Transforming Steel Domain Green Through Innovative Waste Management – A Jindal Approach

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ABSTRACT

The paper summarises the various innovative approaches taken at the COREX process based integrated steel plant of M/s. Jindal Vijaynagar Steel Limited. The economics of resource recycling has also been described.

Key Words : Resource recycling, innovative waste management, integrated steel plant, COREX process

INTRODUCTION

Jindal Vijayanagar Steel Ltd., with a turnover of Rs.1500 Crore, is conceived as the most modern, technologically efficient and eco-friendly green field integrated steel plant with a capacity of 1.60 mtpa hot rolled flat steel products. Spread over 3600 acres of land, JVSL is the single largest investment in the state of Karnataka. The entire capacity realisation of 1.60 mtpa through the technology route, namely, Pellet Plant - COREX - BOF - CCP - HSM, has been established from April 2001 onwards.

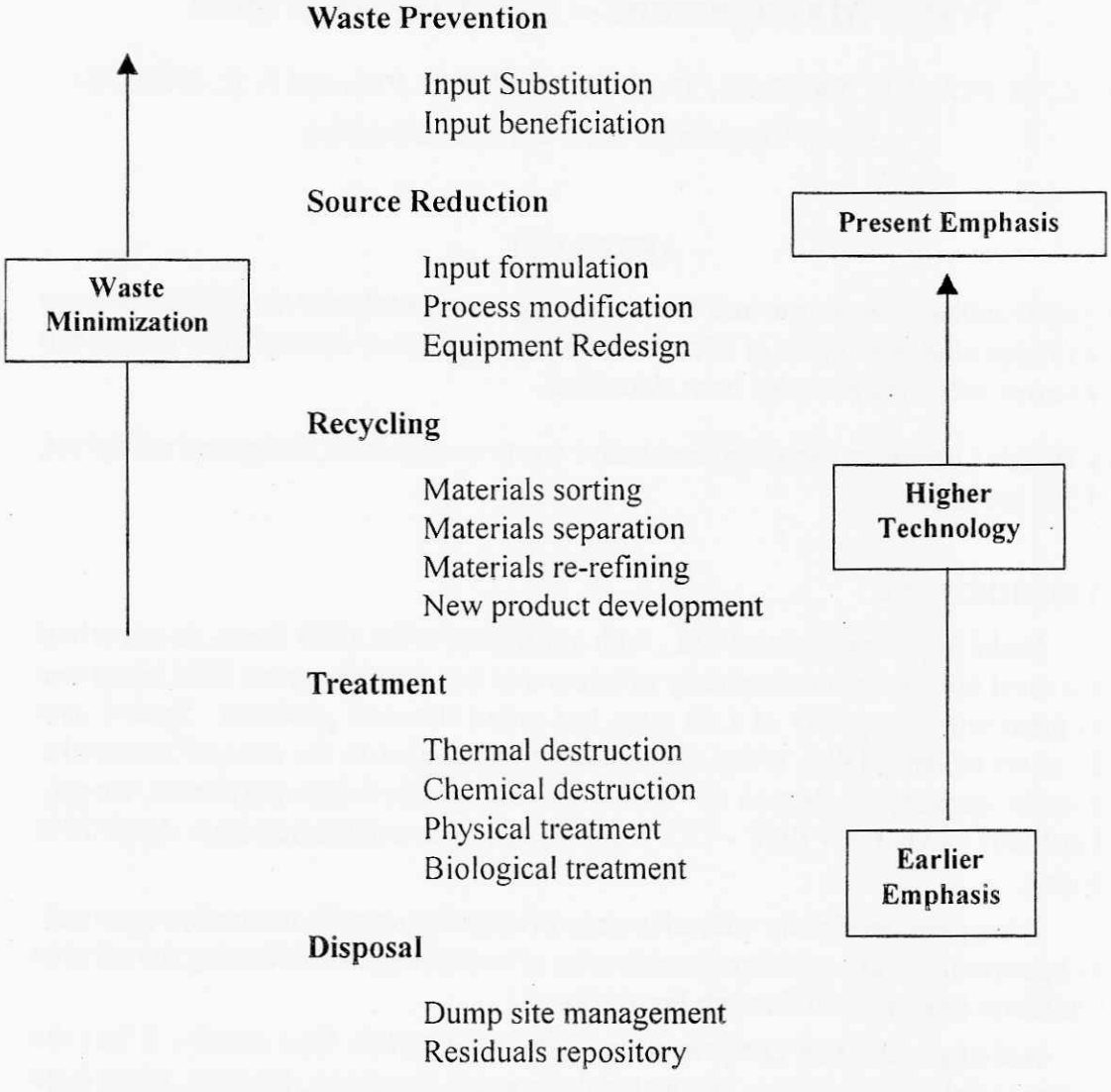
It is a green steel plant with advantage of adopting a totally innovative approach. This opportunity was capitalized in selection of technology for achieving the mission " Transform steel domain through innovations".

Although, the site comprised undulated and fallow land mostly, it has the advantage of close proximity to raw materials (iron ore, limestone, dolomite, manganese ore, etc.), good railway linkage, proximity to two major ports, i.e. Goa and Chennai. The Company has the distinction of becoming the first and the only flat steel producer in South India.

However, the location has some constraints :

- Non-availability of coking coal in the region.
- Water starving region - average yearly rainfall is only 450 to 550 mm.
- Single perennial source of water is Tungabadhra Dam, which cannot be used for any dumping of pollutants even within the statutory stipulations of water discharge.
- Land area is available for production units, not for waste dump sites which is common for Indian steel producers.

The JVSL team took these constraints as challenges and through innovations transformed these constraints to opportunities. The strategy adopted for the selection of steel plant technology was as follows :



To facilitate the mission, JVSL carried out technology search with an aim to become lowest cost producer of steel. Recognising the need to preserve ecological balance, a detailed analysis of constraints vis-à-vis the alternatives available zeroed in on the selection for hot metal production through COREX. The main arguments for selecting COREX are :

- Unlike conventional plants with Blast Furnaces for hot metal production, coking coal converted into metallurgical coke is practically not required for COREX operation. COREX directly uses non-coking coal/semi coking coal for iron making obviating the need of establishing the most polluting reactor known, the coke oven battery. Besides, India's coking coal reserve is fast depleting and these reserves are concentrated in the eastern parts of the country.

- COREX gas can be used for power generation, eliminating the need for 100% coal based power plant. The coal based power plant contributes more to pollution of air, water and generates more solid wastes having serious environmental consequences.
- High equipment productivity and manpower productivity.
- Lower CO_2 output per ton of hot metal.
- Wide flexibility of operation.

Besides, the COREX technology was adopted for its ecological advantage over conventional Blast Furnace as depicted by the following bar chart (Fig. 1) :

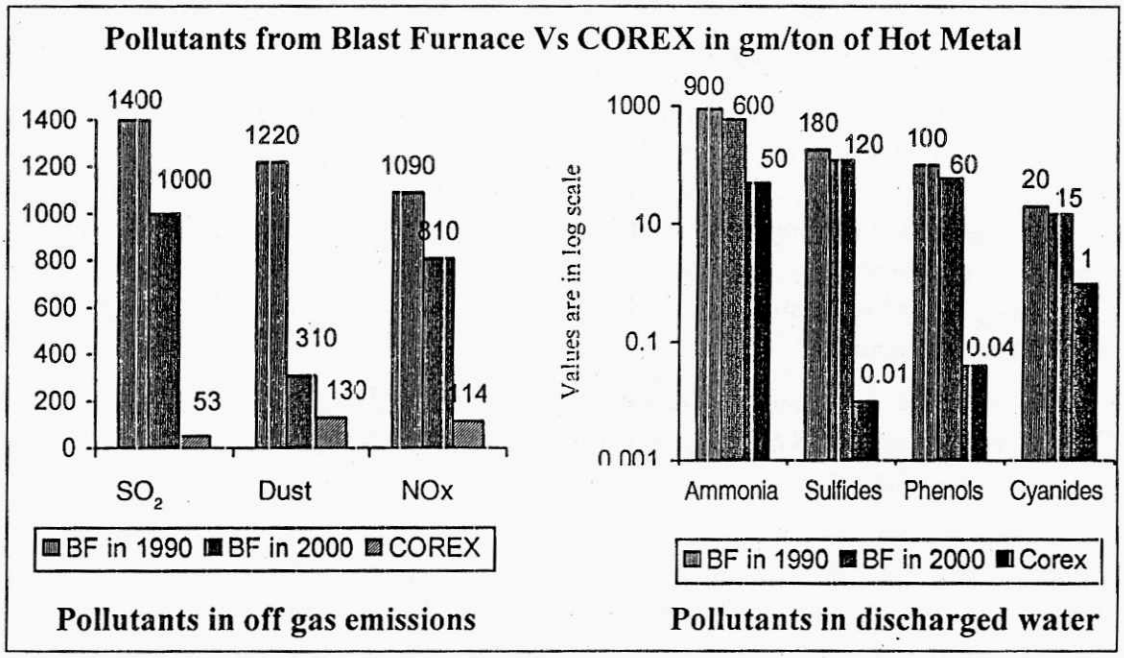


Fig. 1 :Pollutants in off gas emission and discharge water

The planners also adopted an innovative idea of using pellets in COREX plant mainly because of the fact that, available reserves of Iron Ores in Bellary - Hospet region are high in Fe content, but are decrepitating in nature. This property will lead to high fines generation to meet the COREX input requirement of calibrated lump ore and it will also increase the cost of lump ore. It will also use the accumulated dumps of iron ore fines over the decades after exporting lumps, thereby reducing pollution. This not only solves the problem of disposal of fines but also took care of a large portion of waste arisings from material handling and COREX operation through recycling. Also, use of pellets in COREX provides a unique opportunity to increase the hot metal production by increasing the productivity (advantage of prepared burden).

In JVSL, the latest technology of iron making (2 Nos. COREX C-2000 modules) has been supplied by Voest Alpine Industrianlagenbau (VAI), Austria. The steel making facilities include two 120T converters and two single slab casters of latest design from SMS Demag, Germany. The quality slabs produced are suitable for hot charging into the Hot Strip Mill which has been engineered by Danielli United, USA, incorporating

the latest technology of Coil box and a 250T walking beam furnace from Stein Heurtey, France. The other major units of the project are a 4.0 mtpa Raw Material Handling Plant and a 3.0 mtpa Pellet Plant besides a number of infrastructural and auxiliary units.

In an integrated steel works, environmental protection is based primarily on process-integrated measures. This measure involves forward looking development, effective utilisation of resources, and adoption of waste management techniques that involve Reduce, Reuse & Recycle (3 R's). The off gases from COREX units are not directly discharged to the atmosphere but utilised for power generation and heating purposes in the plant. These gases are relatively clean since they do not contain significant SO_2, H_2S, NO_X, dust and higher valance hydrocarbons like phenols, tar etc. Various dust suppression systems and dust collection equipment such as, cyclones, bag filters, scrubbers and ESP are provided in different units to control the emissions to the atmosphere and to keep them well below emission standards.

Jindal Vijayanagar Steel, in order to achieve minimal or no effluent discharge with no contaminants, have incorporated newer technologies. These technologies include higher recycle rates, process water cascading and secondary use of water. All these have resulted in making JVSL as integrated steel plant with zero water discharge. Keeping in view the scarcity of water in the region, water conservation has been effected by recycling treated effluents back in the process and reusing the treated sewage for green belt development.

Solid waste if disposed on land may cause pollution of ground water and soil. JVSL has, therefore, planned to recycle most of them in the plant, sell some and dispose balance in the sludge pond.

The dust and dewatered sludge from raw material handling unit and COREX plant will be recycled to pellet plant. COREX slag will be granulated by the impingement of water and sold to cement industries. Though BOF slag is suitable for soil conditioning and railway ballast, till the time JVSL finds an appropriate application, it is stored in the slag dump. The re-use in converter, and in COREX as flux additive has started. Mill scales from continuous casting and Hot Strip Mill is recycled to pellet plant. Steel scrap is completely recycled to steel making unit. Oil from cooling water, if present, shall be skimmed and used as fuel for furnace and boilers.

SCENARIO OF WASTE DISPOSAL IN INDIAN IRON & STEEL INDUSTRY

Slag

Blast furnace/COREX slag forms the greatest portion of the steelworks wastes and efforts are on since inception to utilise them. The present level of utilisation of blast furnace slag is nearly 60-70%. With the development of application for cement manufacturing, the production process has rapidly shifted to granulated slag from conventional air cooling slag. The overall granulated slag ratio in 1998 was around 60% in India compared to 80-90% of world average. There are continuous efforts to increase the value addition for the slag. Establishment of a slag cement plant in JVSL is being negotiated with a cement major which will ensure 100% usage of granulated COREX slag. In the mean time, 100% marketing of granulated slag is being attempted (Fig. 2).

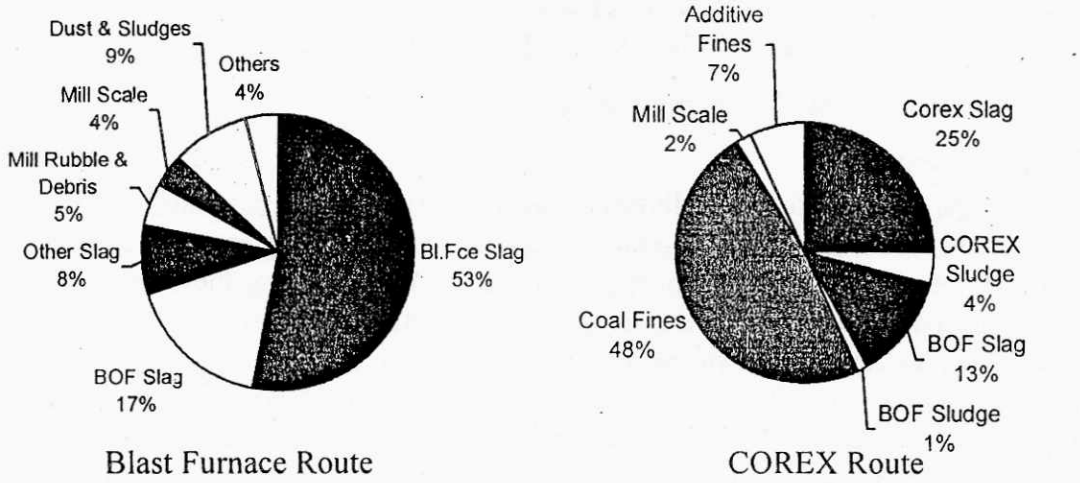


Fig. 2 :Composition of the wastes generated in integrated iron and steel works

Converter slag is the next major generation. The re-utilisation has not yet picked up though number of usage such as railway ballast, road aggregate and civil engineering applications are being experimented to a large extent of success. Also re-use in converter, as flux additive in blast furnace / COREX and as soil conditioner have already been established. However, a large volume of converter slag is still being disposed off by land-filling. This clearly indicates immediate need for re-utilisation technologies.

Dust

"Dry" or "wet" dust collectors are generally employed to collect dust arising out of handling of raw materials, iron making and refining process. The major ingredients of these dusts are iron. They are normally recycled back as iron bearing material. Almost 60 - 70% of these dusts are used as pelletising feed stock.

Sludge

Sludge in a steel works is generated in two ways.

- From water treatment facility
- Gas scrubbing.

Almost 50-60 % sludge is re-utilized, but yet a major portion still goes to land filling. In JVSL, the COREX sludge utilization in pelletizing process has been established. So far 50% of COREX sludge generated in a month has been utilized successfully in the pellet plant.

Wastewater

A typical integrated iron & steel works employs large quantity of water for direct, indirect cooling for scrubbing of air pollutants and for process re-cyclants. Depending on local meteorological conditions and water availability, 150 - 200 m^3 of water is required in circulation for production of 1 t of steel. The requirement of make up water depends on technology adopted, level of recycling and reuse. The world bench mark is 3 m^3 /t of steel. The JVSL plant was designed for 2083 m^3/hr of make-up water. However, the water conservation measures at JVSL have reduced the requirement of make up water to 620 m^3/hr which is near to the world benchmark level.

STATE OF THE ENVIRONMENT AT JVSL AFTER COMMISSIONING OF 1.60 MTPA INTEGRATED STEEL PLANT

The state of environment after commissioning is as follows :

Air Management

The systems installed for pollution control in various plant units have provided acceptable and favourable environmental conditions in the working area and abate air pollution in the surrounding area of the steel plant. After meeting the steel plant's internal requirement, the excess export gas from COREX along with coal fines is supplied as fuel to 260 MW power plant. The power plant, which is a joint venture of Jindal and Tractebel SA, Belgium is the greenest power plant comparable to only hydel power. The ratio of COREX gas to coal fines usage in the power plant is 65:35. This power plant not only caters to captive requirement of JVSL but also provides substantial power to Karnataka state grid. Out of the total generation, JVSL consumes 53% and around 47% is supplied to KSEB grid. Various dust collection equipment such as cyclone separators, dust suppression systems, scrubbers, fabric filters and electrostatic precipitators have been installed to remove the particulate matters from the gas stream. Additional bag filters for lime storage at RMHS, Pellet Plant new circuit and dedusting system for COREX cast houses are under commissioning. The effectiveness of these control equipment are evident from the ambient air quality level of the adjacent village called "Vaddu" where level of SPM has come down from what it used to be before JVSL came into existence and continues to show the downward trend as depicted below (Fig. 3) :

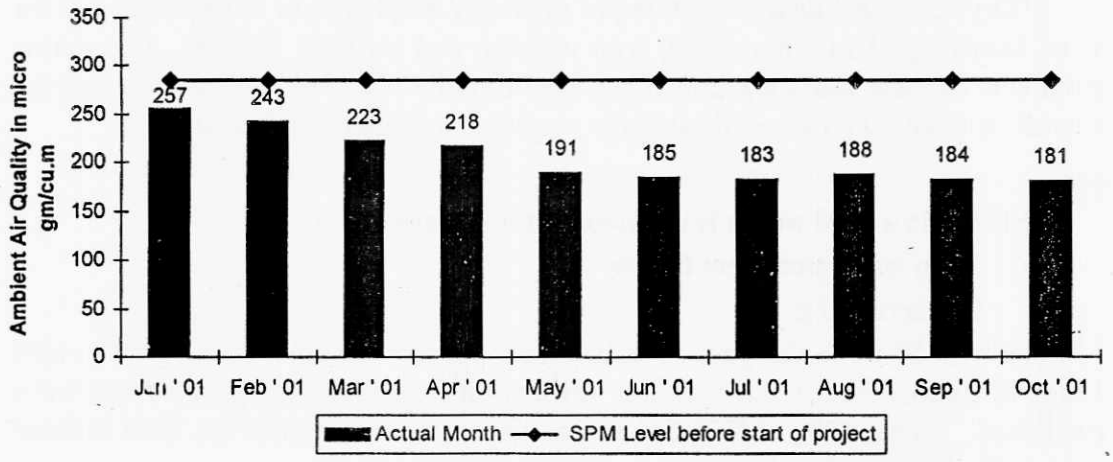


Fig. 3 : Trend of Ambient Air Quality at village "VADDU" which is almost adjacent to plant

Water Management

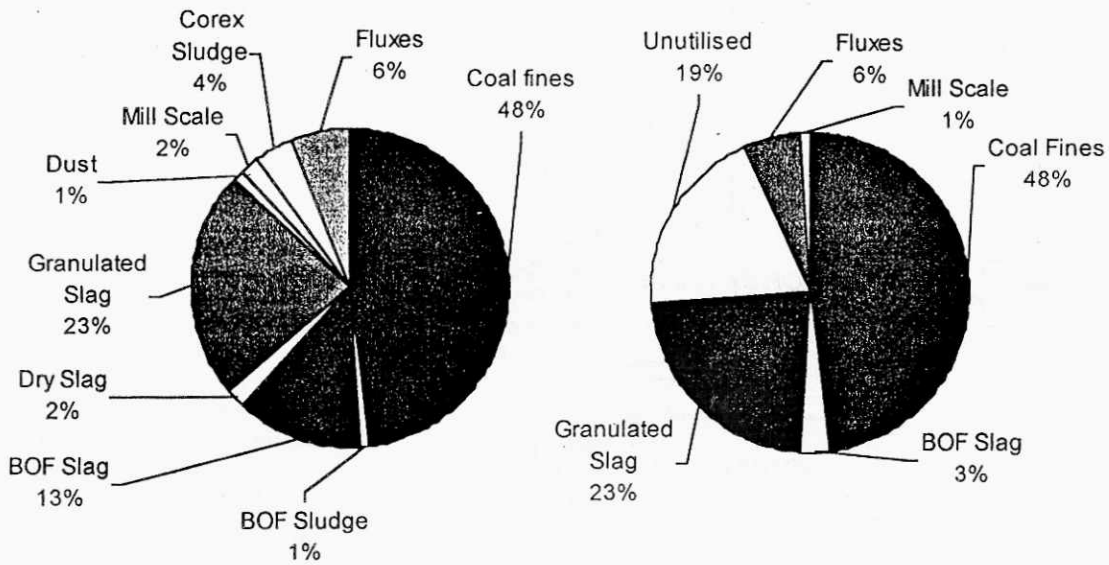
JVSL has adopted a unique water management system wherein no water is discharged from the plant. Concept of water recirculation & reuse and cascading use of water has been adopted at all possible areas. This has resulted in reduction in the blow down to bare minimum. Even these blow downs, the seepage and leakage if any, are arrested at four low level points inside the plant with help of check dams and

recirculated for horticulture purposes inside the plant and town ship. A continuous vigil is maintained to keep the water chemistry under control within the stipulated norms of water as laid down in EP Act 1986 for discharge on land for irrigation purposes (IS 2490 of BIS).

Solid Waste Management

Solid wastes, if disposed on land is a liability but if reused or recycled provides competitive edge in terms cost per ton. Value addition and further processing is done for some solids wastes. At JVSL, the production of steel for the year 2000-2001 was 849,220 Mt and solid wastes generated was 10,36,700 MT including coal fines which is a by-product. The specific solid waste generation works out to be 635 kg/t of product excluding coal fines. JVSL has, therefore, planned to recycle most of them in the plant, sell some of them and dispose off balance in secured landfill.

The solid wastes reused during 2000-2001 were 8,41,302 Mt that works out to 81% (including coal fines). The solid wastes generated and utilized are shown in the pie charts below (Fig. 4) :



Generation of Solid Waste Utilization of Solid Waste

Fig. 4 : Generation and utilisation of solid wastes

The present status of major solid wastes generated and reused is given below :

Coal fines	Recycled and excess is sold to outside parties
Additive fines	Recycled in pellet plant
COREX sludge	Recycled in pellet plant
BOF slag	Recycled in BOF & COREX. Reused as railway ballast and road aggregate
BOF sludge	Recycled in pellet plant
Granulated slag	Sold to cement industries
Mill scale	Recycled in pellet plant
Lime fines	Used in WTP, ETP, PCM and balance sold
Limestone fines	Recycled in COREX and pellet plant

Future Action Plan for Solid Waste Management

The projected generation of solid wastes at 1.60 mtpa stage is 20,17,116 Mt. With the present reuse pattern, the proposed reusage will be 17,36,030 Mt per annum. This will leave the balance waste of 2,81,086 Mt. The proposed action plan for reuse of balance waste is given below:

- Coal fines
  - Marketed as fuel
  - To be briquetted for use in COREX
- COREX sludge
  - To increase the usage in pellet plant
  - To explore the possibility of making briquettes

The waste recycling pattern at JVSL is presented in Fig. 5.

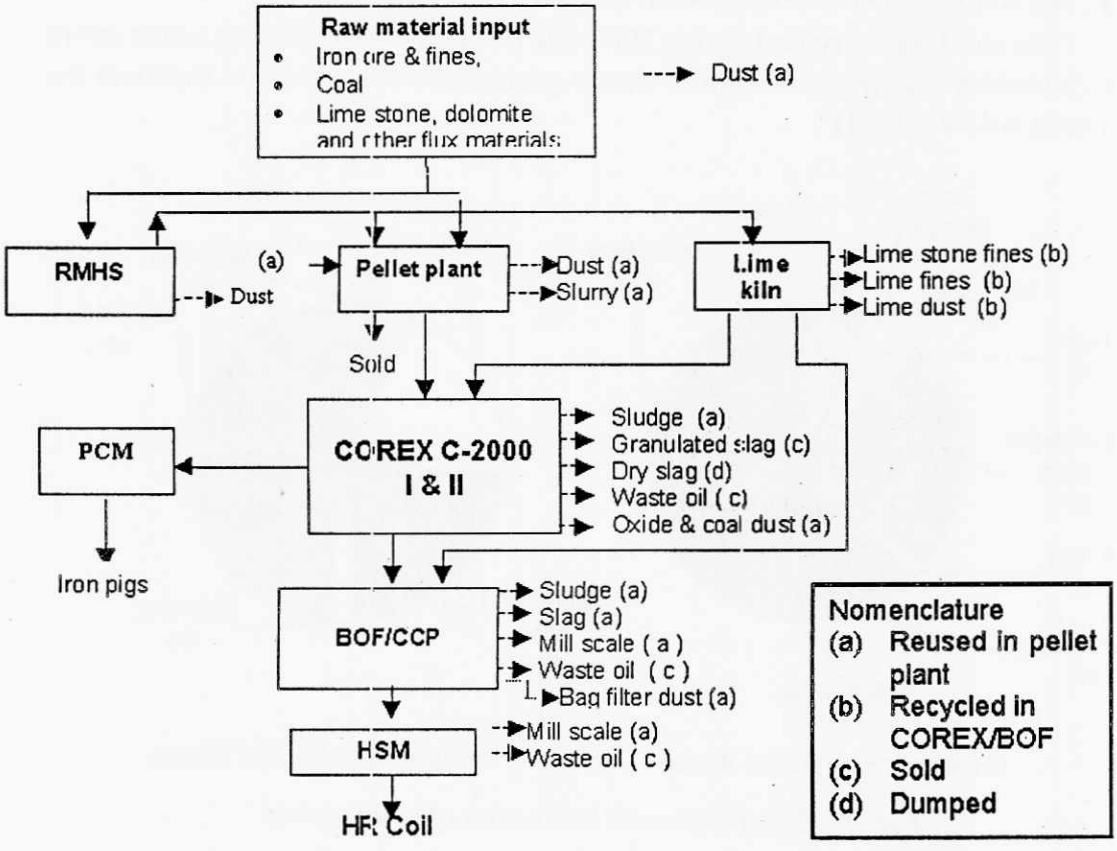


Fig. 5 : Waste recycling at JVSL

Greenbelt Development

To preserve ecological balance and create eco-friendly environment, JVSL has taken up vigorous afforestation program and made a target plan of planting 8.2 lakh trees in 5 years. The total number of plantation in last two years has crossed 3.25 lakh plants with an excellent survival rate of 80%. Considering the arid climate prevailing in the area, this is a remarkable achievement. This would not have been possible but for the innovative idea of reusing of all blowdown water within the norm of IS:2490 and using it round the year for plantation. It is pertinent to mention here that the ambient temperature in the region has come down by ~ 2°C during the last 3 years.

Quality Management

ISO 9002 quality systems and ISO-14001 Environment Management Systems are the two most widely accepted systems to ensure total quality and total environmental quality for an industrial enterprise. The key to success for today's business activity is customer satisfaction with consistent quality and continual improvement in all facets of industrial operation.

With its utmost commitment and emphasis on quality assurance, JVSL has already implemented ISO 9002 quality systems in a phased manner and it is now an ISO-9002 company.

The top management to state its objective towards quality has defined the following quality policy.

"JVSL shall strive to continuously innovate and excel to achieve customer satisfaction and enhance stakeholders wealth".

What distinguishes JVSL from other steel majors is its commitment to environment, JVSL is not only employing the most environment friendly COREX technology of iron making, but is also taking several other measures as part of its endeavour towards environmental management.

The top management to state its objective towards environment protection has defined the following environmental policy.

"We shall strive for continual improvement in our environmental performance through integrated steel plant operations to achieve stake holders delight and enhance credibility in national and international markets".

From the day one of its operation, JVSL has implemented the EMS and have got ISO-14001 certificate within a short span of its starting the operation.

With its zeal to provide safest and healthiest working environment to its employees, JVSL has initiated action for implementation of OSHAS-18001 (Occupational health and safety assessment series). Implementation of OSHAS-18000 System is in progress and JVSL will be first integrated steel plant to have OSHAS-18001 certification.

THE ECONOMICS OF RESOURCE RECYCLING

The economics of waste management is complex. From a private perspective, waste management rarely contributes directly towards profit. If the cost of environmental requirements and social obligations are taken into considerations, which eventually have become a reality in our country, then the economics becomes highly favourable. All over the world a number of studies have been conducted to evaluate the economics of waste management, but only a few specifically focused on issues such as water cost, economic impact of land disposal restrictions, cost of dump site management, landfill reclamation and problem of transboundary shipments. In the absence of waste management cost data, estimation of costs of various methods of treatment and disposal remains a complicated task. It requires information that is

often difficult to obtain and highly site specific. A cost benefit analysis for reuse and recycle of waste on implementation of all the reuse, recycle action plan in JVSL has been attempted. This study does not include the cost due to economic impact of land disposal restrictions, cost of dumpsite management and landfill reclamation and problem of transboundary shipments as well as intangible cost such as insurance or legal liability. Even without these costs which are already prevailing or going to be a reality in very near future, the existing reuse and recycle gives an impact of 5 to 8 % reduction in cost of per ton of crude steel as enumerated below.

Use of coal dust and COREX sludge in pellet plant	
Cost of coal	Rs. 2700/ t
Cost of limestone	Rs. 480 / t
Production of low basicity pellets	
Requirement of coal @ 1% carbon (Carbon availability 55%)	54,545 t
Total cost of saving per annum in coal that will be replaced by COREX sludge and coal dust	Rs. 14,72,71,500
Supplementation of limestone by addition of COREX sludge	
CaO in COREX sludge	5.7 %
Replacement of limestone by addition of 81,500 t of COREX sludge assuming 50 % CaO in limestone	930t
Saving per annum in limestone	Rs. 4,46,400
Use of BOF sludge in pellet plant	
a) As a supplementation of Fe	
Cost of iron ore fines	Rs. 200 /t
Fe in BOF sludge	46 %
Fe in iron ore fines	65 %
Projected generation of BOF sludge	30,000 t
Total Fe availability in BOF sludge	13,800 t
Replacement of iron ore fines by BOF sludge	21,230 t
Saving per annum	Rs. 42,50,000
b) As a supplementation of limestone	
Cost of limestone	Rs. 480 / t
CaO in limestone	50 %
CaO in BOF sludge	8.35 %
Replacement of limestone by addition of 30,000 t of BOF sludge	501 t
Savings per annum	Rs. 2,40,480

Use of BOF Slag in COREX

Cost of limestone	Rs. 480 / t
Replacement of limestone by LD slag	50 kg / thm
Total amount of limestone to be replaced by LD slag	78,500 t
Cost of crushing and screening of LD slag	Rs. 100 / t
Net saving by using 1 t of LD slag	Rs. 380 / t
Saving per annum	Rs. 2,98,30,000

Recycle of dust and slurry in pellet plant

Dust from pellet plant stacks	19,098 t
Slurry from scrubbers and ESPs	65,828 t
Total amount of replacement of iron ore fines	84,926 t
Cost of iron ore fines	Rs. 200 / t
Saving per annum	Rs. 1,69,85,200

Recycle of mill scale from HSM & CCP in pellet plant

Total projected quantity of generation per annum	28,000 t
Cost of iron ore fines	Rs. 200 / t
Annual saving by using mill scale in pellet plant	Rs. 56,00,000

Lime fines & lime dust

a) Lime fines

Projected annual generation	19,461 t
Selling price of lime fines	Rs. 1450 / t
Saving per annum	Rs. 2,82,18,450

b) Lime dust

Projected annual generation	11544 t
Saving per annum	Rs. 1,67,38,800

Limestone fines & limestone dust

a) Limestone fines

Projected annual generation	46,713 t
Cost of limestone fines	Rs. 480 / t
Saving per annum	Rs. 2,24,22240

b) Limestone dust

Projected annual generation	6120 t
Saving per annum	Rs. 29,37,600

Slag	
Projected generation of slag per annum	5,20,000 t
Selling price of slag	Rs. 120 / t
Saving per annum	Rs. 6,24,00,000
Additive fines from COSP for use in pellet plant	
Projected annual generation of additive fines	61314 t
CaO in additive fines	21.5 %
Fe_2O_3 in additive fines	28.31 %
Equivalent limestone (assuming 50% CaO)	26365 t
Equivalent Fe	12134 t
Annual saving in limestone	Rs. 1,26,55,200
Annual saving in Fe	Rs. 24,26,800
Total savings to the company (2000-2001)	Rs. 35,24,22,670
(Approximate impact of ~ Rs. 415/- per ton of steel)	

The study result indicates, if the potential of 3 R's are fully utilized, the dictum of Environmental Management System (EMS) "the Pollution Control Pays" becomes a reality.

CONCLUSIONS

The foregoing analysis has sought to show that the traditional perception of a battle between the industry and environment is incorrect. If the enlightened self-interest of the industry becomes proactive, the environmental constraints may well become a strength. The common belief that "Industrialize and perish" can easily be transformed to "Industrialize and flourish."

In Jindal Vijayanagar Steel Limited, the proactive and innovative approach has enabled JVSL not only to become a producer of Green Steel but also to become one of the lowest cost producer of steel with highest manpower productivity.

JVSL is fully aware of establishing a legacy of harmonious environment for future generation and has taken into consideration environment protection as its primary responsibility during the planning stage itself for this 21st Century integrated steel plant. In order to achieve the target of having an 'incidental steel plant amidst greens', thrust is given for green belt development.

In a nut shell, Jindal Vijayanagar Steel has established an integrated steel plant which is 'Green' on a barren environment, generated employment both direct and indirect, built infrastructure, made value addition to the national resource i.e. iron ore using environment friendly technologies embarking upon what is called today "Environment friendly transformation".

Present performance in terms of production, productivity, specific consumption of inputs and quality is of world class standard. With the future expansion plan of 3.0 mtpa, at a later stage, on the anvil, JVSL is forging ahead with its mission of 'transforming steel domain through innovations'.