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The Nuclear Waste Issue – Technical Facts and Philosophical Aspects

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Abstract

A description of conventional or thermonuclear nuclear fusion, the currently popular He-3 fusion, and cold fusion, also called low energy nuclear reactions - LENR or chemically-assisted nuclear reactions - CANR is followed by a description of spontaneous and induced nuclear fission that may be used for constructive (nuclear reactors) or destructive (nuclear weapons) purposes.

A short summary of the nuclear waste problem, management efforts, and international response is presented. The philosophical aspects are examined.

Keywords*: fission, fusion, He-3, nuclear wastes, nuclear weapons, plutonium, philosophical issues, reactors, storage, transmutation, uranium, waste management*

Introduction

Matter in the whole universe is made up of over 100 kinds of elements, the simplest forms of which are the atoms - the smallest particles that cannot be split up under normal conditions. The atom itself is made of subatomic particles that are smaller than the atom: protons (positively charged), electrons (negatively charged), and neutrons (zero charge). The protons and neutrons are packed tightly in the center of the atom. This forms a dense center called the nucleus. Electrons are outside in designated paths.

Atoms of some elements have nuclei with excess protons (neutron/proton n/p ratio is low – lower than the stability ratio) and some have nuclei with excess neutrons (n/p ratio is high – higher than the stability ratio). These nuclei are unstable. These radioactive nuclei stabilize by decaying or disintegrating into more stable nuclei with emission or transformation of the excess protons or neutrons, resulting in nuclear radiation consisting of alpha α and beta β particles, and gamma γ radiation. This radioactive decay is one of three nuclear processes. The highly penetrating radiations can destroy living tissues and cells; and can cause radiation sickness, cell damage, and mutations or DNA changes. However the long-term effects are not clearly understood yet.

In addition to radioactivity, described above, there are two other nuclear processes: *fission*-splitting nuclei into smaller fragments; and *fusion* - combining small nuclei into bigger ones **(**jet.efda 2006). The fission and fusion processes are major sources of nuclear energy - for both constructive (nuclear reactors) and destructive (nuclear bombs, nuclear warheads) purposes. The practical aspects are well developed for fission process.

A summary of these two nuclear energy processes is followed by a description of nuclear wastes and their management together with associated philosophical issues.

The Technical Facts

Background facts that are necessary for understanding the nuclear waste issue are presented in this section.

The Fusion Process

Nuclear fusion is the process powering the sun and stars. Fig. 1 shows a diagrammatic representation of nuclear fusion (Atomicarchive 2005). There is an intense interest in fusion processes as they promise high energy yields with an abundant fuel source (hydrogen), producing only small amounts of radioactive waste – a relatively