 1 shows a fission reaction model.

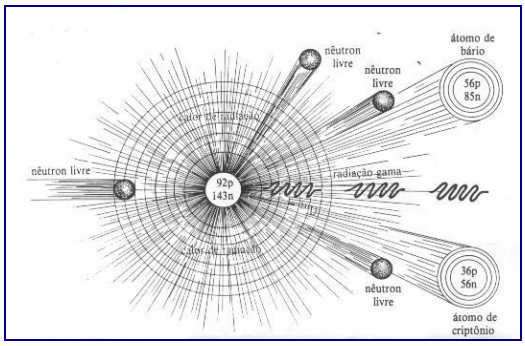

Figure 1: Modelo de Fissão Nuclear[3].

Among all types of reactors, the PWR (Pressurized-Water Reactors) is the most widely used for electric power generation. This type of reactor uses water as moderator. The core of this reactor contains water pressurized at 150 atm. After the chain reaction pressurized water is pumped into a chamber containing water pressurized at one atm, by the heat exchange water under high pressure is vaporized, the vapor is conducted through tubes to a steam turbine which produces electric energy. At the same time pressurized water generates heat required to move the turbine and the water is also cooled by controlling the reaction within the core.

After driving the turbines, the steam is condensed into a compartment through which the other pipe system of cold water and it is directed back to the steam generating chamber highly pressurized. The water that cools the steam is discharged into rivers or coasts depending on the plants location [3,4,5]. The Fig. 2 shows the operating diagram of a PWR type reactor.

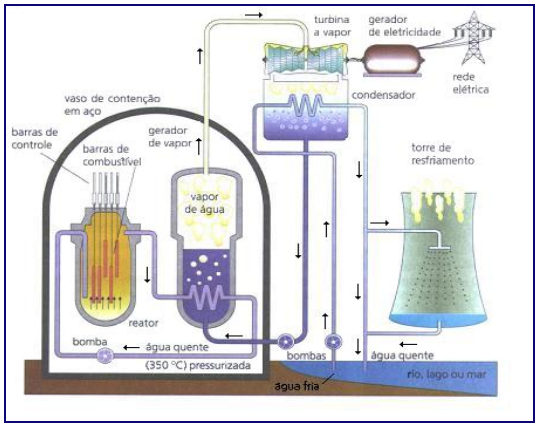

Figure 2: PWR Reactor [3].

2.2 Nuclear Energy: Advantages and Disadvantages

In this century the world is experiencing a unprecedented climate and environmental crisis, the vast majority of the population has no idea of what is happening around the world, which is more populous and requires more energy. The majority power generation today comes from the hydroelectric and thermal power plants, but both oil and water resources are increasingly precious due uncontrolled consumption. Hydroelectric plans are becoming less viable because its construction devastate large green spaces and even cities, and not only that, the vast majority of countries do not have water or even space for such engineering, since oil getting expensive and rare it is needed to get a renewable energy source.

The XXI century inherited the largest environmental impacts caused by man and now a major issue in the international sphere is as how to mitigate these impacts without damaging development. Nuclear power is the main alternative to generate energy on a large scale without releasing CO2. "The Kyoto Protocol would be impossible without nuclear power" words of the speaker Rubens Lazlo one of the INAC 2005 participant, who summarized the importance of nuclear energy for the future of the planet [6].

The nuclear energy has become one of the main options for reducing CO2, but his past mirrored in wars and disasters built a barrier to their development, the growth of nuclear power plants in the 80's dropped dramatically after the Chernobyl accident. In 2003, nuclear power accounted for 22% of the energy generated in the OECD (Organization for Economic Cooperation and Development) and only 6% in non-member countries. The main reasons that slow investments in the sector are:

- ✓ Os problemas econômicos enfrentados pelas usinas nucleares depois da liberalização dos mercados de energia elétrica em alguns países da OCDE, inclusive o problema de financiar a desativação das usinas e a disposição dos resíduos;
- ✓ Maior resistência do público contra a energia nuclear em muitos países, particularmente com relação a grandes acidentes nucleares, a disposição dos resíduos radioativos, o transporte do material nuclear e os problemas de proliferação e terrorismo;

- ✓ Maior rigor nas exigências e normas de segurança para usinas nucleares novas e existentes; e
- ✓ O preço relativamente baixo dos combustíveis fósseis e grandes avanços em tecnologias concorrentes para a produção de energia elétrica [6].

More than 80% of nuclear plants in the world are concentrated in developed countries and those countries, we believe, will dictate the future use of nuclear power plants.

As previously mentioned, the public resistance has become a major barrier to the advancement of nuclear technology, but even the international leaders experts in environmental points nuclear power as a key agent for the reduction of global warming and the solution to global energy problems while the conventional means of electricity production are the most responsible for global heating[6].

Nuclear energy has began to be used as electricity producing just 30 years ago and at first time it amounted to only 0.1% of world energy produced, nowadays, even with all the problems already faced, it corresponds to 17% of the produced electricity in the world, just for comparison, the hydroelectric plants are operating over 100 years and correspond to approximately the same 17% of nuclear energy and has no intend to increase because of the irreversible impacts to nature, such as: the devastation of large areas productive; irreversible destruction of flora and fauna, the social impact, economic and cultural dispossession of entire cities and changes in the river leads to fish migration.

The thermonuclear plants advantages are immense, with its 17% corresponding to the total energy produced in the world it avoids the emission of 2.5 billion tons of CO_2 per year into the atmosphere, a survey conducted through air contained in ice sheets and examinations in the growth rings of trees reveal that since 1750 has had a considerable contribution of CO_2 by fossil fuel use.

Despite all the clear advantages demonstrated in scientific papers about nuclear power, there are still several critical points regarding this type of energy, such as the bombing of Hiroshima and Nagasaki were two hundred thousand people, while firearms were responsible for the deaths of more than forty-five million people and only after the use of pumps is that the conflict finished.

The Chernobyl accident was a really catastrophic event, but its cause was negligence and malpractice. The employees wanted to test the cooling system of the reactor in case there was loss of alternating current. Every nuclear power plant, when it is running above 20% of its maximum load transfers its own energy produced for the internal equipment, but if the power is below this value the energy is supplied by external systems or by diesel generators. They wanted to test the reactor in case of external problems in power supply and the reactor was working below its maximum load, in which case the system would not work high supply, to see if the turbogenerator would keep the cooling system running until the diesel systems be connected, but it turned off and the emergency cooling system did not operated, which triggered a series of problems that could not be resolved manually. Chernobyl is by far the largest nuclear disaster, but it was caused by a number of factors which today have been eradicated by new generations of PWR reactors type, far safer and a solution was recently traded to Chernobyl. Ukraine's government, along with other nations collaborators built a steel dome on the structure of the plant to contain the radiation emanating from the waste that

remained there, the structure will be 190 meters tall 200 meters wide and had total cost of 1.5 billion euros over five years [1, 7].
The terrorism is a real problem, but until now, there are no reports about attacks involving nuclear weapons and after September 11 every nation has efforts against terrorism counter the action of terrorist groups.

The biggest problem of the thermonuclear plants is related to the waste left over from the reactions occurring in the reactor core, after the fission of U^{235} other radioactive elements such as cesium, strontium, iodine, krypton and plutonium are produced in the reactor core.

These wastes require extreme attention, because they are highly radioactive, some of them even radiate for thousands of years and become a problem for future generations, then the biggest problem is how to keep that junk stored for so long.

3. RESULTS AND DISCUSSIONS

The nuclear power long ceased to be a problem for humanity. With the technological and intellectual evolution, great powers understand that they cannot control the whole world, because for this the result would be the destruction of it. World leaders understood that the nuclear arsenal should decrease and the control must be monitored closely. Countries like Iran and North Korea tried unsuccessfully again to possess the threat, but eventually succumbed by international pressure, especially by the U.S.. With the action of groups of intelligence on terrorist groups the chances of terrorist groups use this arsenal is null.

The Chernobyl type accidents are the reason the new generations of reactors are safer including many buildings that contain them. With the end of the oil reserves in the world is inevitable the use of nuclear energy for sustainable progress, and there is no other type of energy source more promising than the one discussed here. To get an idea of solar energy is extremely inefficient when it comes to large-scale production because it depends on the availability of a good weather that does not happen often and storage is expensive.

Regarding radioactive waste, the United States is building a deposit, Yucca Mountain, where it will be stored all nuclear waste from commercial reactors, the capacity of this deposit is 70,000 tons of garbage radioativo [7].

The Federal Institute of Geosciences and Natural Resources of Germany released a study showing that two areas of Germany contain full capacity to contain radioactive waste indefinitely. Areas containing layers of clay at least 100 meters thick at a depth of 300 - 1000 m, this study is a result of a report that indicates local salt stone and granite which are also suitable for storage. Scientists say that the issues surrounding the safety of storing radioactive waste long term already been answered and that the biggest problem is political.

The nuclear waste does not have a solution. Much research is being done to give a solution to nuclear waste, for example, scientists in Japan are developing a subcritical reactor that with the help of a particle accelerator decreases the decay time of the waste of thousands of years to hundreds of years, the first reactor is scheduled for operation in 2015 and research is titled Project Kumatori1.

4. CONCLUSIONS

It was concluded that nuclear energy in addition to being a potentially clean power generation, it may be secured in order that the residues generated are already managed securely, and that in the near future there will have to final destinations such material, as well as deposit Yucca Mountain that the United States is building for storage of all nuclear waste from commercial reactors, with storage capacity of 70,000 tons of garbage. In addition, the Federal Institute of Geosciences and Natural Resources of Germany contains full capacity to contain radioactive waste indefinitely.

The Chernobyl accident is by far the biggest nuclear accident, which was caused by a series of negligence and malpractice, but today has been eradicated by new generations of PWR type reactors which are much safer.

In relation to terrorist groups, U.S. intelligence monitor them, seeking to ensure the security world when it comes to nuclear weapons, and when the matter are accidents, every event has brought learning to the area and made the nuclear industry today, one of the safest .

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