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POLLUTION POTENTIAL OF ROCKET LAUNCHING AND CLIMATIC IMPACT

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ABSTRACT:

Rockets are used in space exploration programs. The use of outer space, for communications, disaster management, education, environmental protection, and natural resource management is significant in recent times. Space science and technology are important to attain sustainable development and equitable sharing of space resources for human civilization. Rocket launching is associated with emissions of GHGs in the troposphere, stratosphere, mesosphere, and upper space. The global contribution of GHGs by rocket launching is negligible as that of other sectors. The Paper highlights modernization and the use of substitute fuel for rockets.

KEYWORDS: GHGs, troposphere, stratosphere, mesosphere

INTRODUCTION:

The first rocket was launched by Germany in 1942. Since, then, these rockets have been used for searching the extra-terrestrial world. In 1898, a Russian schoolteacher, Konstantin Tsiolkovsky (1857-1935), put forward the new proposal of space flight. The credit of modern rocketry science goes to the great English scientist Sir Isaac Newton (1642-1727). Newton's laws explain the working of rockets in the vacuum of outer space.

Rocketry as science

Solid fuels burning in the rocket have a long-term impact. Very high temperatures during rocket launching can convert nitrogen in the air into reactive NOx. It is understood that liquid hydrogen generates clean water vapour in the rocket exhaust.

Space Launch System (SLS) uses aluminium powder as the fuel and a mineral salt, ammonium perchlorate, serve as the oxidizer[1]. Aluminium is not found naturally in its pure form but is highly reactive that's why it is being used in the space programmes. In the SLS boosters, the aluminium powder, ammonium perchlorate, polybutadiene acrylonitrile is packed as a mixture, which finally is packed in a steel case.

During the initial stage of burning, oxygen in the ammonium perchlorate combines with aluminium which is converted into aluminium oxide, aluminium chloride, water vapor, and nitrogen gas, and in this process, lots of energy is generated. This reaction can create a temperature of about 5,000 degrees Fahrenheit, resulting in water vapor and nitrogen expanding so quickly to lift the rocket from the launching station. Initial launching produces over 84% of the emissions as the rocket takes off.

Release of solid fuels in air

Rocket engine during launching releases trace gases and soot particles can have a potential impact on climate and ozone layer depletion. Ammonium perchlorate is a strong oxidant [2].It reacts violently with combustible and reducing materials and metals. It produces toxic and corrosive fumes when it reacts with materials comprising ammonia and hydrogen chloride. A

high concentration of air-borne materials can react quickly when released. The air borne particles can be absorbed into the body as aerosols and by ingestion. The aerosols can also cause irritation to the eyes, skin, and respiratory tract.

A high concentration of aluminium oxide inhalation is associated with pneumoconiosis and irregular pulmonary function. Increasing concentration may be associated with neurocognitive dysfunction [3]. Aluminium Chloride can cause a burning sensation, cough, difficulty in breathing, sore throat if the concentration is high in the air. It is corrosive and irritating to the eyes, skin, and mucous membranes [4].

Water vapour generated during initial launching can act as the main source of climate change as it absorbs longwave radiation. It is estimated to add 60% of the warming effect [5].

Nitrogen gas increases the emission of nitrous oxide, which contributes 6.2%. Nitrous oxide is the essential part of the nitrogen cycle [6]. Rocket launching can initiate its concentration in the air.

Recent researches simply highlighting the release of gases during rocket launching, the released carbon dioxide in addition to existing concentration has to be worked out in recent time [7]. Carbon dioxide concentration accounts nearly 47 percent increase since the beginning of the Industrial Age [8]. The enhancement of the rocket programme can elevate carbon dioxide concentration which can be significant in climate change.

Black carbon released during rocket launching has a greater impact on arresting solar radiation and increase in heat of the atmosphere. Its contribution is estimated higher than carbon dioxide. Black carbon also has a potential role in cloud formation.

The Emission of carbon monoxide is correlated with its effects on other greenhouse gases, which are related to climate change [9].

Inorganic chlorine compounds are ozone depleting substances, irritants, their presence due to rocket emissions in the stratosphere is a cause of concern for human civilization [10]. Sulphur containing compounds are notorious both in the troposphere and stratosphere.

Critical assessment of rocket emissions and climatic impact

Rocket launching immediately releases a huge white cloud of smoke which is a mighty cloud of steam. Rocket launching can produce emissions like CO_2, water vapor, carbon soot, carbon monoxide, nitrogen compounds, Inorganic chlorine, alumina, and sulphur compounds. Emissions from rockets can have long- lasting effects starting from the troposphere to the stratosphere. Carbon dioxide, soot, and water vapor are continuing to warm up our planet. The real worries lie in carbon soot and alumina particles by putting them into the stratosphere. The fate of the stratosphere would be different than our imagination.

Modernisation and substitution of fuels

Rocket launches contributed a negligible carbon dioxide burden as compared to industries and airlines. The initial step would be to stop using solid rocket -boosting fuels. Utilizing more fuels such as methane or hydrogen will burn completely and will have an insignificant impact on climate.

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