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# Space Debris Eliminator-SAS -1

ShantanuVidwans[1], Ayush Khushu[2], Sneha Gayen[3], Keshav Sharma[4]

[1,2,3,4]*Aerospace, SRM University, (India)*

## ABSTRACT

*This Paper aims to provide an Integrated Solution for the Armageddon of Space Debris. The research involves one of the possible methods to eradicate the problem of space debris since the amount of debris in low earth orbit (LEO) has increased rapidly increasing the likelihood of cascading collisions .So far; researchers have proposed a variety of ways to reduce the number of debris. Unfortunately, all projects are yet to be completed The principles and concepts can be used to develop an electrodynamic net which would be a mesh of aluminium and steel wires that hangs from a manned spacecraft. Will deposit the debris inside the crewed spacecraft. Inside the spacecraft, the dead satellite will be subjected to a several process which are illustrated in (Table 1 ). These satellites will melt inside A Combustion chamber, of dimension 4 x6 x 4 ft. Made of W-Mo Alloy in the Ratio 25-75% which would be surrounded by a coolant System so that during an emergency situation the chamber does not get overheated leading to an explosion. This will result in slight volume reduction of the mass of satellites since they will be in Semi – solid form. This will again be transferred to a cooling Chamber via a conveyer Belt Where It Will Be Cooled by subjecting them to Coolants and deposited back into the electrodynamic net and with the help of tethers, after it is subjected to Mechanical Compression. Standard Atmospheric Pressure Must Be maintained in the Aircraft throughout the Process the resulting mass of debris can be thrown towards Venus. The atmosphere of Venus is composed of Carbon Dioxide and thus is much denser and hotter than Earth. Hence, if the debris is directed towards Venus, then it will get destroyed completely.*

***Keywords-Space debris eliminator, SDE-SAS-1, Space debris, Laser Broom, Satellite***

**CONTENTS OF THE RESEARCH PAPER**

## I. INTRODUCTION

Space debris, Space junk, Space waste, Space trash, or Space litter is the collection of defunct human-made objects in earth orbit, such as old satellites, spent rocket stages, and fragments from disintegration, erosion, and collisions including those caused by the space debris itself. They are of 2 types – Artificial and Natural. Natural Space Debris aresmall pieces of cometary and asteroidal material called meteoroids. The Artificial Space Debris are the ones such as dead spacecraft, lost equipment, Boosters, Weapons, cones, payload covers, shrouds, bolts and other launch hardware,etc.

### 1.1. Why Are Space Debris A Threat?

1. The main worry about space debris is possible collision with active or functioning satellites or spacecraft.
2. Small pieces of space debris (less than 1/10 mm) are prolific enough to cause erosion of optical surfaces. This is like sandblasting, and can ruin telescope mirrors, and decrease the efficiency of solar cells.
3. It is believed that any fragment of space debris larger than 1 centimetre will penetrate the walls of existing satellites/spacecraft.
4. It will lead to a Kessler syndrome - Although most manned space activity takes place at altitudes below 800 to 1,500 km (500 to 930 miles), a Kessler syndrome cascade in that region would rain down into lower altitudes and the decay time scale is such that "the resulting [low Earth orbit] debris environment is likely to be too hostile for future space use".
5. Space junk is a threat to active satellites and spaceships. The earth's orbit even become impassable as the risk of collision grows too high.
6. Estimated Amount of Space Debris in Orbit: More than 500,000 pieces of debris, or "space junk," are tracked as they orbit the Earth. They all travel at speeds up to 17,500 mph (Fig1). Hence the nature of the problem is quite serious.

### 1.1. Current Space Debris Removal Methods

In June 2007 the United Nations General Assembly adopted a set of 7 orbital debris mitigation guidelines for member states (countries) to follow.

Most space-faring countries realise that space debris is a problem and have their own programs to try and reduce the creation of more space debris in future space activities

The Japanese Aerospace Exploration Agency proposes to use an electrodynamic tether whose current would slow down the speed of satellites.

NASA proposes that geostationary satellites to move to a graveyard orbit at the end of their lives; the selected orbital areas do not sufficiently protect GEO lanes from debris. Rocket stages (or satellites) with enough propellant may make a direct, controlled de-orbit.

Giant "sponge" like objects could be deployed to "catch" or "soak up" small debris pieces. After a time, the sponge would be removed from orbit

### 1.2. The Shortcomings which are associated with Current Methods are -

There is no binding international regulatory framework with any progress occurring at the respective UN body in Vienna.

The problem is that these programs do not reduce the amount of debris that is currently in orbit.

Removal of the largest debris would be required to prevent the risk to spacecraft becoming unacceptable in the foreseeable future (without any addition to the inventory of dead spacecraft in LEO).

Removal costs and legal questions about ownership and the authority to remove defunct satellites have stymied national or international action. Current space law retains ownership of all satellites with their original operators, even debris or spacecraft which are defunct or threaten active missions.

Unable to Provide all-round integrated solution for space debris removal.

### 1.3. The Purpose of the Project is -

To Overcome the Shortcomings of the current methods and to try and provide an Integrated Solution to reduce the amount of Space Debris.

## II. COMPOSITIONOF SATELLITES BY MATERIAL USED

Aerospacematerials are materials, frequently metalalloys, that have either been developed for, or have come to prominence through, their use for aerospace purposes.

These uses often require exceptional performance, strength or heat resistance, even at the cost of considerable expense in their production or machining. Others are chosen for their long-term reliability in this safety-conscious field, particularly for their resistance to fatigue.

The Most Prominent Materials that are used in Satellites are as follows -

Primary

1. Aluminium
2. Magnesium
3. Beryllium
4. Titanium

Secondary

1. Gold
2. Polymer –Matrix
3. Super Alloys

The Melting and Boiling Points Are Enlisted Below -

| **Metal** | **Boiling Points** | **Melting Points** |
|---|---|---|
| Aluminium | 2470 | 660 |
| Magnesium | 1091 | 650 |
| Beryllium | 2970 | 1287 |
| Titanium | 3287 | 1668 |
| Gold | 2700 | 1064 |

Super Alloys : Forging Temperatures Are 500-1250 Celsius.

*Table 1.1: Melting and Boiling Temperatures of Satellite Materials*

The above mentioned values are in Degree Celsius. Thus The Working Temperature of the Combustion Chamber Is 1700 Celsius.

## III. SPACE DEBRIS ELIMINATOR –SAS-1

In this the Dead Satellite is made to Undergo 4 Processes as Illustrated in (Table 2). Firstly, the Dead Satellite is attracted towards the Space Shuttle while it is entangled in the Electrodynamic Tether. Then it is deposited in the Combustion Chamber where it is subjected to High Temperatures (around 1700 Celsius) to cause melting the Dead Solid Satellite is converted into a Semi- Liquid Form. After which it is moved in to a Cooling Chamber where it is subjected to a Coolant so that it freezes. The melting of the Dead Satellite has caused Volume Reduction. Then the melted (Not Completely) is subjected to Mechanical Pressure where it is compressed and finally is ejected out of the Space Shuttle at a Specific Trajectory towards Venus or any available Trajectory Ejection is carried out by a force. This is the basic system the Dead Satellite goes through.

### 3.1. Components of SDE-SAS-1

1. Electromagnetic Tether
2. Combustion Chamber
3. Coolant System
4. Cooling Chamber
5. Compression Chamber

#### 3.1.1. Electromagnetic Tether

Electromagnetic (EDTs) are long conducting wires, such as one deployed from a tether satellite which can operate on electromagnetic principles as generators, by converting their kinetic energy to electrical energy, or as motors, converting electrical energy to kinetic energy. Electric potential is generated across a conductive tether by its motion through a planet's magnetic field.

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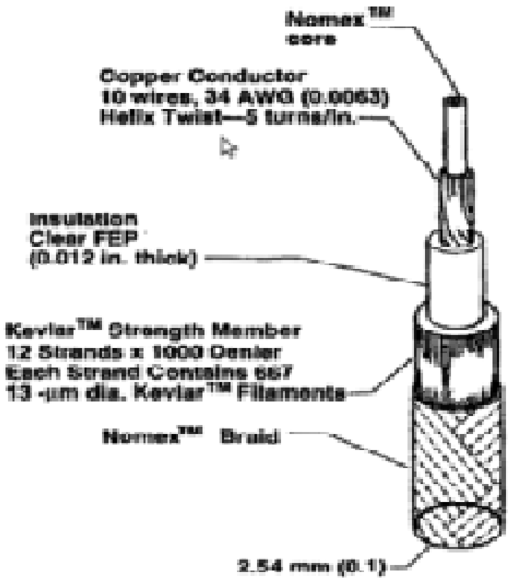


***Figure 1.Electro Dyamnic Tether***

Tether Propulsion

As part of a *tether propulsion* system, crafts can use long, strong conductors (though not all tethers are conductive) to change the orbits of spacecraft. It has the potential to make space travel significantly cheaper. When direct current is applied to the tether, it exerts a Lorentz force against the magnetic field, and the tether exerts a force on the vehicle. It can be used either to accelerate or brake an orbiting spacecraft.

The choice of the metal conductor to be used in an electrodynamic tether is determined by a variety of factors. Primary factors usually include high electrical conductivity, and low density. Secondary factors, depending on the application, include cost, strength, and melting point.

An electromotive force (EMF) is generated across a tether element as it moves relative to a magnetic field. The force is given by Faraday's Law of Induction (Equation 1

$$V(\text{emf}) = \int_0^L (\vec{v} \times \vec{B})\, d\vec{L}$$

Equation 1

Without loss of generality, it is assumed the tether system is in Earth orbit and it moves relative to Earth's magnetic field. Similarly, if current flows in the tether element, a force can be generated in accordance with the Lorentz force equation.

$$\vec{F} = \int_0^L I\,(L)\,\overrightarrow{dL} \times \vec{B}$$

Equation 2

**3.1.2. Combustion Chamber**

It is a Chamber has Dimensions of 4x6x4 Ft and is made up of an Alloy of Tungsten and Molybdenum. In the Ratio 25-75 % .The Alloy was chosen because it has a Melting Point (Depending On the %) It varies but is always more than 2620 Celsius. So it can easily withstand the working temperature of Combustion Chamber is around 1700 Celsius. The Thickness of the Chamber is around 5 Inches.

### 3.1.3. Coolant System

The Coolant System is provided to the Combustion Chamber to avoid Heat Transfer. By reducing heat transfer, we can improve the Efficiency by a Slight Value. The Coolant Circulated is Ammonia (NH3). Active thermal control systems (ATCS) pump fluids through closed-loop pipes.

Because of ammonia's vaporization properties, it is a useful coolant. Anhydrous ammonia is widely used in industrial refrigeration applications and hockey rinks because of its high energy efficiency and low cost. It suffers from the disadvantage of toxicity, which restricts its domestic and small-scale use.

Ammonia coolant is also used in the S1 radiator aboard the International Space Station in two loops which are used to regulate the internal temperature and enable temperature dependent experiments.

### 3.1.4. Cooling Chamber

The Cooling Chamber will be Approximately the same size of the combustion chamber. Made up of Aluminium. When helium is cooled below its critical temperature of 5.2 K to form a liquid. Even at absolute zero (0K), helium does not condense to form a solid.

Advantage of gaseous Helium is its operation window: it can be used at any temperature between ambient down to approx. 10 Kelvin. Restrictions that you might have with other fluids like liquefaction and or freezing are no issue with Helium gas. If the gas is pressurized sufficient density is available for proper heat transfer.

### 3.1.5. Compression Chamber

The Compression Chamber is a Mechanical/ Hydraulic Press that crushes and compresses the Satellite. In such a way it undergoes reduction of Mass and Volume. Like the Cooling Chamber it to is made up of Aluminium. As it is Light in Weight.

### 3.2. Processes That Take Place in SDE-SAS-1

The Satellite is subjected to various processes to reduce its Mass and Volume as the Satellite is Non Functional and No Longer of any use to its owner's .The Components of the Satellite can be treated as Waste. So there is no Pilfering on Satellite Components that is required. The Satellite is subjected to various Extreme Processes that are sequentially named below;

Assimilation
Combustion (or) Melting
Rapid Cooling
Mechanical Compression
Ejection

*Table 1: Sequential List Of processes In SDE-SAS-1*

### 3.2.1. Assimilation

Conductive tether whose area maximizes electrodynamic drag while simultaneously minimizing the Area-Time-Product swept by the tether during its operating life. The preferred tether length is two kilometres to five kilometres. The preferred tether mass is one per cent to five per cent of the spacecraft mass.

The same principles and concepts can be used to develop an electrodynamic net which would be a mesh of aluminium and steel wires that hangs from an uncrewed spacecraft. The net is fitted with sensors that look for light reflecting from small pieces of debris and automatically aligns itself so that it can attract the material. An electrical current will flow through the wires, which creates an electromagnetic field reacting with the Earth's magnetic field that attracts the debris after which it will deposit the debris inside the uncrewed spacecraft

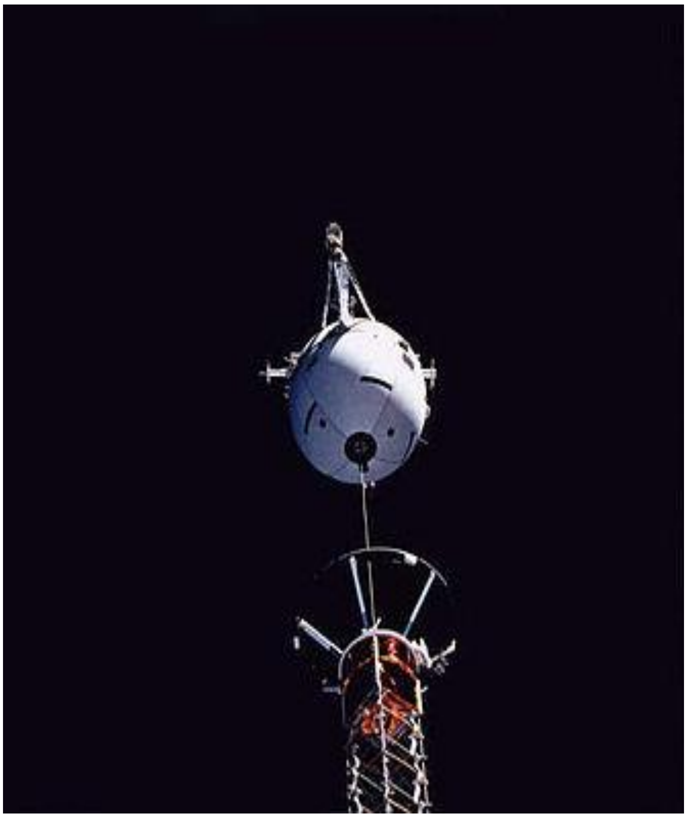

**Figure 2 .Medium close-up view, captured with a 70mm camera, Shows tethered satellite system deployment**

### 3.2.2. Combustion and Melting

The Dead Satellite is subjected to a High Intensity Laser Beam where it is melted to a minimum so that it undergoes a volume reduction.High average power lasers, e.g., free electron lasers (FELs) and solid-state lasers (including fiber lasers) are prime candidates for efficient, directed energy applications. These include laser power beaming and laser weapons, requiring multi-kWs of CW power operating in the IR regime.

High-intensity lasers operate in a different regime, e.g., peak powers of $\sim 10^{12}$–$10^{15}$ W, pulse lengths of $\sim 10^{-12}$–$10^{-14}$ s, intensities of $\sim 10^{14}$–$10^{23}$ W/cm$^2$, and repetition rates ranging from $10^3$–$10^6$ Hz with average powers of >10 W. These lasers are used in high-field physics research and have numerouspotential applications.

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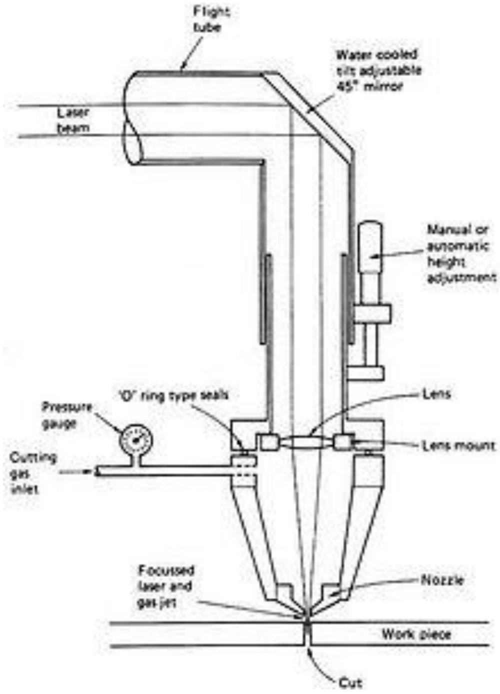


**Figure3. Diagram of Laser**

### 3.2.3. .Rapid Cooling

In This The Molten State The Satellite Is Moved Into The Cooling Chamber Via A Conveyer Belt. Where It Is Subjected To A Coolant So That The Melt Is Frozen To Shape And Can BE Made Easily Feasible For Mechanical Compression.

The Coolant can either be Ammonia (Liquid) or it can be Helium Gas. Depending upon Availability and Economic Constrains. The Gas will be sprayed On the Melted Satellite So That It Undergoes Rapid Cooling and becomes Brittle, thus can be easily compressed By Mechanical Compression. So In This Stage the Molten Properties of Satellite materials (Table) Are Exploited.

### 3.2.4. Mechanical Compression

In This A Hydraulic Press (Figure) Is Used To Crush The Frozen- Melted Dead Satellite. The hydraulic press depends on Pascal's principle: the pressure throughout a closed system is constant. One part of the system is a piston acting as a pump, with modest mechanical force acting on a small cross-sectional area; the other part is a piston with a larger area which generates a correspondingly large mechanical force. Only small-diameter tubing (which more easily resists pressure) is needed if the pump is separated from the press cylinder.

Pascal's law: Pressure on a confined fluid is transmitted undiminished and acts with equal force on equal areas and at 90 degrees to the container wall.

A fluid, such as oil, is displaced when either piston is pushed inward. Since the fluid is incompressible, the volume that the small piston displaces is equal to the volume displaced by the large piston. This causes a difference in the length of displacement, which is proportional to the ratio of areas of the heads of the pistons, given that volume = area × length. Therefore, the small piston must be moved a large distance to get the large piston to move significantly. The distance the large piston will move is the distance that the small piston is moved divided by the ratio of the areas of the heads of the pistons. This is how energy, in the form of work in this case, is conserved and the law of conservation of energy is satisfied. Work is force applied over a distance, and since the force is increased on the larger piston, the distance the force is applied over must be decreased.

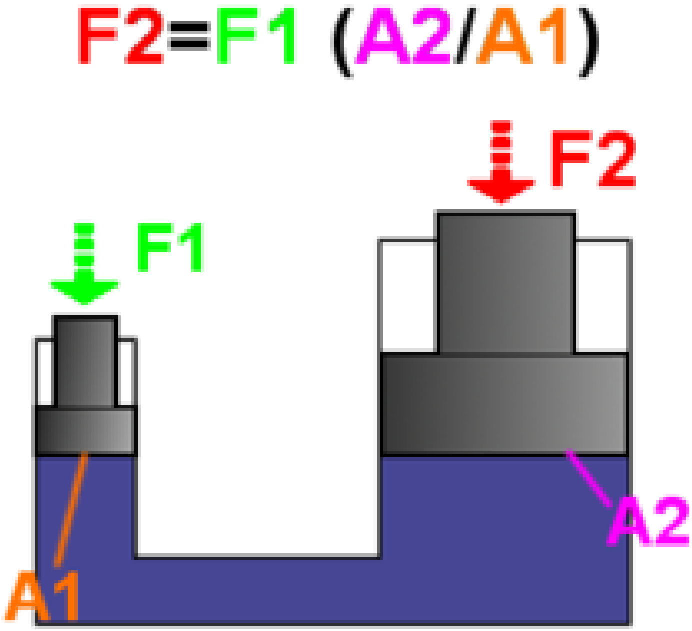


**Figure 4.Hydraulic force increase**

## IV. SOLUTION FOR MICRO SATELLITES AND LOWER SCALE

The laser broom (Figure) uses a ground-based laser to ablate the front of the debris, producing a rocket-like thrust which slows the object. With continued application, the debris would fall enough to be influenced by atmospheric drag. The momentum of the laser-beam photons could directly impart a thrust on the debris sufficient to move small debris into new orbits out of the way of working satellites. NASA research in 2011 indicates that firing a laser beam at a piece of space junk could impart an impulse of 1 mm (0.039 in) per second, and keeping the laser on the debris for a few hours per day could alter its course by 200 m (660 ft) per day. The ablating material imparts a small thrust that lowers its orbital perigee into the upper atmosphere, thereby increasing drag so that its remaining orbital life is short.[3] The laser would operate in pulsed mode to avoid self-shielding of the target by the ablated plasma. The power levels of lasers in this concept are well below the power levels in concepts for more rapidly effective anti-satellite weapons. Space debris is re-entered regardless of the direction of laser illumination. Using a laser guide star and adaptive optics, a sufficiently large ground based laser (1 mega joule pulsed HF laser) can deorbit dozens of objects per day at reasonable cost

Figure 5. Artistic representation of Laser Broom

## V. WHY VENUS FOR DUMPING THE COMPRESSED SPACE DEBRIS

Venus is a terrestrial planet and is sometimes called Earth's "sister planet" because of their similar size, mass, proximity to the Sun, and bulk composition. It is radically different from Earth in other respects. It has the densest atmosphere of the four terrestrial planets, consisting of more than 96% carbon dioxide. The atmospheric pressure at the planet's surface is 92 times that of Earth, or roughly the pressure found 900 m (3,000 ft) underwater on Earth. Venus is by far the hottest planet in the Solar System, with a mean surface temperature of 735 K (462 °C; 863 °F), even though Mercury is closer to the Sun.

Venus is shrouded by an opaque layer of highly reflective clouds of sulphuric acid, preventing its surface from being seen from space in visible light. Thus Venus Was Chosen.

## VI. CONCLUSION

Space debris has become the topic of great concern in recent years. Space debris creation can't be stopped completely, but it can be minimized by adopting some measures. Many methods of space debris mitigation have been proposed earlier by many space experts, but some of them have limitations in them. After some modification those measures can be proved beneficial in the process of space debris mitigation.

The Research Paper has reminded us about the Urgency to Deal with Space Debris, How Is It Harmful, What Are is The Current Research going on, explained to us the Concept (SDE-SAS-1)and the Various Processes. Also Has Given Us Something to Ponder About

We have already polluted our own planet earth; we should now ensure that the space is kept least polluted for our own safe exploration of the outer space and also for the safety of aliens from other planets if they happen to exist.

In this Project there is no loss of initial raw material like the Tether.

1. There is no residual waste.

2. The Waste is Completely Demolished instead of storing it in graveyard zones / orbits unlike the solution proposed by NASA.
3. One time Solution.
4. It requires only a one time investment of materials like Tether.
5. Diminish the chances of a catastrophic event like a Kessler's Syndrome.
6. A Solution for both satellite ranges above 10 cm and Below 10 cm in Size.
7. Solar Panels will be used to power the system and the Shuttle.

We the Authors would like to conclude our Research Paper titled "SpaceDebris Eliminator-SAS-1" by Reminding the Future Generation.

"Pessimism Can Never Lead To Innovation "

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