Lewis Hill’s essay on why I burped and the consequences, as well as differences between nuclear fission and fusion

I burped because I felt the need to burp. When you have the need to do something, as a human, isn't it right to do so? If we can't freely express ourselves as humans, then what are we?

I later then found out that I had the made the wrong decision. Daniel Hands of Milton Keynes was displeasured with my actions. As a consequence of this, I had to sit in the naughty step in the home channel. This was both humiliating and time consuming.

I think that right now, fission is the only way that we can get more

energy out of a nuclear reaction than we put in. First, the energy per fission

is very large. In practical units, the fission of 1 kg (2.2 lb) of uranium-235

releases 18.7 million kilowatt-hours as heat. Second, the fission process

initiated by the absorption of one neutron in uranium-235 releases about 2.5

neutrons, on the average, from the split nuclei. The neutrons released in this

manner quickly cause the fission of two more atoms, thereby releasing four or

more additional neutrons and initiating a self-sustaining series of nuclear

fissions, or a chain reaction, which results in continuous release of nuclear

energy. Naturally occurring uranium contains only 0.71 percent uranium-235; the

remainder is the non-fissile isotope uranium-238. A mass of natural uranium by

itself, no matter how large, cannot sustain a chain reaction because only the

uranium-235 is easily fissionable. The probability that a fission neutron with

an initial energy of about 1 MeV will induce fission is rather low, but can be

increased by a factor of hundreds when the neutron is slowed down through a

series of elastic collisions with light nuclei such as hydrogen, deuterium, or

carbon. This fact is the basis for the design of practical energy-producing

fission reactors.

In December 1942 at the University of Chicago, the Italian physicist

Enrico Fermi succeeded in producing the first nuclear chain reaction. This was

done with an arrangement of natural uranium lumps distributed within a large

stack of pure graphite, a form of carbon. In Fermi's "pile," or nuclear reactor,

the graphite moderator served to slow the neutrons.

Nuclear fusion was first achieved on earth in the early 1930s by

bombarding a target containing deuterium, the mass-2 isotope of hydrogen, with

high-energy deuterons in a cyclotron. To accelerate the deuteron beam a great

deal of energy is required, most of which appeared as heat in the target. As a

result, no net useful energy was produced. In the 1950s the first large-scale

but uncontrolled release of fusion energy was demonstrated in the tests of

thermonuclear weapons by the United States, the USSR, Great Britain, and France.

This was such a brief and uncontrolled release that it could not be used for the

production of electric power.

In the fission reactions I discussed earlier, the neutron, which has no

electric charge, can easily approach and react with a fissionable nucleus ,for

example, uranium-235. In the typical fusion reaction, however, the reacting

nuclei both have a positive electric charge, and the natural repulsion between

them, called Coulomb repulsion, must be overcome before they can join. This

occurs when the temperature of the reacting gas is sufficiently high, 50 to 100

million ° C (90 to 180 million ° F). In a gas of the heavy hydrogen isotopes

deuterium and tritium at such temperature, the fusion reaction occurs, releasing

about 17.6 MeV per fusion event. The energy appears first as kinetic energy of

the helium-4 nucleus and the neutron, but is soon transformed into heat in the

gas and surrounding materials.

If the density of the gas is sufficient—and at these temperatures the

density need be only 10-5 atm, or almost a vacuum—the energetic helium-4 nucleus

can transfer its energy to the surrounding hydrogen gas, thereby maintaining the

high temperature and allowing subsequent fusion reactions, or a fusion chain

reaction, to take place. Under these conditions, "nuclear ignition" is said to

have occurred. The basic problems in attaining useful nuclear fusion conditions

are to heat the gas to these very high temperatures, and to confine a

sufficient quantity of the reacting nuclei for a long enough time to permit the

release of more energy than is needed to heat and confine the gas. A subsequent

major problem is the capture of this energy and its conversion to electricity.

At temperatures of even 100,000° C (180,000° F), all the hydrogen atoms

are fully ionized. The gas consists of an electrically neutral assemblage of

positively charged nuclei and negatively charged free electrons. This state of

matter is called a plasma. A plasma hot enough for fusion cannot be contained by

ordinary materials. The plasma would cool very rapidly, and the vessel walls

would be destroyed by the temperatures present. However, since the plasma

consists of charged nuclei and electrons, which move in tight spirals around

strong magnetic field lines, the plasma can be contained in a properly shaped

magnetic field region without reacting with material walls.

In any useful fusion device, the energy output must exceed the energy

required to confine and heat the plasma. This condition can be met when the

product of confinement time t and plasma density n exceeds about 1014. The

relationship t n ³ 1014 is called the Lawson criterion. Numerous schemes for the

magnetic confinement of plasma have been tried since 1950 in the United States,

the former USSR, Great Britain, Japan, and elsewhere. Thermonuclear reactions

have been observed, but the Lawson number rarely exceeded 1012. One device,

however, the tokamak, originally suggested in the USSR by Igor Tamm and Andrey

Sakharov, began to give encouraging results in the early 1960s. The confinement

chamber of a tokamak has the shape of a "torus", with a minor diameter of about

1 m (about 3.3 ft) and a major diameter of about 3 m (about 9.8 ft). A toroidal

magnetic field of about 50,000 gauss is established inside this chamber by large

electromagnets. A longitudinal current of several million amperes is induced in

the plasma by the transformer coils that link the torus. The resulting magnetic

field lines, spirals in the torus, stably confine the plasma.

Based on the successful operation of small tokamaks at several

laboratories, two large devices were built in the early 1980s, one at Princeton

University in the United States and one in the USSR. In the tokamak, high plasma

temperature naturally results from resistive heating by the very large toroidal

current, and additional heating by neutral beam injection in the new large

machines should result in ignition conditions.

Another possible route to fusion energy is that of inertial confinement.

In this concept, the fuel, tritium or deuterium ,is contained within a tiny

pellet that is then bombarded on several sides by a pulsed laser beam. This

causes an implosion of the pellet, setting off a thermonuclear reaction that

ignites the fuel. Several laboratories in the United States and elsewhere are

currently pursuing this possibility. Progress in fusion research has been

promising, but the development of practical systems for creating a stable fusion

reaction that produces more power than it consumes will probably take decades to

realize. The research is expensive, as well.

However, some progress has been made in the early 1990s. In 1991, for

the first time ever, a significant amount of energy, about 1.7 million watts,

was produced from controlled nuclear fusion at the Joint European Torus (JET)

Laboratory in England. In December 1993, researchers at Princeton University

used the Tokamak Fusion Test Reactor to produce a controlled fusion reaction

that output 5.6 million watts of power. However, both the JET and the Tokamak

Fusion Test Reactor consumed more energy than they produced during their

operation. If fusion energy does become practical, it offers the many advantages

including a limitless source of fuel, deuterium from the ocean, no possibility

of a reactor accident, as the amount of fuel in the system is very small, and

waste products much less radioactive and simpler to handle than those from

fission systems.

I conclude, that even though fusion is much better, cleaner, and safer,

than fission, we do not have the knowledge of how to create and contain the

energy released in a fusion reaction. So, until we do, fission is the only way

we can use the atom to create power.