Extraction of Uranium from Seawater: Design and Testing of a Symbiotic System

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ABSTRACT:

This proposal addresses the design of machines for seawater uranium mining. Seawater is estimated to contain 4.5 billion tons of uranium, about 1000 times that accessible by traditional mining techniques. Finding a sustainable way to harvest uranium from seawater will provide a source of uranium for generations to come. Furthermore, it gives all countries with ocean access a stable supply and eliminates the need to store spent fuel for potential future reprocessing. Although extraction of uranium from seawater has been researched for decades, efforts have not yielded an economical, robust, ocean-deployable method of uranium collection. Much previous work has focused on deploying adsorbent polymers in seawater, regularly collecting the adsorbent, bringing the adsorbent to shore, stripping the uranium from the polymer by elution, and finally returning the adsorbent to sea; however these stand-alone intermittent operation systems have significant practical and economic deployment challenges. Preliminary work by Prof. Slocum's team indicates that the uranium collected from the adsorbent can be increased by increasing the frequency of harvesting.

This project seeks to develop design rules for a uranium harvesting system that would be integrated into an offshore wind power tower. The concept is comprised of a platform at the base of the tower that supports a belt of adsorbent that loops in and out of the water. The belt slowly cycles through the seawater beneath the tower and through an elution plant located on the platform. The belt is weighted in the seawater by rollers which also space the loops out and prevent the belt from tangling. The design rules for this device will be refined into a set of design tools that would allow others to design systems based on the adsorbent properties and scale of their intended installation. The design analysis will also include failure mode and effect analysis to address not just the uranium extracting capability but also the robustness of the device. Thus the end result is not a single design for a particular adsorbent chemistry or location, but rather a flexible tool to allow this technology to be spread broadly.

To achieve this goal, two prototype stages will be fabricated. A $1/50^{th}$ size scale prototype will be bench-tested to verify initial analysis and theory. A second $1/10^{th}$ size scale prototype will be deployed in the ocean for more comprehensive testing and validation.