University of Houston - Downtown

Hydrogen-Boron Fusion

Sustainable Case Study for Health and Safety of Hydrogen-Boron Fusion

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Thesis

Hydrogen (H) is one of the most abundant chemical elements in the universe. When uniting the chemical element Boron (B) with Hydrogen, we create fusion, or in this case, Hydrogen-Boron Fusion. This reaction produces a chemical compound into a renewable energy source that challenges nuclear fission, fission being the adverse reaction of fusion when splitting two elements from one another rather than uniting them. This study attempts to present research and recommendations on best practices for the creation of Hydrogen-Boron Fusion in the scope of industrial hygiene implementation.

Background

Sustainability is the long-term ecological balance and management of Earth, its climate, and resources. Precisely aimed to avoid the depletion of Earth's resources and ensure a healthy quality of life for future generations; there are three pillars to sustainability: economic, environmental, and social (Asheim, 1994). Energy is one of the many components sustainable development intends to address. Conventional wisdom deems fossil fuels as the sole contributor to our current socio-economic and environmental conditions, yet there are many other factors associated like education, food, water, land use, and materials. The act of creating energy through Hydrogen-Boron Fusion can be a great asset for future energy consumption as demand is expected to rise 50-percent with a population of roughly 4-billion more people (Sachs, 2015).

The chemical symbol for Hydrogen is H. It is virtually untraceable to the five human senses: taste, touch, smell, and sight; proceeding with caution is paramount as Hydrogen is known to be a flammable gas with a poor track record in reference to the Hindenberg (Jolly, 2019). Boron with the chemical symbol, B is an element vital to plant growth and can also be used for a wide range of other industrial applications (Editors of Encylopedia Britannia, 2019). One of the many industrial applications is by creating the chemical compound, Hydrogen-Boron. A company, Tri Alpha Energy (TAE) has led scientific efforts for roughly twenty years to understand the power and industrial use case for Hydrogen-Boron to make it a commercially viable solution for our growing global energy demands.

Dr. Norman Rostoker, department chair of physics and astronomy at the University of California at Irvine (UCI) was one of the founding members of TAE. Before his passing at age 89 in 2015, he was recognized as the first generation of fusion pioneers driven with a deep understanding that fusion can be an unlimited nonpolluting source of clean energy (Pham, 2015). Co-founder Dr. Michl Binderbauer graduated from UCI with a Ph.D. in physics and is considered the architect behind TAE's research and development program (University of California Irvine, 2019). Dr. Rostoker and Binderbauer contribute their time by devising a safe, compact, affordable, and dependable energy reactor through the thought of using hydrogen-boron as a future fuel source (Hawken, 2017).

Hydrogen-Boron Fusion

Hydrogen is the simplest known element in the universe. It contains one proton, one electron, and is the only known element without a neutron (Jolly, 2019). Since electrons are not present, Hydrogen is technically a molecule, which is strange considering most conductors of energy include electrons and explains the inclusion of Boron. The structure of an Atom contains three particles: protons, neutrons, and electrons. Adding a proton with a neutron creates a nucleus or Hydrogen. Electrons, or Boron in the case for our discussion will orbit the nucleus. Imagine a Solar System with the

Sun as the nucleus (protons and neutrons) and the planets orbiting the Sun as electrons. Let's say this solar system has multiple planets that share the same orbit and there can be 2, 8, 18, or 32 planets that share an orbit; the farthest known planet from the Sun is a valence shell. The number of planets (electrons) in the valence shell determine if the Atom is a: conductor, semiconductor, or insulator. If there is only one planet in the valence shell then, it is a conductor of energy.

Hydrogen's simplicity makes it the most abundant element in the universe, but it only makes up 0.14 percent of Earth's crust; although it commonly accumulates in our water bodies (ice, rivers, lakes), atmosphere, petroleum, and in animal and vegetable tissue (Jolly, 2019). Electric cars dominate the news cycle but a small-cap publicly-traded company, Plug Power has invented a sophisticated hydrogen fuel cell for commercial and consumer use making partnerships with Amazon, Walmart, and automakers like Toyota, Mercedes-Benz, and BMW (Plug Power, 2019). Their technology has the potential to be a stepping stone toward the implementation of Hydrogen-Boron Fusion and a technological breakthrough that far surpasses electric vehicles or that of a Tesla.

Boron-10 and Boron-11 slightly differ from one another. Boron-11 occurs more frequently (80.1 percent) then boron-10 (19.9 percent) and boron-10 share one less neutron resulting in the ability to absorb neutrons more effectively than its counterpart (Editors of Encylopedia Britannia, 2019). Neutrons do not mix well with fusion reactors. The production of neutrons can cause a reactor to become radioactive and decay the inner-working components (Hawken, 2017). Found in mass quantities around Turkey, there is believed to be a hundred-thousand-year supply of Boron, and it is relatively inexpensive in comparison to more common yet expensive and scarce elements like tritium and deuterium (Hawken, 2017).

Combining heat to Boron and Hydrogen causes a flint-like effect and creates a spark when struck. The only difference is that instead of starting a fire by smashing steel and flint over some pine needles, the two elements fuse into each other and initiate an intense plasma field. The kicker is that this plasma field must reach 5.4 billion degrees Fahrenheit (Jolly, 2019). Our Sun's core is only 27 million degrees Fahrenheit (15 million degrees Celsius) (NASA, 2019). The faster the plasma field spins, the hotter it gets, the more stable it becomes consequently generating a magnetic field - similar to that of a spinning top minus the magnetic field (Hawken, 2017).

Recognition, Evaluation, and Control

A FAT-CM device is a central confinement vessel for the plasma with two field-reversed theta-pinch (FRTP) formation sections (Fumiyuki Tanaka, 2018). The FRTP produces hot, high-density plasmas and feeds it into the central confinement vessel (Fumiyuki Tanaka, 2018). Field-reversed configurations (FRC) help confine the plasma through magnetic flux; and the magnetic flux behaves similarly to a cathode (positive) and anode (negative) that harnesses the kinetic energy of the plasmas confined by the FRC into thermal energy (T. Asai, 2019). Without a FAT-CM device, there would be no way to produce and contain 5.4 billion degrees Fahrenheit of highly dense plasma. The FRC helps guide the plasma to its positive and negative terminals to generate power from kinetic and thermal energy. Without the FRC, the plasma will react erratically and unsure how exactly that will affect the FAT-CM. The latest upgrades in a November 2018 study saw ~1000 km s^{-1} collision speeds of the plasmas from the FRCs exceeding 1.5 keV (17 million Kelvin or 31 million degrees Fahrenheit) and achieved a ~9 ms plasma lifetime with a total injection power estimated to go up ~21 MW (20,000 kW or 20 million W) (H. Gota, 2019).

The major chemical hazard involved with Hydrogen-Boron Fusion is ionized gas. When heated, the ionized gas turns into plasma, (fourth state of matter) another chemical hazard which anything in contact with the plasma will disappear in a nanosecond and becomes virtually impossible to control (Hawken, 2017). That said, it produces zero-waste meaning no plutonium, radiation, meltdowns, or proliferation and provides three to four times more energy per mass of fuel than nuclear fission (Hawken, 2017). Fission reactors have been deployed in the form of nuclear power plants and generate 1 million times more energy than all other sources; fusion generates 3-4 times more energy than fission (Office of Nuclear Energy, 2018).

Absent of physical hazards like radiation, there are ionized gas, heat stress, and pressures present with Hydrogen-Boron Fusion. The FAT-CM device must be able to contain a projected 5.4 billion degrees Fahrenheit for an indefinite amount of time to sustain the fusion reactor, recreate starlight on earth, and produce an absolute, nonpolluting renewable energy source (Hawken, 2017). I believe the magnitude and duration of these conditions would crossover to physical hazards. The pressures of generating and stabilizing the plasma are apparent. If the FRC help stabilize the plasma field coupled with a C-2U or improved C-2W device that amplifies the temperature further increasing the power of the plasma, then the pressures will assumingly alleviate itself naturally at the FAT-CM (Hydrogen-Boron Fusion Reactors) peak performance.

Fortunately, there are no known biological hazards present. Ergonomic hazards can be assumed. Suitable workplace design considerations can be made for scientists and engineers to perform their tasks. The design of the FAT-CM device and its components along with the material handling and lifting can be addressed in research and development. Protocols for working condition standards can be made to avoid musculoskeletal and cumulative trauma disorders or carpal tunnel syndrome.

There are multiple methods to reduce environmental stresses without impairment of health or productivity. Through proper evaluation techniques, monitoring and measurement of persons and facilities through wearable and automated remote sensing technologies can be deployed. Management can help administrators improve company morale by proper scheduling and completion of tasks. Other controls consist of proper preservation and protection of the research and development chambers and storage with fail-safes for proprietary technologies.

Summary

The future of a nonpolluting renewable, spacefaring civilization starts with Hydrogen. It is the most abundant element in the universe, followed by, the readily available, vast, and inexpensive resource serving as the ignition for fusion, Boron. Electricity can be generated in several forms, and numerous electric vehicles on the road today still rely on fossil fuels for a charge. Without grid management technologies, there is no way to identify if your electricity is running clean or fossil fuels and are far more likely falling victim to a marketing scheme. There is still much to unravel and discover in our case for Hydrogen or Hydrogen-Boron Fusion. For instance, repurposing oil sands projects can be made to keep the shale in the bedrock and synthetically extract Hydrogen. Understanding that we are dealing with very hot, high-density plasmas reaching speeds of 1000 km s and temperatures of 31 million degrees Fahrenheit, at least we know that with only a 9 ms plasma field, Hydrogen-Boron Fusion is proven to generate ~20 million watts of power with zero-waste and without any radiation from clean, naturally replenishing and abundant resources.

References

Asheim, G. B. (1994, May). *World Bank.* Retrieved from worldbank.org: http://documents.worldbank.org/curated/en/605011468739497097/pdf/multi0page.pdf

Editors of Encylopedia Britannia. (2019, August 26). *Boron Chemical Element.* Retrieved from britannica.com: https://www.britannica.com/science/boron-chemical-element

EIA. (2018, July 13). *Energy Explained.* Retrieved from EIA: https://www.eia.gov/energyexplained/?page=renewable_home

Fumiyuki Tanaka, T. A. (2018). Collisional Merging Process of Field-Reversed Configuration Plasmas in the FAT-CM Device. *The Japan Society of Plasma Science and Nuclear Fusion Research*, 3402098-1-4.

H. Gota, M. B. (2019). Formation of hot, stable, long-lived field-reversed configuration plasmas on the C-2W device. *International Atomic Energy Agency*, 1-16.

Hawken, P. (2017). Coming Attractions: Hydrogen-Boron Fusion. In *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming* (pp. 194-195). New York City: Penguin Books.

Jolly, W. L. (2019, August 26). *Hydrogen Chemical Element.* Retrieved from Britannica: https://www.britannica.com/science/hydrogen

NASA. (2019, August 26). *Sun Overview*. Retrieved from NASA: https://solarsystem.nasa.gov/solar-system/sun/overview/

Office of Nuclear Energy. (2018, May &). *Fission and Fusion: What is the Difference?* Retrieved from energy.gov: https://www.energy.gov/ne/articles/fission-and-fusion-what-difference

Pham, P. (2015, January 13). *UCI Fusion Pioneer Norman Rostoker Passes at 89.* Retrieved from New University: https://www.newuniversity.org/2015/01/13/uci-fusion-pioneer-norman-rostoker-passes-at-89/

Plug Power. (2019, Febuary 19). *PLUG POWER TO BEGIN PRODUCTION OF NEXT GENERATION CLASS 1 MATERIAL HANDLING EQUIPMENT.* Retrieved from plugpower.com: https://www.ir.plugpower.com/Press-Releases/Press-Release-Details/2019/Plug-Power-to-Begin-Production-of-Next-Generation-Class-1-Material-Handling-Equipment/default.aspx

Sachs, J. D. (2015). *The Age of Sustainable Development.* New York, Chichester, West Sussex: Columbia University Press.

T. Asai, T. T. (2019). Collisional merging formation of a field-reversed configuration in the FAT-CM device. *International Atomic Energy Agency*, 1-6.

UN. (2018, May 16). *News.* Retrieved from un.org: https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html

University of California Irvine. (2019, August 25). *Leadership Council - Michl Binderbaur*. Retrieved from ps.uci.edu: https://ps.uci.edu/LeadershipCouncil/MichlBinderbauer

World Bank Institute. (2018, December 5). *How to Sustainably Feed 10 Billion People by 2050, in 21 Charts.* Retrieved from wri.org: https://www.wri.org/blog/2018/12/how-sustainably-feed-10-billion-people-2050-21-charts