Monazite ore is composed of several minerals including several rare earth elements (REEs) and thorium phosphates. The thorium content of monazite ores varies up to 20% with North American monazite ores containing about 5% thorium.

Past research has looked at the extraction of REE from monazite ore but discarded the thorium phosphate compound as waste. Since thorium could be a possible fuel for state-of-the-art future nuclear reactors, this research focuses on a way to recover thorium from the monazite ore.

Both processes are scaled for a 1000 kg/hr flow of North American monazite ore. The process will start by acid leaching the ore with sulfuric acid. The products of this step will be dissolved in water and filtered so that thorium will be separated. After this filtration, monazite ore. The process will start by acid leaching the ore with sulfuric acid. The products of this step will be dissolved in water and filtered so that thorium will be separated. After this filtration,

Conceptual Processes
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Equipment Cost for Process A & Process B
Both processes achieve the same level of recovery of thorium and rare earth elements.

Concluding that we are extracting radioactive materials from this system, we must consider the protection of the workers and surrounding community from these dangerous materials. Our main concern lies with the thorium and uranium compounds. For both compounds, proper shielding must be present to limit exposure to any workers. Adequate protection will likely include protective walls, specialized clothing and masks, and ventilation-controlled work areas. Additional protection from thorium dust will include air filters and proper ventilation of the storage locations. This aims to reduce the hazardous exposure to the workers and the surrounding community and environment. Since thorium constantly undergoes alpha decay into appreciably more harmful elements, radon, an off-gas system will be needed for the whole process. This system will operate under partial vacuum and will cause the daughter products of thorium to be trapped onto carbon beds until radon is decayed. The whole process including the monazite storage area will need this off-gas system in order to be under the OSHA requirements for maximum exposure to radon gas.

Total profit was calculated by taking revenue from products and byproducts and subtracting raw material costs, equipment costs and operating costs.

\[
P_{\text{Total}} = P_{\text{Products}} - C_{\text{Raw Material}} - C_{\text{Equipment}} - C_{\text{Operating}}
\]

Even though Process A had a lower equipment cost, the operating cost was significantly higher than Process B. The cost to heat and cool the process several times due to temperature extremes causes large operating costs. Since Process B had a cheaper operating cost and had profit from phosphorus being sold as a product, it was the more economically feasible option.