

A radiated affair (Eine strahlende Angelegenheit)

Have you ever heard of nuclear energy, radiation, or radioactivity? Of course, you have and if not, then this project will enlighten your mind. I will tell you who Marie Curie was and what she achieved in her life. Moreover, I will show you how nuclear energy is used today, and we are going to have a look of the nuclear accident in Chernobyl. I will also briefly look at the atomic bombs.

I will show you how you can calculate nuclear decay with the half-life-method, and I explain what the C₁₄-method is. Finally, let yourself be surprised, what I have come up with for future nuclear energy.

Short summary

I chose this project because nuclear energy interests me and I had a lot of different thoughts when I think about it.

The path from the discovery of radioactivity to the present day has been a long one and has involved several catastrophes that have claimed many lives. I find it extremely interesting how people are trying to use nuclear energy for something good, even though the danger of nuclear war is very present at all times.

The past – 100 years ago

Marie Curie and her relation to nuclear energy

Marie Curie was a Polish physicist and chemist who lived in France. She was born in 1867 and died in 1934 at the age of 66. She received two Nobel Prizes in physics and chemistry for her remarkable and world-changing discoveries, and she was the first woman to receive this honour. As part of her research, she discovered, together with her husband Pierre Curie, the chemical elements polonium and radium.

Furthermore, the term "radioactivity" was coined by Pierre and Marie Curie. However, the phenomenon of radioactivity was discovered by the French physicist Antoine Henri Becquerel. Marie Curie is an extremely important point of view in my project on nuclear energy because she coined the word "radioactive". She is also a very exciting woman, because without her many things would have remained undiscovered. Without her discoveries and research, we would certainly not be where we are now in physics, chemistry and in medicine.

The present – today

Use of nuclear energy today/atomic bombs/accident in Chernobyl.

Where does the word "nuclear" come from?

We also say nuclear energy because the word "nuclear" comes from the Latin word "nucleus" and means "nucleus". Some also say atomic energy or nuclear power station and nuclear power plant. This is also the same thing. Nuclear energy = nuclear power = atomic energy.

How is nuclear energy used today?

Nowadays we use nuclear energy almost only for the generation of electrical energy (= electricity) in nuclear power plants. Unfortunately, the use of nuclear energy is also suitable for military purposes. Today, several countries, including those where the situation is particularly tense, have nuclear weapons at their disposal. The use of these weapons of mass destruction would have consequences of such unimaginable proportions that we cannot even begin to imagine, and which could probably mean the end of humanity.

Nuclear power plants in Switzerland and how they work

We have some in Switzerland too. Five in all. Beznau-1, Beznau-2, Mühleberg, Gösgen and Leibstadt. They all contribute to energy production and run on pressurised or boiling water reactors. Pressurised water reactors have two separate water circuits. The water serves as a moderator and coolant, and the operating pressure of the water is chosen so high that it does not boil at the intended operating temperature. The boiling water reactor has only one water circuit, but it operates with steam. Here again, the water serves as moderator and coolant. The water is heated in the reactor pressure vessel by the fuel elements. The resulting steam is diverted directly to the turbines.

Nuclear weapons in World War II (atomic bombs over Japan)

So-called nuclear weapons, such as the atomic bombs in World War II, practically destroyed the cities of Hiroshima and Nagasaki. In one fell swoop, about 100,000 people were killed instantly, with another 130,000 deaths by the end of the year. And in the years that followed, many more people died. The radioactive fallout from the mushroom cloud spread over the entire city contaminated pretty much everyone who did not die. Cancer increased rapidly as a result, and it is assumed that people are still dying of cancer today because of the drops. So far, the two atomic bombs dropped by the USA on Japan were the only two nuclear weapons used in a war.

Nuclear accident in Chernobyl

On 26 April 1986, the largest nuclear disaster in the history of nuclear energy occurred in reactor unit 4 of the nuclear power plant in Chernobyl (UKR). The accident was classified in the highest level on the international rating scale for nuclear events. The alleged causes of the accident were serious deficiencies in the design of the Soviet RBMK reactor type and glaring deficiencies in the safety culture. Due to grossly negligent mistakes by the operating team, a reactor went out of control during tests on the emergency power supply and exploded. Because very slow action was taken afterwards, the surrounding population and the operating staff were exposed to very high doses of radiation. An open fire also drove large quantities of radioactive material into the air, where the wind then carried it several thousand kilometres to western and northern Europe. An unknown number of people died, and many thousands of people contracted cancer. About 135,000 people had to be resettled and the exclusion zone, which covers a radius of about 37 km and is now more than 4,000 km² in size, will be a reminder of the accident for many years to come.

Is nuclear energy safer today or more dangerous than in the past?

Nuclear energy is much safer today than it used to be. Also, because we have certainly learned from the mistakes that happened in the past. To ensure that accidents like the one in Chernobyl never happen again, the utmost safety, caution and concentration are required when working in a nuclear power plant. The decontamination of nuclear waste plays an equally important role, since the decay of radioactive elements is a process that lasts several thousand years, and conscientious work must be unconditionally guaranteed. In this respect, it is already much safer than it used to be, but on the other hand, it is already extremely dangerous when some countries already possess nuclear weapons.

Countries that possess nuclear weapons

According to statistics from the website [statista.com](https://www.statista.com), nine countries in the world are leaders in nuclear weapons. The following nine countries are:

States	Nuclear weapons
Russia	6,225
USA	5'550
China	350
France	290
Great Britain	225
Pakistan	165
India	156
Israel	90
North Korea	50

As of 2021, more than 13,000 nuclear weapons are distributed among these nine countries. The fact that Russia and the USA, by a very wide margin, have the largest nuclear arsenals is because the two superpowers went head-to-head during the Cold War. The situation was so tense at the time that humanity was almost on the brink of a third world war. So, the decades-long arms race between these two states is quite something to behold. But we'd rather see it on the statistics than anywhere else. In the last 20 years, however, other states have also rearmed mightily, even if no one comes close to the armament strength of the Russians and the Americans. Despite everything, a nuclear war would not be a win-win for either side and there would only be chaos and destruction everywhere. The realisation that there would only be losers in any case gives us an additional security here, so that we don't have to be afraid of being drawn into a nuclear conflict.

Vision of nuclear energy in 100 years

Nuclear energy today, as already mentioned, is mainly used to generate electricity. The future of nuclear energy is uncertain, yet not without possibilities. It is possible to imagine that in 100 years there could be a nuclear power plant in every major city, including Wetzikon and Uster, for example. However, this would most likely not be accepted by the population, as it would be a large project and could be seen as a blight on the landscape. One big advantage, however, is the production of electricity. A whole nuclear power plant a little outside Wetzikon could certainly supply the whole town with electricity. The disposal of nuclear waste will probably not change much. The circumstances that nuclear waste must be stored for such a long time, because otherwise it will contaminate the environment with radioactive material, will still exist in several million years. That's why I think that 100 years is too short a time to have to/be able to change anything there when our system is already functioning perfectly well today.

Half-life and C14 method

In nuclear physics, the half-life is a period in which the quantity of a certain radioactive nuclide has fallen by half, e.g., has been converted into other atoms. (In nuclear physics, nuclide refers to an atomic nucleus) The half-life indicates the period after which the number of radioactive nuclei has been halved. That is, when only 50 % of the actual nuclear activity is still measurable or present. The half-lives vary greatly between different isotopes (= types of atoms that occur in elements).

My calculation was made using the C14 method. It concerns iodine-131 released during the reactor accident in Chernobyl. Further information can be found in the calculation.

Sources

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