Thesis Project Portfolio

Lithium Extraction and Purification from Geothermal Brine

(Technical Report)

The Metaverse as a Technological Fix: An Analysis on the Quality of College Education

(STS Research Paper)

An Undergraduate Thesis

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EXECUTIVE SUMMARY

Within the next five years, the metaverse will revolutionize the traditional way of life and become effectively ubiquitous. As companies compete to increase profitability by lowering operating costs, tech giants like Meta and Microsoft are taking the lead in the creation and utilization of a completely virtual 3-D world. The pace of both technological development and implementation, however, far exceeds the rate at which scholars are analyzing the societal impacts of the metaverse. The Science, Technology, and Society (STS) research paper contained in this portfolio dissects the use of the metaverse, as represented through platforms like Zoom and Second Life, as a technological fix that aims to improve the quality of college education. The analysis is supplemented by highlighting the deepened bifurcation between social classes resulting from increased reliance on the previously mentioned platforms, as the metaverse symbolizes a political tool. Meanwhile, the technical report of this portfolio discusses the design of a plant that produces lithium hydroxide monohydrate ($LiOH \cdot H_2O$) from geothermal brines in Salton Sea, California. While the STS and technical cover seemingly different topic areas, they share the idea of introducing technologies that accelerate the formation of a new sector or industry: virtual college education or the electric vehicle market, respectively.

Technical Report

As a result of the recent rise in electrification of vehicles to combat proliferating CO_2 emissions, domestic demand for lithium, a key component in electric vehicle batteries, far exceeds current domestic supply. The technical report, therefore, explores the extraction and purification of lithium, ultimately outlining key design considerations for building a plant that produces battery-grade lithium hydroxide monohydrate ($LiOH \cdot H_2O$) from geothermal brines in Salton Sea. Within the process, there are four main process blocks: mixing,

adsorption/desorption, electrolysis, and crystallization. The mixing step involves combining citrate to the incoming brine to make adsorption favorable based on the resulting decrease in standard reduction potential. Next, the iron (III) phosphate sorbent in the packed bed reactor selectively adsorbs lithium over other monovalent cations like sodium to extract lithium and form a lithium-pregnant stripping solution (PSS). The resulting solution is directed into an electrolyzer unit where lithium ions (Li^+) transport across the proton exchange membrane (PEM) and combine with hydroxide ions (OH^-), forming lithium hydroxide (LiOH). After electrolysis, $LiOH \cdot H_2O$ is formed through evaporative crystallization. Starting from an inlet brine feed, rich in lithium, sodium, and other valuable elements, of 6,000 gallons per minute, the final product stream of $LiOH \cdot H_2O$ is 2,282 kg/hour which represents 99% recovery.

STS Research Paper

Computer engineers are seeking the development of new technologies that transgress the physical world through the creation of a ubiquitous virtual environment: the metaverse. With rising interest in digitalization, tech giants envision a world that is entirely virtual with its net benefit, or detriment, relatively unknown. Motivation for studying the metaverse stems from an internship experience with a company whose mission was heavily based on the metaverse's widespread implementation, especially with their clients. To what extent does the use of the metaverse serve as a technological fix to solving the deeper issues embedded within the structure of college education? How is the quality of education exacerbated by the transfer of power from college educators to the aforementioned technology giants? Within college education, the implementation of the metaverse fails to adequately address the root of educational structural problems despite providing more personalized curriculums and increased practical skills. Additionally, understanding the metaverse's role as a political tool through limiting equal access

to education strengthens the evaluation of its net determinantal value to society. The analysis of case studies and scholarly articles that assess the success of the implementation of the metaverse on college education provides a microcosmic example into its realized potential. Solutions are further outlined to mitigate the negative impacts of its imminent implementation. Analyzing the use of the metaverse through a social lens aids engineers and technology experts in making more informed decisions in the progression of the inevitable virtual revolution.

With the rapid advancement of technologies that have the potential to revolutionize or even create new industries, such as the metaverse and electric vehicles, a comprehensive and in-depth analysis surrounding their social impact is imperative. Analyzing both topics simultaneously highlights the rapid pace of technological development, and the consequent widespread impact, regardless of industry. As an engineer, taking an active approach toward incorporating social considerations in the design of future technologies is necessary to build a secure foundation for emerging industries.