



Challenges and Innovative Ideas to Improve Steelmaking in India

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Abstract: India is on the threshold of being a world leader in steel production. In this context, India being the 4th largest producer of steel in the world is in a position to dominate the steel industry. This being the case, India should concentrate more on innovative solutions to improve its steelmaking. However, there are a lot of challenges to be faced regarding production of quality steel in accordance with International norms. In this paper, some of the challenges are discussed and innovative solutions are given. Recent research on steelmaking has been given and progress in Indian steel making has been shown graphically. Various types of steelmaking have been briefly touched upon and the challenges that India is facing have been outlined. India has to take up these challenges and is poised to be a world leader in steelmaking. Therefore, improvements and innovations become necessary and, innovative solutions are required in steel making in order to face the challenges of the future. This paper discusses these challenges from an Indian perspective. Data are given from literature indicating some of the innovations already made and some more innovative methods which are unique to the Indian situation are discussed. These ideas when implemented could result in higher and cleaner steel productivity. Future trends in steelmaking have also been suggested. It is hoped that the new ideas given in this work will benefit the global steel industry in general and the Indian steel industry, in particular.

Keywords: Indian Steel Production, Current Trend, Innovative Steelmaking

1. Introduction

Steel making, like other industries is on the cusp of major changes, the world over. While major steel making industries like Arcelor Mittal, Tata Steel and Essar steel are fully aware of the challenges and are taking concrete steps to modernize and reduce emissions, it is felt that the millions of small and medium scale industries should be made to fall in line with major worldwide industrial policies. In management terms, usually a carrot and stick policy works better for any policy change and unless this problem is improved in innovative ways in a big and diverse country like India, the whole world is heading for tough times on the environmental front.

Figure 1 shows steel production in India for the last 10 years. Going by this trend, it is safe to predict uniform growth in both imports and exports for at least the next 10 years. There are also recent reports stating that Indian steel output grew 6% in June 2022 and as per the World

Steel Association data, India is the only country in the world at present showing positive growth in steel production, according to reliable sources. This places us in a responsible position and we should make use of this opportunity to ally with like minded professionals, the world over so that the overall steel community is benefitted.

In this age of rapid improvisation and challenges to the environment, innovative solutions become necessary for the very survival of the steel industry. The emissions produced during steel making are enormous and hence they should be cut down. It is in this context that this paper is written. Innovative solutions are discussed and possible solutions are shown.

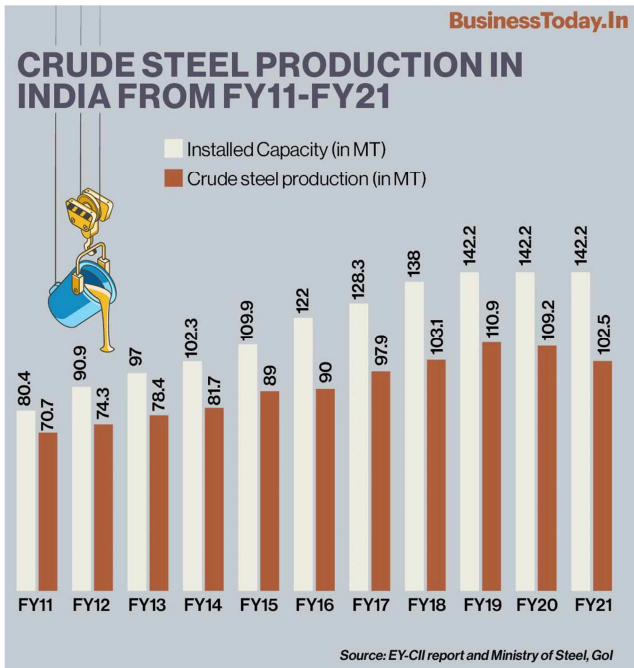


Figure 1. Imports and exports of steel in India over the last 10 years.

2. Literature

A detailed analysis of the raw materials used for steelmaking in India is given by Sujay Kumar Dutta et al. [1]

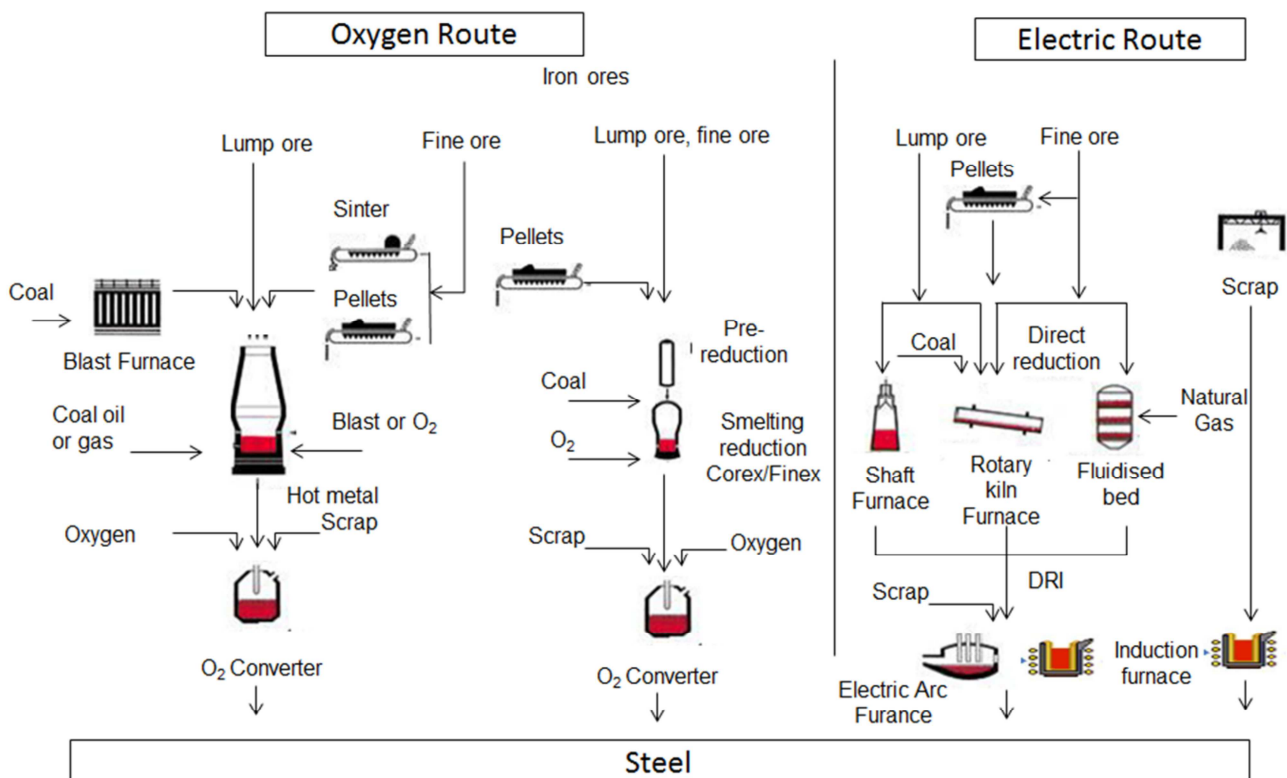


Figure 2. Shows the possible routes taken for steelmaking in India.

Another major issue is emissions. Steel currently is one of the three major industries producing carbon. India is facing the challenge of steel production in a bold way and our export of

Some methods of carbon capture being attempted in India are discussed by TamilSelvi et al. [2] Slag utilization in offshore marine forests and other innovative techniques are researched upon by Hiroyuki Matsura et al. [3] Metallized raw materials and their use has been dwelt upon in detail by Kerimov et al. [4] As can be observed in various researches going on throughout the world, the focus is on making steel in the most economic, green way with least emissions.

3. Challenges in Steel Production

With the current Russia-Ukraine war showing no signs of abating in the near future, the onus is squarely on India to rise to the occasion and supply quality steel to the world ensuring that there is no dearth in supply.

The two main challenges facing Indian steel makers are lack of sufficient capital and inferior quality metallurgical grade. While the Government has taken many initiatives to attract capital into India, the very nature of the Indian populace becomes difficult for foreigners to do business in India. Each state has got slightly varying policies and it is a challenge to understand the culture of the states, its languages and work ethics. It is still very common in India to work mainly day shifts and working night shifts to increase productivity happens only in big steel plants. Labourers are content to get their daily food and are still socialist in their outlook.

steel over the last three years have overtaken imports. Figure 3 shows the export -import bar graphs over the last decade. Hence, it seems that Covid and Post Covid have been

beneficial to the Indian steel industry.

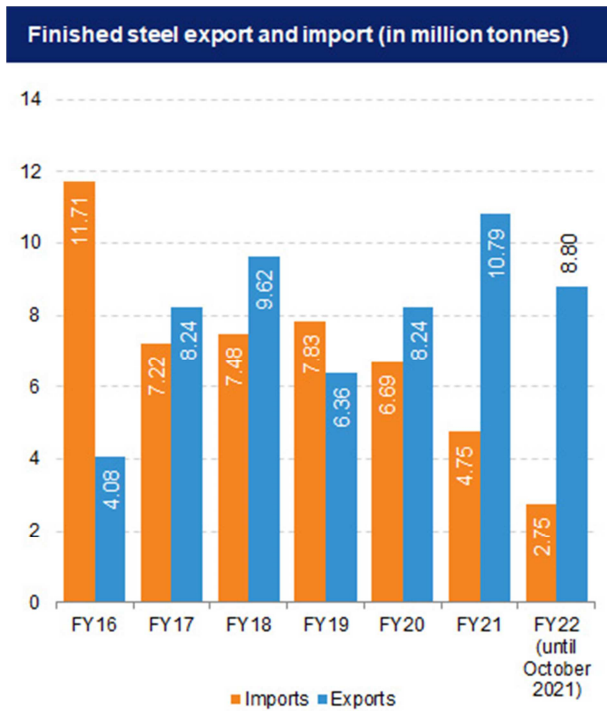


Figure 3. Shows a comparison of export and import of steel in India.

4. Innovative Solutions to Offset Challenges

Educating the working class or labourers seems to be the first step towards growth. As Prof C. K. Prahlad, Management Guru from the University of Michigan, Ann Arbor used to say -there is a lot of wealth at the bottom of the pyramid and while the top is important, it is felt that when you look after the bottom properly, the benefits of the top will reach the bottom more efficiently. So, motivation levels of the labour class is of utmost importance and for this a carrot and stick policy may be applied. Management of steel plants can help give incentives like education of children, family health insurance and maternity and even paternity leave for the employees. In India, more than in the rest of the world, trust is very important and the labour class tend to be very supportive of management's policies only if you earn their trust.

In this context, it should be mentioned that the Korean Giant Hyundai is doing a wonderful job in creating job opportunities for the village folk in their factory near Chennai. The village folk are trained as gardeners or security personnel and many of them from nearby villages are employed in the factory.

Another innovative way is to use the slag produced in steel making for useful purposes, for example in road making or mixed with concrete in building construction. Wealth from waste has become a must in these challenging times, the world over. There have been many instances of plastic waste being mixed with tar for road construction and literature shows China doing a good job of using slag mixtures for constructive purposes.

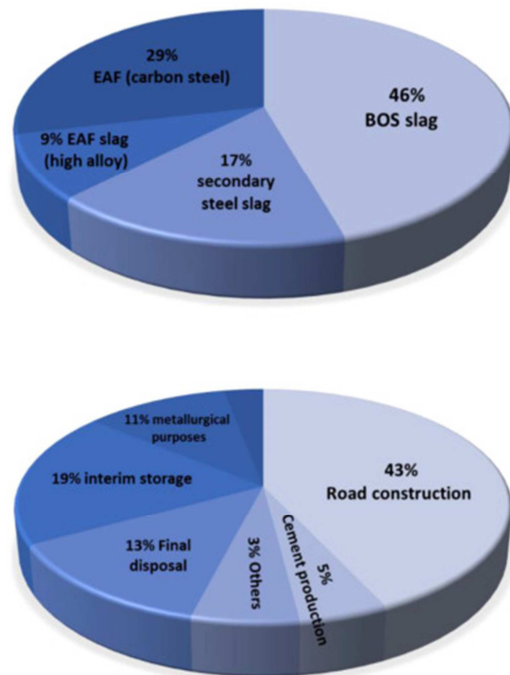


Figure 4. Shows slag utilization of primary and secondary slag.

Slag is real wealth and efforts to utilize it in various industries will definitely pay rich dividends. As the above Figure 4 shows, slag is being utilized for various purposes, but this has to increase.

Rapid investments in renewable energy is a must so that power requirements for steel making can be tapped from renewable energy. Already the Government has invested in a big way in solar energy and wind energy and slowly, it should be made mandatory to produce some percentage of energy by the use of renewable energy as the USA is now doing. Public-private partnerships and partnerships with developed countries like the USA seem to be the practical solution to better steel making. Already these steps are being implemented, but more needs to be done. Bar chart shown in Figure 4 gives an idea of the installed renewable energy scenario in India. The bar chart shows that India is fast moving ahead in solar and wind power. The Figure 5 below shows the renewable energy scenario.

Total Installed Renewable Energy Capacity (in GW)

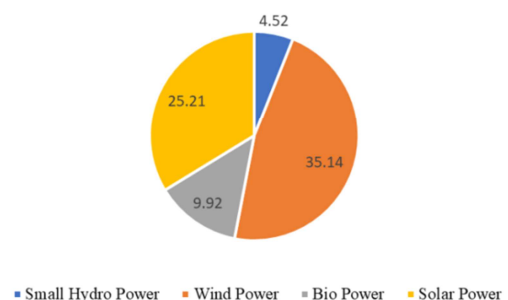


Figure 5. Shows the share of solar and wind in total renewable electricity production.

Steelmakers should be encouraged to produce steel using Electric arc furnaces. It is a well known fact that electric steelmaking is one of the clean steelmaking practices and advanced countries like the USA have moved and are moving in this direction. This is again capital intensive and small manufacturers may face a very tough job to switch over to electric arc furnaces, where steel melting is clean. In severe cases of non-feasibility of using electric arc furnaces,

big companies can be encouraged to become stake holders in smaller industries. This should be a win-win situation, where both the big companies and the smaller units benefit. Care should be taken that the top management is not entirely changed because many of the small steel manufacturers are family run or are very closely knit. There will definitely be huge resistance if any bid is made to completely take over these family run businesses.

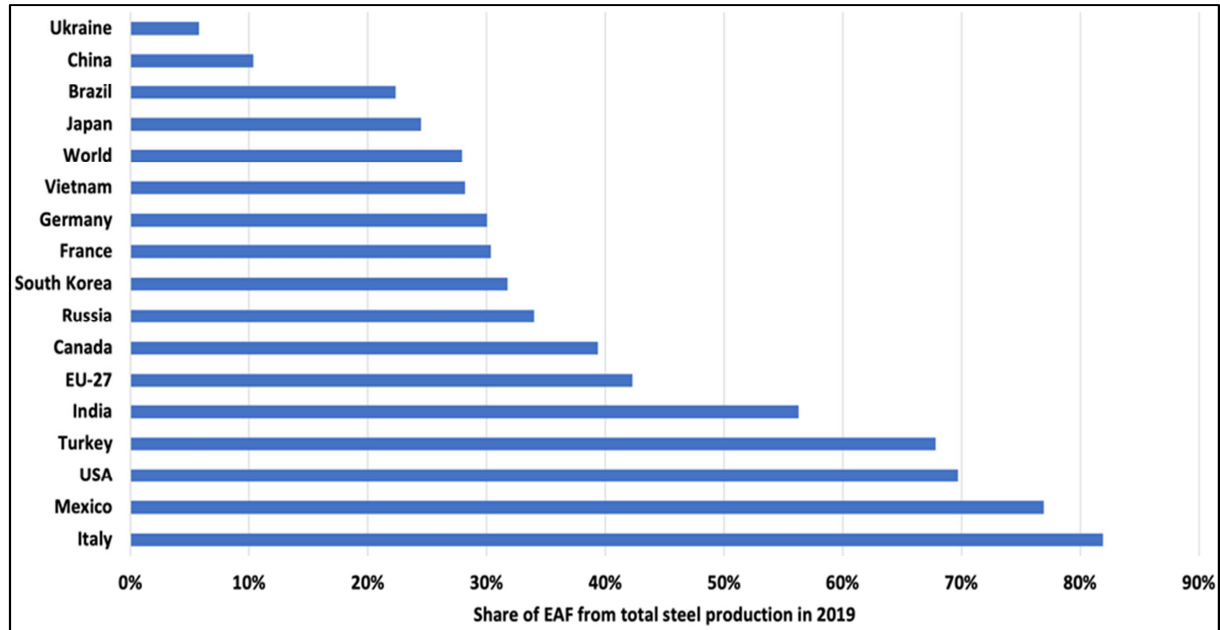


Figure 6. Shows the share of Electric arc furnace melting vs other modes of melting.

The above Figure clearly demonstrates that India is taking clean melting seriously. However, we should step up our efforts as countries like Vietnam and France are ahead of us, in spite of their small size. Clean steelmaking is a must as also improvement in emission standards. A good analysis of emissions in different steel making methods is given by Vergleich et al. [5] Carbon capture is another technology that is being researched upon in recent times by researchers like Tamilselvi et al. [6] Recycling of slags is very important and various methods of recycling have been discussed by Hirovuki et al. [7] It is felt that this aspect of steelmaking can and will be improved a lot in the future since large tonnages of slag are produced, only part of it being recycled and used effectively.

Improvements in the supply chain is a crucial element in steel manufacturing. There appear to be huge gaps in supply chains in India because of the different rules and duties across states. This gap was very much visible during Covid times when plenty of oxygen was available in steel plants, but the means to connect them to the necessary locations was only reasonably successful. Apps were created at that time to connect people requiring material to the suppliers of the material. Hence, it is seen that strong internet connectivity, especially in rural areas are a must for overall development in general and better steel making in particular. This has to be corrected and more uniformity in taxation, cost of raw materials and involvement of middlemen needs to be done.

Carbon capture is essential to reduce emissions Tata Steel has installed India's first blast furnace carbon capture plant in 2021 which captures 5 tonnes of CO₂ per day which is reused on site.

Arcelor Mittal is also doing some innovations in this regard. [8] One method described in literature uses modified porous carbon derived from starch. [9]

While it can be argued that CO₂ emissions can be from a wide variety of sources, there is no doubt that considering the Indian capacity for steelmaking, Indian steel makers contribute a substantial amount of CO₂ to the atmosphere. Hence, carbon capture could be a very useful technology for the future.

Green hydrogen is another novel way forward and the Government seems to be entering this field in a big way. Use of green hydrogen will definitely reduce our dependence on coking coal.

Use of green hydrogen will definitely reduce our dependence on coking coal. Iron ore reduction using green hydrogen is being used in Egypt. [10] Green hydrogen is being considered important in the future energy landscape. [11] Research is also being done on the materials used in power generation using green hydrogen. [12] A good review on the green hydrogen scenario in India is given by Sircar et al. [13] Current scenarios and policy implementation have been discussed by Han Phoumin et al. [14] Development and

applications of green hydrogen have been outlined by Bo Gao et al. [15].

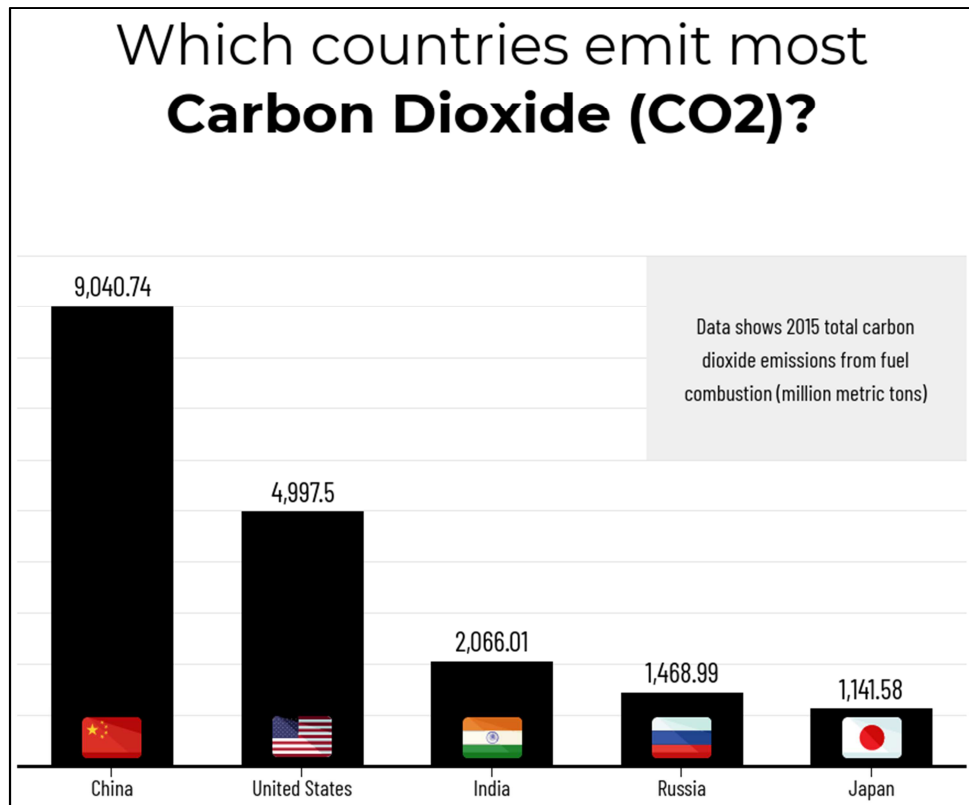


Figure 7. Shows CO₂ emissions countrywide.

5. Conclusions

In the context of modern steelmaking, India should and will take the lead in innovative steelmaking. Big companies like Tata and Arcelor Mittal are already taking adequate steps and are successful in them. More steps are required, especially in the medium and small scale industries to be on par with the bigger industries.

Innovative solutions are required to improve productivity and bring down emissions. Under the Indian context, some unique innovative solutions should be thought of and out of the box thinking becomes a must in these challenging times of steel production in the world. Some suggestions have been given in this paper with support of quantitative data.

It is hoped that this work will inspire other researchers to take up innovative research practices and in future more clean practices like electric furnace melting, use of green hydrogen, better quality materials and better disposal of slag are given importance. The ideas mentioned here will form the basis of future research.

References

- [1] Sujay Kumar Dutta, Yakshil. B. Choksi, Raw materials for steel making, Basic Concepts of Iron and Steel making, pp 307-319.
- [2] Tamilselvi Dananjayan RushendraRevathy, Andimuthu Ramachandran Kandasamy Palanivelu, Utilization of steelmaking slag for carbon capture and storage with flue gas, Green Energy for Environmental Sustainability, November 2021.
- [3] Hiroyuki Matsuura, Xiao Yang., Guangqiang Li, Zhangfu Yuan, and Fumitaka Tsukihashi, Recycling of ironmaking and steelmaking slags in Japan and China, International Journal of Minerals, Metallurgy and Materials Volume 29, Number 4, April 2022, Page 739.
- [4] R. I. Kerimov and S. I. Shakhov, Use of metallized raw materials in electric furnace steelmaking, Metallurgist, Vol. 64, Nos 1-2, May 2020.
- [5] Vergleich der CO₂ Emissionen verschiedener Verfahren zur Stahlproduktion, Comparing the CO₂ Emissions of Different Steelmaking Routes, BHM Berg- und Hüttenmännische Monatshefte volume 162, pages 7–13 (2017).
- [6] Tamilselvi Dananjayan RushendraRevathy, Andimuthu Ramachandran, Kandasamy Palanivelu, Utilization of steelmaking slag for carbon capture and storage with flue gas, Environmental Science and Pollution Research volume 29, pages 51065–51082 (2022).
- [7] Hiroyuki Matsuura, Xiao Yang, Guangqiang Li, Zhangfu Yuan & Fumitaka Tsukihashi, Recycling of ironmaking and steelmaking slags in Japan and China, International Journal of Minerals, Metallurgy and Materials, Volume 29, pages 739–749 (2022).
- [8] Jan Bollen, Role of Carbon Capture and Storage (CCS) or Use (CCU) on Climate Mitigation, Sustainable Technologies, Products and Policies (2018).

- [9] Sreedhar R. Aniruddha Shivani Malik, Carbon capture using amine modified porous carbons derived from starch, *SN Applied Sciences* (2019) 1: 463 | <https://doi.org/10.1007/s42452-019-0482-8>
- [10] Abdelrahman A. Abouseada, Tarek M. Hatem, Iron-Ore Reduction Using Green Hydrogen: A Study for Recycling Wastes in Egyptian Steel Industry, Conference on Minerals, Metals and Materials series, February, 2022.
- [11] M. Noussan, P. P. Raimondi, R. Scita, and M. Hafner, *Sustain. Basel*, 13 (2021).
- [12] R. Pillai and B. A. Pint, The Role of Oxidation Resistance in High Temperature Alloy Selection for a Future with Green Hydrogen, *JOM*, Vol. 73, No. 12, 2021.
- [13] Anirbid Sircar, Krishna Solanki, Namrata Bist, Kriti Yadav, Kabyashree Mahanta, Green hydrogen: Alternate fuel for Indian energy basket, *MRS Energy & Sustainability* volume 9, pages 392–406 (2022).
- [14] Han Phoumin, Fukunari Kimura & Jun Arima, Potential Green Hydrogen from Curtailed Electricity in ASEAN: The Scenarios and Policy Implications, *Energy Sustainability and Climate change*, 2021.
- [15] Bo Gao, Yong He, Yanmin Zhao, Weiliang Liu, Jing liu Xiaodong Peng, Development and Application of Green Hydrogen Energy Production Technology, March 2023.