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Unearthing of Radioisotopes

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Abstract

Isotopes were discovered by Frederick Soddy which are the different forms of the same elements that differs in their number of neutrons and also possess radioactive properties. These isotopes are relatively stable and could be used for numerous purposes.

Keywords: Neutrons; Radioactive; Atomic number; Atomic mass

Introduction

Discovery of isotopes began when evidences were gathered to reveal that some element possess radioactive properties. In 1910, it was observed that certain elements transformed from their unstable state to a highly stable state following the emission of radiations that were found to be radioactive. Salts of thorium and uranium were identified as radioactive. Ionium was produced by uranium ores while mesothorium was yielded by thorium ores which gave these elements their recognized names. Since ionium when mixed with thorium could not be restored by chemicals routes. Likewise, mesothorium was found to be chemically similar to radium. So, it was concluded that ionium and mesothorium were different forms of their corresponding existing elements. Such elements were termed as "Isotopes" by Frederick Soddy who won a Nobel Prize in 1921 for his tremendous work [1]. Isotope is defined as the form of the same elements with different number of neutrons. It means they differs in their atomic masses but have similar atomic number therefore occupy the same position in the periodic table. He also revealed uranium and thorium decay into different isotopes of lead. Since lead was discovered from uranium and thorium rich ores with different atomic masses of 206.08 and 207.69 respectively [2-4]. There are numerous stable isotopes of different element with varying relative abundance given below in Table 1 [5-9].

Isotope	Rel. Abundance	Half-life (years)
Holmium-166 m	-	1,200
Berkelium-247	-	1,380
Radium-226	Trace	1,600
Molybdenum-93	-	4,000
Holmium-153	-	4,570
Curium-246	-	4,730
Carbon-14	Trace	5,730
Plutonium-240	-	6,563
Thorium-229	-	7,340
Americium-243	-	7,370
Curium-245	-	8,500
Curium-250	-	9,000
Tin-126	-	10,000
Iodine-129	-	15,700
Niobium-94	-	20,300

Plutonium-239	-	24,110
Proactinium-231	Trace	32,760
Lead-202	-	52,500
Lanthanium-137	-	60,000
Thorium-230	-	75,380
Nickel-59	-	76,000
Thorium-230	Trace	77,000
Calcium-41	-	103,000
Neptunium-236	-	154,000
Uranium-233	-	159,200
Rhenium-186 m	-	200,000
Technetium-99	-	211,000
Krypton-81	-	229,000
Uranium-234	Trace	245,500
Chlorine-36	-	301,000
Curium-248	-	340,000
Bismuth-208	-	368,000
Plutonium-242	-	373,300
Aluminum-26	-	717,000
Selenium-79	-	1,130,000
Iron-60	-	1,500,000
Beryllium-10	-	1,510,000
Zircon-93	-	1,530,000
Curium-247	-	1,560,000
Gadolinium-150	-	1,790,000
Neptunium-237	-	2,144,000
Cesium-135	-	2,300,000
Technetium-96	-	2,600,000
Dysprosium-154	-	3,000,000
Bismuth-310m	-	3,040,000
Mietnerium-53	-	3,740,000
Technetium-98	-	4,200,000
Lead-205	-	15,300,000
Hafnium-182	-	9,000,000
Palladium-107	-	6,500,000
Curium-247	Abundant	15,600,000

Uranium-236	-	23,420,000
Niobium-92	-	34,700,000
Plutonium-244	-	80,800,000
Samarium-146	-	103,000,000
Uranium-236	-	234,200,000
Uranium-235	Rare	703,800,000
Potassium-40	Rare	1,280,000,000
Uranium-238	Abundant	4,468,000,000
Rubidium-87	Abundant	4,750,000,000
Thorium-232	Abundant	14,100,000,000
Lutetium-176	Rare	37,800,000,000
Rhenium-187	Abundant	43,500,000,000
Lanthanium-138	Rare	105,000,000,000
Samarium-147	Abundant	106,000,000,000
Platinum-190	Rare	650,000,000,000
Tellurium-123	Rare	$>1 \times 10^{13}$
Osmium-184	Rare	$>5.6 \times 10^{13}$
Gadolinium-152	Rare	1.08×10^{14}
Tantalum-180 m	Rare	$>1.2 \times 10^{15}$
Xenon-124	Rare	$>1.6 \times 10^{14}$
Indium-115	Abundant	4.41×10^{14}
Zinc-70	Rare	$>5 \times 10^{14}$
Hafnium-174	Rare	2.0×10^{15}
Osmium-186	Abundant	2.0×10^{15}
Samarium-149	Abundant	$>2 \times 10^{15}$
Neodymium-144	Abundant	2.29×10^{15}
Samarium-148	Abundant	7×10^{15}
Cadmium-113	Abundant	7.7×10^{15}
Cerium-142	Abundant	$>5 \times 10^{16}$
Tungsten-183	Abundant	$>1.1 \times 10^{17}$
Vanadium-50	Rare	1.4×10^{17}
Lead-204	Abundant	1.4×10^{17}
Chromium-50	Abundant	$>1.8 \times 10^{17}$
Tungsten-184	Abundant	$>3 \times 10^{17}$
Calcium-48	Abundant	$>6.3 \times 10^{18}$
Molybdenum-100	Abundant	1.0×10^{19}

Neodynium-150	Abundant	>1.1 × 10^{19}
Zircon-96	Abundant	>3.8 × 10^{19}
Selenium-82	Abundant	1.1 × 10^{20}
Tellurium-130	Abundant	7.9 × 10^{20}
Xenon-136	Abundant	>2.4 × 10^{21}
Tellurium-128	Abundant	2.2 × 10^{24}

Table 1: List of Isotopes.

These stable isotopes of different elements have a wide range of applications in different research areas some of their applications are stated below in Table 2 [10-20].

Isotopes	**Uses**
Thorium-230	Coloring and fluorescent agent in glassware and colored glazes
Californium-252	Explosives detection, monitor soil moisture content and the moisture of materials stored in soils
Krypton-85	Monitors thickness of thin plastics, metal sheet, rubber, textiles and paper. Pollutant indicator. Used in indicator lights in different electronic appliances.
Carbon-14	Biological tracer for pharmacological studies.
Cesium-137	Chemotherapy of cancers and tumors, measurement of correct radio medicine, monitoring and controlling fluid flow in pipelines etc.
Americum-241	smoke detectors, measure levels of toxic lead in dried paint samples
Tritium (H3)	Geological mining, hydrology, used in luminous paint
Iron-55	Electroplating solutions analysis, detection of sulphur in air, metabolic pathway studies.
Cobalt-60	Surgical instruments sterilization, cancer treatment, food irradiation and radiography.
Thoriated Tungsten	Used in welding, aircraft, petrochemical and food processing equipment industries.
Uranium-235	Nuclear fuel for power plants and naval nuclear propulsion
Cadmium-109	Analyzing metal alloys, scrap sorting
Sodium-24	Detection of oil leakages in industrial pipelines
Plutonium-238	Has powered more than 20 NASA spacecrafts since 1972
Nickel-63	Explosives detection, voltage regulators, current flow protectors in electronic devices.
Thallium-204	Detect and quantifies pollutant levels and measures the thickness of plastics, sheet metal, rubber, textiles, and paper.
Promethium-147	Used in electric blanket thermostats
Sulphur-35	Used in survey meters in case of emergencies
Curium-244	Geological mining to analyze material unearthed from pits and slurries from drilling operations
Polonium-210	Reduction of static charge in production of photographic film
Sulphur-35	Used in survey, cigarette manufacturing sensors and medical therapies.
Iridium-192	Used to test the integrity of pipeline welds, boilers and aircraft parts and in brachy therapy/tumor irradiation.
Radium-226	Makes lighting rods more effective.

Thorium-230	Used as coloring and fluorescence agents

Table 2: Applications of Isotopes.

Suppliers of radioisotopes

The main world isotope suppliers are as follows:

ANSTO in Australia,

BR-2 at Mol in Belgium,

Dimitrovgrad in Russia,

ETRR-2 in Egypt,

FRJ-2/ FRM-2 at Julich in Germany,

HFETR at Chengdu in China,

HFR at Petten in Netherlands,

IRE in Europe,

Isotope-NIIAR in Russia,

LWR-15 at Rez in Czech Republic,

Mallinckrodt Pharmaceuticals in Ireland,

Maria in Poland,

MDS Nordion in Canada,

NRU at Chalk River in Canada,

NTP in South Africa,

OPAL in Australia

Osiris & Orphee at Saclay in France,

Safari in South Africa [21-24].

Conclusion

So, it was concluded that discovery of different isotopes of different elements could offer numerous biological and chemical applications used for the welfare of mankind.

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