



CONTROL OF COMBUSTION FLOW & IMPROVE THE PERFORMANCE OF SOLID ROCKET PROPELLANT

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Abstract:

We characterize about propellants in rocket engine. We all know that propellants play a vital role in combustion of engines. Also, there are various form of propellants being used in engines. In rocket engine, propellants are the source of combustion. Even though we have several forms of propellants, we can find some flaws in those propellants. So we have come up with Semi-solid state of propellants. Semi-solid is a state of matter which is state between solid and liquid. In this state propellant attains the properties of both solid and liquid propellants. The thing which motivates us to think about to make a propellant in semi-solid state is solid propellants. We know that solid propellant gives more efficiently comparing it with liquid propellant .But we cannot control the flow of solid propellants like liquid propellants when it's ignited. Once the solid propellants gets ignited, we cannot control the flow of burning. If we thought to use solid propellant fuels in liquid it is much complicated to use it and it also unable to attain the efficiency which we got from it while using it as a solid propellants. So we come to an idea of making propellants in semi-solid form which is either solid or liquid. Even the state of propellant changes, It increases the efficiency of the overall engine.

Key Words: Rocket Propellant, Combustion, Semi-Solid Propellant, Chemical Equilibrium Analysis (CEA)

Introduction:

In Rocket engine, propellants are used in three forms which are solid, liquid and Hybrid. Solid propellants are nothing but the propellants which is used in the rocket engine will be in the form of solid state. Usually we use fuel and oxidizer in solid propellants. Then talking about liquid propellants, the rocket engine which uses propellants in the state of liquid we can call it as liquid propellants. In liquid propellants, fuel and oxidizers will be maintained in separate containers. If we tends to carry both in one container it may get ignited due to temperature increase by frictional force. By the way, Hybrid propellants use two phases that is one phase in solid form, another phase in liquid or Gaseous form. In the case of solid propellants, the phases of propellants are fuel and oxidizer. Where they mixed together and forms a solid propellants. Solid propellants has higher efficiency while comparing it with other form of propellants like liquids. Generally solid propellants are used in missiles, Boosters and also has various applications. In the case of Booster, solid propellants provide higher thrust to the engine.

Comparing with liquid propellants, solid propellants gives higher thrust efficiency to the engine. On the other hand, burning of solid is slower than the other states of matter like liquid and gas. In these case, if we are using propellant as liquid or gas, sure that we will be spraying the fluid for the combustion and if we tends to stop spraying automatically the combustion will be stopped. But the same time burning of fluids occurs very fast as compared with solids it is due to the atomic arrangements. Thus if we are burning solid, it takes time for absorption and transfer heat from one molecule to other.

Rocket Principle & Classification:

Rocket engines use stored rocket propellants as the reaction mass for forming a high speed propulsive jet of fluid, usually high temperature gas. Rocket engines are reaction engines, producing thrust by ejecting mass rearward in accordance with Newton's third law.

Chemical Propulsion:

Chemical propulsion is propulsion in which the thrust is provided by the product of a chemical reaction, usually burning (or oxidizing) a fuel. A chemical reaction combines two or more kinds of chemicals and makes a different chemical as a product.

Chemical Rockets Propellants:

- Solid Rocket Propellant
- Liquid Rocket Propellant
- Hybrid Rockets
- Cryogenics Propellants

Methodology:

The CEA program calculates chemical equilibrium product concentrations from any set of reactants and determines thermodynamic and transport properties for the product mixture. Built-in applications account for theoretical rocket performance, Chapman-Jouguet detonation parameters, shock-tube parameters, and combustion properties.

Chemical Equilibrium Analysis (CEA):

We know that it is important to analyze the efficiency of an engine while using a semi-solid state of propellants. Thus, we came to know about the CEA, which is an open software by NASA. We can analyze thermodynamic properties like pressure, temperature, density, enthalpy, specific heat, Mach number etc. And also these parameters have their own code. We can utilize it to obtain a specifically desired output.

The NASA Computer program CEA (Chemical Equilibrium with Applications) calculates chemical equilibrium compositions and properties of complex mixtures. Applications include assigned thermodynamic states, theoretical rocket performance, and shock-tube parameters for incident and reflected shocks. Over 2000 species are contained in the thermodynamic database. The program is written in ANSI standard FORTRAN by Bonnie J. McBride and Sanford Gordon.

Calculation of chemical equilibrium composition and rocket performance, and during 1957, helped create the first Lewis computer code using this method for an IBM 650 data processing system (Gordon, Zeleznik and Huff, 1959). Zeleznik worked with Gordon on least squares methods for fitting thermodynamic data to empirical formulas (Zeleznik and Gordon, 1961), adding applications (Zeleznik and Gordon, 1962a and 1962b) and on the comparison of various mathematical methods for the calculation of complex chemical equilibria (Zeleznik and Gordon, 1960 and 1968).

The Lewis chemical equilibrium code with rocket performance and Chapman-Jouguet detonations for the IBM 704 and 7090 was documented in 1962 (Zeleznik and Gordon, 1962c). This code used a modified version of the Brinkley-Huff iteration procedure (such as NACA TR 1037) for chemical equilibria which required no special initial estimates for composition and no constraints on mass balance or equilibrium relationships during iterations. This was the first version of the Lewis chemical equilibrium code widely distributed.

Examining Propellants in CEA:

The analysis of solid and semi-solid propellants in CEA software has provided valuable insights into their properties and behavior. CEA software is a powerful tool that enables the prediction of various parameters such as combustion performance, chamber pressure, and thrust. This software uses complex algorithms and equations to simulate the combustion process and predict the performance of the propellant. The analysis of solid and semi-solid propellants in CEA software has enabled researchers to understand the combustion process in greater detail. This understanding has helped in the optimization of propellant formulations and the development of new propellants with improved performance.

The use of CEA software has also reduced the time and cost associated with experimental testing, making it a valuable tool in the development of aerospace systems. The use of CEA software has enabled the optimization of propellant formulations and the development of new propellants with improved performance, making it an essential tool in the development of aerospace systems. We have aimed at improving the performance of solid propellants and have yielded promising results. By transforming solid propellants into a semi-solid state, the team was able to increase the propellant's thrust output. The CEA software was utilized to analyze the propellant's behavior and performance. Solid propellants are widely used in aerospace applications because of their long-term storage capabilities. However, they are limited by their relatively low specific impulse, which affects their overall performance. In contrast, semi-solid propellants have higher specific impulse and combustion efficiency, making them a promising alternative. The project team utilized CEA software to analyze the behavior and performance of both solid and semi-solid propellants. The results showed that the semi-solid propellant had a higher specific impulse and combustion efficiency than the solid propellant, which led to higher thrust output.

By improving the performance of the propellant, the team has opened up new possibilities for aerospace applications. For our project, we used Origin software to draw the graph that compares the performance of solid and semi-solid propellants. Origin is a powerful data analysis and visualization software that offers a range of tools and features for creating high-quality graphs and charts. One of the key features of Origin is its ability to import and manipulate data from a variety of sources.

P	t	Isp	mw	Cf	Mach
2.03E+02	2.58E+03	0.00E+00	5.13E+01	0.00E+00	0.00E+00
1.21E+02	2.50E+03	4.66E+02	5.13E+01	6.25E-01	1.00E+00
7.81E-02	1.38E+03	1.64E+03	5.22E+01	2.20E+01	4.14E+00
3.04E+02	1.33E+03	1.68E+03	5.25E+01	2.25E+00	4.36E+00

1.81E+02	2.59E+03	0.00E+00	5.14E+01	0.00E+00	0.00E+00
1.84E-01	2.51E+03	4.66E+02	5.13E+01	6.27E-01	1.00E+00
1.16E-01	1.43E+03	1.63E+03	5.20E+01	2.20E+00	4.11E+00
2.03E+02	1.37E+03	1.67E+03	5.24E+01	2.25E+00	4.28E+00
1.22E+02	2.82E+03	0.00E+00	5.18E+01	0.00E+00	0.00E+00
1.22E-01	2.71E+03	4.86E+02	5.16E+01	6.18E-01	1.00E+00
7.89E-02	1.40E+03	1.74E+03	5.15E+01	2.22E+00	4.25E+00
3.04E+02	1.34E+03	1.78E+03	5.18E+01	2.27E+00	4.33E+00
1.82E+02	2.83E+03	0.00E+00	5.19E+01	0.00E+00	0.00E+00
1.84E-01	2.74E+03	4.85E+02	5.18E+01	6.22E-01	1.00E+00
1.18E-01	1.45E+03	1.73E+03	5.15E+01	2.22E+00	4.11E+00

Table 1: Output of Solid Propellants

P	t	isp	mw	cf	Mach
2.03E+02	1.84E+03	0.00E+00	2.83E+01	0.00E+00	0.0000E+00.
1.13E+02	1.66E+03	7.73E+02	2.84E+01	6.89E-01	1.0000E+00.
4.18E-02	3.53E+02	2.11E+03	2.99E+01	1.88E+00	5.89E+00
2.45E-02	3.15E+02	0.00E+00	3.00E+01	1.90E+00	6.95E+00
3.04E+02	1.85E+03	7.73E+02	2.84E+01	0.00E+00	0.00E+00
1.69E+02	1.66E+03	2.11E+03	2.84E+01	6.89E-01	1.00E+00
6.22E-02	3.51E+02	2.13E+03	2.99E+01	1.88E+00	5.90E+00
3.72E-02	3.21E+02	0.00E+00	3.01E+01	1.90E+00	6.90E+00
2.03E+02	2.08E+03	8.09E+02	2.87E+01	0.00E+00	0.0000E+00.
1.14E-02	1.88E+03	2.23E+03	2.87E+01	6.83E-01	1.00E+00
4.55E-02	4.40E+02	0.00E+00	3.03E+01	1.89E+00	5.77E+00
2.67E-02	3.93E+02	8.09E+02	3.04E+01	1.91E+00	6.13E+00
3.04E+02	2.09E+03	2.24E+03	2.88E+01	0.00E+00	0.00E+00
1.70E+02	1.89E+03	2.26E+03	2.88E+01	6.83E-01	1.00E+00
6.79E-02	4.38E+02	2.26E+03	3.03E+01	1.89E+00	5.78E+00

Table 2: Output of Semi-solid Propellants

Origin software provided us with a powerful tool for visualizing and analyzing our data, and allowed us to create a graph that effectively communicates the differences in performance between solid and semi-solid propellants. By enabling us to customize the appearance and functionality of our graph, Origin helped us to create a professional-quality representation of our findings that can be used to inform decisions regarding the use of these propellants in aerospace applications.

In rockets, the relationship between pressure and Mach number is a critical factor that affects the rocket's performance and stability. The pressure in a rocket's combustion chamber is generated by the burning of the propellant, which releases a large volume of hot gasses that exert pressure on the walls of the chamber. As the pressure builds up, it forces the gasses out of the nozzle, generating thrust and propelling the rocket forward. The Mach number in a rocket is a measure of the rocket's speed relative to the speed of sound in the surrounding atmosphere. As the rocket accelerates, it can reach supersonic speeds, where the Mach number exceeds 1.0. At these speeds, shock waves can form around the rocket's nose and other high-pressure areas, creating drag and affecting the rocket's stability and performance.

In semi solid propellants, pressure also plays a crucial role in the combustion process. As the propellant material is ignited, it releases gasses that build up pressure within the combustion chamber, generating thrust. However, unlike in solid propellants, the combustion process in semisolid propellants is generally more rapid and complete, with the combustion gasses being released more quickly and efficiently.

Pressure and Thrust:

The relationship between pressure and thrust in both solid and semisolid propellants is complex and depends on a variety of factors, including the composition and structure of the propellant material, the size and shape of the combustion chamber, and the surrounding atmospheric conditions. The Mach number in solid propellants is related to the velocity of the combustion gasses produced by the propellant and the speed of sound in the surrounding atmosphere. However, in solid propellants, the relationship between Mach number and thrust is generally more complicated than in semisolid propellants. This is because the combustion process in solid propellants is generally slower and more gradual, with the combustion gasses being released over a longer period of

time. This slower combustion process can lead to lower Mach numbers and lower thrust, even in propellants with high specific impulse.

Mach number can still be a useful parameter for characterizing the performance of solid propellants, particularly in cases where the combustion process is more rapid or the propellant is being used in a high-speed application such as a rocket booster. As with semi solid propellants, Mach number should be considered in conjunction with other performance metrics such as specific impulse and thrust to fully evaluate the performance of the propellant

Graphical Representation for Performance Analysis:

The x-axis represents the pressure values generated by the burning of the propellant in the rocket's combustion chamber. As the pressure builds up, it forces the gasses out of the nozzle, generating thrust and propelling the rocket forward. The y-axis represents the Mach number, which is the speed of the rocket relative to the speed of sound in the surrounding atmosphere.

By analyzing the graph, we can observe the pressure and Mach number values for both solid and semisolid propellants. The comparison between the two types of propellants can provide insights into their relative performance and efficiency. The data's accuracy and reliability can be verified by using various analytical techniques such as computational fluid dynamics simulations. This can help ensure that the conclusions drawn from the graph are valid and reliable.

In summary, the graph's representation of Mach on the y-axis and pressure on the x-axis with different scales can provide valuable insights into the performance and efficiency of solid and semisolid propellants in rockets. However, it's essential to ensure that the data used to generate the graph is reliable and accurate before drawing any conclusions based on it.

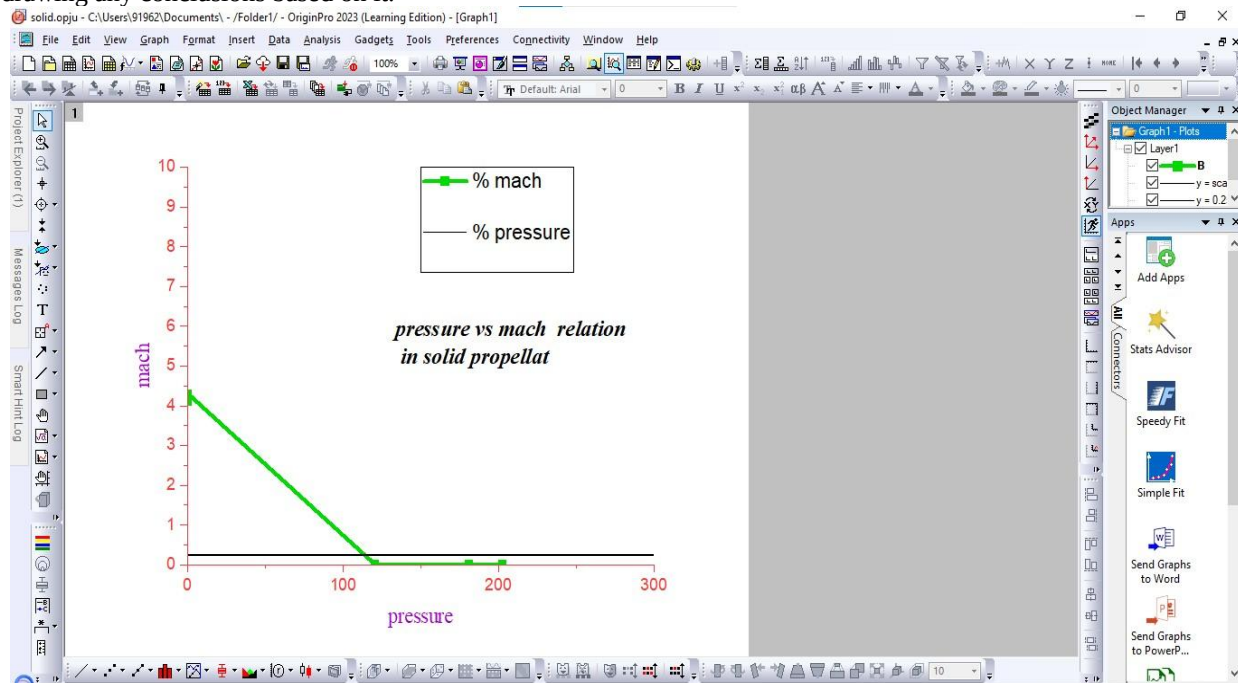


Figure 1: Pressure Vs Mach Relation in Solid Propellants

The graph representing the relation between pressure and Mach in solid propellants has yielded some interesting findings. It indicates that at higher pressures, there is a decrease in Mach number. Additionally, certain values of specific impulse and thrust were obtained from the data.

These findings have significant implications for the performance of solid propellants. The decrease in Mach number at higher pressures suggests that there may be a limit to the amount of thrust that can be achieved with solid propellants alone. Overall, the graph provides valuable insights into the behavior and performance of solid propellants. The specific impulse and thrust values obtained from the data suggest that solid propellants are still a viable option for aerospace applications, despite the decrease in Mach number at higher pressures. These findings could lead to the optimization of solid propellant formulations and the development of new propellants with improved performance.

However, it is important to note that the relationship between mach number and thrust in semisolid propellants is complex and depends on a variety of factors, including the composition of the propellant, the size and

shape of the combustion chamber, and the surrounding atmospheric conditions. Therefore, while mach number can be a useful parameter for characterizing the performance of semisolid propellants, it should be considered in conjunction with other performance metrics, such as specific impulse and thrust, to fully evaluate the performance of the propellant.

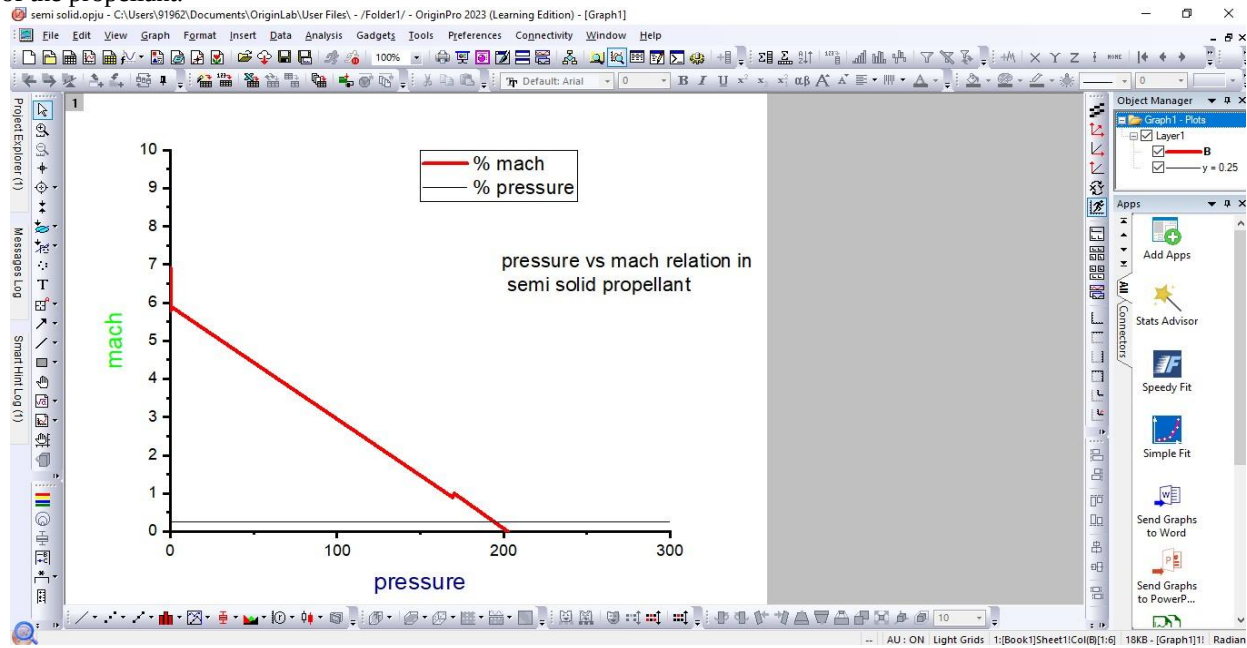


Figure 2: Pressure Vs Mach Relation in Semi-Solid Propellants

Similar to the graph representing the relation between pressure and Mach in solid propellants, a graph representing the relation between pressure and Mach in semi-solid propellants can also provide valuable insights into their behavior and performance.

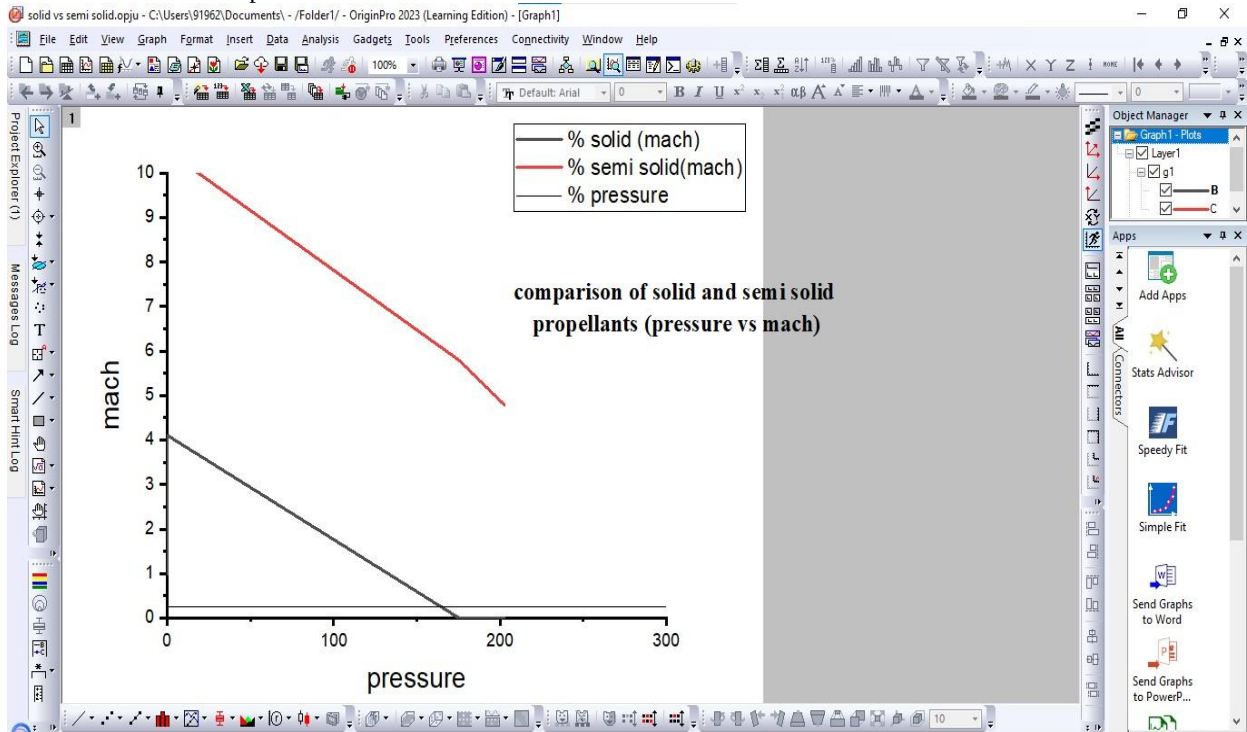


Figure 3: Comparison of Solid and Semi-solid Propellants

Pressure	Mach in Solid Propellants	Mach in Semi-Solid Propellants
0.02	1	6.9

0.07	4.1	5.7
175.4	0	1
202.65	0	0

Table 3: Mach of Propellants in Specified Pressure values

The tabulation drawn for pressure and Mach values in solid and semi-solid propellants provides a clear representation of the differences in performance between the two types of propellants. By using data obtained from CEA software, this tabulation allows for a direct comparison of the pressure and Mach values for both types of propellants, which is critical in evaluating their performance and efficiency.

The graph drawn based on these values can also help in visualizing the differences between solid and semi-solid propellants. The graph can show the variations in pressure and Mach number for both types of propellants, and can provide insights into the specific impulse and thrust values that can be obtained from each. The tabulation and graph provide a valuable tool for understanding the behavior of solid and semi-solid propellants, and can be used to inform decisions regarding their use in various aerospace applications. By providing a comprehensive overview of the performance and efficiency of these propellants, the tabulation and graph can help in optimizing the design and operation of aerospace systems, ultimately leading to more effective and efficient space exploration and other aerospace technologies. A graph representing the comparison behavior of solid and semi-solid propellants can provide important insights into the advantages of using semi-solid propellants over solid propellants. Based on such a comparison, it can be concluded that semi-solid propellants have higher Mach numbers and can produce higher thrust and efficiency.

The graph may show that at high pressures, the Mach number of the semi-solid propellant is higher than that of the solid propellant. This is due to the fact that semi-solid propellants have higher specific impulse and combustion efficiency than solid propellants, which allows them to achieve higher Mach numbers. The specific impulse and thrust values obtained from the data for semi-solid propellants are also expected to be higher than those for solid propellants. These results suggest that semi-solid propellants are a promising alternative to solid propellants for aerospace applications. By using semi-solid propellants, it is possible to achieve higher levels of efficiency and force, which could lead to improved performance of aerospace systems. This could have significant implications for space exploration and other aerospace applications.

In conclusion, a graph comparing the behavior of solid and semi-solid propellants can help in understanding the advantages of using semi-solid propellants over solid propellants. Based on such a comparison, it can be concluded that semi-solid propellants have higher Mach numbers and can produce higher thrust and efficiency, making them a promising alternative for aerospace applications.

Applications of Using Semi-Solid Propellants:

If we make propellants in a semi-solid state, it can offer certain advantages over traditional solid or liquid propellants. Semi-solid propellants can combine the desirable properties of both solid and liquid propellants, such as increased safety, better control over combustion, and higher efficiency. Semi-solid propellants can be more controllable than solid propellants because they have a lower viscosity and can be pumped like a liquid. This means that the flow rate of the propellant can be controlled more accurately, resulting in better thrust control and more precise rocket maneuvering. Additionally, semi-solid propellants can be stored more safely than solid propellants, which are known to be volatile and difficult to handle. Semi-solid propellants can also offer higher efficiency than liquid propellants because they have higher energy density and are less tendency to boil-off. Furthermore, semi-solid propellants can be easily stored and transported, making them ideal for long-duration space missions.

Development of Propellant:

The development of semi-solid propellants has the potential to transform rocket propulsion technology, offering improved safety, better controllability, and higher efficiency. The use of semi-solid propellants has several potential applications in rocket propulsion systems. One significant advantage of semisolid propellants is their ability to improve the performance and efficiency of rocket engines. Compared to traditional solid propellants, semisolid propellants have higher energy density and specific impulse, which means they can generate more thrust and provide better performance. Another significant advantage of semisolid propellants is their flexibility in terms of design and manufacturing.

Because they have a semi-solid consistency, they can be easily molded into various shapes and sizes, making them ideal for complex engine designs. Additionally, semisolid propellants can be manufactured using automated processes, which can result in lower costs and faster production times. Semi Solid propellants are also more stable and safer to handle than traditional solid propellants. Because they have a gel-like consistency, they are less prone to cracking, chipping, or breaking during handling and transportation. This makes them safer to handle and reduces the risk of accidents and explosions during the manufacturing and storage processes. Finally, semisolid

propellants have the potential to reduce environmental pollution and improve sustainability in rocket propulsion systems.

Compared to traditional solid propellants, semisolid propellants produce fewer harmful emissions and waste products during the combustion process. This can result in lower environmental impact and improve the sustainability of rocket propulsion systems. The cost efficiency of using semi solid propellants is a significant advantage when compared to traditional solid propellants. One reason for this is that the manufacturing process for semisolid propellants is highly automated, which reduces the cost of production. Additionally, semisolid propellants are more efficient than solid propellants, which means that less propellant is required to achieve the same level of thrust. Another factor that contributes to the cost efficiency of semisolid propellants is their stability and safety.

Traditional solid propellants are known to be highly unstable and can be dangerous to handle, which increases the cost of manufacturing and storage. Semi Solid propellants, on the other hand, have a more stable consistency and are easier to handle, reducing the risk of accidents and the associated costs. Furthermore, the increased efficiency of semisolid propellants means that less propellant is required to achieve the same level of performance as solid propellants. This reduces the overall weight of the rocket, which can result in cost savings in terms of fuel and launch costs.

In conclusion, the cost efficiency of using semi solid propellants is a significant advantage over traditional solid propellants. The automated manufacturing process, increased efficiency, stability, and safety of semisolid propellants all contribute to their cost efficiency. As research into semi solid propellants continues, it is likely that more cost-saving advantages will be discovered, making them an increasingly attractive option for rocket propulsion systems.

Air Molecules:

The unique atomic arrangement of a semi-solid propellant allows it to combine the desirable properties of both solid and liquid propellants. For example, the solid fuel particles in the semi-solid propellant provide a high-energy density similar to solid propellants, while the liquid oxidizer provides better control over combustion and the flow rate of the propellant similar to liquid propellants.

The presence of air gaps can also cause cracking or fracturing of the propellant, which can compromise the structural integrity of the rocket motor. In contrast, air gaps in storage tanks containing semi-solid propellants are not as critical because the semi-solid propellants are not completely solid and the solid fuel particles are suspended in the liquid oxidizer.

In the case of liquid propellants, air gaps can be problematic because they can cause cavitation or the formation of bubbles in the propellant. This can lead to uneven flow of propellant into the rocket engine, which can cause fluctuations in the combustion process and reduced engine performance.

Air which is more dense weighs more because there are more air molecules taking up the same amount of space:

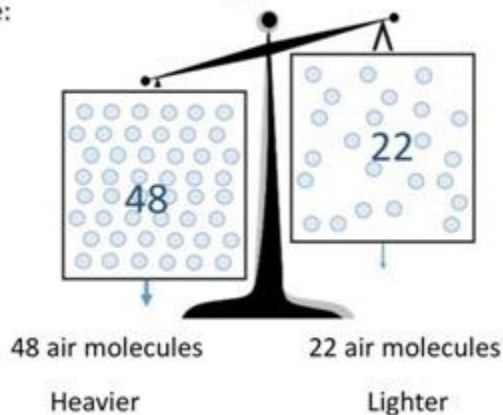


Figure 4: Air Molecules

Additionally, air gaps in liquid propellants can also cause the propellant to become contaminated by particles or impurities in the air, which can negatively impact the performance of the engine.

Space Occupation:

Semi-solid propellants have a higher bulk density than liquid propellants, which means that they take up less space in storage compared to liquid propellants. Additionally, the use of semi-solid propellants can allow for more precise control over the flow of the propellant, which can increase the efficiency of the rocket engine.

This can allow for more propellant to be stored in the same tank volume, which can be advantageous for space-limited applications. The high density of semi-solid propellants means that they have a lower surface area-to-volume ratio compared to liquid propellants, which can help to reduce the amount of propellant lost due to boil-off. This is because there is less surface area available for the propellant to evaporate and escape into the atmosphere.

The high density of semi-solid propellants can also enhance safety during transport and storage. The reduced surface area of the propellant means that there is less potential for flammable vapors to accumulate in the storage tank, which can help to reduce the risk of explosions or fires. The high density of semi-solid propellants can also improve the flow of propellant from the storage tank to the rocket engine. This is because the denser propellant can be pressurized more easily and can flow more consistently through the fuel lines, which can help to increase the efficiency and performance of the engine.

Thrust Generation:

The advantage of using semi-solid propellant in this process is that it can provide a more controlled and efficient burn compared to conventional solid rocket propellants, while still allowing for the ease of handling and storage that is characteristic of liquid propellants. Additionally, the semi-solid propellant can be formulated to provide specific burn characteristics, such as increased thrust or longer burn time, depending on the requirements of the mission. The semi-solid nature of the propellant can allow for more controlled and efficient combustion compared to solid rocket propellants, which can result in higher thrust efficiency and more consistent performance.

Flow Control in Semi-Solid Propellants:

One of the major advantages of using semi-solid propellants in rocket engines is the ability to control the flow of the propellant. Controlling the flow of the semi-solid propellant allows for more precise regulation of the propellant mass flow rate, which can improve the engine's efficiency and performance. This is because it enables the engine to maintain a constant thrust level throughout the burn, leading to a more efficient use of propellant. Controlling the flow of the semi-solid propellant can also improve the safety of the engine.

This is because it can help to prevent unexpected combustion events, such as rapid and uncontrolled combustion, which can be dangerous. Semi-solid propellants are typically less expensive to produce than solid rocket propellants, and they can also be stored and transported more easily than solid propellants. This can lead to lower overall costs for rocket engine development and operation. Semi-solid propellants can be tailored to specific applications by adjusting the properties of the propellant, such as its viscosity and rheology. This allows for greater flexibility in engine design and operation, and can help to optimize engine performance for a given application. The ability to control the flow of the semi-solid propellant in rocket engines is a major advantage that can lead to increased efficiency, improved safety, reduced costs, and greater flexibility in engine design and operation.

Application:

Thrust vector control (TVC) is a technique used to change the direction of thrust in a rocket engine, and it is an important component of many rocket designs. Semi-solid propellants can be used in TVC systems to provide several advantages. The ability to control the flow of the semi-solid propellant allows for more precise regulation of the thrust vector. This can lead to improved control of the rocket and better overall performance.

TVC systems using semi-solid propellants can be more efficient than those using other types of propellants, such as liquids or solids. This is because semi-solid propellants can be tailored to specific applications, allowing for more efficient use of propellant. Systems using semi-solid propellants can be lighter than those using other types of propellants. This is because semi-solid propellants have a higher density than liquids, which means that less propellant is required to achieve the same thrust.

Semisolid propellants can potentially be reused, making them a more cost-effective and sustainable option for VTVL rockets. VTVL stands for Vertical Takeoff and Vertical Landing, which is a type of rocket launch and landing system where the rocket takes off vertically and lands vertically, as opposed to other launch and landing systems like horizontal takeoff and landing (HTAL) or horizontal takeoff and vertical landing (HTVL).

Semi Solid propellants are sometimes used in sounding rockets, which are small rockets that are used to conduct scientific experiments and measurements in the upper atmosphere or in space. Sounding rockets typically have relatively short flight times and relatively low altitudes compared to other types of rockets, such as orbital rockets. Semi solid propellants can be a good option for sounding rockets that require high thrust, simplicity, safety, and performance.

Project Possibility:

We have planned to improve the quality of solid propellants by changing their state of matter. There are several possibilities for achieving high thrust efficiency by using semi-solid propellants. Additionally, we have analyzed the efficiency of using semi-solid propellants and need to test this propellant in practice. This will enable us to determine whether semi-solid propellants increase or decrease the efficiency of the rocket engine. Semi-solid propellants can provide a compact, low-thrust propulsion system that is ideal for small satellites. By using semi-

solid propellants, it is possible to achieve a high specific impulse and a long operational life for the propulsion system.

This could enable small satellites to perform complex maneuvers, such as orbit changes and formation flying. Semi-solid propellants can be used as the solid fuel in hybrid rocket engines. These engines combine a solid fuel with a liquid or gaseous oxidizer, which allows for more precise control of the combustion process. Hybrid rocket engines have been used for applications such as rocket-powered cars and high-altitude balloon launches. Semi-solid propellants could be used to develop a missile defense system. By using semi-solid propellants, it may be possible to develop a compact, high-performance interceptor missile that could be launched from a variety of platforms, including land-based launchers and ships.

Semi-solid propellants could be used to power a space plane that could take off and land like an airplane. By using semi-solid propellants, it may be possible to develop a propulsion system that is both efficient and reliable, which would be critical for a reusable space plane. Semi-solid propellants could be used to power a high-altitude aircraft that could fly at altitudes of up to 100,000 feet. By using semi-solid propellants, it may be possible to develop an engine that is both lightweight and powerful, which would be critical for high-altitude flight. This could enable new scientific and military applications, such as atmospheric research and surveillance.

Conclusion:

Propellants are a crucial component of rocket science and play a vital role in the functioning of rocket engines. They provide the necessary thrust to lift rockets off the ground and propel them into space. Therefore, the development of propellant technologies is of utmost importance in the advancement of space exploration. The performance and efficiency of a rocket engine are heavily dependent on the properties and characteristics of the propellant used. We have described the idea of making a semi-solid propellant for use in rocket engines. In order to make semi-solid propellants, we had to study many solid propellants and their properties. Finally, we came up with the idea of varying the temperature and changing the state of the propellant, which leads to a semi-solid state. We have analyzed these propellants and their chemical properties using CEA and compared the output of solid propellant and semi-solid propellant. Even though we have got a positive outcome, it is necessary to check the propellants practically. If we get a chance to test the semi-solid propellant in practice, we can determine whether it is practically feasible or not. It is essential to work on the development of these technologies.

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