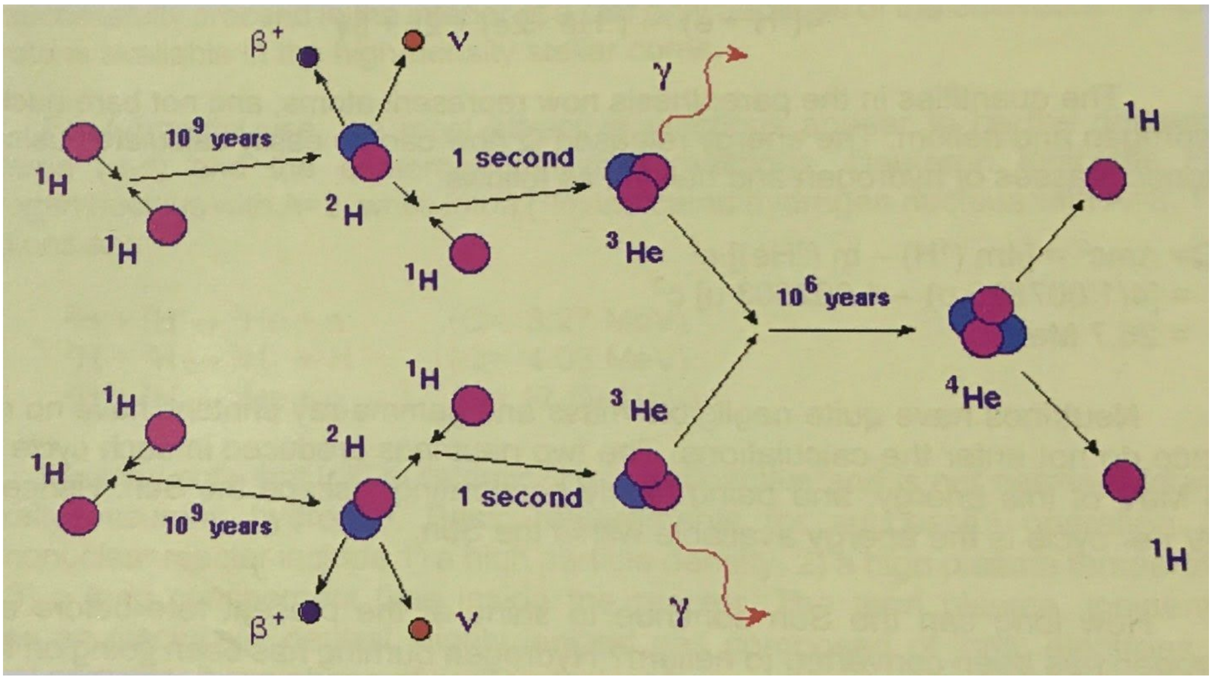
Energy crisis has been a centurion problem giving rise to utilization of various renewable and alternative energy sources other than thermal (coal) energy such as wind energy, solar energy, nuclear energy, etc. Nuclear reaction is mainly categorized into 2 major types including nuclear fission and nuclear fusion. The one with which most of us are familiar is Nuclear Fission. It is the phenomenon by which an atomic nucleus splits into two or more relatively smaller nuclei. These splitted smaller nuclei are termed as fission products. Whereas in Nuclear Fusion, the process is just the reverse. From the word "Fusion", it can be easily understood that the resultant is a combination of two or more things just like a classical flavour in Ed Sheeran's Shape of You with an influence of Carnatic music. Similarly, nuclear fusion is the phenomenon by virtue of which two lighter nuclei are combined (fused) resulting in the formation of nucleus of comparatively larger mass number along with release of energy. But the mass of the combined nucleus is less than the total mass of the lighter nuclei which were initially fused to form the resulting combined nucleus. The remaining mass is released as energy in accordance with the mass-energy relation of Einstein. Therefore, we can define Nuclear Fusion as a process in which lighter nuclei or ions (low atomic number i.e. low Z) fuse into one another at a very high temperature (106K) to form a stable heavier nucleus accompanied by release of high amounts of energy. This fusing phenomenon releases enormous energy which can be used to produce electricity.
In nuclear fusion, Deuterium ions and Tritium ions (isotopes of hydrogen) are fused releasing enormous energy capable of producing electricity. However, fusion of two positively charged particles (ions) is hindered by the mutual Coulomb repulsion, thus tending to prevent the ions from entering within the range of each other's nuclear forces and fuse. To make this phenomenon possible, it is recommended to raise the temperature of the material which will enhance the particles to gain immense energy required to overcome the Coulomb repulsion due to their thermal motions alone. Hence, the phenomenon is known as Thermonuclear Fusion.

It is by this process our own natural power reserve, "The Sun" charges itself and provides the world with rays of light. In the Sun, two protons (^1H) undergo a simultaneous fusion and beta decay to form a positron(e^+), a neutrino(v) and a deuteron ($^2H^+$ ion). Two gamma rays are released as a result of annihilation of the positron with a free electron in the Sun. The deuteron reacts with another proton resulting in a Helium nucleus ($^3He_2$ i.e. helium with three proton and one neutron) and a gamma ray. A $^4He_2$ nucleus and two protons are formed as a result of fusion of two $^3He_2$ nuclei produced in two separate events. Again, these two protons undergo a simultaneous fusion followed by beta decay and the cycle continues. This reaction cycle is termed as the proton-proton (p-p) cycle. Thus it can be concluded that hydrogen is being converted to helium through p-p cycle.

Therefore, the net reaction is: $4\ ^1H \longrightarrow\ ^4He + 2e^+ + 2v$(neu)



<u>Let's take a sneak peek into the controlled thermonuclear fusion which can be carried out inside a nuclear fusion reactor for power production.</u>

The basic requirements for successful operation of a thermonuclear reactor are:
(i) a high particle density
(ii) a high plasma temperature (plasma is the fourth state of matter, necessary to bring two positive ions together, which we'll discuss in our next edition)
(iii) a long confinement time inside the reactor.

The proton-proton (p-p) cycle is quite impossible for use in a terrestrial fusion reaction as the initial step is an extremely slow process, taking a billion years. The most acceptable terrestrial-based fusion reactions are :
(i) D-D reaction (where D is Deuterium (^2H), the second isotope of Hydrogen)
This reaction has two possibilities.
$^2H + {}^2H$ —> $^3He + n$ (two deuterium nuclei fused to form a ^3He nucleus and a free neutron)
$^2H + {}^2H$ —> $^3H + {}^1H$ (two deuterium nuclei fused to produce a Tritium and a high-energy proton).

(ii) D-T reaction (where T is tritium (^3H), the third isotope of Hydrogen)
$^2H + {}^3H$ —> $^4He + n$ (a deuterium nucleus and a tritium nucleus fuses to produce an alpha particle and a free 14.1 MeV neutron). Due to large energy release, D-T reaction is chosen to be used in controlled fusion reactors.

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