TATA STEEL

ANNEXURE 13

Particulars of Energy Conservation, Technology Absorption and Foreign Exchange Earnings and Outgo

[Pursuant to Companies (Accounts) Rules, 2014]

(A) Conservation of Energy

i) Steps taken or impact on conservation of energy

Jamshedpur

- Best by-product gas utilisation of 97.56%
- Lowest ever fuel rate at Blast Furnaces ('**BF**') - 533.35 kg/thm - Use of Pellets and higher coal injection (189 kg/thm) at BF
- Lowest ever middling consumption in in-house power station of 7.0 Kilo Tonnes
- Lowest ever specific water consumption 3.68 m^3/tcs
- Reduction in Cyanide concentration in Works drains by 26%
- Highest ever LD Gas recovery of 58.795 kNm^3/hr rate achieved
- Optimisation of Coke Oven Booster operation and gas supply strategy by modifying Coke oven gas headers has enabled to eliminate entire Waste Plant Booster House
- Reduction of Cold Blast venting loss by utilising excess wind for Coke drying for 'H' BF
- Optimisation of coal tar consumption at Pellet Plant by effective utilisation of Coke Oven Gas ('**COG**')
- Optimisation of compressor operation through network modification enabled permanent shutdown of Centac Compressor House with lower power consumption
- Experimentation/adaptation of new technologies, energy management using real time data capturing, visualisation and analytics. Pilot completed at Rurhstahl Heraeus ('**RH**') degasser of LD2

Kalinganagar

Blast Furnace

- Reduction in coke rate/fuel rate by charging pellets - Charging trials were taken and stabilised for >10% pellet in burden.
- Commissioning of waste heat recovery unit to reduce gas consumption for stoves heating
- Commissioning and stabilisation of Top Recovery Turbine ('**TRT**') as an integral part of Blast Furnace - Power generation at a rate of 14 MWH stabilised
- Commissioning and ramp-up of PCI system - Pulverised coal injection plant was commissioned and stabilised for injection rate > 130 kg/thm as an alternate fuel (replacing coke)
- Initiatives to reduce specific water consumption (Average consumption for Financial Year 2017-18 - 0.56 m^3/thm) by reusing the waste water generated inside blast furnace in slag granulation system
- Flaring of BF gas minimised by efficient operation of flare control system

Steel Melting Shop

- Total amount of LD gas recovered in Financial Year 2017-18 is 1,57,355 Gcal
- Total specific water consumption in Financial Year 2017-18 is 0.54m^3/tcs

Hot Strip Mill

- Mill Specific Power reduction from 144KWh/T to 127KWh/T, achieved through:
  - Stopping the line in planned way and putting off all auxiliaries power at that time
  - Increasing production rate to reduce variable power
  - Introducing idle running mode in de-scaler for small mill stoppages
- Reducing Specific gas consumption from 0.33 Gcal/tonnes to 0.30 Gcal/tonnes by increasing Hot charging percentage
- Reducing Specific clarified water consumption from 0.52 m^3/tonnes to 0.43 m^3/tonnes by using blow down from Direct Cooling Water in laminar makeup water

Utility

- Electrical power demand met from by-product gases - 46.6%
- By-product gas Utilisation - 93.6%
- Specific Energy Consumption - 6.72 Gcal/tcs
- Specific Water Consumption - 4.75 m^3/tcs
- LD Gas recovery started from June 2017 and 76% heats recovered
- Tri-fuel co-axial burners are being used in Captive Power Plant Boiler for flame stability
- LD gas Holder and BF gas Holder are being used to maintain temperature or to continue production in Hot Strip Mill, Lime Calcination Plant and Sinter Plant during BF planned shutdown

ii. Steps taken by the Company for utilising alternate sources of energy

Jamshedpur

- Projects on low grade heat recovery and Solar Power generations initiated at Jamshedpur

iii. Capital investment on energy conservation equipments

Particulars	₹ Crore
Jamshedpur	
Recovery of sensible heat of Coke by installation of Coke Dry Quenching System in Battery # 10 & 11 at Coke Plant	243.91
Replacement of Boiler # 3 at Power House # 4	14.15
Duel Fuel burner at Pellet Plant	26.67
Installation of Variable Frequency Drive in HT motors with variable load at Blower House and LD3 & Thin Slab Casting & Rolling ('**TSCR**')	3.40
Provision for Light Diesel Oil ('**LDO**') firing facility in boilers of Power House # 4	11.25
New LD Gas Holder	55.76
Kalinganagar	
Commissioning of Top Recovery Turbine ('**TRT**') in Blast Furnace	62.40
PCI system in Blast Furnace	348.12
Coke Dry Quenching ('**CDQ**') in Coke Plant (excluding coke power plant)	367.94

(B) Technology Absorption

1. Efforts made towards technology absorption

(i) Projects under Research and Development

Project Title	Benefits
Jamshedpur	
Prevention of dust formation in Ladle Furnace ('**LF**') slag to improve environmental issues	Addition of different additives in the LF helped in preventing slag dust formation which is a major environment concern. The results were achieved by addition of a naturally occurring compounds in earth crust.
Implementation of cyanide removal by Anion Complex at blast furnace	The results showed that 80% removal of cyanide was achieved as compared to inlet.
Use of 'Super absorbent Polymer based flow aid' in Dry Processing Plant to improve flowability of iron ore	The average increase in plant throughput during the trial period was 5,500 tonnes/day. Subsequently, data collected for the average throughput rate per hour indicated that the plant could achieve a throughput rate of 10,00 tonnes/hour which is about 30% more than that what was achievable during the monsoon period.
Integration of Grinding Model into the Level-2 System of Pellet Plant	The Grinding model is generalised so that it can be used for any input size ranges using Rosin Rammler distribution. Back calculation method which consists of experimentation and simulations is used for calculation of breakage parameters.
Improvement in Sinter Reduction Degradation Index ('**RDI**') by controlling rate of sintering	Improve in sinter strength with reduced cost of fuel. This will also result in increase of utilisation of low grade ores.
Utilisation of LD (Lindz and Donawitz) slag in Cement making	LD slag can be added in the clinker mix to replace the limestone and to lowering the energy and CO_2 emission. Based on the results, plant trial was carried out by adding the LD slag up to 1.5% (clinker burden) at one of the cement plant.
Pigmented Organic Coating on GI (Galvanised Iron) barbed wires	Better look and corrosion resistance. Commercial line has been designed and commissioned and commercial production and supply to the market has started in the 4th quarter of last year.
Use of blow down water with higher chlorine content	Based on evaluation and recommendation of research and development team, the plant is now using blow down water with higher chlorine content in sinter making.
API X-80 for non-sour & API X-65 for sour application	These two products have been developed at pilot scale & plant trials are under plan.
Abrasion resistant steel with 400 Brinell Hardness Number ('**BHN**') for Locomotive & Earthmoving ('**L&E**') application	This product has been developed at pilot scale. The plant trial is under plan using TSK hot strip mill facility. This will replace the conventional quenched & tempered material.

Project Title	Benefits
Development of polymer coated steel (Poly Steel)	This product has been developed for eliminating cumbersome 7-stage pre-treatment process for powder coating.
VAVE and EVI (Early Vendor Involvement) with Major Auto Customers	A total of 5 models from major auto OEMs (Original Equipment Manufacturer) and 1 non-automotive model were covered as part of the Value Analysis Value Engineering ('**VAVE**') workshops for Financial Year 2017-18. The objective of the workshop was to create value through cost and weight reduction ideas on the vehicle by means of use of newer steel grades apart from the blank optimisation and engineering design changes. These activities result in improved CSI (Customer Satisfaction Index) and opportunity to present Tata Steel with supply of new grades material in newer models. This also helps in customer engagement initiatives.
Online copper stave thickness measurement technique for H-BF	Reliable copper stave thickness measurement enables safe operation of blast furnaces.
Development of an Non-desdructive Testing ('**NDT**') technique for thickness measurement of hearth refractories in BFs	Thickness measurement of hearth refractories is needed to obtain effective extended life of BFs. In-house development of this NDT technique eliminates dependency on external agency and cost.
To develop a process to address distortion control	Serving customer by providing welding simulation results performed in a finite element based commercial package - SYSWELD. The result provided welding process parameters and sequence of joining large components without facing the distortion problem. This led to cost saving as well as increased productivity at customer's (Tata Growth Shop) end.
Kalinganagar	
Development of SPFH- 590B steel with high stretch flangeability through TSK	New product for automotive application developed. This is at customer approval stage. This product has superior stretch flangeability as compared to normal grade required for suspension parts.
Development of API X 70 for sweet applications in Oil & Gas segment through TSK	API X-70 steel has been developed using TSK facilities. Results conform to API specification up to 16 mm thickness strip.

(ii) Process Improvement:

Jamshedpur

Ore Beneficiation

- Established 'High Intensity Magnetic Separation' technology on a pilot scale at Noamundi iron ore processing plant to recover iron value from slimes.
- 'Dry Magnetic Separation' technique for beneficiation of low grade manganese ore fines established on a pilot scale which will facilitate using of ore which is currently being dumped.
- Comprehensive/deep beneficiation flow sheet developed for processing low grade iron ore at Noamundi & Khondbond to achieve higher yields at lower alumina.
- Reduction in specific water consumption at Noamundi wash plant by optimising the scrubber performance.

Coal Beneficiation

- Through trials on lab & pilot scale, it was successfully established that an intermediate circuit is essential at West Bokaro Washery#3 for beneficiation of 1.5mm-0.25mm size fraction of coal. This will mitigate the inefficiencies of Dense media cyclones & Flotation cells in processing the said size fraction of coal.
- Impact of increase in ash on the clean coal yield & rheological properties established through lab studies. Based on the same, West Bokaro clean coal ash was increased from 17 to 17.5% which led to ~50 kt additional clean coal despatch from West Bokaro.
- Initiatives taken to enhance process visibility of critical unit operations at West Bokaro Washery#3 like Flotation cells, Reflux Classifier, Vacuum Belt Filter & Thickeners by installation of critical measurement systems to improve process efficiency.
- 0.8% coal yield improvement observed at Jamadoba washery by application of modifier in the flotation cells.

Agglomeration

- Development of carbon composite briquette using plant reverts as third agglomerate in Blast furnace. This will enable reduction in carbon rate of blast furnaces.
- Implementation of lime excess framework for sinter chemistry control to optimise flux consumption in Iron making.

Coal Coke

- Established new coal in the blend which will help to reduce the blend cost without affecting coke quality.
- Development of coke quality prediction model using machine learning techniques to facilitate attainment of consistent coke quality.

Process Energy & Emission

- Improvement in coke ovens Biological oxidation treatment plant performance leading to significant reduction in pollutants (cyanide and ammonia).

Ferro Alloys

- Physio chemical characterisation of Manganese ore done for the first time for better understating of raw material characteristics. This will enable optimisation of furnace feed for Ferro Manganese production.
- Metallurgical know-how for premium grade low Silicon Ferro Chrome production established.

Blast Furnace

- Lowest ever coke rate achieved through process improvement
- Controlling furnace hearth wear by suitable adjustment of casting practice and use of acoustic technology

Kalinganagar

Process Solid Waste Utilisation at Sinter Plant

- Solid wastes from Blast Furnaces, Steel Melt Shop and Hot Strip Mill are mixed and processed in various proportions and are utilised as by-products in Sinter making. This not only reduces the Sinter cost but also helps prevent disposal cost and preserves natural resources thereby supporting sustainability of Steel Plant. Processed Solid Waste utilisation started in Sinter-making from April 2017 and has reached the utilisation level of 80 kg/tonnes of Net Sinter in Financial Year 2017-18 which is equivalent to consumption of all the solid wastes that get generated at Kalinganagar Plant.

Modification of wagon tippler under Raw Material Handling System

- Tata Steel Kalinganagar is equipped with the most advanced Twin Wagon Tippler for handling different raw materials. This was designed for handling different types of wagons such as BOXN, BOXNHL, BOY, BOY-25 etc. This wagon tippler has been modified and made capable of handling BOST, BOBSN & BOBYN rakes as well. This has created flexibility in rake allocation with increased rake availability and faster turnaround time for raw material movement, thereby strengthening the Raw Material supply chain. It has also supplemented the dispatch of finished goods from TSK in wagons such as BOST types.

Coke Plant

- Sulphur Recovery Unit was commissioned in the third quarter of Financial Year 2017-18. This unit helps in reducing the sulphur content of coke oven gas and thereby reduces SOx generation from all the chimneys of the steel plant. In addition, the heat generated during the recovery process is used for steam generation, which helps in reducing the steam consumption from the central steam grid. Operation of sulphur recovery has improved the overall coke oven gas yield. The recovered sulphur is also a valuable by-product.
- Treated water from biochemical oxidation and dephenolisation ('**BOD**') plant is transferred to Central Effluent Treatment Plant ('**CETP**') from Q4FY'18 for re-circulation in the TSK fire hydrant and miscellaneous other industrial water circuits. This has reduced the load on the consumption of fresh clarified water in the system.
- PCI coal is being used in the coal blend from August 2017, thereby reducing the usage of costly imported semi-soft coal. PCI usage has gradually increased from 5% to 10%.
- Coke Dry Quenching has been ramped up to almost 80% of the coke production. This has significantly reduced the coke moisture, and thereby coke rate at Blast Furnace.

(iii) Product Development

Jamshedpur

- High strength structural steels (IS 2062 E350 Grade A) for hot dip galvanising applications.
- High strength enameling grade – Entry into new segment of constructions and projects.
- Higher size, 36mm corrosion resistant 500 CRSD rebars – First in India
- Grade B 500B rebars as per BS4449 for NatSteel Holdings Singapore – First time Export
- Fe 500 S (20 to 32mm) rebars through QST route – First in India
- HC 72A wire rods for direct draw to 1.26mm motor tyre bead wire – Entry into new segment
- HC 48B (low Silicon) wire rods for earth wire – Long pending Customer demand fulfilled
- Grade 4 and Grade 6 wire rods for ribbed welded wire mesh – Entry into new segment

- HC 82B Cr wire rods for high strength Aluminium Cladded Steel Reinforcement ('**ACSR**') – New application
- 8mm SD rebars from Indian Steel & Wire Product ('**ISWP**') – fulfilling the requirement in the eastern region

Kalinganagar

- High strength HS800 grade (Strength >= 800 Mega Pascal) in the thickness range of 4.0 mm - 8.0 mm for long members of heavy commercial vehicles.
- 80 kilo square inch grade [5.0 mm -12.0 mm thickness] for suspension applications of commercial vehicles.
- SPFH 590 high strength grade [2.0 mm – 6.0 mm thickness] for wheel rim and disc applications.
- JSH 590B high strength grade [2.0 mm – 3.2 mm thickness] for automotive structural high HER (Hole Expansion Ratio) application.
- High strength grades (S275 J0 and S355 J2) with better structural integrity for Lifting and excavation applications
- Thicker high strength grade (ASTM A 572 Grade 50, S460) for Pre-engineered building applications.
- Medium & high carbon steels with high internal soundness – new segment of high end tubes & pipes
- API Grades X46, X65 and X70 developed for Sweet Applications in Oil and Gas segment.

2. Benefits derived from key projects:

Project Title	Benefits
Jamshedpur	
Modification of cooling in run out table of hot strip mill.	Lower residual stresses in thick plates used for high end application which demands better shapes (BOW) after blanking & shearing.
Tension levelling in steel processing centres for L&E and Pre-Engineered Building ('**PEB**') grades	Higher plasticity (~75%) while levelling to homogenise the locked in stresses and ensure better flatness after processing.
Optimise coiling temperature and rolling speed in hot strip mill to avoid coil sagging.	Thinner and wider sections with higher level of carbon are prone to sagging after coiling in down coiler. Optimisation of coiling temperature and rolling speed was done to reduce the defect.
Rationalise the sequencing of grade in continuous casting to reduce rejections.	With the objective of compliance to quality control order the mixing logic and conditions were redefined to reduce the scraps and transition slabs in LD#2 & LD#3.
Improve co product management in the supply chain	Unorganised diversions of prime grades were always a concern in supply chain. Hierarchy based cascading with stress on diversion in value added grades helped in improving the availability and reduction in ferro alloy consumption
Optimisation of rolling parameters for 5.5mm, ER70S6	Reduction in adherent scale content and reduction in entanglement during coil pay off
Reduction of start-up breakouts at CC3, LD1	From May 2017 to February 2018, there were just 7 start-up breakouts, down from 46 in the 10 months preceding. The initial casting speed at main heat increased by increasing the nozzle diameter from March 2017 from the existing 16mm nozzle (3.0mtr/min) to 16.5mm nozzle (3.2mtr/min).
Lime reduction in vessel at LD1	Average lime additions at LD1 reduced from 9.88 to 9.05 tonnes/heat without any adverse effect on turndown P. Further scope for reduction identified.
Kalinganagar	
Reduction of breakouts in Steel Melt Shop through logic modification in Breakout Detection System	Number of breakouts reduced to 3 per year. This has also reduced the number of false alarm generation.

3. Information regarding imported technology (last three years)

Sl No.	Technology imported	Year	Status
Jamshedpur			
1.	Pulverised coal injection at existing H Blast Furnace	2016	Commissioned
2.	Coke Oven gas holder		
3.	BF gas holder		
4.	Installation of 3rd blower & interconnecting piping for 'G' & 'H' BF's		
5.	Slab Deburring & Slab Marking Machine in Caster# 1 & 3	2017	
6.	Installation of Torch Cutting Machine in Caster# 1 & 3		
7.	Installation of Tension Leveller at CGL#1		
8.	Coil Box revamp at HSM		
9.	Installation & Commissioning of Twin RH Facility		
10.	Installation of 4th Grinder		
11.	Installation of Surface Inspection System for TSCR		
12.	Installation of new Slab Scarfing machine		
13.	Power augmentation at Bulk Power receiving station ('**BPRS**')		
14.	Fire fighting system at LD gas holder		
15.	Hot Rolled Skin Pass & Oiled ('**HRSPO**') coils at Cold Rolling Mill ('**CRM**') Bara (Ph-II)		
16.	Barrel reclaimer		
17.	Conveyors for pre-screening plant at Noamundi	2018	
18.	E BF Re-lining		
19.	H BF - Augmentation of electrics		
20.	SP#2 Dedusting system		
21.	Coke Oven Flare Stack		
22.	Upgradation of RCL1 at CRM		
23.	Dust extraction system at H BF Stockhouse		
24.	LD Slag processing plant		
Kalinganagar			
25.	Coke Oven Batteries	2016	Commissioned
26.	Sinter Plant – Sinter Cooler, Sinter Machine, Screens, Granulator, Mixer, Noduliser		
27.	Blast Furnace – 4330 CuM capacity – Furnace, Charging System, Pulverised Coal Injection System		
28.	Steel Melt Shop – Converter, Composition Adjustment System with Oxygen Blowing ('**CASOB**'), Twin Strand Caster		
29.	Hot Strip Mill – Roughing Mill, Finishing Mill and Down Coiler		
30.	Dynamic Soft Reduction facility in Slab Caster	2017	
31.	Installation of Slab tilter facility at Steel Melt Shop	2018	
32.	Installation of RH Degasser facility at Steel Melt Shop		

4. Expenditure on Research & Development (R&D)

		(₹ crore)
(a)	Capital	22.42
(b)	Recurring	159.22
(c)	**Total**	**181.64**
(d)	Total R&D expenditure as a % of Total Turnover	0.30

(C) Foreign Exchange Earnings and Outgo

		(₹ crore)
	FY 2017-18	FY 2016-17
Foreign exchange earnings	5,898.19	3,996.55
Value of direct imports (C.I.F. Value)	13,355.43	10,298.00
Expenditure in foreign currency	334.94	447.38

On behalf of the Board of Directors

sd/-
N. CHANDRASEKARAN
Chairman
DIN: 00121863

Mumbai
May 16, 2018