

## RESEARCH AND DEVELOPMENT

Research & Development Centre for Iron and Steel (RDCIS) has provided innovative technological inputs to different units of SAIL, with special emphasis on cost reduction, product quality enhancement, development of new products and commercialisation of value added products. RDCIS completed 74 projects fulfilling 100% of its target.

During the year 195 technical papers were published / presented, besides filing of 26 patents (including 5 from SAIL plants) and 31 copyrights (including 9 from SAIL plants). In addition, the scientists at the Centre won 8 national awards.

### EMPOWERED COMMITTEE ON RESEARCH & DEVELOPMENT

To supplement and encourage research activities in iron and steel sector, Govt. of India is providing financial assistance from the Steel Development Fund (SDF) for some of the R&D projects received from public and private sector steel plants, national laboratories, academic institutions etc. Thrust areas of the R&D projects, so assisted, are given below:

- Design & development of new technologies & production processes.
- Reduction in raw material and energy consumption.
- Development of Human Resources.
- Utilisation of waste materials.
- Environment management and pollution control.
- Development of new value added products.

To obtain the financial assistance, application in the prescribed format in 5 copies available at the website ( [www.nic.in](http://www.nic.in) ), Ministry of Steel are to be submitted to Industrial Adviser, Ministry of Steel, Govt. of India, Udyog Bhawan, New Delhi -110011.

In pursuance of the decision of Government of India, an Empowered Committee under the Chairmanship of Secretary to the Government of India, Ministry of Steel with members from Department of Science & Technology, Department of Scientific & Industrial Research, Steel producers in both private and public sectors, Indian Institute of Technology (IIT), Kharagpur, National Metallurgical Laboratory (NML), Jamshedpur, MECON Ltd, Secretary, SDF Managing Committee and others has been set up on 24.2.1998 with a view to providing overall directions to the total research effort on iron and steel in the country and approve specific research projects placed before it for funding fully or partially, from SDF.

The terms of reference of the Empowered Committee are as follows: -

- ◆ Examine all aspects of Science & Technology in the Iron & Steel Sector.
- ◆ Co-ordination of the on-going research programmes in both the private and public sector iron and steel plants and monitor their progress.
- ◆ Evaluate and decide upon the research proposals placed before it for fully or partly funding from the interest accruals from the Steel Development Fund.
- ◆ Review, periodically, the progress of Science & Technology programmes of national importance in the Iron & Steel Industry.
- ◆ Advise Ministry of Steel on the policies and programmes which need to be pursued in



R&D Centre at Hyderabad

developing domestic capabilities in scientific and technological research, development of design, engineering and research in the iron & steel processes and products.

**SECRETARIAT OF THE EMPOWERED COMMITTEE (EC):**

The responsibility for providing secretarial assistance to the EC has been entrusted to the Technical Wing in the Ministry of Steel. The Technical Wing processes the applications in consultation with an Evaluation Group (EG) comprising of Industrial Advisor, Ministry of Steel and representative from Department of Scientific and Industrial Research as well as Department of Science and Technology. Assistance of other experts in the field is also taken, if required. Their recommendation of the EG are placed before the EC for final decision in the matter.

The Technical Wing, the EG & some specifically constituted Empowered Boards (EB) of experts for some high values R&D projects monitor progress of research work and report to the EC. On the recommendation of the Empowered Committee, the money is released by Joint Plant Committee. They also keep check on proper utilisation of fund by the project authorities. In case any deviation is noticed the same is brought to the notice of the Empowered Committee.

**REQUIREMENT OF FUND FROM SDF**

An outlay of Rs. 60.0 crore (RE) is available for financing research and development activities for the year 2004-05.

Since beginning (1998), as on 31.12.2004 the Empowered Committee (EC) has met 12 times and approved 36 R&D projects. The total cost of these 36 projects is Rs.218.04 crore. Out of this Rs. 99.50 crore is to be met from SDF. The year-wise release of money from SDF is as follows:-

(Rs. in crore)				
S.No.	Year	R&D Projects	Other Science and Technology related projects	Total
1.	1997-98	00.0400	0.08	0.12000
2.	1998-99	01.2958	0.04	1.33580
3.	1999-2000	32.68457	NIL	32.68457
4.	2000-01	16.11600	NIL	16.11600
5.	2001-02	07.93070	NIL	7.93070
6.	2002-03	00.40603	NIL	0.40603
7.	2003-04	13.92800	NIL	13.92800
8.	2004-05( as on 31.12.2004)	07.36500	NIL	07.36500
	<b>Total</b>	<b>79.76610</b>	<b>0.12</b>	<b>79.88610</b>

**ACHIEVEMENTS/ BENEFITS FROM THE COMPLETED R&D PROJECTS:**

Out of 36 research projects approved so far, 16 research projects have been completed. Research results of some of the projects have already been implemented and they are yielding benefits in areas of Iron & Steel making processes, up-gradation of Raw material, product development, increase in productivity, reduction in refractory consumption during steel making, reduction in energy consumption in Electric Arc Furnace/Induction Furnace route, development of new process for weld components and utilization of waste materials etc. 3 projects have been stopped after mid course review.

The completion report of 4 research projects has been received. Based on the research results, the user industries are being approached for giving feedback on the success of the projects. 13 projects are in progress.

**RESEARCH & DEVELOPMENT BY INDIVIDUAL IRON & STEEL PLANTS**

Iron and steel producers, both in the public and private sector to have continued to pursue their research and development activities to deal with their plant specific problems, assimilate and innovate newer technologies, utilise Indian minerals and raw materials in larger proportion, reduce pollution, conserve energy and reduce cost of production.

Total amount of money spent in Research and Development by Iron and Steel Plants and other related industries during last three years were as follows:-

	(Rs. in crore)		
	2002-03	2003-04	2004-05 (upto Sept.'04)
<b>(a) Public Sector</b>			
Steel Authority of India Ltd.	54.82	71.91	46.44
Rashtriya Ispat Nigam Ltd.	2.50	2.50	1.0
National Mineral Dev. Corp.	6.25	6.51	2.74
Kudremukh Iron Ore Co. Ltd.	1.24	3.50	0.75
Manganese (Ore) India Ltd.	0.97	1.08	0.30
Sponge Iron India Ltd.	6.10	7.70	3.20
Bharat Refractories Ltd.	0.15	0.18	0.10
MECON Ltd.	0.41	0.26	0.16
<b>Sub Total (a)</b>	<b>72.44</b>	<b>93.64</b>	<b>54.69</b>
<b>(b) Private Sector</b>			
Tata Iron & Steel Co. Ltd.	16.33	24.26	9.96
Mukand Ltd.			
Sunflag Iron & Steel Co. Ltd.			
Jindal Vijay Nagar Steel Ltd.	1.36	2.41	1.98
Jindal Steel & Power Ltd.	1.26	0.69	0.41
<b>Sub Total (b)</b>	<b>18.95</b>	<b>27.36</b>	<b>12.35</b>
<b>Grand Total (a+b)</b>	<b>91.39</b>	<b>121.00</b>	<b>67.04</b>

**STEEL AUTHORITY OF INDIA LTD.**

Research & Development Centre for Iron & Steel (RDCIS), SAIL have undertaken 99 R&D projects in the year 2004-2005. Out of these 71 projects are to be completed during the year. 19 projects have already been completed during the period from April to October, 2004. These projects provided technological inputs to SAIL plants / units with thrust on cost reduction, value addition, quality improvement and development of new products.

Till October, 2004 the centre have filed 10 patents. During this period 26 patents which were filed earlier, have also been sealed by the Patent Office. The Centre have also filed 6 copyright proposals. During the period 3 copyrights which were filed earlier have been granted. As many as 8 prestigious national awards were bagged by RDCIS collective and 60 technical papers were published/ presented. In addition, RDCIS undertook contract research work and provided significant consultancy services and know-how to organisations outside SAIL, yielding external earning of Rs. 79.72 lakh upto October, 2004.

**BENEFITS DERIVED AS A RESULT OF R&D EFFORTS**

**TOWARDS COST COMPETITIVENESS**

- Improvement in Lining Life of Steel Ladle at SMS-II at Bhilai Steel Plant (BSP)
- Improvement in the Productivity of Colliery Arch Section at HSM at Indian Iron & Steel Company Ltd. (IISCO)
- Signature Analysis of Critical Machines for Detection of Fault at Durgapur Steel Plant (DSP)
- Improvement in Life of Coke Screens at Coke Sorting Plant at Rourkela Steel Plant (RSP)

- Evaluation of Sponge Iron Usage in Blast Furnace at Bokaro Steel Plant (BSL)
- Stabilisation and Implementation of in-house made full MgO-C brick lining at 150T Steel Ladles of SMS-II at RSP
- Improvement in Performance of Back-Up Rolls of Hot Strip Mill at BSL

**PRODUCT QUALITY INITIATIVES**

- Standardisation of VAD Practice in R-19, R-34 wheel and other grades of steel with respect to desulphurisation required by Alloy Steel Plant (ASP) at DSP
- Quality Improvement of Cast Slab at BSL
- Improvement in quality of existing forged steel CRM Work Rolls produced through ASP-GPI Route at RSP
- Horizontal and Vertical Gap Measurement and Drive Synchronisation in Side Trimming Shear, Plate Mill at BSP
- Reduction of Off-Corner Crack in 125 mm Cast Billets at DSP

**NEW PRODUCTS**

- Commercialisation of Low Carbon (C < 0.04%) EDD (HR/CR) Steel at BSL
- Development and Application of Corrosion Resistant Low Alloy (CRLA) Steel for Fuel Gas Pipelines at RSP
- Market Promotion of Special Grades of Steel at RSP

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	19207	54.82	0.28
2003-04	24178	71.90	0.29
2004-05 (upto Dec. 2004)	21578	70.35	0.33

**NATIONAL MINERAL DEVELOPMENT CORPORATION LTD.**

**RESEARCH & DEVELOPMENT**

Some of the major assignments taken up by NMDC in progress completed during the year 2004-2005 (upto Dec.,04) are listed below:

**A) Technology Development Projects**

- a) Production of Carbon Free sponge iron powder and value added products there off
- b) Production of Power Ferrite Powder from Blue Dust concentrate
- c) Process Development for Bailadila Projects of NMDC Ltd.
- d) Production of composite material and Nano-Crystalline iron powders from blue dust.
- e). Process Development for Preparation of Sodium Silicate, Zeolite-A and Precipitated Silica obtained from Kimberlite waste
- f) Development of Indigenous Technology for Production of synthetic rutile, pig iron and High pure Iron Oxide using Thermal Plasma Technology from East Coast Beach Sand.

**B) Various assignments from Investigation/Construction/Production Projects were carried out.**

**C) Various Projects sponsored by several Public Sector and Private Sector companies have been taken up.**

**Collaborations:**

- i) Joint Research Project between NMDC and MISA, Russia for investigating the Properties of Nano-crystalline Iron Powders from Blue Dust.

- ii) Sharing of cooperation with Telemark Technological Research and Development Centre, Norway in the field of Flow of Bulk Solids and Silo Technology.
- iii) Sharing of Cooperation with MMG (India) Ltd., Chennai for production of Ferrite Powders.

**E) Patents**

- (i) Dissolution of Blue Dust under pressure and Temperature - Awarded.
- (ii) Development of Pigment Grade Ferric Oxide from blue dust - Accepted.
- (iii) Development of Caustic Magnesia from Panna Tailings - Registered.
- (iv) Development of Filter Candles from Kimberlite tailings as an adsorbent for removal of fluoride - Registered.
- (v) Novel process for utilization of effluent from chemical process at Vizag -Registered.
- (vi) Application of Kimberlite Tails in cold bonded tiles - Registered.

**R&D EXPENDITURE DURING THE LAST 3 YEARS**

(Rs in crore)

Year	Turnover (Rs.Crores)	Expenditure on R&D (Rs. Lakhs)	R&D Expenditure as % of turnover.
2002-2003	1214.23	625.22	0.51%
2003-2004	1453.69	651.72	0.45%
2004-2005 (Apr.-Dec.,04)	1513.92	425.29	0.28%

**RASHTRIYA ISPAT NIGAM LTD.**

Research Projects to be undertaken during the year are identified at the beginning of the year. These projects are carried out as per the stipulated time frame and the status is closely monitored for their effective implementation. Various research projects, under implementation in 2004-05, are indicated below.

- Development of model for coal blend selection on the requirement of CSR, CRI, M10 and coke ash.
- Study for reduction in gangue content of sinter to reduce the specific slag volume in Blast Furnace (BF)
- Study for use of alternate recarburizer for production of carbon steel
- Study for improving the properties of 12mm rebars in Wire Rod Mill (WRM).

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	5058	2.5	0.05
2003-04	6169	2.5	0.04
2004-05 (upto Sept. 2004)	3414	1.0	0.03

**KUDREMUKH IRON ORE CO. LTD.**

Objective of R & D activities at KIOCL is directed towards quality improvement through process development / modifications to suit multi-product needs and to modify process flow chart to cater to the present run of mine ore characteristics which keep changing from location to location.

**R & D (ORE PREPARATION & PROCESSES) PROJECTS TAKEN UP**

- ◆ In order to realize concentrate with around 4% silica from low DTC residual ore and to enhance the life of mine, derrick screen has been installed for process improvement.
- ◆ Testing of SMC Derrick screen has shown satisfactory results. With the introduction of derrick screen, consistency in the quality of concentrate is expected to be maintained.
- ◆ Feasibility studies on process and technological modification for use of hematite ore for pellet making and grinding facilities have been undertaken.
- ◆ Assistance of M/s Metchem Canada Inc. for process and technological modifications for use of hematite ore for pellet making and grinding facility is being utilized.
  - ⌘ Blending of Kudremukh magnetite concentrate with hematite ore progressively sourced from outside for use in pellet plant. Ultimately plans are to produce 100% hematite pellets.
  - ⌘ Sourcing of iron ore fines for export.
  - ⌘ Development of infrastructure facilities at Mangalore for receipt, unloading, handling, blending, storage and grinding of hematite ore sourced from different agencies.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	727.14	1.24	0.17
2003-04	1029.38	3.50	0.34%
2004-05 (Upto Sept 04)	763.13	0.75	0.10%

**MANGANESE ORE INDIA LTD.**

The R & D efforts are directed towards meeting the challenges of safe and cost effective mining practices in underground mines with increasing depth. The thrust in the R & D activities is also being given for development of beneficiation and up gradation technique in addition to exploration of the new deposits. The main areas where the R&D efforts of the Company have been directed are as follows:

- Development of safer and cost effective mining method.
- Development of new support system in underground workings and improving the existing supporting methods and practices.
- Development of cost effective beneficiation technique for upgradation of minerals.
- Development of manganese based chemicals.
- Technical upgradation and automation of activities for productivity enhancement and safety improvement.
- Mechanization and system improvement.
- Exploration of new deposits.

**ONGOING R&D FOR CONTINUOUS IMPROVEMENT IN EXISTING PRACTICES**

- ◆ Rock Mechanics instrumentation and application of the recent advances in rock mechanics, for monitoring the ground behaviors in the underground mines.
- ◆ Pit slope stability studies in the open cast mines and optimization of slope angles to reduce the development costs.
- ◆ Blasting studies in the underground as well as open cast mines, for optimization of blasting parameters, reduction in explosive consumption and blasting costs, and improvement in the fragmentation of the blasted material.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	177.88	0.97	0.55
2003-04	228.74	1.08	0.005
2004-05 (Upto Sept 04)	127.61	0.30	0.24

**SPONGE IRON INDIA LTD.**

As a part of R&D programme samples of iron ore and coal were collected from different sources and experiments were carried out in laboratory followed by plant scale trials. This has helped the company to optimize the process and improve production and reduce consumption of coal.

**SPECIFIC AREAS OF R&D**

- During the year testing was carried out about the suitability of pellets formed from iron ore fines and waste coal fines for reduction in rotary kiln.
- Samples of iron ore and coal were collected from different sources from Karnataka State and singareni mines respectively. The collected samples were analysed in Salvis Kiln for optimization of reduction process.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	44.14	0.06	0.14
2003-04	58.86	0.07	0.13
2004-05 (Upto Sept 04)	28.85	0.03	0.11

**BHARAT REFRACTORIES LTD.**

The Specific area in which R&D were carried out by the company are as follows:-

- ◆ Silica Mortar
- ◆ Spray coat
- ◆ Silica Dusting Mass
- ◆ Development of Nozzle filling compound
- ◆ Development of Zirmul Castables
- ◆ Novalac Resin Trial
- ◆ Hot Patching Mass
- ◆ Development of LD Gunning Mass with use of Dunite

The above R&D work has helped in reducing cost of manufacture as well development of new products. To meet the future demand of Steel Plant, the company has given thrust to the development of heat shield material.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	72.69	0.15	0.21
2003-04	110.97	0.18	0.16
2004-05 (Upto Sept 04)	65.30	0.10	0.15



**MECON LTD.**

**ONGOING PROJECTS**

- ◆ "Miniaturization of Thermoelectric Cooling Unit for Tank Crew":- This is an ongoing sponsored project fully funded by DIPAS, DRDO, Delhi. A successful demonstration of the developed equipment has been completed at DRDO, Delhi. Awaiting for field trial at CVRDE, Chennai.
- ◆ "Heating gloves and socks at an ambient of (-15)° C for defence personnel":- This is an ongoing sponsored project fully funded by DIPAS, DRDO, Delhi. The system has been developed and submitted to DRDO, Delhi for their trials.
- ◆ "Development of LED Opacity Monitor for on-line Measurement of Particulate Emissions":- This is an ongoing sponsored project fully funded by MOEF, Govt. of India. The project is progressing as per schedule and results obtained so far are encouraging.
- ◆ "Solid State Cooling / Heating of 'IR' Optics for 'NAG' Missile":- This is an invited proposal from DRDL, Hyderabad. Just received LOI from DRDL, Hyderabad for Engineering R&D. Work yet to start.
- ◆ "Development of Optically Variable Microwave Phase Shifter at 12 GHz":- The proposal has been submitted to Directorate of Training and Sponsored Research, DRDO, Delhi for evaluation and funding. This project is under active consideration.
- ◆ Provisional

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

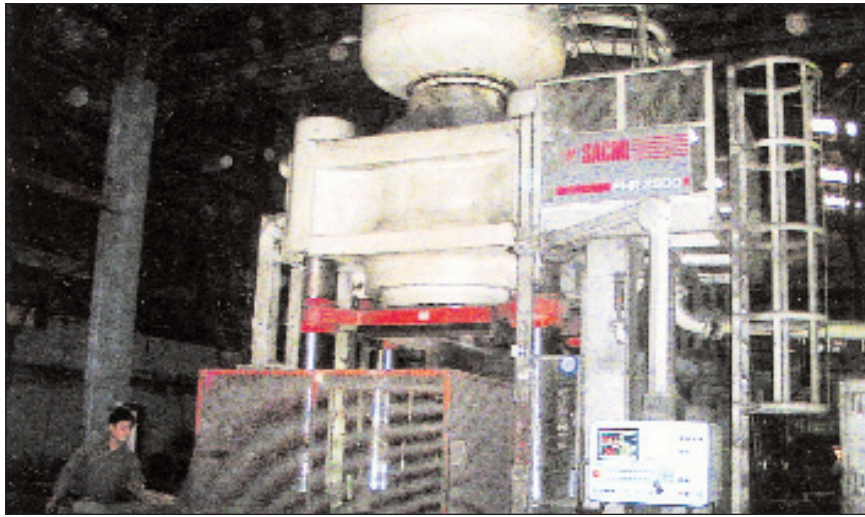
Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	283.49	0.41	0.14
2003-04	271.14	0.26	0.10
2004-05 (Upto Sept 04)	90.80	0.16	0.18

**TATA IRON & STEEL COMPANY LTD.**

**SPECIFIC AREAS IN WHICH R&D WAS CARRIED OUT BY THE COMPANY ARE:**

- Studies for optimisation of bulk density of coal cake for increasing the productivity of stamp charged batteries showed that semi-soft hard coking coal are the most difficult coals to stamp.
- Developed an alternative method of reduction of Cr6+ using organic reductant to 0.01ppm level in Sukinda Chromite Concentrates
- Identified the process flow sheet to lower alumina from 5-7% to <4% in Manganese ore feed (-75 +10 mm size) to Ferro Alloy Plant (FAP), Joda.
- Impact of deadman characteristics in Blast Furnaces (BF) such as effect of porosity, free space and deadman configuration has been simulated thorough models.
- The effect of charging sequence on burden distribution and surface profile generation is being investigated in 1:10 scale model of F-BF.
- Mould friction during billet casting has been measured using a novel uni-axial accelerometer.
- A mathematical model developed for the optimisation of aluminium wire injection.
- Optimisation of parameters of electromagnetic stirring (EMS) has been undertaken for improving the surface as well as internal quality of billets





400 Kev Transmission Electrn Microscope

- Tundish flow model has been developed using the FLUENT, CFD software for the proposed design change at LD-2.
- A thermodynamic investigation has been undertaken to assess the influence of various deoxidation processes on the morphology of inclusions and steel cleanliness for the Al and Al-Si killed steels produced at LD-2.
- A mathematical model based optimisation of normalizing furnace of Tubes Division has been undertaken.
- Steel with higher yield strength (35% higher than that of conventional) for welded tube for two wheeler : trial at customer's end is in progress.
- Ferritic bainitic Dual Phase steel for Wheel rim/disc application developed
- BH-260/370 : Chemistry decided based on literature. Commercial trials awaited .
- FEM modeling for wrinkle formation during cold bending of welded auto tubes
- Reduction in the scale by 20 % in EWNr wire rods by increasing the cooling.
- Forming simulation of floor panel of Ashok Leyland using EDD and IF material
- TRIP steel : Lab scale experiments are in progress
- Work to determine the sensitivity of different process variables on strip profile and flatness of HR coil is being carried out.
- A Model to Reduce Shape Defects of CR Coil for White Goods developed
- The austenite grain size evolution during reheating and rolling of TISTEN 55 microalloyed steel was determined.
- A suitable surface passivation process has been developed to avoid early rusting of TMT rebars during transit and storage.
- Improved resistance to stub end rusting of EWNr wire rods achieved through suitable modification in the chemistry of EWNr grade.
- Optimum pickling process conditions through effective use of inhibitors were established through lab scale simulation study. Plant implementation in progress.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	9844	16.33	0.17
2003-04	12070	24.26	0.20
2004-05 (Upto Sept 04)	7513	9.96	0.13

**JINDAL VIJAYANAGAR STEEL LTD.**

➤ **Indigenous non-coking coal for COREX**

Earlier, JVSL had carried out plant scale trials using indigenous Singareni unwashed grade 'B' coal to replace imported coal to the tune of 10%. However, since the availability of 'B' grade coal being limited, search for lower grade coals, which could be made suitable by washing, was continued. Based on the washability characteristics of six coals, 'C' grade coal from Medapali, Singareni was selected for washing. Accordingly, steps were taken to procure 5000 tonnes of this coal and carry out plant scale trials with 3500 tonnes of washed coal. This project is partly funded by Ministry of Steel and Department of Science & Technology and has been carried out in collaboration with Society for Innovation and Development, Indian Institute of science, Bangalore and Central Fuel Research Institute, Dhanbad.

➤ **Coal for Coke Ovens**

A mathematical model has been developed to select suitable coal blend for Stamp Charged and Top Charged Coke Ovens. Further, another mathematical model has been developed for prediction of Coke Oven Gas Composition, its heating value and amount of power that can be generated.

➤ **Beneficiation of Iron Ore Slimes**

JVSL has successfully commissioned 1.5 mtpa Iron Ore beneficiation plant based on in-house developed technology. Iron ore slimes is a major waste from this beneficiation process to the tune of 15-20%. Based on Laboratory scale and pilot scale trials, a scheme has been developed for beneficiation of iron ore slimes with a possible yield of 50% and alumina drop of 40%.

➤ **Mathematical Model for Control of Super Heat**

An online Mathematical Model for Control of Super Heat in Continuous Casting Process has been developed and implemented as regular plant practice, to improve the quality of slabs.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	2786	1.36	0.04
2003-04	3596	2.40	0.06
2004-05 (Upto Sept 04)	2272	1.98	0.07

**JINDAL STEEL & POWER LTD.**

During the current year R& D work have been carried out in the following areas:

1. Standardisation of rolling parameters of parallel flange beams, columns, channels and rails.
2. Generating facilities for residual stress measurement in rails leading to controlling the residual stress in rails.
3. Development of high conductivity rail (third rail) in killed steel variety.
4. Development of high tensile steel grades structural sections with stringent transverse impact property.
5. Standardisation of operating parameters of new DRI kilns (500 T/Day capacity).
6. Development of new round section, 140 mm and 220 mm diameter.

**EXPENDITURE ON R&D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	1109.79	1.26	0.113
2003-04	1550.25	0.69	0.04
2004-05 (Upto Sept 04)	1285.20	0.41	0.33

**ISPAT INDUSTRIES LTD.**

Following special grades as per the customers' special needs were successfully developed during the year.

- API X70 - having application in Petroleum pipes
- TR 46 - having application in Automobile structural application.
- Dual Phase - having application in Automobile structural application
- Medium Carbon - having application in manufacturing of components for automobiles and engineering application.
- High Carbon - having application in manufacturing of components for automobiles and engineering application.



R&D Centre at Hyderabad

**SPONGE IRON PLANT**

- High Rate thickener has been commissioned. This has resulted in handling of thick slurry coming out from the Clarifier. This will reduce the operating cost, water consumption & environmental hazards in the area and will improve the housekeeping
- Nitrogen line has been connected to bottom seal to eliminate the possibility of re-oxidation of DRI. This has eliminated the chances of choking the furnace due to Oxygen ingress with Seal gas.
- Hot Air pre-heater developed indigenously & put in operation and is working satisfactorily.

**EXPENDITURE ON R & D DURING LAST THREE YEARS**

(Rs in crore)

Year	Turnover	R&D Expenditure	R&D expenditure as % of turnover
2002-03	3370.25	#	
2003-04	4114.71	#	
2004-05 (Upto Sept 04)	2987.40	0.77	0.026

# Expenses incurred were charged to natural heads of accounting and not allocated separately.



Continuous Casting Machine