Deep–Seabed Mining – Advantages and Challenges of Extracting Battery Material from the Ocean Floor under Technical, Ecological and Economic Consideration

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Abstract – A huge continuous supply of specific economic metals is vital for any high tech future. Because of growing population we required lot of resources, more than we can supply now, particularly specific metals like silver, gold, copper, manganese, cobalt, zinc and other rare elements to. But their supply is normally an ecological and social nightmare. For examples, the waste from Li and high-purity Si processing has vanished whole villages and ecosystem in china, Indonesia and Bolivia. Our study revealed Advantages and difficulties of extracting manganese nodules from the ocean under the consideration of technical, ecological and economical.

Key Words: High-purity Si, Manganese nodules, technical consideration, ecological consideration, economical consideration.

1. INTRODUCTION

An increasing demand for green technology to reduce the use of fossil fuel and to create a more sustainable environment has driven up the price of many metals like Manganese, copper, Nickel and some rare earth elements, which are used in manufacturing batteries and some technology equipment. The soaring and demand have bolstered the business of sea-bed mining.

Deep-sea mining is the operation of recovering mineral reserve from the deep sea – the region of the ocean below 0.2km which covers around 65% of the Earth's land. Deep-bed mining has potential to fulfil the newly developed demand of the metals and other elements that are necessary for development of green technology and to produce high tech application like smartphones. The Three sites of importance for the sea-bed mining are ABYSSAL PLAINS (at depth of 4000-6000 meters), HYDROTHERMAL VENTS (at depth of 1000-4000 meters), SEA MOUNTS (at depth of 800-2500 meters) and three primary sources of commercial interests are manganese nodules (MN) or polymetallic nodules (PN) on the abyssal plains, sea floor massive sulphides (SMS) on both the active and inactive hydrothermal vents and cobalt-rich crusts (CRC) on the seamounts. Taking current terrestrial mining practices into consideration that are known to cause severe environmental problems from loss of bio-diversity, soil erosion and pollutions, sea-bed mining might prove a boon. As seabed mining gaining more importance, it might cause a huge threat to deep-sea ecosystem. The area of deep sea ecosystem is relatively untapped and we have very less knowledge and information about deep eco system and sea creatures which are living at the three prime location of interest of deep-sea mining.

2. TECHNOLOGICAL CONSIDERATIONS

Mining vessel, Hydraulic pick-up device for nodule collection and ore lift system with pump and pipeline are the basic components for the nodule mining. . A basic benefits of nodule mining is that the same technical instruments that are used for one mining site, can be used for the different mining site and the equipment's are portable so that it can easily be transferd from one place to another with the minimum cost compare to land based mining.

Another advantage is that it can considerably reduce the emission of exhaust gases from burning of the fossil fuel as the hydraulic pick-up device is powered through electricity and it will not have to excavate much of the ocean surface because the nodules can be find on the ocean floor itself, but in contrast land based mining use fossil fuel powered machineries and the amount of the extra material to be removed to recover primary ore is also high. Consequently, land based mining equipment's have to burn more fossil fuel compare to seabed mining machineries.

Moreover, the adjustable riser structure with only one positive displacement pump mounted on the hydraulic pick-up has been designed and it is distinct from the stiff riser idea of the seventies where many pumps are mounted at different levels along the river that cause noise pollution.

There are some technical challenges against the deeps mining

The mining system is not just about collecting nodules from the seabed but it also need lift mechanism to carry them to the surface via five km of water column, as well as handling apparatus on the mining platform. In addition, for these operations, uninterrupted power supply and sufficient storage space for polymetallic nodules will be needed on the platform, as the mining sites lie thousand kilometers far from the processing plant.

The real difficulty lies in integrating various subsystems and making them work continuously for 300 days/year under drastic environments, like cyclones, winds and rainfall and harsh operating condition (high pressure, low temperature, currents and darkness) coupled with sea- floor environment. Besides, discharge of the sediments and nodules fragment from the mining vessel into the ocean creates sediment plumes and it is a big challenge as it is not cleared yet, how far this fragments and sediments can scattered. Compaction of the seabed by the weight of the hydraulic pick-up device is also a challenge because it create ecological imbalance in deep water eco cycle.

In terms of processing of Manganese nodules, perhaps the least importance has been given to the disposal of material that will left after processing and extraction of metals. Taking into consideration, the residual 74% of material (after processing 4 primary metals) that will have to be discard, which is probably not in its original form after processing. There is plausible environmental danger of disposing such residue.

3. ECOLOGICAL CONSIDERATIONS

Polymetallic (Manganese) nodules are likely to turn out as a chief source of ores, which demands by renewable green energy technologies and emerging technologies like wind turbines hybrid cars, battery systems, and other electronics, which need increasing quantity of Cu, Co, Ni, Mn. Exploration of substitute energy depicts that Green Energy technology is far more Ni and Cu dependent than conventional form of energy. To decarbonize the economy and circular economy for the planet we will have to move towards the deep-seabed mining and it is an alternative source which will create less pollution to retrieve these crucial green energy elements and metals compare to the land mining activities. In addition to this that we have exploited land based mining a lot and as a result there is depletion in land based resources. We have already used sulphides mines first to fulfil the demand of Co and Ni which creates moderate pollution but now people are moving towards the laterite mining which causes a great deal of pollution via flotation process of laterites (terrestrial Ni-Co ore).

A basic advantage of seabed mining is that biomass is very low at the seabed and seabed mining of polymetallic (Manganese) nodules does not require the social displacement, loss of source of income and will abolish a big class of legitimate limitations associated to environmental conservation or social disturbance. Besides, Polymetallic nodule deposits can be find straight on the seabed and consequently, unlike land based deposits, do not require considerable pre-strips or overburden transfer to retrieve the ore deposits. Furthermore, Deep-seabed mining will demand surface platforms and vessels built in well organized shipyard locations as oppose to land base mines 'on site'. Deepsea framework such as pipes and ships could be re-used and re-located from one mine site to other. Whereas, much land based mining infrastructure is fixed.

There are major three threats of seabed mining on the ecosystem of the deep sea.

3.1 Disturbance of the seafloor

The removal of the ocean bed by machines can change or demolish deep-sea habitats, result in the loss of ecosystem function and structure or deprivation of fragmentation and species. Countless species dwelling in the deep sea are endemic – means they do not found anywhere else on the planet and physical disturbances in a single mining site can conceivably wipe out an entire species. This sites at risk genetic substance that could have pharmaceutical or biotechnical use in the future. There could also be influence on ecosystem work like fisheries, climate regulation, detoxification and nutrient cycling whose values in the high seas and Deep Ocean are not yet completely comprehended or quantified. This is one of the considerable likely impacts from deep-sea mining.

3.2 Sediment plumes

Some type of deep-sea mining equipment will agitate fine sediments on the seabed composed of silt, clay and the left over of microorganisms, generating plumes of suspended fine particles. It is uncertain how far these fine particles may scatter on the far side of the mining area, how long it would take for suspended particle to resettle on the seabed, and to what degree they might affect species and ecosystems, for example by suffocating deep sea animals or harming filter-feeding species that depend on clean water to feed.

3.2 Pollution

Species such as sharks, tuna and whales could be influenced by light pollution, vibrations and noise caused by mining machinery and vessels, as well as possible spills and leaks of combustible and noxious products.

4. ECONOMICAL CONSIDERATIONS

International Seabed Authority (ISA), regulate international waters to prevent technologically advanced country from colonizing the seabed and monopolizing these resources.[8] In 2001, ISA Started to issuing contacts to explore the Clarion–Clipperton Zone (CCZ), a 6-million-squarekilometre swathe of the Pacific Ocean floor that stretches from Hawaii to Mexico, where polymetallic(Manganese) nodules are in abundant .The agency has given 29 companies permission to explore mining in international sea beds, including at 17 sites in the CCZ. Profits that company would made from this site will be divided into two parts and one half will go to the UN which will be used for welfare of mankind.

Moreover, polymetallic nodules majorly contains five metals Manganese (29.40%), Iron (6.00%), Nickel (1.34%), Copper (1.25%), and cobalt (0.25%). [10] In which demand of cobalt and nickel is increasing after each passing day because of growing demand of green technologies like electric storage batteries, wind turbines and solar panels. Global production of cobalt was 140 MT in 2019 and the requirement of cobalt is predicted to reach around fourfold until 2025. Thus mining out manganese or polymetallic nodule can benefit more when compare to the land mining. In addition, Cobalt is a technologically pivotal metal that has numerous diverse uses. The main use of Co (up to 50%) is in rechargeable batteries including nickel- metal-hydride batteries, nickel-cadmium, and lithium-ion, where Co is found in the cathode. Current global supply chain of cobalt is totally dependent on African mines around 70% of total global supply is controlled by Democratic Republic of Congo (DRC) and the DRC own about 50% of global Co reserves. The DRC has a monopoly over global Co productions and has created a supply concentration issue, with supply often erratic due to its unstable political environment. So it would cut the mineral cost if we will have more resources rather than one.

It is crystal clear that, with the emergence of ocean mining (nodules mining), cost of nickel, manganese and cobalt would decrease and customers would benefit. On the other hand, local producers of the same minerals from terrestrial resources would lose income and would likely to choose to produce less at the lower market prices and as a result unemployment ratio will increase in some underdeveloped countries.

The cost evolution for various sort of risers, power generation and collectors suggested by different contractors currently associated with technology development for mining of 1.5 tonnes of nodules per year illustrate a capital spending of $372–562 million and an operating spending of $69–96 million/year. Likewise, capital cost for buying 3 vessels for ore transfer is predicted at $495–600 million with operating spending of $93–132 million per year and a capital spending of $750 million for the processing plant with operating spending of $250 million per year. Taking into account the highest costing (approximately to the nearest 50), the total predicted cost of a single deep-sea mining venture works out to $11.90 billion for the period of 20 years. These do not take into account any unexpected failures or risks that may shoot up the expenditure. All these elements will have to be compared with the availability of ores on land as well as the metal prices (with constant fluctuation) with a view to ‘determine’ the timing for starting of deep-sea mining.

5. CONCLUSIONS

It is predicted that the increased demand of the green technology will bolster the deep sea mining. Taking into account the investment costs (∼$12 billion) and the gross-in- place value of metals (∼ $21 billion) for nodule mining at the rate of 1.5 million tonne per year at present calculations, the clear returns may be comparatively low, indicating the requirement to focus for higher production and/or decreasing operating costs for the processing plant that comprised of almost half of the total predicted expenditure.[4]Present-day technologies may not be adequate to keep away consequential and long lasting damage to the environment, including the loss of biodiversity. Measure should be taken to come up with such design parameter that the mining process will bring about minimum plausible harm to the marine environment. Deep seabed biological community remain alive in a delicate ecosystem by maintaining an extremely sensitive balance with their environment.

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