Study Of Thorium As A Nuclear Fuel.

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Abstract: Conventional fuel sources for power generation are to be replacing by nuclear power sources like nuclear fuel Uranium. But Uranium-235 is the only fissile fuel which is in 0.72 % found in nature as an isotope of Uranium-238. U-238 is abundant in nature which is not fissile, while U-239 by alpha – decay naturally converted to Uranium- 235. For accompanying this nuclear fuel, there is another nuclear fuel Thorium is present in nature is abundant can be used as nuclear fuel and is as much as safe and portable like U-235.

Index Terms: Fissile fuel, Neutron generator, Nuclear power plant.

I. INTRODUCTION

Presence of Thorium -232 is abundance in nature like Uranium- 238, but Th-232 is not fissile and has to undergo some phases to convert in to fissile fuel of U-233 and U-235. Thorium-232 in its pure form is not fissile, rather than it is transmuted by neutron absorption and continues process can make it fissile too. The existing technique in nuclear source is use of Uranium-235 as a fissile fuel, but Th-232 can also be used as a fissile fuel in nuclear power plants as from Th-232 we can get a fissile U-233 and U-235. Ultimately from Th-232 we can get products U-233 and U-235. There as certainly a very minor change of technique in the use of Thorium as that of U-235 and conversion of Thorium to U-235 and conversion of Thorium to U-233 and U-235 is happened in nuclear reactor itself and we can use direct Thorium fuel in the nuclear reactor. Ultimately our aim is to get fission in the Thorium reaction or Thorium can fissile. How it is achieved with thorium in nuclear reactor we are checking out now. In transmutation of thorium it is converted to Thorium-233, isotope of Th-232 by neutron bombardment. The reaction is as follows,

$$^{232}_{90}\mathrm{Th} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{233}_{90}\mathrm{Th}$$

But the half life of Th-233 isotope is 21.83 minutes. Th-233 undergoes beta decay in 21.83 minutes and Th-233 is converted to isotope of protactinium.

$$^{233}_{90}\mathrm{Th} \xrightarrow[21.83\ \text{minute}]{\text{beta decay}} {}^{233}_{91}\mathrm{Pa}$$

^{233}

The isotope of Pa is a radioactive material but is not fissile

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^{233}

Pa is not also a stable

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^{233}

Isotope and has a half life of 26.967 days with a b-decay. Pa beta

^{91}

^{233}

decay convert in to U isotope of Uranium which is fissile 92 fuel. Hence first fissile material we get. But within this period,

^{233}

U usually fission on neutron absorption but sometimes retains a

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^{234}

neutron and becomes U.

^{92}

^{233}

But within 26.967 days period Pa absorb the neutron again, then

^{91}

it convert in the another,

^{234}

^{234} ^{234}

Convert isotope of Pa to isotope of U.

^{91} ^{91}

$$^{234}_{91}\mathrm{Pa} \xrightarrow[6.69\ \text{hours}]{\beta^- \text{ decay}} {}^{234}_{92}\mathrm{U}$$

^{234}

But U is not a fissile and absorbs slow neutrons in the system and

^{92}

^{235}

isotope of Protactinium Pa. The reaction is as follows, *becomes U which is fissile fuel.*

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^{92}

$$^{233}_{91}\mathrm{Pa} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{234}_{91}\mathrm{Pa}$$

$$^{234}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{235}_{92}\mathrm{U}$$

234 234 235
But the isotope Pa is unstable and has a half life of 6.69 hours U absorbs slow in the system, becomes U as it is
91
92 *92*

with a beta decay. Beta decay, found that neutron capture ratio is

238

More 100 barns than U of just 2.7 barns.
92

Consider, if Proton generator is used in the nuclear reactor instead of nuclear generator then proton is

232 233
Bombarded with Th in transmutation it becomes, Pa,
92
91

232 233
Th + 1p --------- Pa
90 91

233
But half life of Pa is very short of 22 minutes and undergoes
91
233
beta decay and convert in to fissile Fuel of U.
92
isotope of protactinium

233 beta decay 233
Pa ---------- U
91 22 min 92
232 233
Th + 1p --------- Pa
90 91

233
But half life of Pa is very short of 22 minutes and undergoes
91
233
beta decay and convert in to fissile Fuel of U.
92

233 beta decay 233
Pa ---------- U
91 22 min 92

II. Conclusion

Here when thorium decay occurs the products we get is
235 233
1) U 2) U both are fissile in
92 92
Nature. And when fission occurs fission products krypton, barium in case of u-235 and bismuth, fluorine and neon in case of U-233 obtained. Hence from the above study we can see that nuclear fuel U-233 and U-235 can be used for nuclear power plants obtained as a product from Th-232 which is readily available and abundant in nature too.