

1. Conservation of Endangered Elements

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Overview

According to some studies, nearly **40 %** of elements (**44 out of 118**) in the periodic table face an imminent danger of getting wiped out from the Earth mainly due to limited availability or increased use. Methods that promote **reusability** of these elements or aim towards **maximizing the resource efficiency** are gradually coming into practice both in industry as well as research. It becomes imperative to adopt these practices because of a few elements within this exhaustive list being critical to several existing industries that sustain the population. Therefore, we'll be looking at these elements and their impact areas closely and discuss on the possible practices which can be adopted for some of them.

Elements and Impact Points

Helium is the second most abundant element in the whole universe, however, on Earth it faces a huge risk of depletion at a rapid rate. Its numerous applications in **cooling systems**, underwater sea diving, and **fibre optics** owing to its inertness, low density and ability to reach low temperatures faces a serious challenge in the coming years. The limited availability of metals such as **Lithium, Magnesium, Zinc, Lead, Silver, Platinum, Gold, Mercury, Neodymium, Indium** etc. also poses a serious threat to a lot of businesses and mankind in general. Afghanistan used to thrive on Lithium but the recent social and political crisis have put a big question mark over the fate of those minerals in current times. The **EV** and **electronics industry** might take a huge hit owing to the threat posed to some of these very important metals. **Phosphorus** is another common yet important element which might see a decline in the coming years owing to careless use and handling in the supply chain. A lot of phosphorus goes to waste within the supply chain and its runoff into water bodies causes environmental concerns like Eutrophication. The **FMCG industry (mainly, detergents, food production, matches etc.)** and **Fertilizer industry** can take a huge hit if Phosphorus reserves start dwindling owing to this wastage. **Uranium** is another important element whose existence is under threat owing to rising use. **Nuclear energy** provides around **10%** of the world's **electricity** at present and will come under the radar if Uranium starts diminishing. These were a few instances which might be directly affecting us in a more significant way as compared to their other counterparts. All the endangered elements are classified into 3 categories mainly: **Limited availability-future risk to supply** (28 elements), **Rising threat from increased use** (7 elements) and **Serious threat in the next 100 years** (9 elements). The first kind requires mostly **conservation** (or **efficient use and recyclability**), second kind would require searching mainly for **alternatives** and the third and most critical one would require a combination of both these practices.

Possible Practices

For conservation and efficient resource management, work needs to begin from the **Supply Chain** involved in the movement of these metals. Firms taking care of this should employ the Japanese business practice of **Kaizen** to reduce wastes while driving efficiency up. Reaching six sigma levels in this process is important to ensure that elements are used in the most efficient way possible without unnecessary wastage. Recycling practices become important for elements like **Helium**. Helium has a tendency to be vapourised instantly because of a very **low boiling point** of its liquid form used in **cooling systems**. Therefore, **efficient heat exchangers** need to be employed for restoring as much amount of Helium as possible. Similarly, in case of metals used in electronics can be used again if **proper waste management** is performed. When electronics are discarded, they should be processed separately to extract these elements again for reuse in manufacturing of devices again. Separation methods such as **electrolysis, preferential solubility in solvents, magnetic separation** etc. can be employed for this practice. Another effective conservation and reuse practice could be to **extend the life** of the electronic gadgets we use by **upgrading them slightly less** often or **donating them** to be kept in use continuously. Conserving **Phosphorus** (an important element) can be attained by practices such as **composting kitchen wastes** or maybe moving to a **plant-based diet** which will **prevent the rearing of Phosphorus-heavy livestock**. Using **fewer chemical fertilizers** consisting Phosphorus for agriculture could be another way of conserving the element and promotion of **organic farming using biomass** can serve as a slow and steady but good replacement for current practices.

Radioactive isotopes of **Uranium** (more common) and **Cobalt** are usually used in nuclear reactors for the generation of nuclear energy to provide electricity. Usage of **renewable energy (solar, wind, hydroelectricity etc.)** in place of these can be a feasible option everywhere, however, it would need to be done in very large scale to match the capacity of a nuclear reactor. That might drive up the cost a bit but in the long term it is sure to bring in benefits. **Reduction in nuclear waste** as well as **conservation of these elements** for the long run could prove to be useful in various spheres. Apart from serving this purpose, renewable energy can also serve as **reduction in net carbon footprint** derived from fossil fuels, thus, promoting it would serve as a double purpose. Another possible approach could be **major countries forming a pact in the UN** to divert their Uranium from production of **nuclear warheads** to the **power generation industry** for the greater good of people and give a major boost to these elements employed in utilities. Nuclear energy industry can also focus on effective **nuclear waste disposal** and **utilize the rods to their maximum capacity** before disposing them off. Possible threats to elements like **Lithium, Nickel, Lead** etc. can hinder the development of **batteries** for the upcoming **EV** boom in the market. Therefore, alternatives such as **Hydrogen fuel cells** or **ultra-thin batteries** made using **Graphene Oxide** can be worked on developing more rapidly for the future and to be made available at regular prices. Elements like **Indium** which have huge application in **LCD monitors** and displays can have alternatives in the form of **Antimony, Carbon nanotubes** or other **conductive polymers**.

Conclusion

Looking at the above practices and the state of the endangered elements in present day, it seems that we can attain the regularity of some of these practices within time. Each and every practice might not be economically very feasible but with advancement in research, cheaper methods to perform these may appear. For example, recycling of whole electronic gadgets to yield these elements again might be a costly affair so performing this at a very large scale. However, with continued awareness among institutions, industries and the general public of these methods could lead to the process getting more demand with the existing infrastructure. In complicated situations like that of Afghanistan, there is a lot of uncertainty regarding the fate of the reserves but in order to be effectively utilised, some nation would have to take up the initiative. However, it's novel research in scientific practices and materials is what's going to lead the way into the future to make it more sustainable and utilize the existing resources in the best possible way, searching up/ creating alternatives to be used at a time when the depletion is completed and creating a new normal.

2. Comparison of Ionic Character

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a) Electronegativities of elements involved:

Mo: 2.16, S: 2.58, Zn: 1.65, Ga: 1.81, N: 3.04, Cu: 1.9, Cl: 3.16

Comparing the electronegativity differences between elements forming the given semiconductors, the order of semiconductors from most covalent to most ionic is as follows,

MoS₂ > ZnS > GaN > CuCl (decreasing order of covalent character/ increasing order of ionic character)

b) Electronegativities of elements involved:

W: 2.36, Se: 2.55, Zn: 1.65, S: 2.58, Te: 2.1, O: 3.44

Comparing the electronegativity differences between elements forming the semiconductors, order of most covalent to most ionic is as follows,

WSe₂ > ZnTe > ZnSe > ZnS > ZnO (decreasing order of covalent character/ increasing order of ionic character)