References

1. Borovskiy E.E. Wastewater: chemical pollution of the hydrosphere // Chemistry. 2012, № 6. pp. 3–12.
2. Vermiculite. https://en.wikipedia.org/wiki/Vermiculite (accessed 11 May, 2016).
3. Mesyats S.P. Versoil – natural sorbent to reduce oil pollution. Science of Moscow and regions, 2004. № 2, pp. 64 –69.
4. Vakalova T.V., Habas T.A., Pogrebenkov V.M., Vereshchagin V.I. Clay. Structure, properties and methods. Tutorial. Publisher TPU Tomsk. 2005. 260 p.
5. Chemistry and Life (Soltersovskaya Chemistry) Part III. Workshop. Moscow, 1997. 406 p.
6. Lurie Yu.Yu, Rybnikov A.I. Chemical analysis of industrial wastewater. Ed. “Chemistry”. 1966. 278 p.

GOSSAMER ORBIT LOWERING DEVICE AS A WAY TO SOLVE THE PROBLEM OF SPACE DEBRIS

Startseva D.A., Devyatova K.P.
Tomsk Polytechnic University, Tomsk
Scientific supervisor M.V. Kuimova, PhD in Methods of TFL, Associate Professor of TPU

Nowadays people have become increasingly aware of their responsibility towards future generations for the environmental pollution. It is undisputable that the destruction of the environment has serious impacts upon the quality of life in the future. At present, no one is as eager to conquer nature as it was in the early twentieth century. Humanity is facing the need of secure development and requires new knowledge about the environment and new technologies. We need to manage our natural resources more reasonably, improve the environment and protect human health. It is impossible to solve these challenges without the study of ecology and development of ecological knowledge. Environmental knowledge helps explain not only unknown aspects of reality, but also environmental risks and restrictions in relation to human activities.

Currently, much has been written about the alarming pollution of the atmosphere, oceans, rivers and soil [1, 2, 3]. Environmental pollution is associated with health problems. Emissions of greenhouse gases lead to global warming and contribute to the depletion of the ozone layer. Various

forms of pollution negatively affect human life and wildlife. In this paper we are going to research space pollution. Space debris or "space junk" encompasses both natural (meteoroid) and artificial (man-made) particles. Meteoroids are in orbit about the sun, while most artificial debris is in orbit about the Earth.

The growth of space debris in Earth orbit may lead to the termination of manned and unmanned missions. Even the smallest particle of space debris may represent a great danger because it travels at a speed of nearly 15 kilometers per second.

Scientists and engineers develop many different strategies for the removal of space debris. These include:

- Ballistic Orbital Removal System (rockets filled with water can be sent into space. After they unload their cargo on the orbit, a field of crystallized water will appear. Space debris will fall in the field, slow down and descend from the orbit);
- CleanSpace One (robots will move large fragments and satellites to re-entry into the atmosphere);
- Gossamer Orbit Lowering Device (large and thin balloon which will rotate the object and increase its aerodynamic drag in a few hundred times, thereby causing it to fall into Earth's atmosphere);
- ElectroDynamic Debris Eliminator (capture orbital debris in a net, then drag it down out of harm's way);
- Laser Orbital Debris Removal (powerfully pulsed lasers which will shoot from the surface and create plasma jets on space debris. This will cause the debris to slow down and re-enter the atmosphere falling into the ocean).
- Telescope with laser (a giant laser on a space telescope will explode the junk in orbit);
- Surrey Space Centre (this system will remove objects from orbit due to aerodynamic drag and momentum exchange with charged cables and ionospheric plasma);
- Tungsten dust in low orbit (we could release a cloud of tungsten dust in orbit to create atmospheric resistance).

In this paper, we are going to research Gossamer Orbit Lowering Device.

Global Aerospace Corporation is developing a Gossamer Orbit Lowering Device (GOLD) for safe and efficient removal of dangerous space debris from Low Earth Orbit (LEO). The patented GOLD system concept uses a very large ultra thin balloon envelope to increase the aerodynamic drag. This will cause the space debris enter the earth's atmosphere and burn up. It will reduce the natural orbit decay of some objects from centuries to

months. The computer-generated image below illustrates GOLD system de-orbiting a large scientific observatory.

Figure 1. GOLD system

The envelope material is thinner and lighter than sandwich bag material. The system will work even though it gets punctured many times by small debris objects and tiny meteoroids. Despite these small holes, the total leak rate will be very low. The pressurization system will easily keep the leakage. Even if a large object hits the thin envelope, it will not cause the breakage into new fragments.

Although the ultra thin envelope could be the size of a sports field (100 m diameter) when inflated, it is so thin that it can be folded and stowed in a surprisingly small volume (a medium size suitcase). There are three possible applications of GOLD. It can be attached to a spacecraft or rocket upper stage before launch and deployed after the end of mission. However, GOLD could be attached to existing large debris objects using an orbital robot. For large dense objects that could pose a hazard to people or property on the ground during reentry, GOLD can be used to aim the reentry safely into an ocean.

We tend to think of space as being a complete vacuum, but there are enough molecules and atoms to produce a small but noticeable drag that slowly reduces the orbital altitude of spacecraft. GOLD takes advantage of this effect and increases it. The air at these altitudes has a very small density. Sun spot activity is known to follow an eleven-year cycle, with an associated cycle in the radiation coming from the sun. At “solar max”, the extra radiation causes the Earth’s atmosphere to bloom outward, increasing the average air density in LEO by a factor of three. When GOLD is attached to a

spacecraft, it is usually beneficial to wait until the solar max to use it because then it brings down three times faster than average.

In summary, the operation of GOLD has a lower risk of disabling than other operational satellites and a lower risk of creating large orbit debris. In addition, GOLD does not require an operating satellite to provide attitude stabilization or power as with propulsive de-orbit. GOLD can be integrated onto the satellite prior to launch or attached to derelict satellites by robots. De-orbit from LEO can be reduced, in some cases, from many centuries to as little as a few months. Finally, GOLD can assist civilian, commercial and military space satellite operators in meeting their obligations to mitigate the growing space debris problem in a cost effective and low risk way.

References

1. Berkes F. Sacred Ecology: Traditional Ecological Knowledge and Resource Management. 1999. 232 p.

2. Huntington H. Using traditional ecological knowledge in science: methods and applications // Ecological Applications, 2000, Vol. 10, Is. 5, pp. 1270–1274.

3. Whyte K.P. On the role of traditional ecological knowledge as a collaborative concept: a philosophical study // Ecological Processes, 2013, 2:7. DOI: 10.1186/2192-1709-2-7.

PEDOMETER – PULSOMETER

Torbogoshev A. A.
Tomsk Polytechnic University, Tomsk
Scientific Supervisors: Ivanova V. S., associate professor at the Department of Precision instruments , Gormakov A. N., Ph.D., associate professor at the Department of Precision instruments.

A pedometer is a special device which designed to automatically calculate the traveled man’s steps. Currently, pedometers are used not only by military or athletes, but also by all those who take care of their health. Handed pedometer is a way to control calories. There are various types of this device, among which primarily mechanical and electronic one distinguish. Mechanical pedometer, which is attractive to its low price, has the following principle of operation. Each step forces to move from side to side some weight in the device. As a result levers move – it is the result of counter indications increasing. Electronic pedometers have broader