Navi Mumbai Science Foundation

EdUREKA

Education for Spirit of Science

Volume 4, Issue: No. 2 **April-June 2022**

Microplastic under microscope

Navi Mumbai Science Foundation

[Regn. No.: Maha/2592/10/ (Thane)
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Editor-in-Chief: **Dr. P. K. Joshi**
Reach me: pkkjoshi@gmail.com / 9969000848

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Address
B-51, Gitanjali, Plot No.52, Sector-17,
Vashi, Navi Mumbai-400703.

Webpage
www.navimumbaisciencefoundation.org
Email: edureka.nmsf@gmail.com
Contact No.: 022-27891475
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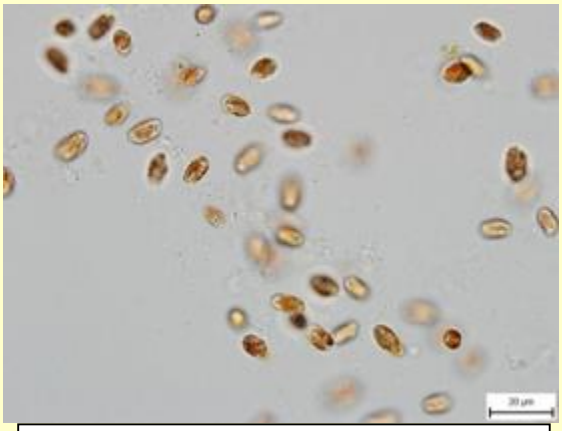
This is a quarterly e-magazine published by Navi Mumbai Science Foundation, a society engaged in spreading science education and scientific temperament among students of Navi Mumbai region for the last one decade. The magazine will mainly cover activities and articles on science education useful to students, teachers & society at large.

Contents .....



Microplastic under microscope

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From Editor's Desk!!....

Editor's Corner

Dear Readers, students and teachers, we continue with our endeavor to bring articles to you which will give you a different perspective to things that you already know or introduce you to new concepts. Walking in that direction, this time we bring you articles written by people who have devoted their lives to science and science popularization.

This time the articles written by students take the centre stage. The essays of the winners of Vikram Sarabhai Essay competition (VSEEC-2021), held by NMSF and New Horizon public School, Airoli, are included in the issue.

These essays are almost in the original form, as they were submitted for the competition. They are very well written, on the topic of challenges in long space travels. One of the points which gets highlighted is that energy never comes for free and that there are no perpetual machines (output greater than input).

In addition, in the students' corner, an article written by a student on a topic on which the student received an award on a science project, has been included. The award was received at the Indian National Science and Engineering Fair held online in 2019. The National Science and Engineering Fair is held every year by Science Society of India (http://www.sciencesociety.in/). In continuation of the series of experiments without equipment, we bring to you the invention of voltaic cell, its history and development, which incidentally began with a very hilarious and funny accident, leading to very important discovery of our planet.

I encourage students and teachers to go through the activity section of our magazine. These activities are designed to develop the basic requirements of science learning. These can also be adopted by teachers in their classrooms.

Vikram Sarabhai Essay-cum-Elocution Competition-2021

An essay competition was conducted for higher secondary school students on Space technologies. In this annual feature, this year's theme was "Recycling technologies, a must for survival in space". Following are the four essays that won the prizes in the competition.

Essay in the First position.

Recycling Technologies: A must for survival in space

"Space – The final frontier" the catch phrase of the famous TV and movie series "Star Trek" amply describes the excitement that humans have for the unchartered and unexplored vastness that surrounds us. It has been 60 years since a human few into space since then, there have been a number of crewed flights. With it, the need to ensure survival / health / comfort of the crew in these space missions has also risen. And in that we also face the problem of managing waste produced by the crew. In fact, this is a very important problem that needs innovative solutions.

It is calculated that on an average, four astronauts generate 2500 kilograms of waste during a space mission that lasts for a year. Some of the wastes that the crew produces are fabrics, foam, food packaging, human waste, hygienic wipes, low-and-high-density plastics, nitrile gloves, paper etc. Theis poses physical as well as biological hazards to the crew apart from taking up space which is severely limited in spaceships.

The current method of processing the waste by storing it in a vehicle to be sent back to earth or burnt in the atmosphere will not be available for long distance space travel that is beyond the low earth orbit. Hence the need to recycle waste, so that – the hazard from the waste is reduced, the waste repurposed and reused to the extent possible and space freed up inside the space vehicle. Here come the recycling technologies

The current technology of managing waste is by using a high temperature reactor to burn the waste into gases and then filter out impurities and then collect water and to her gases (CO, CO_2, H_2) which upon further processing in secondary reactors provide highly useful oxygen (for breathing) and methane that can be used as propellants. Conversion of waste into gas propellants in low earth orbit are estimated to provide 660 to 330 kg of propellants that can be used for maneuvering the space vehicle (which also leads to reduce propellant storage tank requirements leading to savings of space and propellant load). However, collecting waste and feeding them into the

reactor needs more tuning and better automation since the current highly manual system poses leakage / pollution hazards in spaceships.

The solution for reusing the plastics that are broken and out of use is polymer Recycling System. This is being developed to reprocess plastic waste into feedstock for 3D printing machines. These machines can print useful plastic wares and spare parts for the crew. This is a very useful technology to build the needed space parts and other things from broken and worn-out plastic parts.

This refabricator will be useful in recycling plastic items such as foam. As most the materials are delivered to the space station are protected by foam or plastic bags, these used bags or foam can be loaded into the refabricator and the machine will deliver useful items such as simple medical equipment, eating utensils, wrenches, etc. This can further be extended to using space debris and other materials available on planet surfaces and feedstock.

A closed loop water recycling system on board the international space station currently circling the earth is a case in point, capturing waste water from urine sweat and even moisture from breath, the impurities are then filtered out and the water hence produced is used by crew members as drinking water and for bathing purposes. Approximately 93% of all water is collected and recycled, thereby greatly reducing need to carry water.

In addition to recycling air and water, to enable longer time space missions, we need systems capable of reusing human waste to regenerate food. As pre-packaged food has its limitations, the ability to grow plants in space is one of the most important efforts in recycling and reusing the crew's waste products.

Plants need carbon and soil rich in nitrogen content and a regular supply of water and carbon dioxide. Humans in some way create all these products as waste, which can be used by plants to provide food and oxygen. So growing plants achieves both recycling of the crew's waste products besides revitalizing the air/ providing food. Astronauts have been able to grow lettuce, peas and radishes and sun flowers already in spaceship and we have to further this ever more. Key challenges here are achieving plant growth in micro gravity situation, providing lighting for photosynthesis – such lighting consumes high levels of energy posing its own set of challenges.

There have been what are called plant pillows in the space ship made of calcinated clay, heated to high temperature to remove microbes and containing fertilizers. Dried seeds are planted in these plant pillows and watered. These are placed inside greenhouse chambers that provide light and conditions that are right for the plants. Minimal water is administered directly to the roots. Care is also taken to circulate air inside the chambers. There have to be more of such experiments that further these

sorts of solutions. Hence, plants provide a primary means of reclaiming oxygen from carbon dioxide purifying waste through transpiration filtering and proving food.

Creating genetically engineered bacterium fungi, etc. and to use them in anaerobic recycling of petrochemical products such as plastics is a promising field of study. bacteria and fungi are also beneficial for growing crops in the harsh environment of space.

Long- term space exploration will definitely have to prioritize food, water oxygen, fuels to ensure sustenance of humans in space. Additionally, the treatment / recycling of growing pile of expended waste materials has also to be prioritized so as to ensure continued availability of above critical items and also to minimize space usage and load to carried.

Long-term missions and permanent habitats in other heavenly bodies will need a great deal of innovative efforts in terms of waste management. Long-term space habitation will demand extremely efficient management / recycling of water. The recycling techniques discussed provide some solutions to this end. this will not only help in space but application for these technologies will also go a long way in saving or home that is earth. So let us be prepared when we adventure into the vast outer spaces – "Where no one has gone before"

Ms. Raksha Kandaswamy

Podar International School CBSE, Nerul

Essay in the Second position.

Recycling Technologies: A must for survival in space

Introduction

The international space station (ISS) is a unique scientific podium and an orbiting laboratory that has facilitated researchers over 106 countries to conduct various in vitro trials in microgravity. Although each ISS scientist has varied scientific goals, the collective objective is to encompass skill and knowledge reaped to benefit humankind. Going green is no longer just an earth thing, the need for sustainability extends beyond scope of picking up geospatial refuse.

Recycling has a key role in growing and stimulating extraterrestrial economy by maximizing resources availability through converting mission waste into useful commodities. The basic of survival in space such as war, air, protecting from radiation even things like bathing and laundry needs to be evaluated by keeping sustainability in mind.

The emerging application of outer space for the progression of standard of living and quest of wisdom has led to the growth of space junk or space debris in orbits where a large number of satellites are operational. The fact is that even if the upcoming space launches are called off, the debris that already exists will be tendering threats for numerous decades to come before all of them reenter the earth and burn off. the space system designers have reported that there is no foolproof technique of tracking down and mitigation of space debris having the size between 1 and 10 cm which could cause significant damage to operational spacecraft etc.

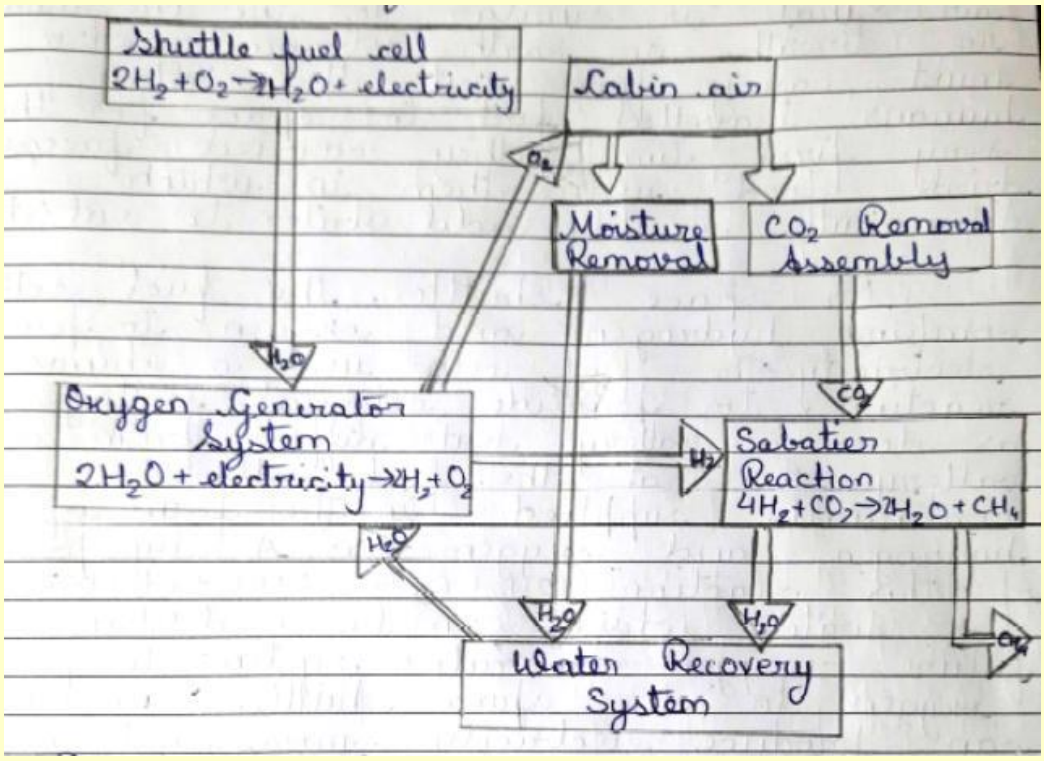
Methodology and Recycling

So, it is mandatory for recycling of waste on board and energy conservation system to convert the space debris into fuel and feigned soil.

a) Recycling of human needs

Astronauts have basic needs. They need food, water, air and rest for survival. These needs are usually easy to meet on earth. But to meet these needs in space is a very complicated process. There are no gases at all to support life in space. This is what scientists call as vacuum. Space shuttles have their own sources of gases which they carry and provide them to their passengers. They carry oxygen and Nitrogen to provide air that is similar to the one which we breath on earth. Astronauts also must carry food with them. When humans travelled to the space for the very first time, they carried freeze dried food with them in which astronauts would add water to eat it.

On space shuttle the fuel cells combine hydrogen and oxygen to produce electricity. The fuel cells use a chemical reaction to provide external voltage as does a battery but differs from a battery in that the fuel cell is continually supplied in the form of hydrogen and oxygen gas. A by-product of this reaction ($2H_2 + O_2 \rightarrow 2H_2O$ + electricity) is water which can be used by future oxygen generator system to provide oxygen to the space shuttle. Fuel cells can produce electricity more safely and efficiently than just burning hydrogen to produce heat to drive the generator. Water supply is a limiting factor on ISS. When the space shuttle can't routinely provide its passengers with water. With two crew members recycling of water is a more complex process than recycling of air because water on space shuttle produced by fuel cells then store. Even the urine of the astronaut is recycled and stored. Thus, ISS uses both physical and chemical processes for recycling as well as filtration and temperature sterilization in order to make sure that the water is safe to drink



b) Recycling debris

Debris which are generated in the space orbit is also very dangerous for satellite etc. As both, the space shuttle and debris are moving at extremely high speeds, the impact of even one small space junk with spacecraft can cause major problems.

The space debris are increasing in number which is very dangerous so recycling them can reduce the risk of threat. The following are the methodology of recycling space debris

1) Debris collection by space broom method

2) Debris sorting

3) Debris melting method

4) Powder fuel production

By high velocity jet atomization process in space lab, the molten debris are converted in to small granules and the water is recycled, filtered and stored for further use. The water which is required for atomization administration is acquired by recycling, alkaline cell and electrolysis method.

The powders are separated and used for different purposes. the Silicon powder segregated from the debris powder is converted and used in artificial soil in ISS for vegetation as it has the mineral nutrients required by a plant. The powders, essentially Aluminum, could be used as micro thrusters in nanosatellite or any propulsion device in space lab as it has properties of a solid propellant.

Conclusion

So from the point of economy in mission, scarcity of basic needs in space and less weight of spacecraft recycling technology is must for survival in space.

“Going green is no longer just an earth thing. The need for sustainability extends beyond the scope of picking up geospatial refuse.”

Ms. Surasa Ghosh

Atomic Energy Central School 2,

Mumbai

Essay in the third position.

Recycling Technologies: A must for survival in space

"The development of nation is intimately linked with the understanding and application of science by its people"

Such is the quotation by Vikram Sarabhai a well-known scientist known for his contributions in the field of physics and astronomy. Indeed, life styles and economies are evolving at a very fast pace in the times we live in. However, this rapid progress has cost the earth its valuable and finite resources. To make best use of them, recycling plays an important role. Recycling refers to the reutilization of used materials for the development of useful products. Many items like glass bottles and plastic bags are recycled for their utility sustains for a long time. Although recycling is generally associated with the industrial business its viability and necessity extend all the way to space! Recycling is an important part of space exploration programmes for it is necessary for the survival of astronauts. For example, air is an essential resource that is absent in the vacuum of space and the needs to be recycled.

Recycling resources that are necessary for survival is a must. There are no resources in space that can directly help in the maintenance of technologies and health of the astronauts sent to space. It is impractical for research agencies to have a constant supply of the required resources for the missions can last for long periods of time. It thus becomes important to have modern techniques for converting any materials available at hand into fuel. Similarly, it is unrealistic to have large quantities of water to be loaded in spacecrafts. Hence it is of utmost importance that resources are efficiently recycled.

In space there are three main resources to be recycled – water, oxygen and fuel. Apart from this it is also important to eliminate any unwanted substances like waste carbon dioxide. The use of Lithium Hydroxide (LiOH) is an excellent solution to do so; it easily absorbs carbon dioxide to produce lithium carbonate and water without the release of energy before or after the reaction. The waste carbon dioxide can also be used to produce water and methane by a reaction between carbon dioxide and hydrogen. The water produced can be cleaned and methane can be recycled for usage as fuel or it can be released according to the needs.

Fuel cells are also great media for recycling. They are devices that can cause a reaction between hydrogen and oxygen to produce water and electricity. This is extremely beneficial for not only can the water be used or decomposed to reobtain oxygen but the produced electricity can be used to drive motors. It also becomes a necessity to have efficient means to purify water and reverse osmosis holds the key to the same.

It is an effective technique to recycle water. Although, this method is generally used for the purification of sea water, it can also be used in the space. High pressure is used to force down contaminated water through a series of filters to filter the impurities. As can be seen there exists multiple means for reutilizing the waste resources and producing new useful products which has been possible only by the desire to soar across the endless sea of stars and galaxies.

Humanity is at the dawn of a new era led by science. The desire to explore distant and unfamiliar regions is governed by mankind's ability to make best use of the available resources. The Expansion of human knowledge to new dimensions planets and ecosystems is possible only through the smart and effective use of resources. Thus, recycling is not merely the reutilization of scarce resources but also the means of preparing for the future generation of humanity and science. Science and resources are interdependent; the progress of one will simultaneously lead to the effective utilization of the other and this is only possible when mankind's intelligence harmoniously balances both by recycling.

Mst. Vardhan Negi,

DAV Public School, Thane

Essay in the third position.

Recycling Technologies: A must for survival in space

As the human population is ever increasing, we are running out of resources to sustain life on the earth. The most important of these resources is the space to live. As we run out of space to live, it is essential that humans start colonizing other planets to accommodate the population.

We have already discovered many such habitable planets and it is only a matter of time before we travel to these planets to colonize them. However, since these planets are light years away from the earth we have to travel for many years on spaceships before we reach these planets.

On spaceships, we have a limited amount of space in which all life activities like eating breathing drinking etc. have to be performed. To utilize the limited space and resources with maximum efficiency, it is essential to reuse and recycle these resources. Many methods to do so have emerged in the form of recycling technologies which are discussed further.

One of the main factors that allows survival on the earth is its unique atmosphere. If we want to survive for long times in space, it is necessary to recreate an atmosphere similar to the earth. The three most important gases in an artificial atmosphere are oxygen that we need for respiration, Carbon dioxide which is the byproduct of respiration and nitrogen which helps maintain a stable cabin pressure.

It is possible to reduce the carbon dioxide (CO_2) that we exhale to obtain oxygen (O_2). Two possible methods of doing this are as follows. The first method is to perform the Sabatier Reaction. IN this reaction Carbon dioxide (CO_2) is made to react with hydrogen (H_2) at high temperatures with nickel as a catalyst to obtain methane (CH_4) and water (H_2O). While methane can be released overboard, water can go through the process of electrolysis to give hydrogen (H_2) and Oxygen (O_2). Oxygen will be inhaled by us and we exhale carbon dioxide which again reacts with hydrogen to create a cyclic process.

Another method to recycle carbon dioxide is to pass UV light through it in such a way that it breaks down to carbon monoxide (CO) and oxygen atom (O). The oxygen atoms combine to form oxygen (O_2) which we inhale and exhale carbon dioxide again creating a cyclic process.

Nitrogen will have to be carried on the spacecraft in the form of Ammonia (NH_3). Ammonia can be broken down into nitrogen (N_2) and hydrogen can be used for other reactions.

After air the next step is to recycle water. To do this we first have to collect all waste water like sweat, urine, moisture in the air etc. Once collected the water hat to be treated thoroughly. First it has to be distilled. Then this distilled water has to be passed through a multi-layer filter. The filtered water must first be quality checked. If the quality is acceptable then this water can be used else it must go through same process again.

Next, we need a renewable source of energy. The simplest method to do this is to use solar energy. However, solar energy is inefficient as we only get power when the panels are exposed to direct sunlight. Instead, we can use alternatives like pyroelectric crystals. These crystals produce a charge when acted upon by a force. We can make the floor of the spacecraft of a piezoelectric crystal, like quartz. When we walk, we apply a force on the crystal creating a charge. The energy can be collected stored and used later. However due to limited efficiency, we must use other alternatives like nuclear energy.

We can even grow plants on our spaceship. Plants not only take waste carbon dioxide and convert it to oxygen; they also provide a renewable food source. Plants like strawberries and leafy vegetables can be grown which provide food without much processing. Plants are hard to grow as they require continuous air, water and light, but if we recycle all these resources, it may be possible. We can use solid human wastes as manure for the plants.

In conclusion, using recycling technologies it is possible for large populations to undergo interstellar space travel. Recycling technologies can allow survival even with minimal space and resources. Humans must continue to strive forward in developing recycling technologies not just for space travel but for improving life on this planet too.

Prakhar Meherotra

Podar International School, CBSE, Nerul

Great discoveries without sophisticated equipment

Electric charge: it's hilarious introduction to humans.

The year was 1760, when a Government clerk (who was actually a philosopher and person of keen observation) had a habit of wearing two different socks on each leg. White silk socks over black woolen socks. In front of the Royal society, he described how his opposite-coloured socks attracted each other, whereas the ones with similar colour repelled each other and went into "quite an agitation", as described in those times. Especially, when the two black socks were held in one hand and the two white ones in another hand. This history is not recorded in great detail anywhere but a legend passed on from "word-of-mouth" and quite believable.

This went unexplained for 25 years, with lot of fun being experienced with static electricity and mild shocks.

In our series on science without experiments, it is an attempt to show how the most obvious aspects to us, were quite a struggle to observe and understand, during the days of discoveries.

In 1786, Luigi Galvani was experimenting with headless frogs, trying to understand the most elementary and basic biology. Science, those days, did not come in compartments of Biology, Chemistry and Physics. He had placed headless frogs on a table with a wire connecting the sciatic nerves to a clothesline overhead. The legs of the frogs twitched whenever there was lightening during a thunderstorm.

Scientists at that time used to assume that the electricity was "produced" in the brain, and made the muscles move.

These were the days when static electricity generators were available. Similar effects on frogs were also seen in the presence of these generators or even Leyden jar which could store the charge. Even a spark at a distance would generate these effects. Luigi observed that the effect was not seen if the wire was connected to a piece of glass instead of metal.

There was no dependence on the distance at which the spark occurred or the distance of the lightening. It acted as a trigger. The initial conclusion was that this was "animal electricity". Hence, lightening or electricity generator caused a tension in the

atmosphere (“electrical atmosphere”), where the wire served as an antenna, discharging the charge through the nerves of the frog.

Luigi was perplexed by the fact that if the frog was responding to the electricity transmitted through the air, then the intensity of the twitching should have depended on the distance or proximity of the source of the charge generation. So, he repeated the experiments by connecting a metal hook to the frog’s spinal cord and the hook to a length of wire, placed at different distances from the generator, but there was no difference. Hence, the generator was just a trigger, the “electricity” was within the nerves.

So, to make things even more clearer, on a day when there were no clouds, he had a frog connected to a hook and the feet touched a silver box. He held the frog in his one hand and in the other hand he held a piece of metal which he touched the silver box. The leg muscles contracted, lifting the leg, which in modern language is “breaking the circuit”. But breaking of circuit stopped the “flow of electricity” and hence the muscle contraction stopped, the muscles relaxed, allowing the legs to touch the silver box, just to contract the muscles once again. This hopping of the legs continued till the energy was all lost. This was the “animal electricity”.

At the same time, Alessandro Volta, decided to dismantle this theory. He touched the back of the frog with a metal and its leg with a coin (or some metallic key), and closing the circuit by connecting the metal and the coin. The results were same as that of Luigi, BUT ONLY when the metals used were of two different kinds. So, it worked when two metals were tin and silver or tin and brass. He called it “bimetal electricity”.

For a long time, even though both of them had similar observations, they both tried to disprove each other.

Luigi, used two pieces of metal which were similar to demonstrate the contractions, to which Volta argued it on the basis of differences in impurities in different pieces. So, different conducting materials were tried with same effects.

So, Luigi Galvani eliminated the metal (external connectors) and touched the sciatic nerve directly with muscle controlling the leg, and it gave a kick. Where did the electricity come from?

This then boiled down to the fact that both of them were moist in nature and thus the author George Johnson, in his book “The ten most beautiful experiments”, on page 72, writes “Put a silver coin on top and a copper one on the bottom and you can taste electricity” essentially get a shock on your wet tongue. “The experiments involving a single metal were as readily explained. One first class conductor formed an arc between the two second class conductors: the nerve and the muscle.” Thus, the main reason for the electricity was “Finally you could make an arc entirely from mushy

second-class conductors: a hand and a frog. Organic or inorganic – it didn't matter, as long as the dissimilarity was there."

Hence, they both slowly arrived at the same point discovering the concept of a battery. Volta stacked several alternating zinc and copper discs separated by cardboard spacers, dipped in salt water and could generate a mild shock.

These simple observations led to the discovery of voltaic cell or the concept of battery. Author then finishes by saying "how, in an organism, each microscopic cell acts like a litter battery, with membranes behaving like cardboard spacers and charged ions playing the role of zinc and copper coins/plates".

This is the end result of the electromotive force (voltage) between the positive and the negative (charges).

STUDENTS' CORNER

A Novel Device for the Dye-Based Detection and Algae Driven Filtration of Microplastics in Drinking Water

Aditya Pratap Singh Chauhan, Tejas Sharma
apschauhan250@gmail.com, tsharma1704@gmail.com

Mentor – Mr. Sushil Kumar Pandey
sushilpandey0176@gmail.com

Bharatiya Vidya Bhavan's R K Sarda Vidya Mandir
Raipur, Chhattisgarh, India – 492001
info@bvbraipur.org

Abstract

Microplastics are tiny particles, mostly ranging from 0.1 µm to 0.2µm size, and are found frequently in drinking water samples. These are difficult to identify or removed by existing techniques. They are known to be toxic and can cause serious health problems in entering the human body. Hence, a unique device named 'MICROPA' with the novel approach is conceptualized and developed for its easy detection, quantification, and removal from drinking water. Here, an optimized dose of Nile Red dye in1:100 ratio, v/v is used to stain the microplastics in order to be detected due to their property to shine under UV rays. The image of the fluorescent spots provided the exact particle count of microplastics using the newly developed web app based on the Open CV image processing algorithm for pattern recognition. In this device, Rhodomonas salina microalgae are used for the removal of microplastic contaminants from drinking water, owing to its property to form natural hetero-aggregates with microplastics. The microalgae are non-toxic and are washed and cleaned to remove any kind of external contamination which in turn form the most efficient aggregate. A layer of nitrocellulose membrane filter (0.22µm) is used to restrict the aggregate to get to the outlet. Standard samples of microplastics are used for calibration, detection, and quantification procedures. Pre- and post-filtration samples are quantified to evaluate the filtration system. Results confirm that MICROPA provides great accuracy in quantification (Tol. ± 5 particles) and a high filtration rate (average 85%). Therefore, based on these observations it can be confirmed that this novel and validated

MICROPA gives a green edge to the accurate removal of microplastics from drinking water.

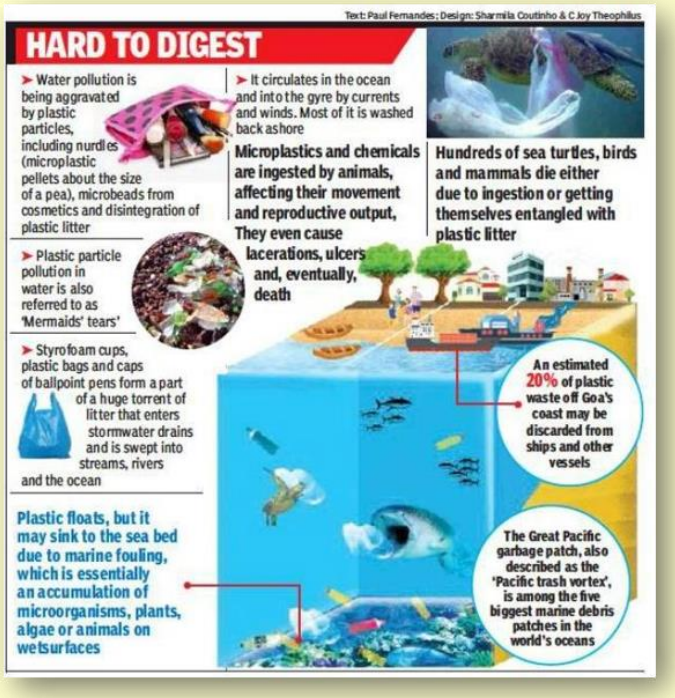
Problem Definition

Microplastics are the plastics particles of size <5mm, but they are generally found in very small sizes up to <0.1*u*m. These microplastics contribute a larger proportion to pollution that the big visible macro plastics substances. These are mainly formed by the breaking down of larger plastic particles either by the effect of UV rays from the Sun or by the abrasion of the waves.

It was observed that microplastics are rising in quite a lot amount on the surface of the oceans. But just recently in some studies, it was found that microplastics are present in the drinking water systems of many important portions of the world. Due to their really small size, these microplastics are never really filtered away and are also not identified in the filtration systems that are used by the common people in their house.

A survey and analysis done by the esteemed *Orb Media* took 159 drinking water samples from around the world and it was found that a huge 83 % of the drinking water samples that were tested showed microplastics contamination with an average contamination of 300 particles of microplastics per litres. It was found that the USA and Lebanon had the highest contamination with 94% contaminated samples and India stood second with 82% contamination level.

Any sort of direct or immediate health effects of the microplastics in the human body have not yet been identified. However, inflammation is one of the major problems that the human body suffers with the ingestion of any foreign element. It is estimated that due to its microscopic size and with continuous biomagnification, the microplastics may become a big disaster for the human health with possible problems ranging from cardiovascular health issues to cancer.

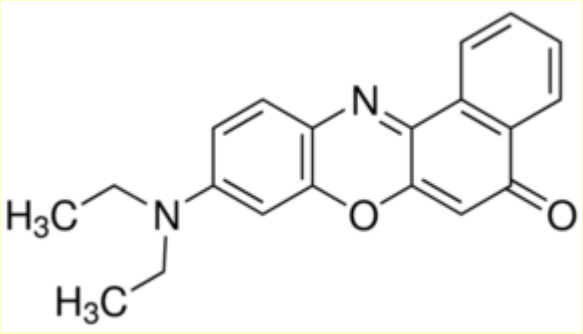


Origination of Idea

I found a very interesting article in the esteemed Times of India. This article was completely focused on microplastics as it defined the term and

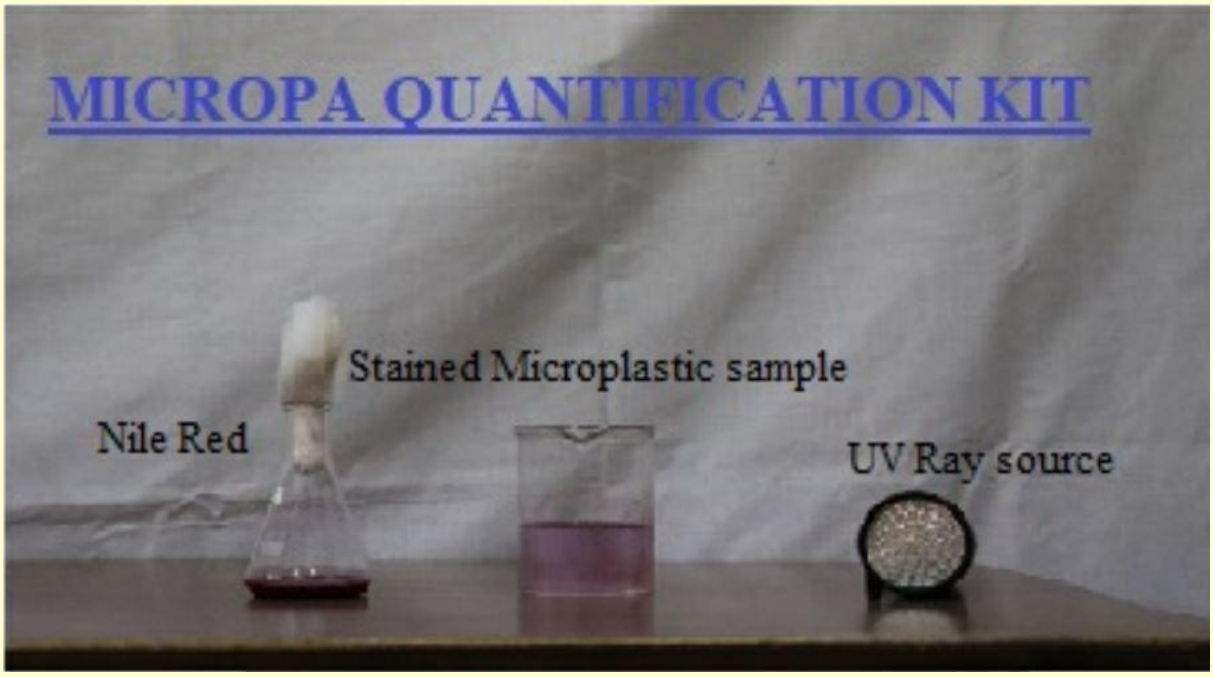
talked of the rising level of microplastics in the marine environment. I found this intriguing and looked upon the issue of microplastics. This is when I found that the microplastics are a havoc for not only the marine environment but also the drinking water systems. Hence, I decided to come up with solution for the same.

Detection System



The detection system of my device is the first step that is followed by the quantification. The detection of microplastics is done by staining the microplastics in the contaminated water samples with a biochemical dye Nile Red and then irradiating the stained microplastics by throwing UV rays of specified wavelengths on them.

Nile red is a biochemical dye that is generally used for lipid polymer staining, but it is found in a study that the Nile Red has very good efficacy with the plastic polymers and stain them very efficiently. I found the Nile Red dye to be the optimal choice over the other staining dyes as it stains the microplastics in the water sample very well and also that we were using them on only the drinking water samples, which ends all possibilities of finding any kind of lipid, and hence eliminating false staining.

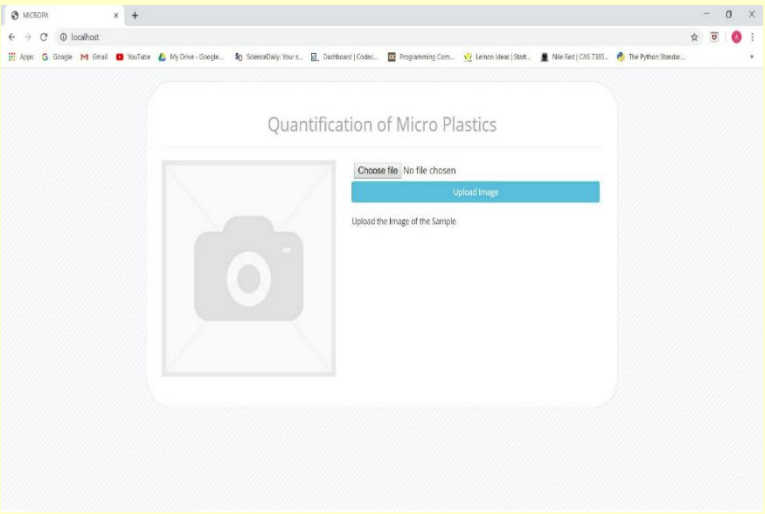


The microplastics stained by the Nile Red dye have the property to shine bright fluorescent when UV rays of the wavelength of crime light are thrown on them. Thus, in my system, I have included a crime light UV torch that is used to shower the UV rays on the stained microplastics particles present in the contaminated water samples

in a glass beaker. When the UV rays fall on the water sample, the stained microplastics shine bright fluorescent and are uniquely identified.

Quantification System

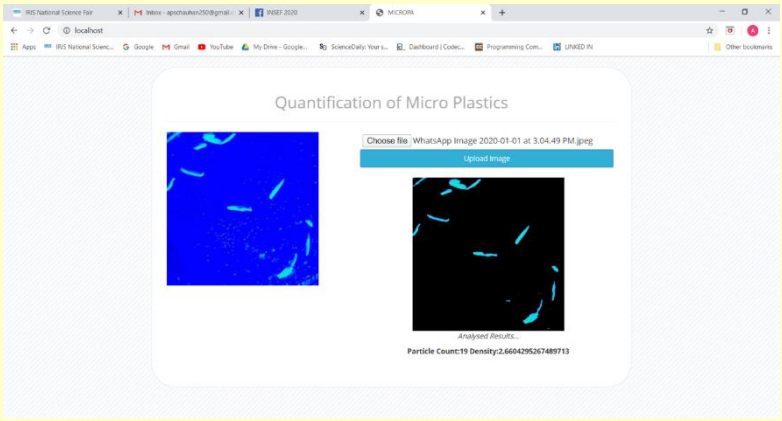
I have developed a web application to take a step further into the detection of the microplastics in contaminated water samples and predict the accurate particle count of the microplastics in the drinking water samples. After the microplastics shine bright by the detection system, an aerial image of the water sample is clicked, which consists of bright and small fluorescent spots in them which are actually the microplastics.



Hence, my Open CV based image processing python algorithm would read the image of the sample to identify the bright spots in the image and then predict the accurate count of the microplastic particles that are present in that particular contaminated water sample.

However, the results of the quantification web application may vary with very little disturbance with any change in the quality of the camera, the wavelength of the UV rays and also the maximum surface area of the glass beaker in which the aerial image is taken. Thus, preventive measures need to be taken in the tests.

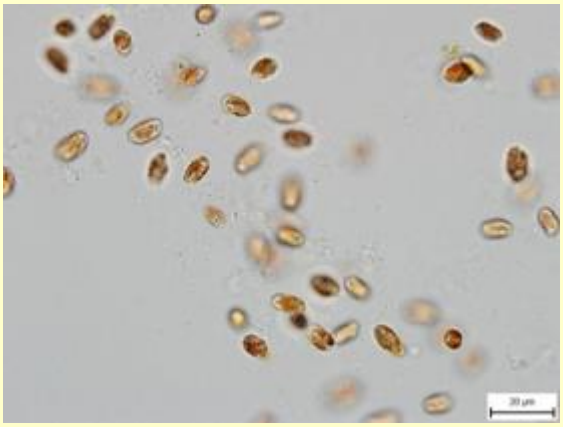
Filtration System



The filtration system of the device is novel and almost first of its kind. It basically is a filter cartridge that is supposed to be added to the existing drinking water filtration systems that are being used in the houses. My filter cartridge would be completely focused only on the removal of the microplastics from the drinking water.

The cartridge would use microalgae Rhodomonas Salina as its primary filtering agent. The microalgae R. Salina is studied to have wonderful natural interactions with the

microplastics on the ocean surface. These microalgae have a special external layer made of a bio adhesive that is Biogenic Silica. The microalgae thus stick with the microplastics when they collide. I have taken inspiration from the same natural interaction between the two occurring in the nature and implemented it on my system.

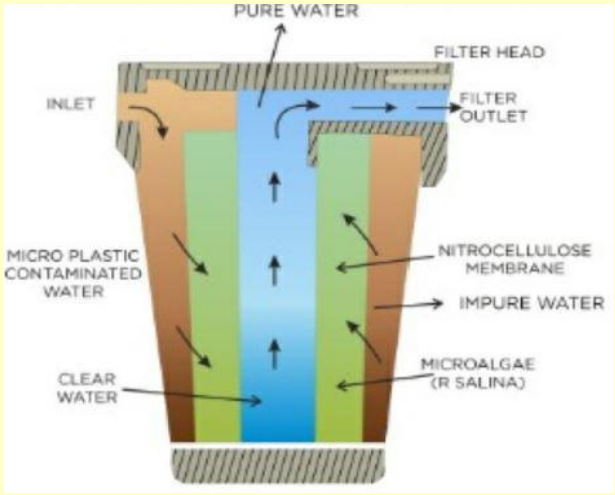


It mainly consists of a filter cartridge that has a mud filter (2 um pore size) to provide support to a layer of Nitrocellulose Membrane (022um pore size), that in turn acts as a barrier between the filter space and the outlet. In the filter space, the microalgae R. Salina are freely suspended to let them interact naturally. Thus, the microplastics get stuck to the microalgae to form hetero-aggregates, which are blocked by the layer of membrane. In this way, microplastic clear water is received at the outlet.

Step – wise Algorithm

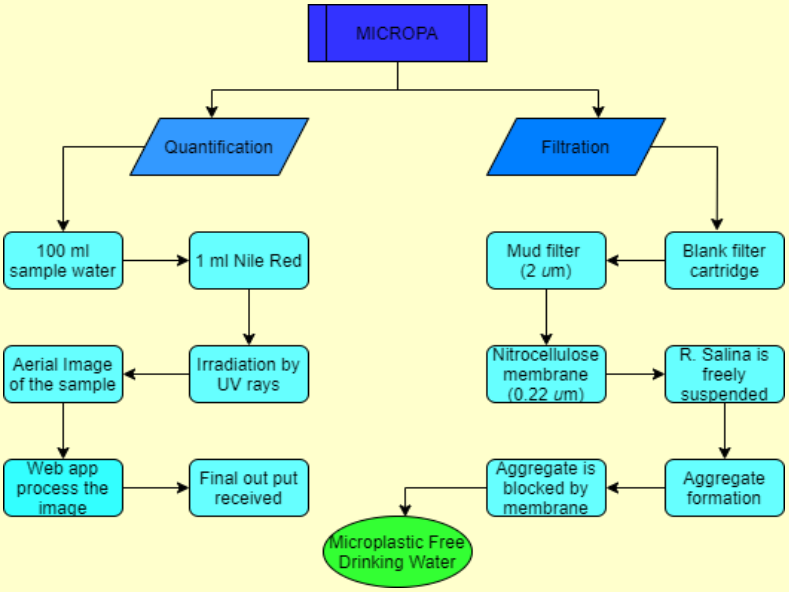
Conducting Tests

The tests for the efficiency of the detection and quantification systems along with that of the filtration system were conducted with the step defined in the algorithm. Along with accuracy and efficiency tests, other tests were also conducted that focused on aspects that might be related to it. The test procedures and observations are described in the test report.



From my observations obtained from the tests conducted, it was concluded that the detection and quantification system was highly accurate in identifying and counting the microplastic particles in the contaminated water samples. Also, the microplastic

were filtered out by the filtration system with a high average filtration rate of 85%. This concludes that the device is accurate and efficient and hence is successful.



Innovative Device

The three systems discussed above that are detection, quantification and filtration of microplastics from the drinking water are combined into a single unified body that is basically a filter cartridge that continuously removes the microplastics from the drinking water. However, this unit would also include automated or manual detection and quantification systems installed on both openings of the filtration cartridge, that would periodically keep a record of the filtration efficiency of the cartridge and also notify the person when the filtration cartridge reaches its utmost capacity.

Lime – Light

- This is a completely novel, affordable and efficient method for the easy quantification and filtration of microplastics present in the tap water.
- The quantification system tends to be better than the existing methods like FTIR imaging and Raman Spectroscopy.
- My quantification kit can very easily used by even a common man by his own. Thus, one can easily get to know whether his/her tap water is contaminated by microplastics, and to what extent.
- With the filtration system, I even provide a way to get rid of the microplastics that is present in the tap water.
- Use of microalgae Rhodomonas Salina gives a green edge to the filtration of a non- biodegradable compound like microplastics.

Conclusion

This device of ours is a novel one and makes it very much simple for the common man to identify the microplastic contamination of his/her drinking water and also provides a filtration system to avoid any such contamination. The device is highly accurate and effective, along with being cost-effective. Thus, this device would definitely mark a milestone in the water filtration industry as it makes really complex process much easier, so that it can be conducted even by a lay man.

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Finally, my utmost gratitude to team RISE for giving me this wonderful opportunity and a chance to utilize my skills for the betterment of the world.

Activity question

P.K. Nawale

Observation is a very important activity in every walk of life. Science education has this capacity to inculcate OBSERVATION in students. Following activity is suggested and students are welcome to write to me or P.K. Joshi their findings. But the list should have more than 15 different answers.

Take following items. A candle, a match box, a shallow container for water like petri-dish or any flat shallow container available at home, a transparent glass and water. Now we know what the experiment is about. But let me still tell you.

We need a lighted candle in the dish, surrounded by water and then insert the empty glass, upside down, over the candle. And answer the following question.

Q**. What did you see?**

If you can list out more than 15 observations, report back to the EduREKA email address or pkkjoshi@gmail.com or mumbaiprakash@gmail.com

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