DOI: https://doi.org/10.46632/jemm/8/1/6

REST Journal on Emerging Trends in Modelling and Manufacturing
Vol: 8(1), 2022
REST Publisher; ISSN: 2455-4537
Website: www.restpublisher.com/journals/jemm

Theoretical Model Study on Chemical Compositions Affecting the Space Launch Vehicles

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Abstract. In this paper we clearly discussed about composition of chemical substances that affects the launch vehicle in ground station as well as atmospheric conditions. During the rocket-launching the large amount of inhalation of an exhaust gas released and it majorly affects the surface of the launch pad as well as the atmosphere. In rocket, the combustion produces huge number of hot gases with high temperature and pressure. This hot gas passes into the nozzle and accelerates, that time hot cloud is formed in the ground station which composed of (CO2) Carbon dioxide, (HCl) Hydrogen chloride, and carbon monoxide (CO). These hot gases not only affect the ground surface but also the atmospheric layers, will see how it's affecting the launch vehicle as well as to protect the environment from air pollution affected by emission of gases from different types of rockets and spacecrafts.
Keywords: atmospheric conditions, chemicals, modelling, space vehicle

1. Introduction

During launch, the rockets work by burning the propellant and much more. The rockets light up the fuel in the fire and push themselves forward using rising gas canisters. The car carries tons of fuel so that more than 95% of the weight of most rockets is just petrol. Now in SpaceX's heavyweight Falcon, basically the 3 Falcon 9 line is integrated, the Falcon uses oxygen a strong liquid and fuel from a rock called RP1, highly refined paraffin. Approximately 86% of the RP-1 weight is carbon and SpaceX does not publish specific details, but the estimated value of a full Falcon gas tank is approximately 425 tons of RP-1 metric. That means it consider 365 tons of carbon per launch. Suppose all that carbon incorporates oxygen to form carbon dioxide, carbon makes up 27% of CO_2's mass, so divide that 365 tons of carbon by 0.27, will receive approximately 1,352 tons of carbon dioxide per launch. A typical vehicle emits 4.6 tons of carbon dioxide every year, so the launch of a single rocket equals 294 cars on the road year-round. In the region of stratosphere, the heat accelerates reactions and leads to the destruction of Ozone (O_2) that depletes the ozone layer and exposes themselves to a wide range of UV rays. RP-1 generates Nitric oxide (NO) and Nitrogen dioxide (NO_2) in addition to black carbon, which is more efficient and damages the ozone layer further. Nowadays, due to the rapid launch of rockets and arrows, the environment and atmosphere are affected. Compared to solid propellant, liquid propellant affects a few causes. According to NASA, faraway gases contain 78 percent nitrogen (N), 21% oxygen (O_2), 0.93 percent argon (Ar), and 0.04 percent carbon dioxide (CO_2). Track the amount of Neon (Ne), Hydrogen (H), Methane (CH_4), Krypton (Kr), and Helium (He) and water (H_2O). While the space car flies into space and is close to space, its structure and air quality are related to the atmosphere. Prior to the launch of the car, a ground scientist had been analyzing temperature, humidity, air quality, air conditioning and quantity. This paper discusses air quality, the atmospheric conditions that a car can leave to discuss and briefly discuss the introduction of air-conditioning and restraining vehicles.

2. Literature Review

The troposphere is the layer nearest to the ground surface having the altitude of up to 15 km Appx. The launch vehicle emits the atmosphere emissions into the troposphere layer. The stratosphere is the layer of the atmosphere which was located above the tropopause and beneath the stratopause so that emission in this layer can accumulate. The Stratosphere is the region where all the launch vehicle directly injects the combustion of gas particles. The ozone layer was in the region of stratosphere and mainly focusing on the depletion of the ozone layer. The emissions of the rockets were first appeared in 1994. The propellant combustions such as CO_2 and H_2O emissions which makes the main portion of all rockets [1]. Trushlyakov et.al the main problem is the selection of materials for the design of separable parts of missiles which causes the rapid disposal after the emissions from the exhaust of missiles or rockets. The development of materials science and structures are working to clear these major impacts. The possibility of burning the separating parts of the steps depends on the trajectory of their descent. To decrease the impact causing on the boosters of the missiles and launch vehicle, the material (such as Ti, Al etc.) is more important. The booster of the rockets is depending upon the required capacity of the launch vehicle. Now days the liquid rocket engines are constructed mostly by Nickel, Cobalt, and iron- nickel system [2]. Goo Peng-fei et.al mentioned about launching vehicles such as airplane, rocket, and arrows. This height control is related to the surrounding air. The conditions of atmosphere are pressure, temperature, wind, wind etc., are based on the relevant details. A

new type of spacecraft is flying very high at 80 km from the earth's surface. A total of 75% of the earth's atmosphere was present in the troposphere. There will be rapid atmospheric changes in all stratosphere regions (at an altitude of 15-50 km). The air is thin in the mesosphere layer where the height increases but the temperature decreases. The top (80 km) will be extremely thin, completely ionized, and neutral particles [3]. B T Suimenbayev et.al describes about the pollution not only affects the environment of ground surface but also in the atmosphere range. When the launch vehicle (LV) with some of the fuel engine likes (LRE) Liquid Rocket Engine, this impacts the atmosphere. Any kind of (LV) for example Missile, Indian rockets such as PSLV, GSLV, SLV etc. when this was launched it creates huge amount of pollution in the environment and it affects the living life, peacefully. To reduce these impacts, we can use "Irtysh" type of Oxygen-kerosene liquid rocket engine. And to solve these problems related to this, the solutions are proposed related to the unused liquid fuel [4]. Alessandro Gard et.al presented a study focusing on the development of a new bistatic system. This LADAR- Light Detection and Ranging is (RS) Remote Sensing is a tool used to analyze the shape and texture of the earth's surface and can measure gases and particles in the atmosphere. This device of various high technologies. Therefore, it can provide information on mining, weather, archeology, weather monitoring, or even more. Also, the system monitors the release of pollutant cells and aerosol. Recent research activities are performed under test and analytical testing. Research activities use an aircraft laboratory (LV) to perform vehicle testing to analyze aerodynamics before using it [5]. Alessandro Gardi et.al investigated about air quality check techniques and the recent updated techniques to check air quality. Describes about the inefficacy of currently used techniques and how it can be improvised by using updated techniques. The limitations on the operation of LIDAR usage to check the air pollution in environment and also availability. It can be further improvised in future if LIDAR is used and analyzed in a proper way. JPL et.al describes about the ways to study about climate with the help of various satellite. A set of satellites have been used to study about various layers in atmosphere and its compositions for a time. All these experiments are being carried out to understand the climate in a better way and minimize the damage that is being caused to atmosphere [6]. Gullett.B et.al describes about collecting air samples from various locations using an unauthorized system or drones to detect the pressures of CO, CO_2, NO, NO_2. These samples were collected at various locations such as industrial areas, open fires, gas discharges and volcanic eruptions. The main idea behind this is to compare the NOx ratings obtained by UAS-carried samples with the corresponding emission monitoring (CEM) measurements. The standards for UAS are accurate, secure, and fast for CEM certification [7]. Tommaso Francesco Villa et.al explains about growing pollution in today's world and in terms of naturally as well as anthropogenic emission; how pollution is affecting human life, animal life, global warming, climatic changes and also in agriculture sector. In order to study about the pollution at different places and altitudes UAS are used as it is more flexible and not harmful for human life. This mainly aims to know how flexible UAVs are and major benefits of them. UAVs mainly investigate on the atmospheric composition, climate changes and pollution. This also helps to find a solution for future applications of UAV's [8].

3. Discussion

Rocket emission: Launch vehicle that emits the exhaust gases, which affect the atmosphere especially troposphere which is very close to the earth [11]. Currently launch vehicles affects the ozone layer (Below the stratosphere and above the troposphere), it depletes the ozone layer. This stratosphere is a particularly sensitive region where the launch vehicles inject the combustion. The black carbon mainly accumulates in stratosphere and that are carried by atmospheric into hemisphere [12].

FIGURE 1. Different layer of atmosphere

Effects of earth's climate by emissions: Nowadays, as the number of launches rises, so does the rocket engine's power. The gases and particles released by rocket engines can have an impact on the climate and the ozone layer of the earth. The most common extraction of liquid water and CO_2 from liquid fuels is solid, which also releases hydrochloride (HCl). The eruption of water vapor affects the mesosphere and ionosphere. Temporary electron emissions have been observed in increasing ionospheric logs. The key products that contribute to climate change are H_2O, lead and alumina. H2O is naturally produced in vast quantities in the atmosphere, and when the temperature drops, the water vapor condenses into little ice crystals, which evaporate as the plume mixes and mixes with the air behind it. The main reason is that the amount of infrared in ice crystals is greater than the amount of sunlight they display, so in the 'net', they burn the air. Rocket engines spew large amounts of lead particles (or black carbon, BC) and alumina (aluminium oxide) into the stratosphere. The "Black Carbon" particle absorbs radiation, lowering the albedo, while the earth's alumina trash replicates the albedo's slow-growing radiation. Massive quantities of Black Carbon are emitted by fire rocket engines. This situation results in a decrease in the solar's electricity flowing into the region of the troposphere. The reduction of sunlight because of stratospheric particles is properly

understood to cool the air. So, and perhaps all of sudden, the release of rocket launchers contributes to the cooling of the earth's decrease atmosphere and past.

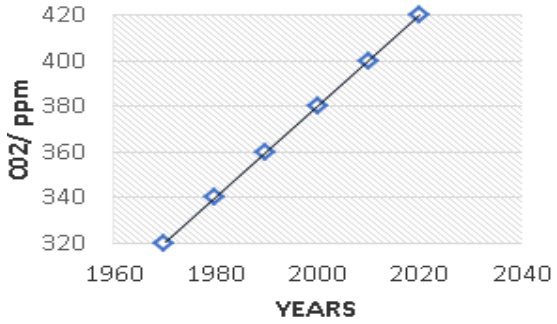

FIGURE 2. Composition of CO_2 variation along with years

Fig 1.2, clearly shown that the CO_2 is increasing rapidly for every ten years. The rocket, which uses hydrazine (N_2H_4) and nitrogen tetroxide (N_2O_4), emits a large quantity of nitrogen oxides, which can continue to react with water vapor and sulphate in the environment to form small particles with nitric acid. Hybrids are a combination of liquid oxidizer, nitrous oxide (N_2O), and tough but synthetic rubber (butadiene) which, when burned in unhealthy air, produce CO_2 and a massive amount of Black Carbon and probably a huge number of nitric oxides. The larger rockets discharged roughly 1,400 tonnes of alumina particles into the stratosphere, while the lighter rockets dropped 225 tonnes of black carbon into the stratosphere. The annual launch rate increased rapidly with 157 launches in 1967, and over the next four years it dropped to 42 in 2005. Implementation increased by 114 launches in 2008, and the number of submissions grew by 8% over a ten-year period. This launch results in the emergence of 600 tons of black carbon per year. Exhaust leads to an increase in temperatures in the north of the country above 1 ° C and more than 5% of the sea cover lost.

Elements affecting the space launch vehicles: The launch vehicle is a Rocket Propelled vehicle which is used to carry the payloads (like Satellites, crewed spacecraft, robotic spacecraft, etc.) from earth to the space. The launch vehicle travels up to certain levels in the Atmosphere according to their purpose and stages, the vehicle or aircraft should survive the extreme conditions of the space puts. The space puts the Launch vehicles, aircrafts, satellites, etc. Up to some extreme conditions like temperature, gravity, pressure, radiations, etc. So, the vehicle should survive all their factors [11]. Few of factors are described as below-

Temperature: As the temperature fluctuates high and low due to the sun and the orbits of the spacecraft will be from 17,000 to 25,000 mph, the collision of the atmosphere will bring out ambient temperatures up to 2,800°C. Pressure: As the pressure varies during launch and space, it deals with internal and external forces. Radiation: As the spacecraft travels outside the earth, radiation levels will be higher. Those in the low orbit of the earth will receive less radiation than those on highways or set to travel long distances. Solar storms can significantly increase radiation levels without much notice. Gravity: As the level of Gravity will vary accordingly, the spacecraft must survive. At the time of launch, the gravitational force would be three times the gravitational force of the earth, as long as it reaches the orbit there will be gravity. As a result of this zero access, the integrity of substandard materials or materials not designed to withstand such pressures will be affected [13]. Vibration: Vibration will not occur in space, but during launch or after launch, any weakness of the material may occur.

Trash or other impacts: The number of lost satellites in orbit continues to rise. This produces a massive debris field all over the planet, with several consequences for current orbit technology. Space debris isn't the only issue with satellite and space activities. Meteors (trash) may travel at rates of 42 kilometers per second (26 miles per second), which is faster than light. Even the tiniest spacecraft can rip a hole in the satellite's weakest part at these distances. According to studies, there are more than 128 million pieces of junk particles less than 1 cm, 900,000 pieces of trash between 1 and 10 cm, and 34,000 pieces larger than 10 cm in orbit globally as of January 2019.

Rocket Exhaust: As we use a variety of fuels in launch vehicles and other aircraft, they pollute the air and other layers of the road, which may pose a threat to the atmosphere and affect delivery vehicles and other aircraft. The need for rapid preparation of strategic arrows requires the use of a good form of fuel; that fuel was a strong refuge. While all rocket-launching engines produce pollutants that can affect the environment, the waste from solid rocket residues has been specially tested, as they contain chlorine, which is known to deplete ozone depletion in the stratosphere. The need for rapid preparation of strategic arrows requires the use of a good form of fuel; that fuel was a strong refuge. While all rocket engines that launch cars produce pollutants that can harm the environment, the waste from solid rocket reserves has been specially tested, as they contain chlorine, which is known to deplete ozone depletion in the stratosphere. The need for rapid preparation of strategic arrows requires the use of a good form of fuel; that fuel was a strong refuge. While all rocket engines that launch cars produce pollutants that can harm the environment, the waste from solid rocket reserves has been specially tested, as they contain chlorine, which is known to deplete ozone depletion in the stratosphere. The rocket extraction components contain HCl, Al_2O_3, etc. [14].

Heavy Material Selection: The composition and size of elements will be examined to verify that they can withstand stress. Space material testing cannot be done by design engineers. The conditions on Earth vary greatly from space, so the

materials used in a spacecraft will not meet the atmospheric conditions until they are introduced. To better assess the strength of objects, testers use objects using a series of high-pressure objects that will be found in space [17]. Few of parameters are mentioned below-

1. **Impacts:** Impact tests confirm that the equipment can withstand large blows.
2. **Rust:** This type of test confirms the length of life before the property is damaged.
3. **Pressure:** The pressure force is important for objects designed to feel the maximum pressure of an area.
4. **Fatigue:** Spacecraft are subjected to a great deal of stress, and fatigue testing determines how long building materials can withstand severe pressure before failing.
5. **Thermal:** Thermal testing includes exposing equipment to extremely high and low space temperatures.
6. **Flexure:** Flexure testing is frequently required for support materials to determine how much stress the components can withstand before bending.
7. **Burning:** The rate at which things burn affects how hot they are, which is connected to how quickly the fire spreads. Building materials in the safety-related areas of aerospace art must halt flames rather than move them forward [15].
8. **Thermomechanical Analysis:** Thermomechanical analysis examines how events change when temperatures rise and fall. This test guarantees that the construction components will be able to survive the elements [16].

4. Conclusion

The chemical reaction affects the atmosphere especially in the stratosphere region. These are the essential components of satellites that land in space with the help of rockets for strong suction or liquid. Distinct chemical forces have different effects on the air. This means that due to the aviation industry, agencies and aerospace-related companies including commercial and national, this is having an impact on the global climate. We know this because of the introduction of the rocket, which created many effects in the air. In today's world, many aerospace or aviation companies use a Solid or Liquid propulsion system. Compared to solid propellant, liquid hydrogen is less polluting. To reduce these causes, we can use hydroelectric power especially to reduce these causes and we can save the atmosphere in the future.

References

[1]. J Malcol K.W.Ko, Nien-Dak Sze & Michael J.Prather, Better protection of ozone layer , Nature, 665(17), 1994, 505-508.

[2]. V I Trushlyakov and K I Zharikov, Applied Mechanics and Systems Dynamics (AMSD) Journal of physics: Conf. Ser. 1791, 012-029.

[3]. Guo Peng-fei China Academy of Launch Vehicle Technology, Beijing 100076, China; 2 National Space Science Center, Beijing 2019, 100-190, China.

[4]. B T Suimenbayev , Journal of physics Phys.: Conf. Ser. 2019, 112-025

[5]. B. Stark, T. Zhao and Y. Chen, An analysis of the effect of the bidirectional reflectance distribution function on remote sensing imagery accuracy from Small Unmanned Aircraft Systems, *2016 International Conference on Unmanned Aircraft Systems (ICUAS)*, 2016, pp. 1342-1350,

[6]. Atmospheric Dynamics &Composition, Jet Propulsion Laboratory, NASA. 2016, https://scienceandtechnology.jpl.nasa.gov/

[7]. 7. Gullett, B., Aurell, J., Mitchell, W., and Richardson, J.: Use of an unmanned aircraft system to quantify NO_x emissions from a natural gas boiler, Atmos. Meas. Tech., 14, 2021, 975–981.

[8]. Larson, Robert W. Portan, Karen H. Rosenlof , Global atmospheric response to emissions from a proposed reusable space launch system, 2016, Earth's Future, 5(1), 37–48,

[9]. T. Nejat Veziroglu ,International Journal of hydrogen energy (2015)

[10]. J.A. Vedda, Orbital Debris Remediation Through International Engagement, The Aerospace Corporation, March 2017

[11]. M.N. Ross, 1997, Observation of Stratospheric Ozone depletion in Rocket Exhaust, Nature, 390, 62-64, 1997.

[12]. S.O. Andersen and K, Sarma, Protecting the Ozone Layer, Earthscan Publications, Sterling VA, 2002

[13]. M. Prather et al. (J, Geophys. Res., 95, 18583- 18590, 1990) published the first paper identifying the rocket exhaust as a source of ozone depletion. The outbreak of the following papers concluded as Chapter 10 in 1991 Scientific Assessment of Ozone Depletion (World Meteorological Association, Report No. 25)

[14]. Ross, M, 2, Potential climate impact of rocket black carbon emissions, Geophys. Res, Books, 37, 2010.

[15]. M. Ross noP. Sheaffer, 2014, Radiation impulses caused by rocket engine emissions. Earth's Future, 2: 177–196,

[16]. Ozone Extreme Scientific Survey, World Meteorological Association, Report, 2014

[17]. C. Jackman, A global modeling study of solid rocket aluminum emission effects on stratospheric ozone, 1998, Geophys. Res. Letters., 25, 907-910.