

RESEARCH & DEVELOPMENT IN IRON & STEEL SECTOR

BACKGROUND

In 2016-17, India produced 97.44 MT crude steel and continued to be the 3rd largest steel producer in the world, after China and Japan. However, the Per Capita steel consumption in India is low at around 63 kg as against the world average of around 208 kg. This justifies the need for a rapid increase in capacity and production of steel in the years to come. As per the present projections, it is expected that India will emerge as the 2nd largest steel producer soon. India has accordingly, fixed a target of 300 million tonne production capacity by 2030.

Post-liberalization, technological profile of the Indian Steel Industry has undergone substantial change. With setting up of new large modern steel plants based on state-of-the-art technologies and modernisation/ expansion of existing steel plants, there is an upward trend in efficiency parameters of operation viz. productivity, energy efficiency, environment friendliness etc. Further, with setting up of Electric Induction Furnaces in the unregulated regime, technology-mix of the Indian Steel Industry has changed to a unique position. About 59% steel is produced through the Electric Furnace route of which about 31% steel is produced through the Electric Induction Furnace (EIF) route and 28% from Electric Arc Furnace (EAF) route. About 41% steel is produced through the conventional integrated route of BF-BOF route as against the world average of around 70%. India is the world's largest producer of Direct Reduced Iron (DRI) or Sponge Iron. During 2016-17, total production of sponge iron is reported at around 24.39 million tonnes of which 85% are coal based plants and 15% are gas based plants.

The R&D efforts by the Indian steel companies out of their own corpus have mainly concentrated on improving internal processes related to saving costs and improving efficiency. Process improvements such as beneficiation and pelletization of iron ore have received good response in the industry. Adoption of continuous casting together with thin slab casting as well as dedicated technologies for harnessing waste heat are drawing the attention of the steel companies. These have led to improved productivity and energy efficiency in the Indian steel industries. However, there are certain constraints in raw material quality, particularly high Alumina in Indian iron ore and high ash in Indian coal, which adversely affect the techno economic performance of the whole industry. To address these constraints and also to sustain the projected high growth rate, there is an urgent need for concerted R&D and technology intervention in the iron and steel sector.

Product development is yet another challenging area being faced by the steel industry in India. While large varieties of value added steel products are now being produced indigenously, the country is dependent on import for several high performance and value added steel products like electrical steel, automotive grade steel and steels for specialized use in defence, space and nuclear applications. The technology in such high-value products is closely held by the companies in the US, Japan & Korea, who do not part with such technologies easily. Not only huge R&D investments to develop such technologies are needed but efforts are also required for technological collaborations with such companies for acquiring high-end technologies possessed by them.

STATUS OF R&D IN IRON & STEEL SECTOR

The first R&D Laboratory in the steel sector in India was set up in 1936 at Tata Iron & Steel Company (TISCO). SAIL set up their Corporate R&D Centre in 1972 at Ranchi. R&D facilities in newer plants of JSW Steel and Essar Steel came into being in 2000's. Government has also set up several National / Regional Laboratories / Institutes under CSIR. Amongst them, National Metallurgical Laboratory (NML), Jamshedpur and Institute of Minerals and Materials Technology (IMMT), Bhubaneswar are associated with R&D in iron and steel including minerals and fuels. In addition, some academic institutes, like IITs and NITs, are also engaged in carrying out sponsored research work in the area of iron and steel.

The steel companies like SAIL, Tata Steel, JSW Steel and Essar Steel have accomplished some significant work in the area of raw material beneficiation, agglomeration and product development. However, the major focus of work in these companies generally relates to incremental technology development to address the present and short term needs of various production units. As a matter of fact, barring some commendable product development efforts, their contributions towards disruptive technology development have not been noteworthy. The actual investment on R&D by the large steel companies in India varies from company to company in the range of 0.05-0.5% of their sales turnover. Secondary Steel sector has limited capacity for undertaking research and development. Ministry of Steel is therefore, pursuing several R&D projects for the benefit of the secondary sector units.

R&D scenario in Steel companies abroad, particularly, in China, Japan and South Korea is quite different. They have large outlay of funds earmarked for R&D and also have visible tie-up with external laboratories and academic institutions. Annual R&D investment in these companies is high which is upto 1% of their sales turnover. Steel industry across the globe, and particularly in the advanced countries have identified climate change as a major challenge for more than two decades and have been proactive in reducing energy consumption and green house gas emissions by aggressive R&D and technology interventions adopting the clean & green and state-of-art technologies in all areas of production. In India also, some of the R&D projects undertaken by research laboratories and steel plants are also being directed towards reduction of energy consumption and Green House Gas Emission (GHG).

GOVERNMENT POLICY FRAMEWORK ON R&D

As per the Department of Public Enterprises guidelines, Maharatna & Navaratna category of CPSEs are required to invest in R&D @1% of PAT and @ 0.5% of PAT in case of Miniratna companies. This guideline is being adhered to by the CPSEs steel companies viz. SAIL & RINL. However, these guidelines are the minimum guidelines and also provide that CPSEs should make an attempt to benchmark R&D spending with internationally prevalent best practices in the sector.

Ministry of Steel has published '**A Roadmap for Research & Development and Technology for Indian Iron & Steel Industry**' in Sept 2011 with as aim to sensitize the Indian steel industry to improve its technological face through R&D and technology intervention (**Annex-1**). Further, the report of the **Working Group on**

Steel Industry for the 12th Five Year Plan (2012-2017) has called for aggressive R&D initiatives in steel sector (**Annex-2**).

The R&D and Technology Roadmap had taken a stock of the low R&D investment in the country and recommended major steel companies must increase their R&D investment during the next five years in the 12th Five Year Plan and achieve the target of 1% of sales turnover. The Working Group on Steel Industry for the 12th Five Year Plan has also recommended minimum 1% investment in R&D by the steel companies on their sales turnover.

In pursuance of the recommendations of the **Parliamentary Standing Committee on Coal & Steel**, Ministry of Steel has issued necessary advisory to the steel PSUs as well as private sector companies to chalk out a strategy for taking up more and more R&D activities to 1% of their sales turnover.

The R&D and Technology Roadmap delineates the thrust areas for R&D and Technology development in Indian Steel Sector (**Annex-3**), which encourages/facilitates development and adoption of such technologies which are relevant to natural resource endowment of the country, which minimize damage to the environment, optimize resource utilization, facilitate achievement of global standards of productivity and efficiency and development of front end and strategic steel based materials. Against this backdrop, the issue of utmost importance is the R&D intervention to find out techno-economic solutions to use indigenous raw material resources. Another area that requires attention is the product development to develop and produce high performance steel indigenously.

GOVERNMENT INITIATIVES TO PROMOTE R&D IN STEEL SECTOR

1. Promoting R&D with financial assistance from Steel Development Fund

(i) R&D Scheme pursued with SDF: In order to augment R&D initiatives and to step up investment for it in the steel sector, the Government had decided in 1997-98 to fund upto Rs. 150 crore per year for R&D projects in iron & steel sector, from the interest proceeds of Steel Development Fund (SDF). An Empowered Committee has been set up under the chairmanship of Secretary (Steel) and members from Ministry of Science & Technology, Steel Producers, Research Laboratories and Academic Institutes. Under the Scheme financial assistance from SDF is provided to R&D projects pursued by reputed Research Laboratories, Academic Institutions & Industries. There is a two tier structure for evaluation of R&D proposals under this scheme. An Evaluation Group (EG) comprising Ministry of Steel, Department of Science & Technology, Department of Scientific and Industrial Research and Defence Research and Development Organisation evaluates the R&D proposals and its recommendations are placed before the Empowered Committee for consideration & approval. There are also independent Empowered Board (EB) of experts for each project for review and monitoring the progress. Technical Division (TD) of the Ministry of Steel works as the Secretariat of the Empowered Committee to scrutinize the research proposals, obtain views of independent experts and monitor the progress of the projects for reporting to the Empowered Committee.

However, R&D and investment thereof even under this Scheme over the years has not been very encouraging. This is mainly because of limited number of overall R&D infrastructure in steel companies or in Laboratories resulting in limited number of applications. In between, R&D work under the scheme also had a slow pace because of limited availability of liquid fund in the SDF upon waiver of loans amounting to around Rs. 5000 crore advanced to SAIL from SDF as part of its restructuring plan in the year 2000. Further, Tata Steel has got a stay from the High Court on restricting the utilisation of their contribution in the SDF.

Under this scheme, upto December 2016, 91 R&D projects have been approved with a total cost of Rs. 950.65 crore with approved SDF contribution of Rs. 536.26 crore. The R&D projects include basic/ fundamental research as well as applied research i.e to find out ways to solve problems being faced by the industry. Research results of several R&D projects have already been implemented by plants under SAIL and in Tata Steel, resulting in improvement in productivity, reduction in energy consumption and pollution etc. A list of R&D projects pursued under this scheme along with their status/ outcomes, upto March 2017, is given at **Annex-4**.

Guidelines for submission of Research Proposal for financial support from SDF

R&D Project Proposals are invited from Reputed Academic Institutions/ Research Laboratories and Indian Steel Companies for pursuing R&D projects for the benefit of the Iron & Steel Sector in the country

Activities Supported:

- Development of innovative/ path breaking technologies for utilization of Indian iron ore fines/slimes and non-coking coal.
- To pursue R&D projects to address Climate Change issues in line with other countries.
- Beneficiation/ up gradation of low grade iron ore, coal etc. and agglomeration.
- Development of commercially viable technology for utilization of steel plant and mine wastes including LD/EAF Slag.
- Improvement in quality of steel produced through the induction furnace.
- Development of indigenous technologies for new processes and improved products viz. Ultra High Strength Steel, High Strength High Formable steel, CGRO Steel Sheets, emerging coated products etc.
- Achieving global benchmarks in Productivity, Quality, Raw material consumption.
- Development of Low carbon technology.
- Development of innovative technology for effective recovery of waste heat in different iron & steel making processes.
- Development of innovative solutions for addressing the challenges faced by the iron & steel industry.

Scope of Support:

- R&D work in Lab Scale/ Bench Scale and scale-up to Pilot Scale/ Demonstration Plants will be supported.
- In case of Industrial/ Commercial organisations pursuing R&D projects with SDF, financial assistance of generally 50% of the total project cost is permissible.

- In case of Academic Institutions & National/ Regional Research Laboratories, financial assistance of upto 100% is permissible. However, preference will be given to R&D project having tie-up with user industry.
- For Pilot/ Demonstration Scale R&D projects, financial contribution from SDF will be limited upto 50% & the balance to be met by the industrial partner.

Eligibility:

- Proposal can be submitted by a Public Entity or Private Entity.
- Industry/ Institutions should have DSIR recognized in-house R&D laboratory.
- Joint Proposals with other laboratories/ institutions/ industry are desirable for support.

In this regard, the **advertisement published in leading newspapers** seeking R&D proposals for financial assistance from Government is given at **Annex-5**.

The **Guiding format** for Research Proposal seeking full/ partial financial support from SDF is given at **Annex-6**. The **Standard Terms & Conditions** of the SDF Grant is given at **Annex-7**. The applications as per guidelines may be initially submitted in 8 copies (along-with a soft copy of the proposal on CD) to: Joint Secretary, Technical Division, Ministry of Steel, Udyog Bhawan, Maulana Azad Road, New Delhi – 110107.

(ii) Centre of Excellence: In addition to funding specific R&D projects, Ministry of Steel in the year 2008-09 has launched a capacity building programme thereby creating state-of-the-art R&D facilities for human resource development in the steel sector with financial assistance from SDF. These initiatives were taken in pursuance of the recommendation of a sub-committee headed by Prof S P Mehrotra, former Director NML Jamshedpur. Under this scheme, one centre of excellence namely, Steel Technology Centre has already been operationalized at IIT Kharagpur with a financial assistance of Rs.16.20 crore from SDF. This centre has facilitated students towards research in Iron & Steel sector. Based on this success story, three more centres have been approved at IIT Bombay, IIT BHU & IIT Madras with financial assistance of Rs.33.06 crore, Rs.30.98 crore and Rs. 35.55 crore respectively from SDF.

(iii) Chair Professor & Scholarships Scheme: Ministry of Steel has started Ministry of Steel Chair Professor & Scholarships scheme since 2008-09. The Chair Professor scheme has been started in order to partly address the shortage of faculty for teaching/ research in metallurgical engineering. The scholarship scheme on the other hand has been started to attract bright students of metallurgical engineering to pursue their career in Iron & Steel sector as well as pursue R&D. Any Academic institution in the country which teaches Metallurgical Engineering are eligible to implement the schemes. The revised Scheme with enhanced allowances for the Chair Professor and enhanced scholarships for the students, was introduced from 2013-14 for a period of five years. The Scholarship scheme has been implemented in 16 institutes and Chair Professors have been appointed in 13 institutes. Total grant released towards salary of Chair Professors and scholarship since inception is Rs 17.07 crore (upto March 2017). The success of the scheme has been established through an independent study carried out by Administrative Staff College of India (ASCI), Hyderabad.

2.0 R&D with Govt. Budgetary Support:

In view of the limited liquid money in SDF, the Government started a new scheme viz. "Promotion of R&D in Iron and Steel Sector", during the 11th Five Year Plan. As per the approval of the Expenditure Finance Committee (EFC) the three broad areas to be pursued under this scheme are:

- **Development of innovative/ path breaking technologies for utilization of iron ore fines and non-coking coal.**
- **Beneficiation of raw materials like iron ore, coal etc. and agglomeration.**
- **Improvement in quality of steel produced through the induction furnace.**

A Project Approval and Monitoring Committee (PAMC) under the Chairmanship of Secretary (Steel) and members comprising Additional Secretary & Financial Adviser and Joint Secretary, Ministry of Steel, Director IIT Kharagpur, Director IMMT, Director NML and other members, is the decision making body for approval of R&D projects, monitoring of ongoing projects and for overall direction. Technical Division (TD) of the Ministry of Steel works as the Secretariat of the PAMC to scrutinize the research proposals, obtain views of experts and monitor the progress of the projects for reporting to the PAMC. Project Review Committees (PRCs) comprising domain experts also monitors the progress and fund utilization of each project.

The aforesaid R&D Scheme has been continued in the 12th Five Year Plan. In 12th FY Plan, two new objectives have been added along with the three aforesaid objectives, namely:

- **Development of technology for CRGO Electrical Steel Sheets and other value added innovative steel products**
- **To pursue R&D on any other subject of national importance concerning the Iron & Steel sector**

The PAMC has so far approved 23 R&D projects with a total cost of Rs. 177.12 crore with financial assistance of Rs. 120.34 crore from Plan Fund. Major projects covered under the scheme include exclusive R&D initiatives to upgrade Indian low grade iron (including BHQ/BHJ) and Indian coking/non-coking coal. Details of the projects along with their status & outcome, upto March 2017, are given at **Annex-8**. So far 7 projects have been completed wherein processes/ technologies have been developed in laboratory/ pilot scale for beneficiation & agglomeration of iron ore & coal for the benefit of the iron & steel sector. Process has also been developed in laboratory scale for production of low Phosphorus steel in laboratory scale Induction Furnace, for which industrial trials have also been carried out. Further, feasibility of smelting reduction of iron ore/fines using hydrogen plasma has been explored in laboratory/ pilot scale.

The technology for production of **CRGO Steel Sheet** is not readily available as only a handful of manufacturers are there worldwide and they are reluctant to provide the technology. The demand for CRGO Steel Sheets, used mostly in Transformers, in the country is 2 -2.5 Lakh TPA. Most of the demand is met from imports. Under this background, Government has decided to pursue the R&D for indigenous development of technology for Cold Rolled Grain Oriented (CRGO) steel sheets and

other value added innovative steel products. Salient features of the project is given below:

- This is a joint collaborative research project by NML Jamshedpur, Tata Steel, RINL & Ministry of Steel
- This project will focus on development of CRGO Steel sheets. However, the facilities created will be used for development of other value added products also at a later stage.
- DPR of the project has been prepared and submitted by MECON
- As per the DPR, the total cost of the project is Rs. 494.65 wherein Ministry of Steel's contribution is Rs. 117.91 crore.
- The DPR has been approved by the stakeholders.
- Approval of the Board has been obtained by RINL & Tata Steel for funding.
- Allocation of the necessary funds for DSIR & Ministry of Steel are being obtained.
- Memorandum of Agreement will be signed by the stakeholders and project likely to be launched in 2017-18.

Guidelines for submission of Research Proposal for financial support from Plan Fund

R&D Project Proposals are invited from Reputed Academic Institutions/ Research Laboratories and Indian Steel Companies for pursuing R&D projects for the benefit of the Iron & Steel Sector in the country

Activities Supported:

- Development of innovative/ path breaking technologies for utilization of iron ore fines and non-coking coal.
- Beneficiation of raw materials like iron ore, coal etc. and agglomeration.
- Improvement in quality of steel produced through the induction furnace.
- Development of Technology for Cold Rolled Grain Oriented (CRGO) steel sheets and other value added innovative steel products
- To pursue R&D on any other subject of national importance concerning the Iron & Steel sector

Scope of Support:

- R&D work in Lab Scale/ Bench Scale and scale-up to Pilot Scale/ Demonstration Plants will be supported.
- In case of Industrial/ Commercial organisations pursuing R&D projects with Plan Fund, financial assistance of upto 50% of the total cost is permissible.
- In case of Academic Institutions & National/ Regional Research Laboratories, financial assistance of upto 100% is permissible. However, preference will be given to R&D project having tie-up with user industry.
- For Pilot/ Demonstration Scale R&D projects, financial contribution from Plan Fund will be limited to upto 50% & the balance to be met by the industrial partner.

Industrial Tie-ups/ Commercialization:

- R&D proposals should have industrial tie-ups and also have well defined mechanism for translation of the research results by the industry.

Eligibility:

- Proposal can be submitted by a Public Entity or Private Entity.
- Industry/ Institutions should have DSIR recognized in-house R&D laboratory.
- Joint Proposals with other laboratories/ institutions/ industry are desirable for support.

In this regard, the **advertisement published in leading newspapers** seeking R&D proposals for financial assistance from Government is given at **Annex-5**.

The **Guiding format** for Research Proposal seeking full/partial financial support from Plan Fund is given at **Annex-6**. The Standard Terms & Conditions of financial support from Plan Fund is given at **Annex-9**. The applications as per guidelines may be initially submitted in 8 copies (along-with a soft copy of the proposal on CD) to: Joint Secretary, Technical Division, Ministry of Steel, Udyog Bhawan, Maulana Azad Road, New Delhi – 110107.

3. Expenditure on R&D from Plan Fund and SDF during last 3 years

Sl.No	Year	Plan Fund (Rs Crore)	SDF (Rs Crore)
1	2013-14	8.00	17.41
2	2014-15	2.03	17.00
3	2015-16	10.26	18.21
4	2016-17	15.00	18.13

4. UAY & IMPRINT Schemes: Ministry of Steel is actively participating in the Impacting Research Innovation & Technology (IMPRINT) & (Uchchar Avishkar Yojana) UAY Schemes launched by MHRD. Under the IMPRINT Scheme 3 R&D projects with total cost of Rs. 11.05 crore have been approved with 50% funding from Ministry of Steel. Under the UAY scheme, 3 R&D projects have been approved with total cost of Rs. 10.09 crore with 25% funding from Ministry of Steel.

5. Steel Research & Technology Mission of India

Ministry of Steel constituted a Task Force under the Chairmanship of Dr. Baldev Raj, former Director, IGCAR, for suggesting a blueprint for an institutional mechanism to spearhead the R&D efforts in Iron & Steel Sector in India. The said Task Force, in its report inter-alia recommended setting up of a new institutional mechanism namely, Steel Research & Technology Mission of India (SRTMI) for taking up research projects of national importance. The proposal has been accepted by Ministry of Steel. The salient features of SRTMI are as under:

- SRTMI will be an industry driven initiative which will be setup as a registered society wherein Ministry of Steel will be a facilitator as one of the members of the society.
- SRTMI will be governed and administered by a Governing Body comprising the steel CEOs, domain experts and a representative of Ministry of Steel.

- The participating companies shall pay an initial entry fee @ Rs 25/tonne of crude steel produced during 2013-14, or, Rs 5 Cr, whichever is higher, to facilitate the creation of SRTMI.
- Ministry of Steel will also provide part fund to facilitate the creation of SRTMI.

CEOs of Major Indian Steel Companies, signed a Memorandum of Agreement with Ministry of Steel in the presence of Hon'ble Minister for Steel & Mines on 6th April 2015 for participation and financial contribution in the initiative with an initial corpus of Rs 200 crore. SRTMI has been registered on 14th October 2015. Selection of Office Space, Preparation of Organisation Structure, Preparation of Budget & Funding Mechanism is in progress. The Director SRTMI shall be its Chief Executive Officer. An advertisement seeking applications for the post of Director SRTMI has been given in newspapers in July 2017. The details are also uploaded in Ministry of Steel's website.