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Molten Salt Reactors: The Next Bet for Nuclear Energy

As the demand for renewable alternatives to fossil fuel energy generation methods increases, more heads are turned towards nuclear energy. More specifically, the concept of technologically advanced Generation IV Reactors have taken the stage, in an effort to show the world the true potential of nuclear power, and ultimately erase the well-known underlying assertion of its danger. We as a society have come to the realization that there is a growing need to ditch traditional energy generation methods due to their environmentally detrimental carbon emissions, but the question then becomes: what will we replace fossil fuel energy with? There are so many possible answers, such as a mix of solar and wind power, or geothermal energy. However, as found from prior endeavors, none of these methods come close to nuclear energy in terms of efficiency, with Generation III reactors already being on par with fossil fuel energy, and still having ample room for improvement. It is without a doubt that if we are to take the issue of global warming seriously, nuclear energy must be strongly considered as the next primary energy generation method.

With that in mind, the Generation IV reactor designs are primarily focused on increasing energy efficiency. One of the designs, being the Molten Salt Reactor (MSR), is particularly promising for commercial use on a large scale due to its unique composition that renders it to an almost meltdown-proof state. Following the horrific events in both Chernobyl and Fukushima, widespread skepticism towards nuclear energy came into play, despite the extremely uncommon conditions in each scenario. Nevertheless, this promoted Generation III reactor designs to encapsulate methods that severely weaken a meltdown in the event that it were to happen, even

under such extreme conditions as those witnessed in Chernobyl on April 26, 1986. The MSR design aims to build upon this by essentially making a “meltdown proof” reactor design. But how exactly does it work?

The MSR consists of a molten salt mixture that acts as both the reactor coolant and the fuel source. Unlike traditional breeder reactors that use a uranium fuel cycle wherein ^{238}U absorbs neutrons to generate ^{239}Pu, the MSR design operates at extremely high temperatures of around 700℃ via a thorium fuel cycle using ^{232}Th that absorbs neutrons to create fissile ^{233}U. Unlike most traditional reactor designs that feature solid fuel, the liquified molten salt fuel in MSR’s allows the fuel inserted to also act as the coolant by way of transporting generated heat to the power plant. In addition, this enables the fuel to be processed during operation, meaning that when atoms split into smaller isotopes, they can be collected from the core very quickly, preventing those atoms from absorbing neutrons that would otherwise continue the chain reaction. As if that weren’t already impressive, some MSR designs, such as the chloride salt fast MSR, can act as nuclear waste burners, which in turn greatly increase the energy efficiency of this design, especially in comparison to the traditional Pressurized Water Reactor (PWR) design currently used all around the world today. In light of its composition, the MSR is much safer than conventional reactors. Due to its liquid fuel source, the fuel mixture is designed to drain from the core where it will solidify in event of an emergency, preventing a nuclear meltdown that could otherwise result in hydrogen explosions.

All things considered, were the United States to shift to renewable energy in the near future, nuclear energy is definitely the best bet, with the MSR design, due to its expansive range of innovative qualities, providing promising characteristics that place it among the most ideal of the known nuclear reactor designs. If the U.S. economy, currently backed heavily by oil trade, were

to completely switch to renewable energy, it would take a ground-breaking design like the MSR to do so, as it proposes an enormous amount of energy generation, while also ensuring that leftover nuclear waste is not simply squandered. Such a design would provide independence in the energy market, as the United States would not have to rely on oil being traded from areas like the Middle East that comes with prices that fluctuate with conflict, as we have seen with the ongoing Russo-Ukrainian War. Indeed, the MSR may still be a mere concept right now, but given the circumstances, it may one day change the world as we know it.