INTRODUCTION

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1.1. Sources of Radioactive Liquid Wastes:

There are two main sources of radioactive liquid wastes. The first, where wastes are generated due to activities related to nuclear fuel cycle steps such as mining milling, uranium conversation, fuel fabrication, nuclear power plants and fuel reprocessing. The second source of liquid wastes is the non fuel cycle, where they are generated from hospitals, and research institutes **(International Atomic Energy Agency 1964)**.

1.1.1. Fuel Cycle Wastes:

The nuclear fuel cycle produces ten thousand m^3/y of Intermediate Liquid Waste (ILW) and Low Liquid Waste (LLW) **(International Atomic Energy Agency 1978)**. Materials and equipment (from nuclear operations) which are contaminated and for which there is no an expected further use are called radioactive wastes. The fuel cycle is divided into two parts each one include number of steps.

The first part is called the Front End of the Nuclear Fuel Cycle which includes:

- Uranium extrapolation, mining, milling and refining
- Uranium enrichment
- Fuel element fabrication

The second part is called the Back End of the Nuclear Fuel Cycle which includes:

- Reprocessing

1.1.1.1. Mining and milling:

The uranium content in the ore is often between only 0.1% and

0.2% therefore, large amounts of ore have to be mined to get at the uranium Wastes water arising from these operations(mining and milling) vary with the type of mine or extraction operation. These liquids arising contain very small amounts of natural α-activity from the uranium ore.

Residual wastes from the milling operation contain the remaining radioactive materials from the ore, such as radium.

1.1.1.2. Uranium enrichment:

Uranium conversation from U_3O_8 to UF_6 for enrichment generates liquid wastes containing 0.03 % of the material processed including uranium, (U^{235} and U^{238} radium, Ra^{226} and thorium, Th^{230} and their daughter products. Turning uranium oxide concentrate into a useable fuel has no effect on levels of radioactivity and does not produce significant wastes. Enrichment plant produces small amounts of liquid waste (from equipment clean-up) as well as slightly radioactive sludge's **(Ginnis 1979)**.

1.1.1.3. Fuel fabrication:

When uranium is used in the reactors that significant quantities of highly radioactive wastes are generated. Fuel fabrication plants also generate some waste oils and solvents. These wastes contain natural α-emitters and large amounts of nitrates, fluorides.....etc and usually discharged to a disposal pond **(Alexander and Blomeke 1979)**.

1.1.1.4. Fuel reprocessing:

Fuel reprocessing plants can be assumed to be the main source of radioactive wastes . More than 99% of the total radioactivity generated

nuclear technology appears in wastes from reprocessing plants, most of it is the high level waste (HLW). A 1400 MT/y reprocessing plant produces about 1500 m^3/y liquid concentrate with activity less than $2x10^3$ Ci/m^3, 3000 m^3/y radiated water with activity less than 200 Ci/m^3, 800 m^3/y non combustible and ash solid waste with activity less than one Ci/m^3 and about 2 m^3/y krypton gas with activity less than $8x10^6$ Ci/m^3 **(International Atomic Energy Agency 1980)**.

1.1.2. Non-fuel Cycle Wastes:

Non-fuel cycle waste arises from industrial applications, institutional researches, medical treatments,..... etc. For one year, quantities of low level liquid waste (LLLW) and intermediate level liquid waste (ILLW) raised were about $3.25x10^3$ m^3 **(Philips 1979)**.

1.1.2.1. Research and development wastes:

Large volume radioactive waste streams come from research and development activities connected to nuclear energy programs and from the use of radioisotopes in research and industry. Such wastes originate from large numbers of installations. The wastes resulting from the use of radioisotopes in industry are generally large in volume, nearly neutral, and have low solid contents. Their activity level is about 400 times greater than permitted for discharge. Liquid wastes may include process solution, chemical solution used for regeneration ion exchange resins, decontamination solutions, contaminated oils and ..... etc .

1.1.2.2. Radioisotope production wastes:

More than 200 different radioisotopes were being produced for