REDUCTION OF SOLID FUEL HYDROXYL-TERMINATED POLYBUTADIENE COMBUSTION IN AIR USING A NON-PREMIXED COUNTERFLOW DIFFUSION MODEL

THE IMPACT OF THE SPACE DEBRIS DILEMMA

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SOCIOTECHNICAL SYNTHESIS

As new research methods and advanced technologies are developed, the aerospace industry will continue to grow exponentially. However, before these new technologies are implemented, outdated equipment such as dead satellites in orbit must be removed to make room for advanced devices and decrease the potential for collisions in orbit. The technical project focuses on reducing the computation time for a current combustion model in a hybrid, air-breathing, hypersonic engine. As hybrid engines become more popular in the aerospace field, it is necessary to reduce computation time of such models so as to better analyze this advanced technology. The STS project focuses on the space debris dilemma and analyzing potential solutions as well as the work already underway to remove junk in low Earth orbit. There is a relatively strong correlation between the technical and STS projects since as advanced aerospace technology is developed, debris in orbit must be removed to make space for the new devices. Without resolving the space debris dilemma, it is possible that advanced aerospace technology such as the technical project will have no application due to the crowding of junk in orbit around the planet.

Currently, the Naval Research Laboratory in Washington, D.C. has a model analyzing the combustion of solid butadiene for a hybrid, air-breathing, hypersonic engine that takes several days to run simply due to the extreme precision of the code. The goal of the technical project is to model this same combustion, but reduce the model to be able to run in a matter of minutes while maintaining a high amount of precision. Naturally the reduced model will sacrifice some of the precision of the more complex code, but it is more useful to generate results faster. With this faster reduction time, the military will be able to more quickly integrate the advanced technology, promoting a significant advancement in the aerospace industry.

To accomplish this reduction, a counterflow diffusion model is used with a 39 species butadiene mechanism. This means only the 39 most abundant chemical compounds involved in the entire combustion process for butadiene are analyzed. The model was constructed using the Cantera chemical database within Python to generate results that were then compared to results obtained in a paper by Ciottoli et al. to validate the models. From here, the model can further be used to investigate combustion of various hydrocarbon fuels other than butadiene and optimize the performance of hypersonic jets with hybrid, air-breathing engines.

The space debris dilemma has been an issue for decades that has arisen as a result of negligence for the protection of space as an environment and a tragedy of the commons. The STS report seeks to analyze the space debris dilemma including the history of satellite technology beginning with the launch of Sputnik in 1957 and looking at what solutions may be available to remove debris from low Earth orbit. This is accomplished using the Actor Network Theory framework. Current projects are attempting to remedy the issue but more research must be done to increase awareness of the space debris dilemma and encourage aerospace companies and national governments to focus efforts on removing junk from orbit.

The major points discussed on the topic of the space debris dilemma include recent magnification of the issue, the impact space debris has on the world, and a discussion of current work being done to prevent the problem from getting out of hand. Some major focuses include the recent launch of the SpaceX large constellation of satellites, StarLink, which presents a new issue as thousands of objects introduced into orbit will only contribute to the problem and increase potential for Kessler syndrome. Although the current state of space debris is stable, the exponential addition of satellites into orbit as well as other factors threatening to create more debris places an emphasis on the urgency necessary to remedy the issue.

As the aerospace industry continues to experience a recent renaissance that has led to the development of advanced technologies, new research methods and analysis techniques will play a large role in the integration of such technologies into society. As this technology is implemented, old systems such as dead or outdated satellites in orbit will have to be removed so as to make room for new advanced satellites as well as to decrease the potential for collisions with debris. If the space debris dilemma is ignored and allowed to escalate, there may be a point in the future where it is too dangerous to send up new satellite technology due to the increased potential for collision with all of the junk in orbit.

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