NAVONMESH

A GLIMPSE OF INNOVATIVE SPIRIT IN SAIL
SINCE 2006

There's a little bit of SAIL in everybody's life

Compiled by: Shri Sanjay Singh, DG (BP); Shri Gopal Banerjee, DG (Operations); Ms. Barali Mitra, AGM (CAD) and Shri Ashok Kumar Atarewad, ML Manager (P)
Chairman’s Message

‘Innovation’ is the core driver of growth & performance of an organisation. It provides a sustainable advantage in the current fast paced dynamic business environment.

We, in SAIL have been fortunate to have innovation as part of our culture since inception. Even in remote corners of our plants, mines & units, there are SAIL employees who at their own initiatives are carrying out creative and innovative jobs. It is because of this strength of our people that SAIL is on strong footing today, confident of facing all impending challenges.

I have always shared in my interactions with employees at plants/units that innovation is not always about creativity. Business innovation is about discipline too, especially for a process industry like ours. Game changing innovations are rare and will always be, what we need to continuously do is to question, observe, experiment and discuss with team members to bring about improvement in our day-to-day working. Innovative thinking can be developed and strengthened only through practice and therefore, to have a continuous thrust on innovation, we need to, practice, practice and practice.

It gives me great pleasure to know that some of the recent significant innovations carried out by our employees are being compiled together as ‘Navonmesh’. These are only some of the examples from the innumerable efforts being made by our employees. I am sure, this compilation will encourage and motivate all of us to focus on innovation with vigour and strengthen ‘entrepreneurial culture’ in SAIL.

(S.K. Roongta)
Management Guru Peter Drucker aptly observed in his book *Innovation and Entrepreneurship: Practice and Principles* that “Innovation is the specific instrument of entrepreneurship... the act that endows resources with a new capacity to create wealth”. It is very relevant in the organisational context, as innovation is linked to performance and growth through improvements in efficiency, productivity, quality, product positioning, market share, etc. In fact, innovation is a phenomenon which involves creativity, commitment, cause and communication for providing a solution to any problem, finding a better way to perform a process or for enhancing competitiveness. The real challenge of innovation is to create a culture and environment that encourages the natural creativity and innovativeness of employees.

Innovation refers to the effort which creates purposeful focused change in a business enterprise, resulting in new dimensions of improved performance, both physical and financial. In today’s competitive world, every organisation is making efforts to nurture and sustain the culture of creativity and innovativeness among their employees for surviving and thriving in a scenario of increasing costs and threatened margins. Enhancing trust and encouraging active involvement of employees in problem solving is the first step in the journey of innovation. Often an employee’s creativity is seen as the basis for innovation, and innovation is the successful implementation of creative ideas within an organisation.

SAIL is committed to inculcate and sustain a culture of creativity, involvement and innovativeness among employees to tap their creative potential. Being a manufacturing enterprise, generating and implementing result-oriented creative/innovative ideas become very critical for long-term success of the organisation. Through implementation of Suggestion Schemes, Quality Circles and various communication forums, SAIL has ascertained an environment where employees can share and implement their creative and innovative ideas. As an HR strategy, to keep employees motivated, SAIL has also established a system of recognising and rewarding employees for their innovative and creative ideas.

Since 2006, the thrust on innovation has been accelerated across SAIL, and a system has been evolved for daily/weekly tracking and reporting of at least one ‘Most Innovative Idea’ from plants/units to Corporate Office. This effort has given greater impetus to employees’ creative abilities and innovativeness. Many innovative ideas have already been implemented in this period, showing huge savings and improved working. Involvement of the top management of SAIL in this initiative has boosted generation and implementation of innovative ideas across SAIL.

This special publication documents some the most significant innovations implemented across the organisation since 2006, as a tribute to SAIL’s enduring spirit of innovation at a time when some of the plants of the company have completed 50 years of production. This compilation not only attempts to record the results of the renewed thrust on innovation in the company but to recognise the achievers as well. This volume will hopefully encourage and motivate employees to re-focus their attention on creativity and innovativeness which have been one of the hallmarks of SAIL’s HR profile and organisational strength. Read on.
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RAW MATERIALS ZONE
BOLANI ORE MINES

Quality improvement in washed iron ore fines

Bolani Ore Mines under SAIL’s Raw Materials Division is located in Keonjhar, Orissa. It was developed in 1960 to cater to the iron ore requirements of Durgapur Steel Plant. The present rated capacity of this mechanised mine is 4.8 million tonnes per annum (MTPA).

During the year 2006-07, the quality norms set to be achieved in the iron ore (both lumps and fines) mined at Bolani were as follows:

<table>
<thead>
<tr>
<th>Iron ore</th>
<th>Fe% (Iron)</th>
<th>SiO₂ % (Silica)</th>
<th>Al₂O₃ % (Alumina)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumps</td>
<td>63</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Fines</td>
<td>63</td>
<td>2.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

However, analysis of fines over a period (see chart below) revealed wide variation in alumina content – around 3% alumina was found in around 13% of the samples and around 37% had Al₂O₃ above 2.5%.

Further analysis revealed that 20% of wet circuit fines had alumina content more than 3.5% – which is absolutely undesirable – and was adversely affecting the average quality of despatched fines.

Among the main causes for inadequate reduction in Al₂O₃ content during washing of fines, the following were found to be crucial on pareto analysis:
- Excess water in the input feed to rake classifier creating turbulence, causing obstruction in settling of heavy particles of iron ore and separation of lighter material.
- Discharge of coolant water from the gear box directly to rake classifier, causing extra turbulence.

A team consisting from the Ore Processing Plant at Bolani was formed to study and resolve the problem. The team set a goal to achieve reduction of alumina in washed fines from ROM feed content by at least 10% over the present value, with overall objective of alumina reduction in despatched fines.

The distribution box which controls material flow to rake classifier was studied in detail by the team. Trials revealed that if the upper portion of material from the distribution box was taken out separately, then excess water flow to rake classifier would reduce. The conclusion arrived at was to fabricate and install a parallel pipeline to the thickener from the upper portion of distribution tank so that lighter material along with water may be isolated from the main circuit and taken directly to thickener and thus reduce overload of rake classifier. Thus the drawing (see facing page) was developed.

A pipe of 250 mm diameter, which was arranged inhouse at no cost, was welded and fitted to the rake classifier in such a way that there was minimum loss of valuable material through the bypass pipelines. Slime through pipes was tested for minimum quantity and poor quality at 730 mm height. (Material - 7.64% by weight, Fe - 54.9%, Al₂O₃ - 6.8%.) In the second stage, discharge of gearbox cooling lines was isolated from rake classifier.

The modified system was made operational in December 2006 after many trial runs. The following benefits were obtained:
- Quality of washed fines (reduction in alumina content) improved at 12% against the targeted 10%.
- Less water at fines stock pile led to:
  a. Reduced feeder jamming at loading plant
  b. More free dozer movement at fines stockpile
  c. Reduced pollution problem
  d. Process water saving as more water available in thickener for recycling.
  e. Improvement in life of de-wateriser screen panels due to reduced load and less clogging.
  f. Improved belt life because of less belt return area jamming.
The case study won an ‘Excellent’ award at the Chapter Convention of Quality Circles (CCQC) 2007 at Rourkela, a ‘Par Excellent’ award at the subsequent National Convention of Quality Circles (NCQC) 2007 held at Kolkata and a ‘Meritorious’ award at the International Convention of Quality Circles (ICQC) 2008 held in Dhaka.

GUA ORE MINES

Crusher oil resistance box breakdown minimised

Gua Ore Mines, located in West Singhbhum district of Jharkhand, was developed in 1958 to meet the iron ore requirements of the erstwhile steel company IISCO in Burnpur. After merger of IISCO with SAIL in February 2005, this mine was merged with Raw Materials Division in 2008. The present rated capacity of this mechanised mine is 3.20 MTPA.

At Gua, an oil resistance box is used to start the 290 HP slip ring motor of the North Line (N/L) Symon cone crusher. During starting of the motor, full resistance is used. After starting, however, the handle is manually rotated 9 times to cut the resistance. If the resistance is not fully cut within 10 minutes, full load current flows through the resistance, which heats up, leading to further rise in temperature of the oil and of the contacts. In such a situation, the resistance box breaks down totally. It takes between 10 and 16 hours to put the resistance in operation once again, after repairs. This was a recurrent problem at Gua.

It is known that 1% reduction in alumina causes 10% improvement in blast furnace productivity (BFP). Considering average yearly despatch of iron ore from Bolani being 4 million tonnes, iron ore-to-hot metal ratio being 1.6 and hot metal produced (at DSP) 2.5 million tonnes, improvement in BFP = 0.05*10 = 0.5%.

It is estimated that this innovation will yield annual cost savings of around Rs. 8.75 crore.

The group responsible for this innovation comprised (in picture below) Deputy Manager (Mechanical) Shri Rahul Dubey (centre), Chargeman Shri D.D. Tripathi, Technician-cum-Attendant Shri G. Tanty, Technician-cum-Attendants Shri P. Roy and Shri N.K. Nayak and Technician (Welding Plant) Shri S.K. Behera.

Reduction in average alumina in despatch quality of fines 0.05% (based on customer analysis).

Due to breakdown of N/L motor, only the South Line would be in operation. The risk was that if any problem arose in the S/L, dumping would have to be stopped totally. Naturally, production

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of the crusher plant would also come to a halt. Under the circumstances, the entire Maintenance group would have to be divided to look into the problems of both the lines. Therefore, due to shortage of manpower, breakdown time would increase.

To solve the problem, a 6-member Quality Circle (QC) team from the Electrical Department of Gua Ore Mines decided to modify the circuit of the resistance box in N/L by inserting an interlocking circuit which would give the operator an indication that the resistance was out of circuit. In the proposed circuit, if the resistance remained in circuit, it would trip the HT circuit-breaker. The interlocking circuit would confirm that there is no resistance left in the circuit. ‘NO’ & ‘NC’ contact of the resistance box is used as a limit switch of the operation. The timer of the circuit, set to 75 seconds, would start as soon as the motor started. If some resistance is left in the circuit, the circuit will trip the MOCB of the 290 HP motor within the time set. Operators would not require any additional training for the modified process, as it is very simple, as shown in the diagram above.

The modified process was put into operation in January 2007 after many trial runs. Tangible savings accrued by Gua Ore Mines due to this innovation included time saving of almost 50-60 hours per year of line detention of the crushing plant and monetary saving of around Rs. 5-6 lakh, which is the cost of a new resistance box.
BHILAI STEEL PLANT

Improvement in blast furnace productivity

Achieving higher productivity at a low coke rate is the aim of any blast furnace (BF) operator. Being a counter-current reactor, a BF uses multi-granular packed bed for the reduction of iron ore.

The BFs built in the 1950s and 60s at BSP were designed for using iron ore of particular sizes using selective mining operations. However, due to depletion of ore reserves, the practice was discontinued and the increased percentages of ore fines being generated were being charged to the BFs. This started creating permeability problems in the BFs.

To solve the problem, it was decided that the nut coke that is being generated in the coke ovens end and the BF end would be charged along with iron ore. A detailed analysis of the arising of nut coke and its usage at appropriate time inside the blast furnace was carried out by a group consisting of the following employees of Blast Furnaces department: Shri Shankar Dutta, Deputy General Manager (Operations), Shri Rajesh Gaikwad, Senior Manager (Operations), Shri Kamta Singh, Master Operative-cum-Technician (Operations), Shri N.K. Nirmalkar, Master Technician (Mechanical), Shri Pentayya, Technician (Mechanical) and Shri Mohan, Welder (Mechanical).

A particular charging sequence was planned for this addition and furnace operating parameters tuned accordingly. Initial trial was taken at BF # 4; after obtaining successful results, the process has been extended to BFs # 1, 2 and 3 as well.

The average nut coke rate is about 29 kg/tonne of hot metal (thm). With the replacement ratio of 0.6 kg of BF coke daily, saving of about 65 tonnes of BF coke is being achieved by charging about 100 tonnes of nut coke per day.

The innovation has resulted in productivity improvement of the blast furnaces, with net savings of over Rs. 2.5 crore during 2007-08.

The same group of employees of Blast Furnaces department has been credited with another innovation – that of improving tar combustibility and thereby increasing the tar injection rate.

Increasing tar injection had always been a problem for BF operators at BSP. Unburnt tar used to come out through the tap hole, causing splitting problems. Hence, tar injection had to be stopped frequently.

The group suitably modified the brass nozzles of a continuous casting machine and welded these at the tip of the tar injector lance. This reduced the top diameter and helped increase tar velocity and atomisation of tar inside the furnace. The divergent flow of tar increased surface area contact of tar with oxygen and improved its combustibility. Consequently, the furnace movement was consistent, hearth choking was eradicated and spitting of tap hole at increased tar injection was also eliminated.

As a result of this innovation, the maximum monthly tar injection rate increased from 8 kg/thm to 12 kg/thm in BF # 2 and from 7 kg/thm to 9 kg/thm in BF # 3. The average tar rate of the shop is presently 3 kg/thm.
The ignition system of Sinter Plant with conventional burners has the following drawbacks:

1. Flame temperature distribution across the width of the bed is non-uniform due to large distance between horizontal side mounted burners, and
2. Size of the ignition hearth hood is large as the conventional burners produce long flame of about 1 to 2 metres in length resulting in higher heat losses.

To improve the ignition of top layer of sinter mix and to reduce the specific gas consumption, RDCIS has developed the new technology of 'Curtain Flame Ignition System' (CFIS). Optimisation trials for burner design were conducted at Combustion Research Unit (CRU) with different burner variants followed by laboratory-scale trials with pot sinter using sinter mix at SP-1, BSP. The new technology was implemented on demonstration-cum-pilot scale in a 50 tonnes per day (tpd) sinter machine at Maharashtra Elektrosmelt Limited (MEL), Chandrapur.

The concept involves mounting specially designed small-capacity burners on the roof in a single row across the sinter bed. The flame configuration is such that intense flame touches the top of the sinter bed with uniform heating of sinter mix across the bed width. Primary air is sent through swirlers for better mixing of gas and air. Secondary air slots are provided in the burner module to obtain curtain flame configuration which also acts as cooling media for burner module. Sketch of a CFIS burner module is shown below.

Implementation of CFIS in the SAIL plants has already started: at SP-2 (4 machines; 75m²) at Bhilai, SP-1 (2 machines; 125m²) and SP-2 (1 machine; 192m²) at Rourkela, SP (3 machines; 252m²) at Bokaro and SP-1 of MEL (pilot scale). CFIS is planned to be implemented at SP-1 of DSP (1 machine; 142m²) in April 2009.

The following benefits are being obtained regularly by the plants:

- Reduction in specific gas consumption (30 to 50%).
- CDM benefit due to reduction in CO₂ emission.
- Reduction in cost of refractory due to reduction in furnace volume by nearly 85%.
- Availability of extra length of furnace for sintering process due to faster top layer ignition.
- Improvement in sinter productivity by increasing bed height / machine speed.
- Uniform heating of sinter mix.
- Simplified gas igniter for light up of pilot burner.
- Reduction in start up time of ignition hearth from 90 to 15 minutes.
- Reduction in damage to pallet side plate.
- Reduction in surrounding temperature.

Annual savings to the tune of Rs. 15 crore is being obtained at SP-2, BSP on account of implementation of this innovative technology. The project can be put up for claiming CDM benefit. Project implementation at SP-2, BSP will lead to reduction in CO₂ emission by 20,000 tonnes (approx.).

The innovative technology has potential for transfer to other Sinter Plants in India and abroad. External earning proposals have been submitted to RINL, Vishakhapatnam, JSW, Toralagallu and Esfahan Steel Company, Iran.
ROURKELA STEEL PLANT

Development of hydraulic test bench & improvement in wagon tipplers of coke ovens

Coal is unloaded from railway wagons in Coke Ovens by 360° rotation of the wagons by using electro-mechanical devices. The loaded wagons are clamped by 16 side-clamping and 8 top-clamping hydraulic cylinders which rotate the wagons to unload the coal. The unloaded coal is then lifted through a series of conveyor belts and charged to the COBs. The entire tippler unit is kept in operation round the clock for uninterrupted coal supply to the COBs. In order to meet the requirement of the Indian Railways and to avoid high demurrage charges, 12 wagons are to be unloaded per hour and released.

The following problems were being faced during the operation:

- Frequent derailment of the unloaded wagons inside the tippler area due to improper clamping of cylinders on the wagons because of non-uniformity in the pressure generated.
- Unwanted leakages from tanks, valves and fittings due to prolonged operation under adverse working conditions.
- Structural deformations such as breakage of wagon wheel guards, door arrestor structures and clamping arms due to high impact load generated during positioning and unloading of wagons.
- Frequent loosening of foundation bolts of gear boxes and tippler mounting bolts due to vibration.

These problems had led to interruption of coal unloading and heavy demurrage charges had to be paid to the Indian Railways on account of the delays in wagon turnaround. After detailed discussions on solutions for the above, it was decided that –

- A hydraulic test bench – not part of the original design of the machine – would be developed, designed, fabricated and commissioned using in-house resources for reconditioning, assembling and testing of various hydraulic cylinders and valves at site on designated test pressure.
- 8 pressure gauges would be installed before the valve blocks of the top clamping cylinders in each wagon tippler to monitor available pressure vis-à-vis required pressure for clamping and take preventive action.

The innovators: Senior Technician (Coke Ovens) Shri Anil Kanti Mohanta and Senior Technician (RC-M) Shri Ashok Kumar Mohapatra

Bhilai Steel Plant

Improving coke making process

The operating principle of regenerators is such that the direction of gas flow in the flues on the heating wall is reversed at frequent intervals by means of changeover valves. Thereafter, the combustion heat transfers via refractory walls of the flues to the coking chamber. The waste gas is transferred through the waste gas channels on both sides of the battery to the chimney and into the atmosphere.

COBs 9 & 10 account for more than 40% of total coke production of BSP. It becomes a prerequisite for these batteries to
The innovation, which won a Vishwakarma Rashtriya Puraskar, has resulted in net annual savings of Rs. 2.2 crore.

produce coke of very high standard to meet the stringent coke quality parameters set by Blast Furnace operators. With the aging of these batteries and due to various thermal shocks experienced during the course of operation, diverse problems started cropping up, such as:
- emission from stack started reaching hazardous levels;
- specific heat consumption increased excessively;
- coke slab temperature became non-uniform adversely affecting quality;
- substantial difference in temperatures of adjoining flues due to increased numbers of non-/partially working flues led to cracks in the brickwork resulting in undesired leakage of raw CO gases into the heating system and its emission from stack; and
- fast deterioration of the batteries due to damage of the oven brick works.

The continuance of this block, in particular COB #9, became questionable. Suggestions included rebuilding of the battery, requiring high capital investment.

A team of five persons (in picture below) – Senior Operators Shri G. Pradeep Kumar and Shri Jagbandhu Dalai, Operator Shri Arjun Singh Thakur, Mason Shri Lallan Singh and Technician Shri Bharat Wadalkar – decided to take up the challenge and analysed the possible causes of these problems. The group developed models to eliminate or minimise the problems. As specific problems required specific treatment, an algorithmic-type flow chart for solving each problem was developed and implemented successfully.

Implementation involved the following:
- High pressure air purging of regenerators to liquidate clogged paths of air and gas into flues and end flue cleaning by opening regenerators.
- Ceramic welding of cracks in the oven to curtail cross leakage of CO gas into the heating system.
- Total refurbishing of regenerator face wall to negate infiltration of undesired air into heating system.
- Banana adjustment of flues to achieve desired temperature profile of the heating wall flues.
- Mixing ratio of CO and BF gas changed to 1:10 from 1:07 to derive advantage of increased flame height from a leaner gas thus assisting in plugging of small cracks in the oven brick work by graphite deposition which has resulted in lowering stack emission and achieving uniform coke slab temperature.
- Regular adjustment of hydraulic regime to have near-perfect burning of fuel gas and also to minimise fuel loss due to adverse air-fuel ratio.
- Sealing of all TRV joints and regenerator plugs to eliminate fuel gas burning, thus saving loss of fuel and minimising damage to the TRV.
- Increase in preheat temperature of fuel and air admitted to ports by introducing system pause in between reversals and raising the regenerator temperature marginally, assisting an increase in preheat temperature of fuel and air.
- Streamlining battery operation to minimise deviation in coking period and exposure of oven brickwork to ambient air.
Improving benzol production

Coke oven (CO) gas is a byproduct of the coke making process in coke oven batteries. One tonne of dry coal yields gas and chemicals like tar, ammonia, benzol, etc. The chemicals are extracted in Byproduct Plant, where the raw CO gas is also cleaned before going to BFs and other users. In Benzol Recovery Plant (BRP) of Byproduct Plant, gas flow is measured by orifice plates and then regulated by throttle valves so that equal gas enters all three scrubbers. Solar oil is sprayed from the top to recover crude benzol from gas in these scrubbers.

To keep the gas line in healthy condition, visual and NDT inspection of gas line network is done regularly. During one such routine, the maintenance personnel observed that there was a sudden increase in localised defects in the CO gas line network and found traces of oil along with gas line condensate from the water drainer. The cause was found to be the flow measuring device (i.e. orifice plate) installed in the gas line. It had become non-operational and this resulted in improper injection of solar oil. This had led to uneven gas distribution in BRP-1 and crude benzol was not being recovered up to the optimum level. Benzol was flowing along with gas into the CO gas network resulting in other problems like defects in gas pipeline, gas leakage from doors of battery, etc.

A group comprising Master Technician Shri P.R. Thakur, Senior Technicians Shri P.C. Markandey, Shri S.R. Dhruv and Shri Uday Pandey, and Technician Shri Kesho Ram concluded that

Repairing of BF distribution chute

Paul Wurth, Germany developed the the Bell-less Top Charging System (BTCS) which is a continuous system for charging raw material into a blast furnace for iron making. Four of BSP’s 7 blast furnaces have this system which is ideal for large blast furnaces operating at high pressure. The valve casing comprising material gate, lower sealing valve and distribution chute assembly is an important unit of the system. This assembly helps to retain the charging material inside the hopper; protect the lower sealing valve during charging; control charging material discharge rate; seal gases of BF reactions; and seal high counter pressure of furnace.

The bell-less top is operated in automatic control mode via PLC (programmable logic controller). All openings/closings of valve/gates of BTCS are in sequence and programmed in the PLC. In addition, all the sequences are interlocked to avoid incorrect operation.

The control panel of BF #5 started showing alarming signals in the distribution chute because of faults in the route of interlocking. The distribution chute was an imported item from Germany and spares were not immediately available. Till spares were arranged, interlocking would have to be bypassed. Consequently, the entire charging unit of was taken in shutdown and production from the blast furnace was stopped.

Realising the gravity of the situation, a group of workmen from Steel Structural Shop, the premier fabrication division of BSP, came forward and took up the challenge of making a distribution chute in good working mode in least possible time. The group members (in picture) – Senior Technicians Shri N.N. Sahu, Shri Baisakhu Ram Sinha, Shri Nemchand, Shri S.N. Roy and Shri Ramesh Verma – thoroughly inspected the dismantled distribution chute and found that it was deformed and badly worn out due to regular use and high temperature of the blast furnace, resulting in improper working and gas leakage.

Since detailed drawings were not available for the part, the group resorted to ultrasonic tests for measuring the thickness of plate required to replace the damaged part. Ten semi-cylindrical hard-faced liner plates protect the parent material of the distribution chute. The group suggested replacing all damaged liner plates with stainless steel hard-faced plates which would give more life to the chute. The main stumbling block for the repair of the chute, however, was the cutting of damaged portions of liner plate. Since the liner plates were hard-faced, they could not be cut using conventional material cutting processes (gas cutting, machining and arc cutting). By using the plasma arc cutting process, the group solved this problem. Special welding techniques were also adopted: the welding joints were preheated before welding and welding electrodes matching the material composition were used. The welding joints were ultrasonically tested to avoid any defects as the assembly works on high temperature and high pressure.

The successful repair of distribution chute using innovative methods has resulted in net annual savings of Rs. 3.63 crore for BSP and a Vishwakarma Rashtriya Puraskar. In addition, with leakage of BF gas being eliminated, safe working conditions have been established, and productivity has increased with downtime of BF reduced.
Designing of COB ‘service car’

To facilitate maintenance of batteries and equipment other than pusher machines, a battery service car was designed, fabricated and erected in coke pusher track of COBs # 9 & 10 by a team from CO&CCD of BSP using inhouse resources. With overall dimensions of 13610 mm x 86900 mm x 11120 mm, the car has provision of 3 platforms to facilitate battery and equipment maintenance at 3 different suitable levels and also regulation of 5 doors in a single parking position, thus minimising time required for placement of the car.

The service car has helped in enhancing execution of pollution control activities like door regulation, ‘T’ bolt tightening, lintel repair, etc., which has improved working environment to a great extent by minimising gas/dust leakages from the ovens. Designed to provide more working space and better visibility to working personnel, the user-friendly car has created safer and more comfortable working conditions.

Financial benefit derived from this innovation amounts to approx. Rs. 1.5 crore, of which Rs. 1 crore is recurring saving. In addition, availability and reliability of coke pusher machines has improved.

Elimination of trolley over-travel

Washed coal from different washeries is unloaded at the wagon tippler and stacked in the coal yard in earmarked areas. The coal is then crushed and stored in different bunkers for blending with imported coal in a predetermined ratio to achieve ash content of 13.5% (±0.5%). The blended coal is fed to batteries where it is heated in absence of air at about 1200ºC for a period of about 20 hours to produce coke, which is then sent to blast furnace. To get the desired strength of the coke, the blending of coal plays a vital role.

Mix-up of different batches of coking coal was continuously taking place in blending bunkers resulting in improper blending leading to inconsistent coal and coke ash, which is highly detrimental to BF chemistry. This also resulted in undesirably high coke rate (kg of coke/tonne of hot metal production). After extensive brainstorming and cause analysis, the following root causes were found:

- Improper communication between blending and control room operator.
- Over-travelling of bunker feeding trolley.
- Absence of automatic reclaiming and bunker feeding information system.
- Sometimes feeding trolley over-travels due to inertia and feeds MCC to adjacent ICC bunker. Absence of automatic bunker feeding information at control room and reclaiming information at blending top also causes coal mix-up.

The flow measurement system would have to be revived for regulating the gas flow with the help of throttles and optimum recovery of benzol. For this, the group came up with the idea of installing 2 new orifice plates at new locations in LORs (line of recovery) 1, 2 & 3 under live gas line condition.

The portion of CO gas ring main near BRP-1 which required shutdown for implementing the idea was supplying gas to Sintering Plant-III and COB # 1. Temporary gas lines were laid for these units and shutdown of the affected portion was taken in a phased manner for flanges to be installed in order to insert orifice plates. To insert orifice plates into the flanges under gas pressure, the group brainstormed to develop a safe and practical approach for carrying out the job. For parting the flange to insert the orifice plate, the group designed ‘jack brackets’ which were to be welded as a pair on both sides of the flange. For parting the flanges the group decided to use ‘turn buckles’ as these were the most reliable equipment for the particular activity.

The group also designed and erected a robust hoisting arrangement for hanging and inserting the orifice plates, each weighing 200 kgs, in the flanges. After the insertion of orifice plates, the measurement of CO gas flow started and instruments started displaying the amount of gas passing through each scrubber. The throttles positioned in the gas lines were then regulated to control the flow of gas as per the capacity of each scrubber. The end result was the enhanced recovery of benzol besides solving other problems.

Net annual recurring saving of Rs. 4.12 crore per year has been achieved due to this innovation. Production of crude benzol has risen by 3.762 tonnes/day. This innovation has won a Vishwakarma Rashtriya Puraskar.

The members of the group that handled the entire job of designing, fabrication and erection are (in picture): Senior Technicians Shri Shiv Kumar Chandrakar, Shri T. Radha Krishnan Nair and Shri Harish Chandra, Technician Shri Gyan Chand Sharma and Senior Operator Shri Bisnath.

This innovation has won a Vishwakarma Rashtriya Puraskar.

ROURKELA STEEL PLANT

Elimination of trolley over-travel

Washed coal from different washeries is unloaded at the wagon tippler and stacked in the coal yard in earmarked areas. The coal is then crushed and stored in different bunkers for blending with imported coal in a predetermined ratio to achieve ash content of 13.5% (±0.5%). The blended coal is fed to batteries where it is heated in absence of air at about 1200ºC for a period of about 20 hours to produce coke, which is then sent to blast furnace. To get the desired strength of the coke, the blending of coal plays a vital role.

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Different solutions were discussed. Decision was taken favouring installation of heavy-duty limit switches beside each bunker to eliminate trolley over-travel and also to provide bunker feeding information system at the control room by activating these switches through pusher units on the trolley. While feeding a particular coal, the trolley would be positioned in such a way that a fixed pusher unit would push and activate the respective limit switch for stopping trolley inertia as well as provide automatic bunker feeding information through an information board containing individual lights for each bunker. Again, for reclaiming information at blending top, a switchboard containing different switches for each coking coal would be provided in the control room for indicating through another information board at blending top containing individual lights for each type of reclaimed coal.

A group consisting of Senior Operators Shri Manoj Kumar Gharai, Shri Sunaram Murmu, and Shri Jhasa Ketan Mishra, Operators Shri Raj Kishore Sahu and Shri Ballav Panda, and Technician Shri Pratulla Kumar Jena prepared limit switch base, pusher unit and information boards. Two limit switches beside each bunker and two pusher units on both ends of each trolley were fixed (total 32 limit switches beside 16 blending bunkers and 8 pusher units on 4 trolleys).

The innovation has resulted in improved productivity. Other benefits include equipment safety and improvement in quality of coke. Estimated financial savings potential of this innovation is Rs. 2 crore per year on recurring basis.

**BHILAI STEEL PLANT**

**Optimising moisture in sinter raw-mix**

Moisture in sinter raw-mix generates fines that become part of return sinter. Apart from other operational problems, variations of moisture level in sinter raw-mix have direct impact on production and quality.

A systematic approach for solving the problem using Pareto analysis, cause & effect diagram, 4W-1H and 5W-1H techniques showed that the root cause was manual feeding of moisture to all individual raw materials of sinter raw-mix, i.e. iron ore fines, flux, mill scale, flue dust, etc., while updation was done occasionally (once a week or so). Manual feeding of initial moisture to all individual raw materials was resulting in wrong calculation of initial moisture available in raw-mix. This led to deviation in calculated water addition (set value) in sinter raw-mix and, consequently, optimum moisture control could not be achieved.

Members of QC Abhiyan who were handling the issue (in picture) – Shri P.N. Maravi (facilitator), Shri M.D. Sahu, Shri V. K. Choudhary, Shri A.K. Gupta, Shri A.K. Mishra and Shri S.S. Dhurve – recommended installation of an online moisture measurement sensor for iron ore fines, which contribute 76.6% of total initial moisture. The accurate online moisture measurement system that has been installed is able to minimise the variation of moisture in the range of ±0.1% of the span. This has improved the sinter strength, reduced generation of sinter return fines and increased productivity by around 3-4%.

**Estimated annual recurring savings as a result of this innovation are Rs. 1.1 crore.**

**ROURKELA STEEL PLANT**

**Reduction in downtime of stackers**

OB&BP department plays a very important role in systematically handling all kinds of raw materials (except coal) required for iron/steel making with activities like unloading, stacking, reclamation, etc. Different types of raw materials such as iron ore lumps/fines, manganese ore, limestone, dolomite, etc., are stacked in layers at OB&BP in 14 beds by using 4 twin boom stackers supplied by M/s Elecon.

The booms were frequently colliding with piles and getting damaged due to ‘half piling’, which arises when reclaiming of material from a pile is forced to stop before completion due to operational or maintenance requirements. Another cause of collision was poor visibility due to dust, fog and rain. On an average, 3 booms were damaged per year due to collision. It was essential to provide collision prevention devices on the stacker booms.
The OB&BP group assigned this job conceived, developed, fabricated and installed an anti-collision device using inhouse resources. Consisting of a hinge box beam, link, striker, counterweight, support string, limit switch and actuator block, this device weighing around 50 kgs was fixed at the tail-end of the stacker boom with a projection of 1.5 m.

The device has successfully prevented collision of booms with piles and their damage. The modus operandi of the device is as follows: The striker of the device will strike the pile before the stacker boom approaches to hit it. The striker will then pull the link along with actuator block attached to it. The limit switch lever linked with the actuator block will immediately activate the contacts. A signal will be conveyed to electrical control panel and forward long travel movement of stacker will stop as per the modified circuit of VVVF drive. Then the stacker movement will reverse automatically. This information is conveyed to Central Control PLC for logging the report. Safety features not originally provided in the stackers have been incorporated in the device.

As a result of the innovation, RSP will achieve annual savings of Rs. 2.22 crore on recurring basis. Other benefits derived include increased reliability of stacker, motor, gear box, coupling, etc., reduced detention of wagons resulting in lower demurrage, no production loss, and enhanced productivity from reduced downtime.

The team responsible for the innovation consisted of the following (in picture): Shri Ajit Kumar Panda, Shri Sanjay Kumar Panda, Shri Rashmi Ranjan Rout, Shri Dilip Kumar Patel, Shri Ratikanta Sahoo, Shri Gobinda Chandra Patel and Shri Chaitanya Prasad Hembram, all Senior Operatives-cum-Senior Technicians.

Conversion of gas regulating valve

Gas regulating valve is an important component of any stove in blast furnaces. It regulates the flow of gas in order to get the optimum temperature without wasting any useful heat. Regulation of the 1000 mm electro-mechanical butterfly valve is done through gear box and motor with suitable gear train arrangement to get the desired torque with minimum power consumption. But this type of valve is very maintenance prone due to large number of quick-wearing parts.

The innovators: Senior Technicians Shri Anil Kumar Mishra, Shri Dileswar Mohanta, Shri Bijaya Kumar Maharana, Shri Bibhuti Bhushan Biswal, Shri Jatindra Nath Mishra and Shri Nilachal Dash.
A decision was thus taken to convert one such valve to a hydraulically driven one using inhouse resources. The group assigned the job arranged for cylinders from the junk yard of Field Mobile MachineryDepartment and other hydraulic components from various sources such as defunct unit of Desulphurisation Plant. The components were made ready, pressure tested and assembled. This was further tested in workshop conditions and suitable mounting and actuation levers were designed. This was then fixed in the stoves of BFs # 1, 2 and 3.

The new valve has a simplified mode of actuation by connecting a lever to the butterfly plate shaft. Rotational motion is acquired through a hydraulic cylinder. Benefits derived from this innovation include: low space requirement, inbuilt pressure relief valves, individual isolation valves and bypass valves make operations safer, low power consumption as no separate motor is required, more durable parts requiring lower spares consumption.

Financial saving achieved due to this innovation is to the tune of Rs. 18 crore per year on recurring basis.

**Bhilai Steel Plant**

Life enhancement of 7m tall battery

The thermal regime of the heating wall of a coke oven battery is of utmost importance. ‘Next to cold blend’, which occurs due to irregular thermal regime is one of the prime factors affecting the quality of coke. In fact, the overall carbonisation process depends mainly on uniformity of thermal regime. Poor gas yield as well as premature failure of battery fabric also result due to irregular thermal regime.

The thermal regime of COBs # 9 & 10 was highly disturbed, with pockets of low temperature existing along with intermittent high temperature ones, resulting in oven sticker and green push along with coke spillage at the time of door opening. The Heating & Regulation Group identified defective vertical flues as the cause of the problem after examining cross wall temperatures of heating walls.

The design of COB # 10, which is under jet firing, allows control of injection of fuel gas and air in individual vertical flues by controlling the opening in grate brick situated just below the regenerator level. It was decided that the opening of low temperature verticals would be increased and that of high temperature verticals reduced. By controlling air and gas flow in this way, the thermal regime of the heating wall could be improved – except that of end vertical (EV). The main hurdle in the EV was the position of grate bricks with respect to bottom inspection hole, through which regularisation of the bottom banana is done. There was a 40 mm gap between two grate bricks here and no banana brick could be fixed from the cellar in EV flues (i.e. 1", 2", 31", 32" vertical flues) in the same manner as in the other vertical flues.

After brainstorming, QC Chunauti members (in picture) – Junior Manager Shri S.U. Shareef (facilitator), Chargeman Shri Raj Kumar, Senior Technician Shri J. I. Verma, Senior Operator Shri Jagbandhu Dalai, Operator Shri Narayan Prasad Sahu and Technicians Shri Tapash Ranjan Dam and Shri Anun Sharma – decided to fabricate a new type of instrument that could be inserted in the EVs for banana bricks to be placed in the respective area given in the EV flues.

The job was done according to plan. The result was marvellous – occurrence of green push, oven sticker and coke falling were reduced to a great extent along with near elimination of black patches, high temperature pockets and the sharp difference in the temperature existing within a pair of EVs.

Other benefits derived from this innovation include: proper coking of coal in the EV; full recovery of gas from coal; decrease in BF coke rate; and saving of imported coal use.
STEEL ZONE
BHILAI STEEL PLANT

Separation of excess slag from liquid steel in ladle

There are 4 twin hearth furnaces in BSP’s SMS-1, each having capacity of 250 x 2 tonnes. During melting period, nearly 50% of the slag formed in the furnaces is flushed out through the centre door of the hearths. But the balance is tapped along with steel in the ladle. High volume of slag is because of presence of high ppm of oxygen, which is due to reasons like hard hole, lance leakage, low melt, etc.

The presence of excessive volume of slag along with liquid steel in ladle was cause of concern. High FeO content in the slag results in violent ladle reaction during teeming operation. This is a serious risk, with the possibility of causing severe burn injuries, for the workforce in the vicinity. Besides, the problem causes cold heat, excessive ladle additions, poor heat quality, lower heat weight (yield) and furnace delay.

Data were collected for about 2,000 heats to analyse the problem and find a solution. Annual financial loss due to presence of excess slag along with liquid steel was of the tune of Rs. 2.48 crore. By applying different Quality Circle tools, the following two factors emerged as the major cause of generation of excessive volume of slag in liquid steel in ladle – fixed furnace and inactive mixer. These two causes could not be eliminated as they were part of the technology being used. Therefore it was decided to develop a foolproof system to overcome these problems.

The solution evolved was introduction of equipment called ‘slag separator’ to divert the excessive volume of slag. As soon as the slag starts flowing out of the tap hole, the slag separator is placed between the launder and the ladle with the help of the teeming crane to divert it to the thimble. The slag separator was designed and fabricated and the SOP for its use has been documented.

Tangible benefits derived from the innovation is recurring saving of Rs. 6.49 crore per annum. The intangible benefits of the innovation are equally significant:

- Probability of ladle reaction is totally eliminated due to easy slag cutoff, making workplace condition entirely safe.
- Using slag separator has helped in keeping pollution under control.
- Undesirable events like burning of hose pipe and damage of ladle slide gate mechanism due to overflow of slag and metal from ladle during ladle reaction have been eliminated.
- Smooth and uninterrupted teeming operation has increased the availability of cranes, furnace, etc.

The innovators: Senior Manager Shri Nirmal Kumar Dethe, Master Operative Shri Ashish Das, Senior Operative Shri Ashish Mohalder, Operative Shri Md. Naeem, Chargeman Shri Rajinder Singh, Chargeman Shri V.S.S. Sridhar and Chargeman Shri Rupesh Kurup

BOKARO STEEL PLANT

New test bench for mould oscillator mechanism

When liquid steel is brought from LD converter via secondary refining unit to caster for casting, it is first poured from ladle into a reservoir called rundish. From rundish, steel flows through a refractory nozzle called SEN into a water-cooled copper plate mould. Solidification of liquid steel starts inside this mould which needs continuous vertical oscillation so that liquid steel does not stick to the copper plate wall.

A mould oscillator mechanism (MOM) keeps the mould in oscillating condition throughout the casting period. The MOM consists of one main motor of 45 kw and four mould width adjustment (MWA) motors of 2.2 kw each which enable slab width adjustment. Width of slab is determined by positioning narrow copper plate of mould and can be changed during the casting process.
The ambient environment of MOM is steamy due to hot water spray in operation. Sometimes steam adversely affects functioning of MOM motors, leading to heavy production loss. Consequently, MOM needs regular maintenance for smooth working. After carrying out repair of MOM along with MWA, it is essential to test it before bringing the steel directly into the strand for casting.

In the original design there was no provision to run and test the mechanism outside caster machine. There was always a possibility of the equipment getting damaged with full electrical supply of 50 Hz/415 volts. Therefore, for testing, supply was being arranged from MOM panel or different panels of suitable ratings. Also this was only possible after casting process was over. Due to this there was a delay in testing of MOM. Further, a temporary cable had to be laid every time for the purpose of testing, involving additional manpower. Also, the parameter of dedicated frequency converter for other system had to be changed to suit the MOM operation. The activity was not only time-consuming but problem-prone. Apart from this, it was not possible to test MWA motors outside the casting machine. Sometimes, after putting MOM in strand machine, if fault in any motor of MWA was detected during operation of caster, it led to prolonged delay in machine preparedness causing heavy production loss.

It was decided that a new testing panel would be developed by making use of one frequency converter for MOM main motor and 04 frequency converters for 04 MWA motors. For this purpose, a group from SMS-2 developed the requisite drawing for fabricating panel using inhouse resources. Keeping in view the testing requirements, the group kept a provision while designing the system to test the spare MOM and MWA at two different places – at caster level (11 m) and MOM capital repair area (ground level). For this they fabricated and installed two local control posts at the two places. The job involved wiring, commissioning and testing of the panels were done inhouse.

With the commissioning of the testing system, the MOM oscillation frequency can be selected as 50, 100 or 150 cycles per minute from the local control box. Current from the ammeter installed in the local control box can be monitored. Similarly, MWA motors can be tested in any combination from local control boxes. Additionally, new or repaired frequency converters can also be tested in this panel exclusively before putting it for regular use. Similarly, MWA motors can also be tested in any combination from local control boxes.

This testing bench has been helping the Continuous Casting Shop keep the MOM system completely ready and healthy. Prolonged delay in machine preparedness causing heavy production loss has thus been eliminated.

**ALLOY STEELS PLANT**

**Used dolomite bricks for relining stainless ladles**

Stainless ladles at ASP are relined with direct bonded mag-chrome (DBMC) bricks at side wall. The bricks used are of circular shape and lining thickness is kept at 150 mm. On the other hand, the AOD vessel is traditionally relined with dolomite bricks to take care of the high temperature requirement of stainless making. After completion of one campaign, the used lining is completely dismantled and removed from the AOD vessel before fresh relining.

During dismantling of used brick lining of AOD, it was observed that thickness of leftover bricks was more than 150 mm in areas below the slag zone and opposite to tuyere side. A group comprising Senior Manager (SMS) Shri J. Pal, Deputy General Manager (RED) Shri K. Prasad and Assistant General Manager (RED) Shri K. Bandopadhyay (in picture on next page) generated the innovative idea of salvaging and reusing the used dolomite bricks in stainless ladles after cutting to shapes with the help of brick cutting machine.

It was decided that DBMC bricks of stainless ladles would be replaced by used dolomite bricks of AOD vessel after each dismantling of AOD lining.

**The innovators: Senior Technician /Operative Shri S. Muresu, Technician (Electrical) Shri S.C. Ray, Technician (Electrical) Shri P.B. Mallick, Khalasi/Junior Electrician Shri L. Singh and Operator Shri G. Johar**

This innovation, which has provided financial benefit amounting to Rs. 2.1 crore annually, has won a Class ‘A’ Vishwakarma Rashtriya Puraskar.
Increasing EAF productivity

Electric arc furnaces (EAFs) of ASP are equipped with a side wall water panel inside the furnace shell to keep the furnace and the surroundings cool. The panel also protects different components of the EAF like hoses, shell, etc., from any damage or distortion due to excessive heat generated during heat processing.

Since its commissioning, EAF # 4 was unable to produce liquid metal as per capacity of 50 tonnes. Due to the bath level of the furnace being slightly high, liquid metal would touch the bottom part of the side wall panel, resulting in water leakage in the furnace, which then had to be shut down for repair of the panel which is a time-consuming job. As a result, production of SMS suffered frequently. Moreover, hot metal coming in contact with water is a major safety hazard. It became absolutely necessary to modify the side wall water panel of EAF # 4.

The solution was to either deepen the bottom of the furnace or increase the height of the water header from the furnace bottom to avoid metal kissing the panels and water header. Since the first would make the vessel unsafe, the only option left was to modify the side wall water cooled panels and water header. Accordingly, a group from Continuous Casting Shop (in picture) comprising Deputy General Manager Shri Meghnad Banerjee and Senior Managers Shri H.K. Verma and Shri Y. Srinivas removed all water-cooled panels, shortened wall panel height by about 300 mm and raised the main water supply header by about the same measure.

The modification has increased furnace capacity by about 18-20 tonnes. Whereas earlier only about 40 tonnes of liquid steel could be tapped, now EAF # 4 is able to produce 50-52 tonnes of liquid steel while maintaining safe slag volume. The innovation has also reduced electrode consumption by over 33% and power consumption from 800 kwh to 620 kwh per tonne of steel produced. Overall yield and profitability has thus increased considerably. With an average of 6 heats per day, EAF # 4 now gives 50-60 tonnes of additional steel per day valued at around Rs. 20 lakh. Also, approx. Rs. 15,000 on electrode consumption and Rs. 25,000 on power consumption are saved daily. This translates to annual savings of Rs. 8.64 crore. Besides, the furnace is now totally safe.

Scrubbing unit for CO gas in BOF

During the steel making process, the generated BOF gas is either stored in gas holder or burnt into the atmosphere, depending upon the percentage of carbon monoxide in the gas. This burning of BOF gas into the main burner of flare stack (each 80 m high) is done with the help of ignition burners and pilot burners. Ignition burners provide sufficient sparking in the form of fire ball to ignite pilot burners which are fuelled with combustion air and unclean coke oven gas. This flame finally burns out huge amount of BOF gas generated in crude steel production. The operation of both ignition and pilot burners are controlled from a station on the ground, supported with a complex network of pipelines, pneumatic valves, sparking units, combustion air blower, filters and other essential instruments.

During the last few years, this system was frequently getting interrupted, leading to extensive maintenance on pipelines, valves, filters and both ignition and pilot burners for choking due to...
impurities in the supplied coke oven gas. Non-functioning of flare stack leads to huge environmental pollution. A scrubbing unit has now been installed to remove the impurities from coke oven gas by water jets (3.5 bar pressure) before entering into the burning system. The water droplets impinge the insoluble impurities like naphthalene, tar fog, etc., and dissolve the soluble impurities like sulphur compounds. Thus, both soluble and insoluble impurities are removed and cleaned coke oven gas is allowed to pass through the flare stack to ignite the pilot burners. The flare stack ignition system in BOF is running uninterruptedly without any maintenance for the last one year, continuously ensuring both smooth production as well as green and healthy environment.

The members of the Maintenance team of BOF (picture above) responsible for the innovation are: Assistant General Manager Shri S. Mondal, Senior Manager Shri S. K.Ghosal, Junior Manager Shri S. Biswas and Senior Technicians Shri D. Bose, Shri D. Kuiri, Shri S.N. Chattaraj, Shri S. Ray and Shri G. Bhattacharya.

Hot metal is poured into mixers from ladles and vice-versa with the help of EOT cranes during the process of iron & steel making. These sophisticated cranes are critical equipments in each stage of the production process and are the lifelines for the smooth and continuous working of the plant. Any interruption of the main cranes directly throttles production in both upstream and downstream facilities. The following problems were being experienced in the performance of EOT cranes:

- Malfunctioning of crane controls and logics affecting work safety in cranes as well as shop-floor.
- Relatively high electrical breakdowns leading to production being interrupted with production delays of more than 2 hours a month on an average.
- Relatively high frequency of failures.
- Repetitive maintenance requirements leading to high downtime of more than 65 hours a month on an average.
- Reluctance of employees to work in cranes.

Senior Operator-cum-Senior Technician Shri A. R. Das suggested and implemented the following to overcome the above problems:

- Modification of control logics and automation systems to ensure safe operation of all devices in the cranes.
- Modification, repair and revival of non-working, obsolete, costly and critical components using inhouse resources.
- Modification of trailing cable systems and implementation of sling & anchor systems in repair trolley, cranes, hoists, etc.
- Installation of mist eliminator monorail using inhouse resources and rejected scrap items.
- Elimination of DSL busbar power tripping problems by using rejected and used conveyor belt packing.
- Use of temperature guns in panels, resistance boxes, cables, thyristorised systems, power circuit components, etc., to identify potential problems and take necessary preventive measures to eliminate failures.
- Modification of thyristorised stack sleeves and control logics to ensure zero breakdown in these systems.
- Use of bimetallic washers in power joints and busbar systems.
- Modification in systems of maintaining remote operation.
- Shifting of panels from to safe position for easier and faster maintenance and fault rectification.

These actions resulted in the following:

- Breakdowns reduced by more than 80%.
- Shutdown time of cranes reduced by more than 31%.
- 100% remote working of slag yard cranes.
Improving ladle temperature in SMS-1

Ladle plays a vital role in transfer of molten metal from BOF to mixer in SMS and then to LD converter in the process of steel making. Liquid steel temperature is almost at 1600ºC to 1700ºC in every sequence. To maintain the temperature, ladle temperature needs to be at 1250ºC to 1300ºC.

However, it was found that ladles in SMS-1 were heating up only to around 875ºC, leading to ladle heating time of 2.45 hours against the standard of 1.20 hours. Also, ladle heating was not uniform. These problems resulted in average refining life of ladle coming down to only 44. Out of 19 ladles (3 for hot metal and 16 for steel) required in SMS-1, a minimum of 11 ladles (2+9) need to be in circulation always with present production rate of 1,300 tpd. However, only 10 used to be in circulation due to the abovementioned problems. Naturally this led to production loss.

On examination, it was found that the primary reason for improper heating of ladles was gas flow at only 375 Nm³/hour against the norm of 480 Nm³/hour with air at 2000kg/cm², leading to choking of porous plug and creating argon failure.

A group decided to improve ladle temperature by a minimum of 400ºC to reach 1250ºC. The members collected data on all the probable causes and developed a cause-and-effect diagram. 13 causes were subjected to why-why analysis for evaluation of possible root causes. Data was collected during the calendar year 2006 for their validation. Consequently, only 5 of the 13 causes were accepted as probable real causes. Pareto analysis of these revealed that the root cause was interruption in gas supply (20% of the causes had 54% impact on production delay due to non-availability of ladle).

The group brainstormed and concluded that converting the hose system to adjustable pipe system would be the final solution to the problem. An action plan was then made to implement this idea. The hose pipe was removed and telescopic pipe system with steam connection fabricated. The entire job was done using inhouse resources.

After implementation of the modified support system, annual monetary gain has been assessed to be around Rs. 1.53 crore through lower consumption of gas hose, porous plug and mixed gas as well as 10% increase in ladle life. Other benefits have also been observed:

- Ladle availability increased to 11.
- Ladle heating time reduced to 1.20 hours for in-circulation ladles.
- Ladle life increased to 49 heats.
- Porous plug choking reduced from 214 to 92.
- Extra gas consumption worth 1.25 hours was reduced.
- Fire hazard was eliminated due to removal of gas hose.

The innovations have given estimated recurring financial benefit of Rs. 1.44 crore per year.

BHILAI STEEL PLANT

Modification of flare stack ignition system

Since inception of Converter Shop at BSP, one constant problem was that of carbon monoxide gas concentration going high every now and then in and around the Shop. The problem was caused due to unburnt LD gas coming out of flare stack as a result of non-working of flare stack ignition system. Every time the old flare stack ignition system developed a snag (either in spark plugs, choking of nozzles, burning of HT cables, etc.) work at the Shop came to a standstill because the pilot burner was located at a height of +70m.

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Modification of flare stack ignition system

Since inception of Converter Shop at BSP, one constant problem was that of carbon monoxide gas concentration going high every now and then in and around the Shop. The problem was caused due to unburnt LD gas coming out of flare stack as a result of non-working of flare stack ignition system. Every time the old flare stack ignition system developed a snag (either in spark plugs, choking of nozzles, burning of HT cables, etc.) work at the Shop came to a standstill because the pilot burner was located at a height of +70m.
This time, a permanent solution was sought. It was suggested that the pilot burner be brought down to a height of +50m and a modified burner be designed and developed to carry the flame from +50m to +70m. By bringing down the ignition system to +50m, any problem arising during the could be tackled without shop shutdown.

Consequently, a 20m-long burner was made which was supposed to work on the lines of a domestic gas burner and trials conducted at the ground level. After successful completion of trials, the suggested modification was carried out in all the three converters.

Annual financial benefit due to this innovation amounted to Rs. 21.6 crore. The team which undertook the job successfully comprised (in picture) Senior Operators Shri Ramesh Kumar Sahu and Shri Ram Narayan Singh Parmer, Senior Technician QC Brahmas was awarded the gold trophy at ICQCC-2009 in Cebu, Philippines

In Steel Melting Shop, two mixers are used for storing molten iron. These are mounted on roller cradles which have their own tilting mechanism to tilt the mixers to pour out metal into ladles. Frequent breakdown of the mixer tilting drive was severely affecting the production of crude steel at DSP.

By applying QC tools and techniques, the problem was analysed as spillage of metal while pouring into ladle, resulting in accumulation of metal on rollers and mixer undercarriage which in turn jams roller rotation, ultimately leading to rollers sliding instead of rolling. The sliding motion of the rollers caused overloading of the motor and resulted in tripping of the tilting drive. In such cases, the mixer comes back on its own and subsequently gains very high momentum and hits hard on the buffer resulting in damage of pedestal bolts, end covers and bearings.

QC Brahmas decided to eradicate the problem and came up with a unique solution of protecting the rollers and roller cradle from metal spillage. The QC members (in picture) – Shri Tapojyote Bhattacharyya, Shri Swarup Chatterjee, Shri Partha Sen, Shri Santi Ram Ghosh and Shri Mrinal Chandra Chaud, all Senior Technicians – designed and then fabricated suitable roller guards. Adequate supporting bases were also fabricated and the roller guards were erected by the team members successfully.

Benefits derived from the innovation included significant increase in productivity and minimisation of production delay due to tilting drive failure. Financial benefit has been to the tune of Rs. 12,845,500 per year.
Life enhancement & protection of mixer hoses

Ladles with molten iron coming from blast furnace are offloaded in mixers of SMS. Mixers play a vital role by not only storing the molten iron before it is fed to converters where steel is produced, they also maintain stable temperature of the hot metal and make its composition homogeneous. Maintenance of stable temperature of the molten iron is very important for techno-economic viability of the steel making process. The fuel required for this purpose in mixers is a mixture of coke oven gas and air that is fed through hoses.

These hoses used to be prone to leaks mainly due to metal spillage that occurred while the molten iron was charged into or poured out from the mixers. Even if there is a small leakage at a single point, the whole length of the hose has to be changed. This is a time-consuming task, leading to the shop suffering major delays every time leakage occurred. Consequently, the temperature of the molten iron in the mixers would fall and productivity would be affected.

The solution implemented by a group of Senior Technicians (in picture) – Shri Debashis Roy, Shri Prasanta Kundu, Shri Partha Sen, Shri Amar Mukherjee, Shri Lalmohan Karmakar, Shri Rudrendu Kumar Mondal and Shri Dilip Kisku – was unique and the results remarkable. The group fragmented each of the 3 coke oven gas hoses into 2 parts and each of the 3 air hoses into 4 parts and fitted them with compatible flanges, so that whenever a portion of a hose was damaged only that section would have to be changed instead of the whole length of the hose. The problem of leakages occurring due to metal spillage was eliminated by wrapping the hoses in asbestos cloth.

Before the modification, there used to be 12-15 breakdowns every year because of leakage in the hoses of mixers. The average duration for each hose changing was around 4 hours. After the modification, annual delay time has been reduced by 27 hours and resulted in increase of 28 heats in SMS converters. The total annual monetary benefit is estimated to be around Rs. 1.56 crore.

BOKARO STEEL PLANT

Fault indicator panels in CCS cranes

To maintain continuity of production, the slightest delay of ladle handling cranes needs to be avoided. In case of any tripping in the main hoist drive of a crane, the maintenance crew had to spend time to find the cause of malfunction and only then take corrective action. This was tedious and time consuming, and threat of heat abortion was added concern.

A group from SMS-2 suggested introduction of a smart indication panel on the cranes to solve the problem and help increase productivity. They modified the circuit in such a way that faults such as breaker tripping, torque failure, overload, overheat, etc., would be displayed on the panel till the fault was set right or reset. An indicator for fault due to mismatch or break providing was also introduced.

Implemented in both ladle handling cranes of CCS and working quite effectively, the innovation has resulted in quickest redressal of malfunction of cranes, leading to better continuity of casting and fewer breaks in the heat sequence. This entails substantial savings since heat abortion in the beginning of casting results in production loss.

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MILLS ZONE
BSP’s long rail finishing line produces rails up to 80 metres length and welded panels up to 260 metres length. After the rails are straightened, their surfaces are milled at one end by milling machines and cut at the other end by carbide saws in the rail finishing area.

There are 6 milling machines for 6 finishing groups. Each machine contains a gear box driven by motor which drives the main spindle having a milling head containing a tungsten carbide cutting tool, which provides finishing to the rail end after clamping. One of the machines was frequently breaking down due to the following reasons:

- Continuous (24x7) use in view of the increasing demand by the Indian Railways.
- Less time for preventive maintenance due to increase in operational hours.
- Frequent failure of ball screw, gear train, liners, etc., as cycle time of finishing groups reduced.
- Fatigue of operators. Machine failure implies average production loss of 2 hours per day, cost of extra spare, loss of manpower productivity, etc. To find a permanent solution to the problem, a Quality Circle group suggested development of a spare machine by revamping and modifying an old and obsolete Russian-make milling machine which was earlier used for milling 72 UTS rails. For this, the circle members undertook the following jobs:

- Replacement of the brass brushes of the old machine with suitable bearings to match the higher rotation speed required for milling 90 UTS rails.
- Modification of the gear train mechanism to achieve 70
The existing banana cooling pipes were not able to penetrate the vapour layer formed just above the roll, so heat remain trapped, which in turn caused roll breakage. To overcome this problem, nozzles were inserted into the tubes of the pipes to spray the same volume of water in the form of jets covering a larger surface area. This jet formation caused the vapour layer on the surface of the roll to break leading to enhanced cooling and increased pass life.

The innovation has resulted in financial savings of Rs. 3.4 crore per annum.

### Augmentation of TMT rolling facilities

The same quality of billets used for rolling of rebar TMT Fe-415 grade in the B, C & D strands of Wire Rod Mill would be used to roll out ribbed bar IS-2062 grade-A in the ‘A’ strand. Thereafter, rolling of TMT Fe-500 was developed in the B-D strands to meet its increasing market demand, but it was found that the same quality billets could not be rolled to IS-2062 grade-A in the A strand. There was no other alternative but to stop rolling in the A strand.

A team consisting of Senior Technicians Shri Bhoj Ray Das and Md. Saluddin, Senior Operator Shri Rajesh Kumar Mishra and Technicians Shri Gaind Lal Thakur and Shri Vinod Kumar Yadav came up with the suggestion of rolling TMT Fe-415 in A strand by converting the descaling zone to the primary cooling zone by addition of one cooling box and replacing the descaling valve with rapid action valve.

After implementation of the above suggestion it was observed that the quenched rolled stock was snapping between the finishing group of stand and the coiler due to the resistive force of the high volume of quenching water being injected at a high pressure on the rolled stock. Successively, the intermediate cooling zone was introduced in between the stand number 19A and 20A to distribute the volume of quenching water between the two cooling zones.

The idea was implemented and the team relished the taste of success of rolling rebar TMT Fe-415 in the A strand. Further improvements were made by incorporating process interlock, controls and monitoring systems for critical parameters like temperature of the rolled stock at coiler, and flow rate and pressure of the quenching water, to achieve a consistent property of TMT Fe-415 throughout the rolled stock. Successively, the intermediate cooling zone was developed a new gear train design. The power scheme was formulated.

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Financial benefit accrued from this innovation amounts to Rs. 85.8 crore per annum.

### Enhancing roll life of roughing stands

Bhilai’s 250-mm, 4-strand continuous Wire Rod Mill was commissioned in 1967 with a rated capacity of 0.42 MT per annum. Roughing group of the mill consists of 9 stands. Stands 2 & 3 and 4 & 5 have common drives. When input billet size was increased from 85x85 mm² to 105x105 mm², productivity of the mill shot up. Production increased from 1805 to 1918 tonnes/day and frequent stand change was required in the event of a worn-out mill shot up. Production increased from 1805 to 1918 tonnes/day and frequent stand change was required in the event of a worn-out mill shot up.

The idle roll of stands 1 & 2 which has a box pass and a hexagonal oval pass, respectively, are used till complete tonnage is achieved and roll is scrapped. The collar portion of the scrapped roll is now being utilised by turning square pass into the collar area for stand 7. Tonnage gained as a result of these actions is 1,253,901 tonnes.

To overcome the above problems, a group consisting of Senior Operative Shri Bodhanlal Patil, Assistant Roller-cum-Senior Operator Shri Baljeet Singh Mann, Chargemen-cum Master Technicians Shri Sushil Kumar Patil first implemented the load monitoring system for stands 1 & 4. The idea was implemented and the team relished the taste of success of rolling rebar TMT Fe-415 in the A strand. Further improvements were made by incorporating process interlock, controls and monitoring systems for critical parameters like temperature of the rolled stock at coiler, and flow rate and pressure of the quenching water, to achieve a consistent property of TMT Fe-415 throughout the rolled stock. Successively, the intermediate cooling zone was developed a new gear train design. The power scheme was formulated.

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The Wire Rod Mill (WRM) of BSP produces about 6.5 lakh tonnes of wire rods in diameters of 5.5, 6, 8, 10 and 12 mm. Plain and TMT wire rods are the two categories of products of this mill. Diameters of 8-12 mm are rolled in the TMT process. TMT steel produced is of the grades FE-415, FE-500 and HRC-500. This steel has a hard shell, soft core and a ribbed surface. The hard shell gives the necessary strength, soft core provides flexibility and the ribs enhance the surface area of the rod and hence contact area with concrete increases. These characteristics are obtained by controlling the temperature of wire rods, composition of steel, and by the design of the rollers.

Finishing temperature of the wire rod is the most important parameter determining the quality of steel. Billets are heated up to 1260°C in reheating furnace and then rolled into wire rods. Temperature of the rod before and after the primary cooling shall be about 1050°C and 950°C, respectively. At this temperature billet enters the block, and ribbing, surface finish and dimensional accuracy are achieved. Then, in the secondary cooling process, the final wire rod temperature is controlled at around 600°C to 640°C so that required properties of the metal are achieved. Deviation from these temperatures result in non-conformity to standards, rejection of wire rods and stoppage of mill due to cobbling.

The temperature of the wire rods is controlled by in-process quenching. Hot wire rods pass through a set of cooling boxes where water impinges on the rods from all sides. Due to this sudden quenching, the surface of the rods hardens but the core, not having sufficient time to get quenched, remains soft. Pressure and volume of water flowing into these cooling boxes are the most important contributors to the temperature of the rods.

The pressure of water is controlled with the help of a pneumatically actuated pressure control valve and the water is led into the cooling boxes, where the hot wire rods are quenched and lose heat.

Temperature is more sensitive to the volume of water than its pressure. Other factors affecting the temperature and thereby the quality of wire rods include incoming temperature of the wire rods into the cooling boxes, speed of rolling of wire rod and grade of steel. The pressure control loop was not sufficient to take care of all the above factors.

Therefore, a suitable temperature control scheme has been developed and implemented in the C & D strands of WRM. It takes into consideration all the above factors and obtains a constant temperature throughout the length of wire rods.

The cascade loop developed and implemented uses flow as the primary loop instead of pressure, temperature control being the secondary loop. Final wire rod temperature measured at the laying head is connected to a PID controller where the temperature set point (600°C to 640°C) is also fed. The resultant output drives a water flow controller. In turn, this controller drives the pressure control valve. Closed feedback is obtained by the result of manipulated water flow in the form of temperature and the loop continues to function endlessly. Speed of the wire rod and the total temperature drop across the system are compensated by the polynomials based on the valve characteristics. Thus a steady temperature of the wire rod is obtained.

The temperature control system in C and D strands has resulted in recurring annual net savings of over Rs. 3 crore.
Slabs received from SMS are heated, soaked and then taken to finishing mill through R0V0, R1, R2 and coil box in Hot Strip Mill (HSM) to convert it to coil of desired thickness and width. Since the hot strip travels over the run-out table (ROT) at a speed of 10-12 metres/second, any obstruction in the path of the strip causes it to fold and not reach the coiler, resulting in cobble generation. The ROT has guards on both sides all along the roller table to guide the strip coming out of the finishing stand. These guides need to be aligned in a straight line so that there is no obstruction in the path of the strip. It was found that 15 cobbles were being generated every year due to displacement of ROT side guards alone.

Generation of a cobble leads to the following –
- loss of production due to loss of about 45 minutes in removal of each cobble;
- damage to mill equipment like entry guides, loopers, side guards, etc., due to pulling & tugging by crane;
- threat of burn injury since coil remains at a high temperature;
- noise pollution caused by removal of strip removal over the roller table; and
- loss of good material resulting in financial loss.

To find an immediate solution, a group of employees of the HSM examined the problem in detail using quality control tools and concluded that there could be 4 possible causes of side guard displacement: interchanging of guards, dislodging of supports, disturbance in FM setting and handling of cobble. These causes were further evaluated after collecting the data on cobble generation and using experiences. It was found that dislodging of supports had the maximum impact (11 times per year) on cobble generation. On probing further, it was found that breakage of supports also contributed 73% of the displacements to ROT side guards leading to cobbles. Thus, ‘support getting broken frequently’ was taken as the root cause.

After evaluating the various solutions that were developed, the group concluded that a permanent solution would be to modify the supports to mount them on top of the roll. An action plan was made to implement this suggestion. More rigid and versatile supports and clamps were made by the group in their own workshop by –
- fabricating vertical supports from IS A75 material;
- making half-ring and C-clamp from 16mm plate; and
- making suitable holes in the half-ring for better support with the roll chock.

After implementation of the modified support system to side guards within the targeted time of 6 months, the total cobble generation in HSM reduced from 0.44% the previous year to 0.33% during 2007-08. Other gains included the following:
- Cobble generation due to ROT side guard displacement became nil.
- Total cobble generation in ROT area was reduced by 85%.
- Replacement of rolls and guards has become much easier.
- No clamp was found to be damaged.
- Safety hazards like burn and noise reduced substantially. Additionally, annual monetary gain resulting from the innovation has amounted to over Rs. 4.28 crore.

The innovators: Senior Technician Shri A.K. Jha, Senior Technician Shri I. Mallick, Senior Technician Shri M.K. Hota, Senior Technician Shri M. Kumbhar and Technician Shri P.K. Rana
During rolling and coiling, vibration in coil car (CC) cradles is transferred to S-pipe connection provided to supply pressurised hydraulic oil to the lifting cylinder. This vibration used to generate cracks resulting in heavy oil leakage and posing a fire hazard. Secondly, during maintenance of hydraulic motor, when the hydraulic lines were disconnected, there would be heavy oil loss from leakage line till the blanking process was completed. Any error in blanking and de-blanking of leak line used to result in total halt of production from 3 coilers or major breakdown in the system due to low oil level or back pressure.

The CC hydraulics device had the following problems: The gap between CC cradle liner and body facilitated sliding movement of cradle, but allowed the cradle to swing in two axes, though it was designed for only one axis movement. During downward movement of the CC the bottom of the cradle used to hit the S-pipe. Due to space constraint it was not possible to reposition the pipe. In case of leakage in the pipe, its rectification used to take 3 hours and complete halt of production from one coiler. In the case of the system tripping, there was heavy oil loss. Loss due to all these factors would amount to Rs. 4-5 crore annually.

Besides, during maintenance of hydraulic motor, it was observed that oil used to leak continuously from main valve stand. As the same leak line was internally connected with leak line of other five equipments, a minor mistake in blanking during maintenance was resulting in huge oil loss and production loss of 4-5 hours or more for that particular coiler.

The structural design of CC cradle is such that there is no room for any change in grease line system or liner fittings, due to which the cylinder assembly position cannot be changed to avoid hitting of whole cradle into S-pipe meant for lifting of cradle as per command given by PLC. Due to continuous movement and operating in hot water and other foreign material exposure, wearout of liner is hastened. In addition, there was no way to alter the structure due to its complex structural design factor and also space constraint.

A group from CRM took up the challenge and resolved that till further revamping of coiler, they will try and run the system with zero breakdown and leakage from CC. The first challenge was to think of a simple but sustainable design, which could be implemented at low cost. As CC revamping/design change was difficult due to complexity of structure and space constraint, they concentrated on ways and means to stop breakdowns and oil loss without touching the main structure.

For the hydraulic motor leak line, it was not possible to provide any stop valve which could be closed during maintenance or change of hydraulic motor, because if the valve was left closed by mistake, the pressure generated inside the line would create abnormalities in operation and also result in bursting of the pipeline. So the group suggested a design wherein the oil flow will be only in one direction. They changed the design of S-pipe to an L-shaped one with no sharp bend, with one side flange and other side union connection to be directly connected to the power track hose below the manifold which would acting as a support for the hose line. They then connected the piston side of hydraulic pipe line with 250 mm L-shaped pipe with one side flange and other side union connection and connected it to the main power track below the manifold where the main hydraulics line from valve stand # 2 pipeline is connected.

The system has been working satisfactorily till date without any breakdown or loss of oil. Subsequently, the group started work on the hydraulic motor leak line. For unidirectional flow, they fitted an NRV and observed that the operation was smooth.

After modification of S-pipe connection and hydraulic motor leak line NRV system of CCs of all 4 coilers of HSM, no breakdown has been observed in the coilers neither any breakdown has occurred nor oil leakage witnessed. Maintenance too has become easier without any oil loss and/or breakdown. This has resulted in direct saving of 32 coiler hours/month, or around rolling time loss of around 120 hours per annum and loss of 16,000 litres of costly hydraulic HLP 46 oil/annum.

In financial terms, there has been a direct saving of Rs. 118.3 crore due to the efforts of the group. This also won them a Vishwakarma Award.
The hot thin strip coming out from the finishing mill in HSM is conveyed to a coiler through the run out roller table. Pinch rolls in coilers drive the strip down the entry chute into the coilers. These pinch rolls consist of a top and a bottom roll. The top pinch roll has three sets of bearings on each side – drive side and free side – and is actuated hydraulically through servo valves to maintain a gap between pinch rolls. It was found that the bearings of top pinch rolls were failing frequently, leading to:

- production loss;
- roll change takes 5 hours and delays production further;
- damage of bearing seats and housings; and
- loss of material due to bad coiling of thin strip leading to downgrading. In one year alone, there had been 12 instances of bearing failure.

A solution had to be found immediately to avoid production as well as bearing loss. Using problem solving tools, a group from HSM listed out 12 major causes, from which the following 4 probable root causes were culled: looseness in assembly, greasing failure, water ingress or disturbance in temperature. These causes were further evaluated after collecting the data on bearing failure of top pinch roll for 2006-07 which showed that looseness in assembly alone caused 67% failures. Analysis of additional data revealed that top pinch roll bearing of coiler occurred mainly due to failure of retract cylinder having 62% impact alone. Thus this cause was taken as the root cause.

The final solution arrived at after thorough brainstorming was to modify the spacer and use it to make the retract cylinder more rigid. This would avoid making the whole assembly unstable. To implement the solution, the following steps were taken:

- A spacer of 12mm size and thickness of 0.5mm was made inhouse from C-45 material for use in the retract cylinder in coiler # 5 as trial.
- To avoid the play which came up during trial run, spacer thickness was raised to 0.8mm from 0.5mm.
The innovators: Senior Technician Shri S.C. Sahu, Senior Technician Shri K.K.M. Achary, Senior Technician Shri P.K. Mishra, Senior Technician Shri B.K. Sharma and Senior Technician Shri D. Minz

Performance was very satisfactory. It was then used in coiler # 4 successfully as well. Sufficient number of spacers have been made and kept ready for use. A weekly check is made and spacers replaced when required.

After implementation of the modified spacer, top pinch roll bearing failures in coilers in HSM reduced from 12 to 2, a gain of 83% over the previous year. Direct monetary gain arising out of the innovation amounted to Rs. 3.93 crore.

In addition, unscheduled change of pinch roll is minimised, area is clean due to control of oil leakage and production has gone up substantially.

Zinc consumption in galvanising lines reduced

Bokaro and Rourkela Steel Plants have been producing galvanised sheet in their hot dip galvanizing lines of 180,000 and 160,000 tonnes/year capacity, respectively. Both plants use zinc ingots of 25-28 kg and aluminum alloyed zinc bars of 10-15 kg for zinc coating. A study revealed that consumption of zinc per tonne of galvanised sheet produced at BSL was 28.5 kg and at RSP 40.5 kg. This was more than their respective product mix and coating thicknesses warranted – 6-7 kgs at BSL and 14-15 at RSP. When the reasons were analysed, it was found that excessive top and bottom dross formation was the main cause for higher zinc consumption.

A chemical composition for exothermic powder was designed by RDCIS and manufactured through a vendor. A trial was conducted for two days at BSL. The powder, mixed with dross in zinc bath, initiated exothermic reaction and raised the dross temperature upto 800-900oC where zinc melted and reverted back in the zinc bath. During the trial, reduction in zinc consumption was achieved to the tune of 2.5 kg/tonne of galvanised sheet.

To establish the success of the trials, 5,000 kgs of exothermic powder were procured and its application monitored for 6 months at BSL. It was found that zinc consumption reduced from 28.5 kg/tonne to 25.5 kg/tonne of galvanised sheet. BSL has been using this powder regularly since April 2006.

Under technology transfer strategy, a similar exercise was undertaken in 2006-07 at RSP, where dross formation was quite high. During the 6-month trial with the exothermic powder, zinc consumption at RSP was brought down from 40.5 kg/tonne to 34.5 kg/tonne of galvanised sheet. RSP, too, is now using this innovation successfully.

The financial benefit derived by BSL has been to the tune of Rs. 5-6 crore per year. Since dross level at RSP was higher, financial benefit has also been higher at around Rs. 10-11 crore annually.
**BOKARO STEEL PLANT**

**Modification in carriage mechanism of roll grinding machine at Hot Strip Mill RGBS**

Roll grinding machine # 8 (RG-8) at HSM RGBS is used for precise grinding of backup rolls of HSM and work rolls of Slabbing Mill (SM). The servo-motor assembly of its carriage mechanism was damaged during operation. It did not work even after repair. No spare assembly being available, the machine was completely down for two months. Rolls were therefore being transported to Cold Rolling Mill (CRM) RGBS for grinding and taken back using trailers. This involved a lot of cost, time and inconveniences. Moreover, the requirements of HSM and SM were not being fulfilled in time, resulting in roll change delays in both mills. This, in turn, was creating quality problem and production delay. Therefore, bringing back RG-8 in working condition became an urgent requirement.

After trying out several alternatives, a spare squirrel cage induction motor of 11 kw was installed in place of the original servo-motor by fabricating suitable coupling. One spare VVVF drive was installed to match the characteristics of the motor with those of the servo-motor by suitable adjustment of various parameters. Interfacing of inverter with existing PLC of the machine was done in such a way that there was no change in mode of operation.

The machine is working reliably with the above modification since January 2008. The innovation has resulted in precise grinding of backup rolls being resumed to meet the requirement of HSM and SM. Roll change delays in both mills are eliminated, ensuring that quality of the products is maintained. Also cost of frequent transportation of rolls from HSM to CRM and back is being saved.

The three employees of ETL department (in picture) who were responsible for this innovation are: Shri G.A. Naikoo, Senior Manager, Shri A.P. Yadav, Senior Manager, and Shri C. Mahato, Electrician.

**Overcoming level-3 computer obsolescence at Hot Strip Mill**

Level-3 Alpha computers were commissioned during modernisation of HSM of BSL in 1997. Spares of these computers are not available in the open market. OEM, which was maintaining these systems since commissioning, expressed their inability to continue their services due to system obsolescence. When contacted, M/s VAI, the original technology provider, expressed their inability to upgrade the process computer systems in isolation. They suggested a comprehensive upgrade of the HSM technological control system, PLCs and associated electrics, costing more than Rs.100 crore and involving few days’ exclusive HSM shutdown. M/s Hewlett Packard agreed to provide a system, free of cost, to modify the existing software and make it compatible with the latest technology in computing.

Mill application software was ported inhouse on to the trial system. The constraints overcome included:

- Communication software (ABB – Link/Master Gate) did not work. Relevant changes were made in the communication software and offline and online testing was done during monthly mill shutdown in August 2007.
- In HSM, the time synchronisation problem between level -2 and level-3 systems used to occur once or twice a month. The operator was forced to roll in emergency mode or kick-back the slab. The problem became prominent once trials were made on the new system. The reason identified was mismatching of information exchange packets for tracking the bar on roller table, due to 10 fold increase in executing programmes. It was overcome by making adjustments in packet sequencing.
- Gigabit networking card supplied with new systems were made compatible with 10 mbps half duplex technology by making necessary corrections in core applications.

Senior Manager Shri A.K. Baranwal and Manager Shri Rajesh Kumar of Computer & Automation department were responsible for suggesting and implementing alternatives.
After rectifying all the problems, the Alpha servers of all three zones served by level-3 automation were tested online successfully. DS 25E Alpha servers and accessories were purchased at a cost of Rs. 1.45 crore. After testing and commissioning of the servers and porting of application software over two weeks, they were introduced online as cooling section computer and slab yard computer on during monthly HSM shutdown in September '08.

The issue of obsolescence of level-3 computer servers has now been resolved. The solution implemented inhouse by purchasing DS25 Alpha servers was a huge saving in comparison to the solution suggested by M/s VAI. Level-3 system performance has improved immensely as the processing speed and memory of the new systems are very high. Other benefits gained include:

- Better control over rolling parameters by mill operators for setup calculation which results in better quality.
- Increase in data storage capacity.
- Online data transfer is now possible as system resources are free.
- Additional online development jobs like grain structure improvement, etc., can now be taken up.

VISVESVARAYA IRON & STEEL PLANT

Introduction of angle rolling in Bar Mill

Primary Mill and Bar Mill at VISL were basically designed to roll only rounds, round corner squares and flats. There was no provision for trying rolling of angle sections. During brainstorming on the possibility of rolling other popular sections like angles in either of these mills, and innovative suggestion was made. It was decided that the idea would be tried out for implementation.

A team was formed from among the Bar Mill collective to study the adaptability of the mill for its roll size, platform length, heating parameters, input length and size, length of the stock between the intermediate stands and other related factors governing rolling. Experts from sister plants were also consulted regarding the modifications suggested. The required roll pass design was made in Bar Mill rolling stands to accommodate a barrel diameter of 490 mm in intermediate stands and 440 mm in finishing stands.

Since this barrel size was not in the regular procurement range, and in order to avoid procuring new rolls for this purpose, discarded rolls of Primary Mill roughing stand (blooming mill) were used after machining them in Roll Turning Shop and Machine Shop. After trial rolling of angles of 75 x 75 x 6 mm and 50 x 50 x 6 mm sizes was accomplished successfully, the process was standardised and commissioned on 15.9.08.

A step forward in value chain management, the innovation has not only resulted in broadening of the plant’s product base but has provided savings of about Rs. 63 lakh by way of utilising discarded rolls of Primary Mill roughing stand and by making ready the required tools, tackles, guide boxes, etc., inhouse.
In DSP’s Merchant Mill there are two water valves – for roughing mill and finishing mill. These valves are operated during rolling to spray water on the rolling stands for cooling. The valves had to be shut when rolling stops. Valve operators have to be in a state of high alertness for the activity.

To avoid occurrence of accidents, production loss due to uncontrolled/untimely operation of the valve leading to rolls not biting the material causing cobbles in the mill, water wastage due to improper closing of valve, life-reducing thermal shock to rolls which are too cool for hot billets, valve head damage due to frequent operation, etc., it was decided that the manual system would be modified and the valves operated hydraulically from control pulpit.

The following modifications were thus carried out: 2 switches were fixed in the pulpit control desk, 2 cylinders installed near the existing valves, hydraulic line tapped from existing hydraulic system, 2 solenoid valves mounted and hydraulic cylinders linked with the valves. As the valves are operated from the control pulpit desk, operators are not required to enter the risk-prone rolling area. Timely and controlled operation of the valves prevents pass slippage and roll breakage, leading to improved mill utilisation. Loss of material and use of spares has also been reduced significantly.

This innovation has resulted in total annual savings of Rs. 2.04 crore and won a Vishwakarma Rashtriya Puraskar.

Modification of limit switch

To attain proper dimensions of rail wheel, machining of block wheel is done in CNC machine with the help of SAWH (semi-automatic wheel handling system) in DSP’s Wheel & Axle Plant. This system also plays a vital role in loading and unloading the wheel.

For unloading, there is a cart which takes the machined wheel and places it on the trolley. Hence, it is necessary that the cart stops over the trolley. There was a problem here as the cart would stop occasionally before or after the trolley which was creating wheel unloading problems. The responsible limit is LS # 4. Previously it was of short arm and there was no provision for arm adjustment.

During actuation by the striker attached to the cart, the limit switch signal was sometimes flickering, which was ultimately going to the PLC. To overcome this situation, a healthy signal of LS # 4 was needed for stopping the cart over the trolley.

Some Senior Technicians of the shop who are members of QC Saurabh – Shri Jujhajt Ray, Shri Pallab Kumar Sarkar, Shri Swapam Kumar Poddar, Shri Manabendra Banerjee and Shri Kingshuk Gupta – found a solution by placing a longer arm limit switch which provided for some adjustment and removed the existing problems. In the modified limit switch, the arm of the limit switch is in the extended form from the limit switch. As a result, the signal doesn’t fluctuate any more, but the thrust by the striker of the cart to the arm of the limit switch was too much to resist.

Earlier, two limit switches had broken within just one month and thus this solution was rejected. Hence, the alternate solution of a non-touching sensor concept was implemented and a proximity switch was placed. This adjusted the gap between the proximity and the striker in a very logical way.

Now when the striker is attached to the cart
coming to the vicinity of the proximity, it signals properly without fail and thus the cart stops over the trolley and the wheel is being unloaded properly.

By completing this project, the reliability of the SAWH system in terms of functional, environmental, safety and longevity has definitely increased, bringing about recurring savings of around Rs. 7 lakh per annum on account of producing 234 more machined wheels.

**SALEM STEEL PLANT**

*Calibration system for roughing mill side guards & edger at HRM*

The input material for HRM is stainless/carbon steel slabs. During rolling, hydraulically operated side guides ensure that the material enters the mill exactly at its centre. Sometimes, due to misalignment of the slab from the mill’s centre line, it comes out of the roughing mill with a longitudinal skew known as camber. This is undesirable since at Steckel (finishing) mill a bar with camber results in:

- Damage of side guides and apron plates because of being hit by the bar.
- The bar getting stuck. In such cases, the temperature drops resulting in disruption of rolling and loss of production.
- Improper coil shape from finishing mill resulting in damage to coil edges while coiling in down coiler.
- The coil edges are not flush and few inner/outer laps protrude out due to telescopic winding in mandrel (entry to coiler).
- The damaged edges need to be trimmed which involves use of skilled labour besides loss of material an shabby appearance of coils.

The calibration system of roughing mill side guides and edger involves use of a piano wire hung with weights set on the centre of the roller tables and measurement of the centre line of side guides, edger and work rolls from the piano wire using a measuring tape. This method requires the involvement of 3 trained persons, but the results are always not very accurate. To ensure the proper centre line of the side guides and edger, it was decided that a plate long enough from the entry side guide to the mill housing window would be provided with permanent marking. The plate would be placed in such a manner that one of its edges is at the mill housing window while it gets centred by the side guides. The edge would be verified for any offset by measuring it with respect to the work rolls. Any offset would be corrected. Once done on entry side, the procedure would be repeated on the exit side.

Accordingly, a straight carbon steel plate was chosen for the calibration plate and its centre line was marked along its length. A stainless steel strip was welded to act as a permanent marking. A sliding aluminium square tube was used as a measuring tool (Vernier type). Two guides for the square tube and a 50 mm stopper at both ends of the plate were fixed. These now provide an extremely safe and foolproof method of measuring the offset.

Besides enhanced productivity and product quality, the innovation has provided total financial benefit amounting to nearly Rs. 1.6 crore due to the improved system and yield, eliminating quality diversions and reducing energy consumption.

**BOKARO STEEL PLANT**

*Changing nipple design in HSM roughing mill*

The roughing mill of HSM has been in continuous operation from 1974 with only preventive/capital repair maintenance since inception. Due to heavy load and obsolescence of equipment, there is a lot of vibration in the mill stand which results in breakage of nipple connected in work roll to lift. Once this happens, there is a heavy loss of oil from the main system which feeds all five roughing stands installed. With activation of interlocks, the system trips causing a loss of oil of about 1,000 litres/tripping, production loss of at least 1 hour and also interruption in supply of semi-finished items to CRM and finished products to external customers.

Since the 2 mm thick nipple breaks from inside near thread portion, a piece of it remains inside the cylinder which in turn is inside the chock of work roll and it is impossible to take it out and fix a new nipple in position. Thus blanking of that cylinder is the only option. When one cylinders is blanked, probability of camber in slab increases, which requires further setting after a couple of slabs have passed. Loss of one slab is loss of Rs. 1.5 lakh. Heavy vibration in pinion stand contributes to this failure.

In addition, the mill stand liners, where the work roll and backup roll are fixed, had developed an uneven surface, which
For reliable edge detection of coils, the process lines of Cold Rolling Mill have an edge guide system. This system uses high-frequency inverter ballast for illumination of a fluorescent lighting system. The emission of photons in the range of about 5 kHz from the light source is in turn detected by a photo-transistorised detection system which discriminates against ambient light at a low frequency. The detected signal is then processed by an electronic amplifier for subsequent utilisation for edge control.

Prior to modification, the system had been facing problems such as recurrent failure of the high-frequency power source leading to telescopicity of coils. The original item was a costly import requiring high lead time for procurement. Repair of the item was difficult due to its moulded construction. Non-availability of good spare and difficulty in vendor development for substitution of the item indigenously aggravated the problem. Besides, the fluorescent light, too, failed frequently.

A group comprising Senior Technician/Operatives Shri N.C. Pathak and Shri S.A. Hussain, Technician/Fitter Shri S.P. Singh, and Khalasi Junior Fitter Shri S.P. Singh, decided to resolve the problems and run the system with minimum breakdown and leakage from work roll chock nipple till further revamping of mill stand. They focused on stopping the nipple from breakage and opening during rolling. The group came up with an idea of providing extra PVC steel plate support, rigidly welded on chock to support nipple at a length of 400 m from chock face. During testing it was observed that slight change was required regarding the fixing of support base plate, which was then fixed with cast iron welding with MS base plate with a hole to fix base plate for support. The nipple was then tightened in the work roll chock before inserting it into the mill stand.

Subsequent to implementation, it was now possible to tighten a loosened support found in running condition of the mill or during small roll change period, which comes in every shift. It is now possible to attend to the issue without stopping the roll from rotation or stopping the hydraulic system. The group also modified the nipple design in accordance with RGBS cylinder revisioning area to 3.5 mm thickness. The internal thread was made in the cylinder accordingly. After modification of nipple design, its support system and continuous monitoring, no breakage of nipple has been observed nor leakage witnessed due to nipple failure. Other benefits from the modification include:

- Process of connecting the nipple and maintenance has become easier.
- Maintenance downtime and cost are very low.
- Blanking of cylinder is now completely avoided thereby resulting in proper load sharing at all points of work and backup roll.
- Pollution due to oil leakage, which was nearly 7,000 litres/month, is now eliminated.

Tangible benefits due to this innovation which won a Vishwakarma Rashtriya Puraskar amount to Rs. 48.28 crore per year. Intangible benefits include enhanced productivity of HSM, reduction in oil loss in HSM and pollution control, smooth, consistent and quality production of HR coil and increase in capacity utilisation.
Two Senior Technicians of SSP – Shri T. Saravanan and Shri P. Mallikarjunan – have implemented innovative ideas that has resulted in recurring savings of Rs. 1.19 crore for the plant. The following modifications and improvements suggested and implemented by them have increased productivity of coil build-up line from 120 to 225 tonnes per day:

- Provision of sheet stopping at set length by mounting a tacho on the leveller and enabling one-press pushbutton operation, eliminating the need for jogging the strip and consequently operator fatigue. Cost of implementation was Rs. 5,000.

- Designing and fabricating pneumatically operated stoppers with provision of operation from control desk, eliminated the need for operator to fix the manual stopper by walking on the roller tables. Two stoppers were also provided to enable processing of sheets of varying lengths. Cost of implementation was Rs. 26,100.

- Eliminating equipment idling and reducing unnecessary movements: (a) Provision of two stoppers enables lifting of two sheets at a time. This ensures optimum utilisation of the vacuum stacker lifting capacity. (b) Due to lifting of two sheets, the number of traverse movements made by the vacuum stacker is reduced to half, thereby increasing the equipment availability and reducing the maintenance cost. (c) Relocating the piling guide rods to eliminate unnecessary lifting of the vacuum stacker thereby saving time and improving the stack quality. The increased productivity has enabled SSP to meet scheduled deliveries without time lags and improved the work environment by eliminating fatigue and safety hazards.

- Innovations suggested by the duo included installation of pneumatic stoppers for holding more than one sheet on the roller table; providing guide bearings for the vacuum stacker to prevent skewing and derailing of the beam; and installation of hydraulic accumulators for valve stands to reduce pressure fluctuations and avoiding running of one pump thereby saving energy. Benefits accrued include:
  - Accurate control of sheet length.
  - No quality diversion due to multiple handling.

This innovation was honoured with a Vishwakarma Rashtriya Puraskar.

### IISCO STEEL PLANT

Better utilisation of HSM general roughing rolls

Rolls of the general roughing stand are designed to accommodate various sizes of box passes, edging passes and slab passes for feeding the input blooms/slabs for rolling required sections. When it was noticed that rolls had to be changed frequently, the rouging stand was examined thoroughly. It was found that 50% of the passes along the roll barrel were not in use, resulting in frequent redressing of particular sections and leading to loss of valuable roll life. Moreover, new rolls were required after rolling of about 1 lakh tonnes due to erosion of the passes.

With the multiple box and slab passes for rolling a wide range of sizes, the traverse of input bloom for bringing down to finished size were taking much more time as shown in the figure and this led to frequent breakdown of side guards and tilter.

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### SALEM STEEL PLANT

Improving productivity & safety during sheet cutting in coil build-up line

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This innovation was honoured with a Vishwakarma Rashtriya Puraskar.
Relocation of entry & exit side guide position transducers in Steckel Mill

Two side guides are arranged at entry & exit side of the Steckel Mill for lateral guiding of the strip. To enable measurement of actual movement, a position transducer (temposonic) is mounted on each side of the side guides. During rolling, metal oxides called ‘scale’ are removed by using high pressure water. The removed scales spread over the equipment and get accumulated on the side guide ways. Due to presence of scales and high pressure water, the movement of side guide beams with respect to cylinder axis gets disturbed during rolling. The position transducer stem rubs with the round magnet, resulting in erratic reading by temposonic. Ultimately, the position transducer stem gets bent and is finally broken, resulting in stoppage of the operation.

To avoid rubbing between position transducer stem and the magnet, the guide roller assembly has to be adjusted by cooling of side guides and nearby equipment, removal of scales, dismantling of roller support bracket and adjustment of shims for setting proper clearance between the guide roller and liner to maintain uniform gap between the position transducer stem and the magnet hole. The entire activity takes about 5 hours. For effective working of temposonic, the position transducer stem and magnet is set at a minimum gap of 1-1.5 mm. Even after this, accurate centering of the position transducer stem with respect to magnet hole is not possible due to uneven corrosion of the guide beams.

To solve the problem, a group comprising (clockwise from top left) Shri K. Muthusamy, Shri K. Kumar and Shri R. Sithaiyan, all Senior Technicians, suggested relocation of the position transducer to a safer place, so that the machine clearance which is variable due to wear and tear does not lead to rubbing of position transducer with the magnet. The location would have to be such that it is free from scales, heat, de-scaling water, vibration, etc. After thorough examination and taking into account other requirements, they suggested that the position transducer can be fixed inside the hydraulic cylinder itself which is used for movement of the side guides.

The successful implementation of the suggestion has resulted in savings of Rs. 1.05 crore. The group won a Shram award.

ROURKELA STEEL PLANT
Reconditioning of hot & cold zones of recuperator of reheating furnace

There are two reheating furnaces installed in HSM. A lot of heat is exhausted in the flue gas at a temperature of about 800°C after complete combustion inside the furnace. Recuperator is used to recover the heat from the flue gas to increase the efficiency of the furnace. Three recuperator modules are installed in each of the reheating furnaces. Each module is divided into hot cold zones. Each zone consists of a bundle of 812 stainless steel tubes of 42 mm dia inserted between top and bottom plates.

Straight tubes are used in cold zone and bent tubes are used in the hot zone. The tubes supply intake air to the furnace while the exhaust gas is passed on the outer surface of the tubes. Hot zone receives the hot flue gas and passes the relatively cold flue gas to the cold zone. Similarly, fresh intake air at ambient temperature enters through the pipes of cold zone, raises its temperature due to heat exchange and then passes through the hot zone raising its temperature further upto 550°C.

The tubes of the recuperator get damaged gradually due to severe corrosion at elevated temperature. The straight tubes get damaged at a faster rate because of sulphur corrosion in the cold zone where the skin temperature of the tubes is relatively low (approx. 220°C). Whenever a tube is damaged there is every possibility of leakage of air through the tube, reducing the pressure of air flow enabling packing in stacking area itself.

Elimination of operator fatigue due to auto length setting or too many movements of vacuum stacker.
and simultaneously reducing the hot air intake into the furnace. So the normal practice is to plug and bypass the damaged pipes and to supply additional cold air directly to the furnace.

Almost 70% of the tubes in the cold zone and 10% in the hot zone were damaged in all the 3 modules of the recuperators of one reheating furnace. Due to this, specific heat consumption in the furnace increased, reducing the rolling rate of HSM.

A group comprising Senior Technicians Shri Rati Kanta Mishra, Shri Nisha Mani Parida, Shri Bidu Prasanna Das, Shri Kalu Charan Moharana, Shri Bhumedra Muduli and Shri Debabrata Mishra and Technicians Shri Rajesh Kumar Nayak and Shri Durga Kishan suggested reconditioning the hot zone and to completely manufacture the cold zone recuperator by using inhouse resources. The consumables, electrodes as well as materials for different components for the job like, tubes, base plates, etc., were selected carefully. AISI-304 and AISI-409 grade plates, fins and tubes were used at different portions of the recuperator as per the technical requirements. Stainless steel pipes of 52 mm OD grade AISI-304 were used as sleeves to protect the most affected area against sulphur corrosion in the cold zone.

A lot of innovative techniques were applied for processing and safe handling of the sophisticated stainless steel parts. A fixture was developed for accurate fitting as well as to facilitate welding and handling of the job. Some modifications were done in positioning and anchoring of cold bundle tube protection sleeves. Three bundles of cold zone recuperators could be successfully manufactured in Structural & Fabrication Shop for the first time in the history of RSP and SAIL. The reheating furnace was down for only 14 days for the job in which all the 3 cold bundles of recuperator were replaced successfully.

Benefits accrued include:
- Recuperator leakage going down to 7.3%, compared to 57.1% earlier;
- Specific heat consumption improving to 351 from 390 Mcal/tonne;
- Rolling rate of HSM increasing to 266 tonnes/hour from 229 tonnes/hour earlier; and
- Elimination of recuperator downtime for repairing/tube plugging.

Financial benefit generated due to the innovation include recurring savings of Rs. 4.12 crores/year due to reduction in specific heat consumption and Rs. 2.5 crore in terms of foreign exchange.

The Innovation won a Vishwakarma Rashtriya Puraskar.
An air turbo compressor motor is installed in Oxygen Plant of BSL. It is a synchronous 9500 kw motor responsible for producing air, argon, oxygen and nitrogen which are used in steel production. SMS-1 and 2 and CCS are direct consumers of these gases. Non-availability or short supply of these gases brings down production drastically and, as a sequel, cash flow, performance and productivity are heavily affected. In a nutshell, this motor is the lifeline for steel production. This motor suffered a breakdown.

The original manufacturers of the machine, M/s BHEL, were notified immediately. After inspecting the motor, they concluded that since it used a vacuum-impregnated coil technology, the stator and rotor which had broken down could not be repaired. The duty, size, capacity and construction are such that partial repair was also impossible. Other motor manufacturers like M/s ABB and M/s Crompton Greaves were also consulted, but the verdict was the same. The duty, size, capacity and construction are such that partial repair was also impossible. Other motor manufacturers like M/s ABB and M/s Crompton Greaves were also consulted, but the verdict was the same. The duty, size, capacity and construction are such that partial repair was also impossible. Other motor manufacturers like M/s ABB and M/s Crompton Greaves were also consulted, but the verdict was the same. The duty, size, capacity and construction are such that partial repair was also impossible. Other motor manufacturers like M/s ABB and M/s Crompton Greaves were also consulted, but the verdict was the same.

The only solution was to either buy a new motor or totally revamp the existing one with new capsule of stator and new component and winding of rotor except the old shaft. The minimum lead time would be 1 year. There was no other alternative but to repair the motor inhouse.

Examination of the stator revealed that its overhung straight portion of winding was severely chafed by a brazed damper bar which had got dislodged from the shorting ring and had bulged out radially. The chafing of about 55-65 mm length was evident on all the coils. A flash was observed on two half coils. The conductors of these coils had melted and the damage on the pressure plate/core could be seen in the affected area. At one of the locations the bottom half coil also appeared affected. The insulation of other top half coil was also affected due to aberration and copper was also seen to have rubbed off in about 8-10 coils. It was not possible to ascertain the extent to which copper had been removed. In the rotor, too, a brazed damper bar had got dislodged from the shorting ring and bulged out radially. The bulged out portion rubbed against the stator overhang. In the rotor winding the closed slot of the damaged damper bar came out to a length by about 300 mm.

The first challenge was to take out the two damaged coils in the stator. The VPI coils were completely moulded and sealed and could not be taken out easily. So special tools were developed and fabricated. The coils were taken out by breaking the sealant and mould using these tools with extreme care and skill so that it did not affect or damage the adjacent or other bottom coils. As no spare coils were available, two half coils were fabricated after ascertaining the size of the conductor, current density and other technical parameters. These coils were tested outside and given proper insulation. A precise top joint surface was made with great care so that after jointing and brazing there was no bulging of the coil and insulation provided would sustain the high voltage, surge voltage and the normal voltage. Thereafter the coils were put inside the slot jointed and insulated carefully. All the overhang of the coils were properly insulated and laced. Insulating putty was pasted over the damaged portions of the 84 coils and thoroughly taped after careful technological cleaning and removing of carbon.

It was noticed that in all the phases the starting coils were damaged. So it was decided to interchange the position of the starting coil and the last coil. This was done by changing the star point to supply point and vice-versa. The stator winding was subjected to high voltage test and interturn voltage by surge comparison test required to ascertain the healthiness of the stator. The total stator winding was sealed and painted by a sealant. Anti-corrosive coating was also given and finally enamelled.

In the rotor, the bulged damper bars were cut and removed. The empty space generated by the removal of bulged bars was filled with sealant putty. After that the rotor was balanced and painted with anti-corrosive and sealant paint.

After re-assembly, the motor was meggered by 5KV megger. It was run on no-load and finally run on full load. The motor is operating successfully since then.

The innovation has generated savings of over Rs. 9.75 crore.

The key members of the ERS team which undertook the innovative repair: Shri K.D. Yadav, T/Winder, Shri R.S. Thakur, T/Winder, Shri B.C. Singh, Welder, Shri G. Singh, Fitter, and Shri S.A. Ansari, Fitter.
For the purpose of installation of 2x1250 tpd new oxygen plant and evacuation of power from NSPCL (NTPC-SAIL joint venture), it was proposed to set up a 220 KV air-insulated substation at BSP in the vicinity of the existing Oxygen Plant -II.

For drainage of the 220 KV switchyard area, a number of drains and area slope would be required. Since the switchyard would have an elaborate network of cable trenches, it was decided to dovetail the surface drainage system with the cable trenches. Therefore a modified cable trench catering to both network of cables and area drainage was opted for and this was incorporated in the project formulation stage itself. Thus duplication of trenches was avoided resulting in a saving of about 300 M3 of concrete. Drainage for the substation was test charged on 12.8.08.

Reduction in quantity of earthwork for land development has resulted in saving of around Rs. 2 crore. Common cable trench for drainage system has given financial benefit of around Rs. 30 lakh besides intangible gains like potential for water harvesting and reduced soil resistivity due to moist soil.
The innovators: Shri G.S. Prasad, Assistant General Manager, Shri S. Maheshwarappa, Junior Manager, and Shri A. Ameer Ahmad, Senior Technician

Reduction of power consumption by compressors

Compressed air is used for operations almost everywhere in VISL. With power consumption for running the air compressors being about 18000 kwh/day, cost of operations was high. After analysing the problem, it was observed that compressed air was being used in very large quantity at SGP of BF. A decision was thus taken to reduce power consumption of air compressors, starting in this area. Also, it was observed that the nitrogen gas was let out to the atmosphere in huge quantity even after utilisation for nitrogen splashing.

To reduce flaring through integrated automatic and efficient energy management system of gas Bleeders, throttles and other parameters, a low-cost PC-based automation system with PLC, RTUs, HMI system and controllers was proposed for installation.

With system engineering done inhouse, the Rs. 54-lakh EMS is now working efficiently. The various parameters of the gas network are taken from the respective bleeder houses and gas throttle station and fed to PLC system provided at GCP-3 control room through RTUs. These data are also communicated to HMIs at GCP-3 and gas control station at PPC building located at a distance of approximately 5 kms. Main functions of the installed system is efficient data communication, set point downloading to field controller, monitoring of gas flow and pressure and overall control of the gas network.

Among benefits derived from the innovation is reduction in bleeding of BF and CO gas, better control of gas network pressure, lower manpower deployment, and automatic control in place of manual control.

Total financial benefit amounted to Rs. 51.2 lakh in 2007-08. During 2008-09, savings rose to Rs. 1 crore on account of reduced bleeding of BF gas alone.

The team of CET/Bokaro Sub-Centre that was responsible for the innovation: (From left) Shri K.A.P. Singh, Deputy General Manager, Shri S.K. Verma, Assistant General Manager, and Shri S.P. Kachhap, Assistant General Manager

PC-based energy management system at BSL

The main objective of gas control station of Energy Management Department of a steel plant is to supply fuel gases from BFs, coke ovens, converters, etc. to various primary and buffer (TPP boilers) consumers at constant pressure and required quantity and to maintain safe pressure in the gas network of the plant. To achieve constant pressure in the gas network, excess gases are released into the atmosphere through gas bleeders (flare stack) which is basically a waste of energy. Gas supply is regulated through throttles at gas pipeline trestle axis 11/4 and 43 from control rooms in Gas Cleaning Plant (GCP)-3 and converter and sent to buffer consumers after primary use.

Existing BF gas bleeders were working on automatic standalone mode by sensing the network pressure. As such there was no direct control on bleeding of excess gas through BF and CO gas bleeders and safe network pressure as well. Therefore, simultaneous consumption by the buffer consumers and bleeding was occurring. At that point of time, buffer consumers could have consumed more of gas, leading to less flaring.

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VISVESVARAYA IRON & STEEL PLANT

Reduction of power consumption by compressors

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The 500 m ingot bogie circuit starting from teeming stage up to soaking pit at ISP was a derailment-prone stretch. Even after incorporating changes at different times, maintaining the railway standard gauge (1.67 m), the derailment of ingot bogies could not be reduced. Every month, there were 20-25 derailments, resulting in loss of manpower, materials and production.

On studying the matter closely, Junior Manager (PWE) Shri A.N. Ghosh and General Foreman Shri S. Chatterjee (in picture) found that the problem could be solved by narrowing the railway track gauge by around 1.25-1.3 cm from its standard gauge in this particular stretch. Introduction of rolled sleeper bars all along the 500 m of the track has reduced derailments to almost nil during the last one year.

IISCO STEEL PLANT

Use of rolled sleeper bars in railway track

The boilers of the Old Power Plant at DSP are stoker-fired and there were inherent combustion deficiencies. Dry coal on stokers has a tendency to be blown away by combustion air, dry coal dust spills through the coal gates and there is a tendency of fire to propagate by burning coal through the chute to the service bunkers.

Uniform combustion is obtained only when coal has some moisture in it. Water would be sprayed manually on the coal bed in the coal yard, coal conveyors and service bunkers, but this gave rise to the following constraints:

- Uneven moistening of coal;
- Occasional jamming of crushers and chutes due to excess water;
- High water consumption;
- Requirement of manpower and supervision;
- Improper moistening of coal resulting in poor combustion;
- Wet coal in the service bunker was becoming dry by radiant heat at the feeding chute.

It was suggested that steam from de-superheater drain which was otherwise wasted could be introduced in the coal-feeding chutes. A steam manifold was installed at the discharge end of the service bunker and connected to the de-superheater drain by a pipeline. Steam was distributed to 4 coal feeding chutes at the entry of the stokers through nozzles for injection. The benefits derived from the innovation include:

- Improved combustion of coal resulting in higher steam generation.
- Elimination of spillage of coal through gates on the boiler floor resulting in better housekeeping.
- Elimination of damage to shutter ledges due to burning.
- Elimination of fire in coal service bunkers.
- Lower specific coal consumption.
- No water consumption.
On 18th June 2007, there was a severe breakdown in the motor resulting in closure of nitrogen compressor unit. A flash was observed on two coils of the same slot just at the end of it on connection side. The conductors of these coils had melted and had damaged the pressure plate as well as slot end. Insulation of several other coils in its vicinity was also damaged. In four coils the inter-turn insulation at the overhang appeared affected. One of the flashed coils was directly connected to the supply lead of the stator, which remains at relatively maximum stress when the motor is in running condition.

No spare of this motor was available. Agencies contacted for repair of the motor required at least six months’ time for the job at a cost of around Rs. 60 lakh. The alternative was to buy a new motor, which again involved a lead time of 1-1.5 years it had to be custom-made. Challenges for inhouse repair of the motor included:

- Space constraints for putting insulation in the slot for withstanding high inter-turn voltage as well as to withstand 11 KV of outer insulations and to take care of heat dissipation and slot factor.
- Generally in high tension motors of 11 KV, numbers of turns are around 10, but in this case it was 28 which made the task of providing inter-turn insulation very difficult. This problem was further compounded, as work was to be executed in situ and providing inter-turn insulation in a long span of 1100 mm of coil through a small bore of 400 mm dia is really difficult.
- Being a high-speed motor (2 poles) having long coil span (1-13) spread in one-third of total slots with very small core bore dia with complicated coil shape having long overhang portion with precision curve and knuckle angle at the end was enough to frustrate even a highly skilled and experienced technical winder.
- To repair the affected coil, one-third of the total coils i.e. 13 needed to be lifted as the fault was in two different directions, spread between 25 slot spans of stator. Further it was required to maintain the designed curve in the overhang portion while repairing without any distortion of arc the knuckle.
- There was no past experience or record of repair available of this high speed (3000 rpm), high voltage motor of such complicated design.

Shri P.N. Prasad and Shri R.K. Singh, both Technicians/Windess, Shri B Manshi, Technician/Electrical Fitter, and Junior Riggers/Khalasis Shri J.N. Manshi and Shri R.K. Manshi (in picture) came to the rescue. They suggested certain innovative ways of carrying out the job reliably inhouse by overcoming all the constraints. They first took out the two damaged bottom coils with extreme care, affecting minimum numbers of coils over its span, using special tools they developed and fabricated. As no spare coils were available, they developed coil drawing & winding-data sheet after taking into consideration the size of the conductor, current density and other technical parameters. They then chose the thickness of the insulation so that heat dissipation and slot factor (which should be less than 40%) should match and to avoid unwanted heat accumulation in the slot.

Subsequently, they fabricated two half coils keeping in mind the relatively high inter-turn voltage. Considering the space constraints in the slot (18 mm) and conductor size, they adopted an innovative method to provide inter-turn insulation having two tiers of protection as shown in the drawing for added safety against any external fault or turbulences. They tested them outside and then kept them in furnace for curing to assure integrity of slot insulation and its reliability. They kept in one column 14 turn stacked in a group of 7 for better workman ship and repair quality.

The group made a precise top joint surface with extreme care so that after jointing and brazing there was no bulging of the coil. Jointing of turns was spread in the overhang by step cutting so that there should be minimum swelling at the overhang joints. They provided inter-turn insulation in the joined overhang portion, which was similar to the inter-turn slot insulation. Finally, outer insulation was provided which could sustain the high, surge and normal voltages. Thereafter the coils were put inside the slot, jointed and insulated carefully. They similarly repaired the other flashed coil and put into the slot. Other coils having damaged insulation were repaired conventionally. End windings were securely braced, thus ensuring the prevention of movement during starting and service. The position of the starting coil and the last coil was also interchanged by changing...
the star point to supply point and vice-versa to assure its reliability and enhance its working life.

Finally, the stator winding was subjected to high voltage test and inter-turn voltage by surge comparison. The stator sustained all the tests required to ascertain the healthiness of the stator. Finally they sealed total stator winding and painted it with a sealant and after applying anti corrosive coating enamelled it. After assembly the motor was meggered at 5KV. It was run on no-load and finally run on load on 27th June 2007. The motor has been running successfully since then.

Total savings from this job have amounted to Rs. 5.99 crore.

**DURGAPUR STEEL PLANT**

**Development of heat exchanger tube cleaning system**

There are 45 inter-stage coolers (heat exchangers of shell & tube type) in Oxygen Plant. The efficient heat exchangers make the compression an isothermal to utilise minimum power consumption. Generally the inner surface of the tubes carrying cold water for cooling get enveloped with a layer of muck, chlorides, etc. This results in loss of heat transmission and reduced efficiency of the inter-stage coolers. This in turn increases power consumption of the compressor.

To maintain low power consumption, the tubes of these inter-coolers are cleaned by Maintenance staff by the following methods: insertion of appropriate size of wire brushes; back-flow purging; pressing appropriate chemical solutions. The most suitable method is selected depending upon availability of chemicals of appropriate composition, shutdown duration, etc.

Cleaning by wire brush gives very good results but takes lot of manual labour. Also, sometimes the rod carrying the wire brush inside the tube hits the tube surface and causes severe damage to the tube, to the extent of reducing the life of the heat exchanger. Back-flow purging yields very poor results, and the method is not always effective. Sticky material on the tube surface does not come off by this process. Chemical cleaning is very effective provided we get the most appropriate composition of chemical, which can dissolve the fouling element. The biggest disadvantage of this method is that all chemicals are acid based. Even the mild acids also attack the tube material and cause untimely failure of the tubes. Thus the life of heat exchangers gets reduced.

Considering these problems it was felt that heat exchanger tube cleaning system should:
- Very effectively clean the inner surface of tubes.
- Not cause damage to the copper/brass tubes mechanically or chemically.
- Reduce manual labour.

To achieve the above objectives, a nozzle was designed and fabricated by utilising internal resources like lathe machine, drilling machine, etc. (The idea of Shri Sreemanta Konar, Senior Technician, was inspired by observing the pressure cleaning system used in Power Plant for cleaning tubes using very high pressure water jets. In Oxygen Plant the same equipment cannot be used since it will rupture the soft tube material like copper/brass.) The nozzle is soldered at the tip of a copper tube and is used for cleaning the insides of the tubes with the help of high pressure water jet.

Other arrangements made for the new cleaning system include the following:
- An idle vehicle washing/cleaning machine with a motor operated plunger pump developing water pressure of 25 kg/cm² max. was made workable.
- Suitable water hose of high pressure from MTB department.
- Copper pipe of 12 mm OD of suitable length.
- Isolating valve.

With the implementation of this user-friendly system, tube cleaning of coolers has become very effective without any damage of the cooler. Other benefits accrued include power saving, less manual labour, high life expectancy of heat exchanger. Use of this system has also brought about a temperature drop of around 5°C was achieved in the first year itself. This has given cost savings of Rs. 28.4 lakh and is recurring in nature.
BOKARO STEEL PLANT

Reduction in breaking of holding unit locking of ferro-alloy chutes in SMS-II

When steel transfer car (STC) with ladle passed under the chutes, jams of metal and slag on chutes and ladle touched, resulting in damage/breakage of lock of the chute-holding device many a time. The holding device was with chain and clits supported by beam. Precautions were usually taken to avoid this type of failure by putting a chain as a holding device in place of making it a fixed device system. The chains provided movement of the chute in upward direction in case of contact of jammed metal/slag of chute and ladle. As a result, the STC with ladle could pass under the lifted condition of the chutes and after passing the chutes could return to its original down position.

Damage/breakage of chute-holding unit mainly occurred in chain fixing part with beam or with chutes. When lifted chutes came down, it used to give heavy jerk on clits fixed with chain due to heavy weight of chute. As a result the clits of brackets attached with the chutes and beam used to get damaged.

The space problem and position of the chute was also a restricting factor to support heavily so that the upward and downward movement of the chute continued and the steel ladle could cross the chute in jammed condition also. Due to continuous production from converter, jamming of metal and slag always accumulated on chute and ladle. Due to this problem, there was frequent breakdown in ferro-alloy chutes. Shutdown of the entire system for 4-5 hours was always needed to take up repair of the damaged lock.

The same problem was occurring in both the converters of SMS-II. Breakdown occurred on an average of 3 times a year. The problem was discussed at different forums, including local QC's. Shri B.N. Puri, Technician/Fitter and leader of a QC, finally came up with a viable suggestion that was universally acceptable. His solution was a very simple modification in the existing holding system.

He prepared a U-shaped hanger of MS plates which would be bolted on the beam and the ferro-alloy pipe would rest on it. The hanger would take the load of the chute and nullify the jerk caused during upward/downward movement of the chute during contact of ladle with chute. Movement in chute will come during contact between ladle and chute and due to this movement only the ladle passes under the chute without damaging the chute.

The modification was done and breakdown due to damage of locking of chute-holding system stopped completely. The simple, low-cost modification was then implemented in ferro-alloy chute-holding devices of the other converter as well.

The innovation gave a saving of Rs. 2.76 crore and won a Vishwakarma Rashtriya Puraskar.

Revival of compressor by modifying old spares

BSL has 3 centrifugal compressor plants (CCPs) to meet internal requirements of compressed air for different stages of production. The chief consumers of compressed air are BFs, SMSs, CCS, HSM, CRM, etc. Any disruption in supply of compressed air directly affects the production process and productivity of the plant.

Of 5 compressors installed in a CCP, 4 are in service and 1 is kept as a standby. When compressor # 5 of CCP-2 suffered a serious breakdown, the reserve machine was pressed into service but that did not leave any other available to meet any future exigency. On dismantling the machine and after preliminary inspection, the following parts were found either broken or badly damaged:

- The compressor housing, including free and load end bearing chambers;
- 4 diaphragms from the suction side;
- Complete rotor, including two suction end discs;
- All 7 bearings of machine housing and gear box, including air and oil seals;
- Gear box bearing block.

BSL had a housing with its spares for a CCP-1 compressor was available. Since the foundation and compressor of CCP-1 and CCP-2 are different, the group modified the foundation frame by blanking some of the existing holes and providing new holes to suit the available housing.

Reputed repair agencies in the country and abroad which were consulted recommended replacement of the machine with a new one or complete revamping. Either would require a lead time of 18-24 months. An internal committee constituted for the compressor's revival; however, after inspecting the damaged machine, felt that it could be revived using available spares of old type of compressors. A decision was taken to implement this using inhouse resources. A group comprising Operatives Shri O.P. Saha and Shri M. Lal, Technician/Fitter Shri D.P. Manjhi, Multi-skilled Technician Shri S. Singh, and Operator Shri B. Kumar took up the challenge. They identified the spares of older-model compressors for the job, modified them suitably for use in this new-model compressor, made the necessary adjustments and matched old compressor components to fit at the new location. Some of their efforts are described below:

- A housing with its spares for a CCP-1 compressor was available. Since the foundation and compressor of CCP-1 and CCP-2 are different, the group modified the foundation frame by blanking some of the existing holes and providing new holes to suit the available housing.
- The group was able to eliminate a wide gap at horizontal plane.
level with reference to gear box by providing steel packings of 69 mm thickness plates, cutting them as per requirement.

- As there was no thrust pads at non-working side of rotor, about 13 mm gap was observed between compressor rotor coupling and gear pinion toothed bush. They adjusted this by taking out the original toothed bush from compressor rotor and fitting a new bush 13-15 mm ahead of its stopper, to make up the gap. As one of its bearing blocks was broken and damaged, they changed it after modifying workable spare.

- There was an electronic axial shift mechanism, fitted after free end bearing housing, whereas in the new model, it is by axial shift relay nozzle of high pressure oil line at drive end bearing.

They modified this by providing an appropriate hole in the HP oil line of the compressor housing body at drive end bearing chamber.

- The existing inlet/outlet ducts matched each other, except one of final discharge. Alteration was carried out to match the final discharge pipe. After assembly of the modified spares, the machine was made ready by end of 2006 and since commissioning has been running successfully. Net direct benefit of around Rs. 30 lakh has been achieved as a result of this innovation.

The desired level of speed of reclaimers is 3.7 m/hr in case of iron ore fines. Reclaimers 1, 2 & 3 had only two fixed speeds in the original design – 3 m/hr and 4.5 m/hr – one less and the other more than the desired speed. When reclaimer was operated in 1st speed, the quantity of material discharged was much less than required quantity of 700 tonnes/hr and there would be a stock-out situation at discharge end. On the other hand, when reclaimer was operated in 2nd speed, quantity of material discharged was much more than the required quantity and there would be overflow at discharge end resulting in belt sway and jamming of conveyor belts. In addition, there was a problem of maintenance of the existing mechanism.

Further, the system had become obsolete and the original equipment manufacturer (OEM) was lax to supply the required clutch gear boxes. Under the circumstances, indigenous spares were being used. This resulted in reliability of equipment becoming even poorer. Dismantling and erection of clutch gear box was much too time consuming. Thus fixed speed drive mechanism was neither operation- nor maintenance-friendly.

There was a strong desire to get rid of the obsolete system. A multi-disciplinary group took up the challenge and suggested converting the existing system from fixed speed to variable speeds in line with the system provided in new reclaimers 4 & 5 using mainly internal resources. The job involved reversal of hangar assemblies, extension and modification of the drive bogies, installation and putting up of electrical panels, mounting of new drive and their commissioning. The first modification was undertaken on reclaimer 3 and the job was finished within 4 days. Subsequent modification in reclaimer 2 took less than 72 hours.

The innovation generated savings to the tune of Rs. 2.6 crore and won a Vishwakarma Rashtriya Puraskar.

The innovators: Senior Technician/ Operatives Shri R. N. Rai and Shri N. Ansari, and Junior Officer Shri Ashok Kumar

ROURKELA STEEL PLANT

Rectification of belt filter press to maintain discharge norms

Sludge water from washers and ESP received in Filter House is collected in clarifiers for thickening. The thickened sludge from each clarifier is sucked by DORCO pumps and mixed in the tank. From tank it is pumped and fed to belt filter press (BFP) where chemical is added for flocculation. In BFP the sludge is passed between two belts (screens) where the sludge cake is separated and the filtered water is put back into circulation. The sludge cake is sent to OBBP where it is used in the base mix for preparation of sinter.

Malfunctioning of any equipment from clarifiers to BFP requires opening of drains of clarifiers to let out the unfiltered water through outfall # 5 into a lagoon which finally connects to the Brahmani river.

The Chetana QC group observed that BFP breakdown always occurred due to loops developing in the top belt of the machine.
These would get folded resulting in a deep crease and eventual rupture. These belts were expensive and had a high lead time for procurement as they had to be imported. As very little life could be extracted from the belts, most of the time the machine used to remain idle. The operators were forced to open the drain to keep the clarifiers operative resulting in increase in suspended solids in outfall.

A group comprising (in picture) Technicians Shri Chhutu Singh and Shri Ashok Kumar Naik, Senior Technicians Shri Sanjaya Kumar Lekia and Shri Suresh Ch. Dalbehera, Senior Operative Shri Powal Topna and Chargemen Shri Alekha Charan Prusty took up the initiative to solve the problem. They located the source of the problem in one of the BFP rolls. They rectified the roll and made the machine operative by:

- providing the scheme with automatic tracking of belts;
- installation of air drier for proper movement of proportional tracking module that enables increase in belt life;
- installation of booster pump for proper cleaning of belts ensuring increased the belt life and formation of proper sludge cake; and
- installation of high-capacity chemical dosing pump for increased and controlled formation of proper sludge cake. Since then the total suspended solids at outfall # 5 is well within norms. Besides increased belt life, safety of man and machine has also improved. Daily 10 tonnes of sludge cake is despatched to OBBP for used in sinter base mix. Improved techno-economics achieved include: power savings of 150KW per hour; water savings up to 1500 m³/hour; dust in BF clean gas reduced to 6mg/nm³ from 8-9 mg/nm³. The success of this initiative inspired the installation of a new second BFP that resulted in a one-time saving of Rs. 30 lakh as installation cost. With continuous BFP operation, there has been a recurring saving of Rs 63-64 lakh on an annual basis.

The innovation has won a Vishwakarma Rashtriya Puraskar.
NAVONMESH

A GLIMPSE OF INNOVATIVE SPIRIT IN SAIL SINCE 2006