# INDUCTION FURNACE NEWSLETTER

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## All India Induction Furnaces Association



## What's Inside



*हमारे सभी सदस्यों को 70वां स्वतन्त्रता दिवस पर हार्दिक शुभकामनाएँ*

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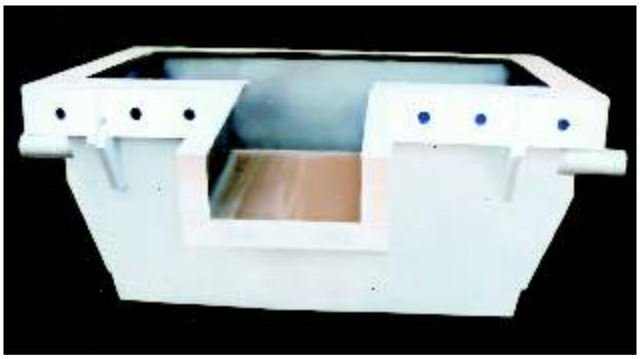

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## Notification With Respect to Acceptance of ISI Mark Steel Products only
## No. 4(13)/2016-SD(I)
## Government of India, Ministry of Steel

*Udyog Bhawan, New Delhi*
*Date the 9th August, 2016-08-26*

**ORDER**

With the abolition of classification in Steel Producers in India vide notification No. 8(1)/2015-TD (Vol. IV) dated 12th May, 2016 no steel producer is to be classified/certified as 'Integrated Steel Producers', 'Primary Steel Producers', Secondary Steel Producers', Main Producers, 'Major Producers' or 'Others' by Ministry of Steel. However, Ministry of Steel has issued Quality Control Orders on 30 non-alloy steel and 3 stainless steel products which cannot be produced, sold, stored for sale, distributed and imported, without certification by Bureau of Indian Standards (BIS) and without Standard Mark of BIS.

2. Major Infrastructure ministries/Departments, like Railways, Defence, Shipping, RTH, UD, Power, Mines etc., while calling for tender/etc. may like to bring these facts to the notice of their major PSUs also.

**(Sarita Taneja)**

Under Secretary to the Government of India

## Quick Disposal/Removal of Garbage Without Garbage Collectors/Trucks

**S K BHATNAGAR**
*Deputy Industrial Adviser,*
*Ministry of Steel, Government of India*

In India, garbage is collected by the garbage collectors from door to door and then gets dumped in the yard/garbage house. From garbage yard/house, municipality vehicles come and load the garbage and then transported to a big yard where garbage is thrown. Every city generates tones of garbage everyday. When the garbage is thrown in the yard, it gives foul smell, which spreads in the atmosphere causing various bacterial diseases and gastro, is one of them. Moreover, typhoid, malaria and various infectious diseases are also caused by it. Mosquitoes and other insects amasses in places where there are piles of garbage and ultimately spread various diseases in the area.

To resolve the aforesaid problem of the cities/towns, steel pipes of diameter of 1.0 meter can be put below the ground level both side of the road and 0.5 meter steel pipes in the small streets. In these pipes, hoppers will be welded to push garbage into the bigger pipes. The bigger pipes will be connected with the high vacuum pumps to suck the garbage at the end where the garbage will be segregated into biodegradable and non biodegradable. The biodegradable garbage may be dumped into the big pond where it could be used as natural manure and non-biodegradable can be used for generation of power, which can be utilized, for operating pumps for sucking of garbage from the pipes.

The aforesaid method will keep all streets and the roads of the city clean. It will stop transportation of garbage by trucks, which consumes tones of fuel causing huge generation of Green House Gases. It stops foul smell in the atmosphere. Several acres of land could be freed for other activities and million tones of steel in the form of pipes will be consumed/used to fabricate such system.

The consultants like Tata Steel Limited, MECON LIMITED, Centre for Engineering and Technology, SAIL, Ranchi, Engineers India Limited etc. may design the system. The first experiment may be conducted in the small city.

The above development will make success the dream of our Hon'ble Prime Minister towards "Swachh Bharat Abhiyan" and also "Make in India"program.

In least developed countries mostly garbage is dumped in open or freely available places and to make its final disposal entire garbage is burnt and no one stops them because of un-awareness.

Garbage pollution means littering civic waste particularly household waste into places not designated to dispose it off. It is mainly caused by mismanagement of solid waste when garbage is not lifted from streets and areas to carry it to landfill sites for its final disposal. It all happens owing to poor system of either garbage collection or its disposal.

Pollution of garbage increases in cities and towns where there is no proper system of garbage collection.

Households have to simply collect the entire garbage of their houses and place it to outside home in dustbin or bag.

Its collection is the task of civic agency of the area. If garbage collection agency or contractor does not play its role properly and does not collect the garbage regularly then the problem of this kind of pollution would obviously arise.

Improper disposal mechanism is another cause of this type of pollution. If garbage collection agency simply collects the entire garbage of its area of responsibility but does not dispose it off in proper landfill site then it would litter around here and there and most of it would pile up in streets and other areas.

It would eventually cause several diseases due to mushrooming growth of harmful bacteria in it.

**Effects of garbage pollution.**

In least developed countries mostly garbage is dumped in open or freely available places and to make its final disposal entire garbage is burnt and no one stops them because of un-awareness.

Burning garbage not only adds land pollution after being fully burnt but it also becomes source of air pollution by emitting harmful gases while burning. It is called one of the worst air polluting acts because it remains directly in breathing zone of human beings.

Garbage pollution is main cause of various bacterial diseases and gastro is one of them. Moreover, typhoid, malaria and various infectious diseases are also caused by it. Mosquitoes and other insects amasses in places where there are piles of garbage and ultimately spread various diseases in the area.

**Solutions for garbage pollution**

The key solution for garbage pollution lies in proper management of solid waste. Apart from that there are three slogans to address this issue; reduce, reuse and recycle. In this way garbage pollution issue could be solved with simply community efforts.

Here reduce means to generate garbage less means fully use the thing and then treat it as garbage like write on every inch of a paper and then through it as useless.

Similarly reuse means if possible use again and again an item instead of throwing it away; for example if you buy oil in a bottle so after consuming that oil use the bottle to keep any other liquid item in it like liquid soap or dish washer liquid etc.

Recycle means instead of disposing of garbage in landfill site sort out from it the things which can be made reusable after slight treatment to it like cans, tins, bottles etc.

## Steel Fabricated Godowns for Food Corporation of India (FCI)

**S.K.BHATNAGAR**
***Deputy Industrial Adviser,***
***Ministry of Steel, Government of India***

FCI constructs godowns for keeping food grains. They are using huge land. Moreover, these godowns are not sufficient to cater the need of keeping million tonnes of food grains. As a result, food grains are lying in an open area covered by plastics sheets. Due to unpredicted rainfall etc, tonnes of food grains are being rotten, which cannot be used for the purpose of domestic supply. Therefore, million tonnes of food grains are either thrown as waste or with a little cost for the purpose of cattle food and wine/beer manufacturing.

The idea came in my mind as to how we can protect our several tonnes of food grains from adverse climatic conditions. This will not only help in increasing consumption of steel but can also avoid for use of several square kilometer of land, if we fabricate vertical steel godowns in the same way as we fabricate Blast furnace for production of pig iron.

If we fabricate 5000 cum vertical steel godown, it can keep more than 0.75 million tonnes of wheat/rice. In this godowns, food grain can be filled by using skip car for filling from top and can be discharged from the bottom at the time of requirement, if we keep such godowns around 10 meter height from the ground level, we can directly load food grain into trucks, which can also fabricate by steel plates for supplying food grains floor mills directly or can be easily filled food grain into bardana. This will help to protect our grain from rats/insects etc. This will also help to increase the consumption of steel in the country. MECON, Ranchi will be helpful to design such godowns.

As you are aware, India is producing more than 250 million tonnes of food grain every year. If we fabricate vertical steel fabricated godowns of 5000 cum volume, it could store more than 1 million tonnes food grains. It means around 250 vertical steel godowns will have to be fabricated, which will consume more than 10 million tonnes of steel plate.

I hope this idea can save tonnes of food grain from adverse climatic conditions as well as from rats/insects.

# Steel Grades for Making Crane Wheels (Production in Indian Mini Steel Plant from Induction Furnace)

*Srikumar Chakraborty*

## Introduction:

Indian Mini steel plants, mostly, produce steel & alloy steels by melting scrap/ scrap substitute, ferroalloys from induction furnace. The common grades for making crane wheels are C45Mn75, C55Mn75 C45/C55/C60, 42CrMo4/ 42CrMo5, AISI4140, 34/40CrNiMo6 or their equivalent specifications depending upon the application areas. Ingots produced from liquid steel are forged to suitable size of wheel, heat treated and supplied as machine finished conditions in proper size to customer/ user industries meeting quality and property requirements. Crane wheels are the equipments used in the factory fitted in the crane structure which move and travel taking load / weight as per specified crane capacity with trolley on both sides and in up-down movement conditions for both loading and unloading operations and are fitted in overhead long travel, double girder crane trolley, gantry and portal crane, transfer car and some other specific areas in the factories. Timely replacement of crane wheels are necessary after inspection because of flange wear, flange breakage, and mechanical overloads characterized by pitting and spalling which are to be carefully considered before selection of parameters like steel grade, composition, quality, wheel design/ shape/ dimension, properties e.g. hardness pattern, thermal/ corrosion/ erosion and yield, fatigue strength adopting suitable heat treatment technology.

## Inter Plant Standardization for Crane Wheels:

Heavy duty cranes with much larger capacity are used in main and major steel plants in India. Cranes are also used in the heavy/ medium/ light industries, machine building and various engineering industries in the country. It was felt the need for standardization of machineries, equipments and operational activities in those areas. Crane wheels, the most vital parts, in the crane structure are also included in the standardization as IPSS (Inter Plant Standardization in Steel Plants) for Crane Wheels which covers the requirements of crane wheels, generally based on IS 4137: 1985 - " Code of practice for heavy duty electric overhead travelling cranes including special service machineries in steel works". The first standard was published in April, 1975 with revision in 1983 keeping provision of lifting crane wheel by introducing holes in the web of the wheel and wheel of 630mm size introduced instead of 600mm size.

Revised standard, prepared by active participation of representative/s of steel plants, established manufacturers, leading consultants in the country, incorporates the changes based on the expectation of user industries/ plants as well as Indian standard. Mounting of crane wheels in the cranes shall be suitable for adoption on live axles mounted on antifriction bearings fitted with "L" shaped brackets. The revised standard, further, was adopted in March, 2009 aiming at achieving rationalization and unification. The defect free crane wheels shall normally have cylindrical tread with flanges wherever necessary to guide the crane effectively and to prevent derailment. The wheels shall be mounted in such a manner as to facilitate easy removal and replacement. The crane wheels are used in different places/ applications like wheels for steel plant, trolley wheels, pulley sheaves, rope wheels, wheel block tyres.

The cost advantage of making steel for crane wheel in IF followed by hot working and heat treatment prompted mini steel plants to go slowly for producing alloy & special steels from their normal production of mild steel and stainless steel. Initially, many such producers were not serious about quality, though captured a bulk of the market, but realizing the competitiveness in the market and customers' need, they, slowly, started giving attention for improving quality and properties of products and established themselves as good quality suppliers from 90 onwards. Compared to medium carbon and high carbon steel, crane wheels produced from grades like DIN 42CrMo4/ AISI4140 have advantages when products are used in the heat treated condition.

## Steel Making and Forging:

Steel for making crane wheels should be melted in either Electric Arc Furnace or in Induction Furnace ( Mini Steel Plants are making steel in IF) meeting composition within standard with low levels of residuals/ trace elements (unwanted) and keeping the inclusion content as low as possible. Molten steel from IF/EAF is tapped into a teeming ladle keeping proper super heat, calculating expected temperature drop. Deoxidizers, decarburizes and alloying elements, if required, are added for the final finishing with respect to oxygen content and other elements in steel. The liquid steel has to be refined in vacuum degassing unit and teemed as ingot by uphill method in mould fitted with hot top with necessary addition of flux/ bottom pouring/ anti piping compound. In most of the mini steel plants, ingot casting is practiced in different sizes.

Ingot casting is done in cast iron moulds having square, round or polygonal cross sections. Residence time of ingots in the mould is to be maintained as per grade giving suitable disposition. Ingots with square cross section are used for rolling into billets, rails and other structural sections, whereas, ingots with rectangular cross section (also known as slab), are used for rolling into flat products. Round ingots are used for tube making. Polygon ingots are used to produce tyres, crane wheels, etc. The defective ingot should be segregated from the acceptable ones and defective portion may be discarded by band saw machine. The good ingots/ cut cheese should preferably be hot transferred and charged in reheating furnace in Forging unit.

Forging operation in mini steel plants is mostly carried out in 2Tor 3T air/steam hammer. Few mini steel plants have installed forging press where ingots are shaped by forging to the desired shape of blank by plastic deformation. Such forged ingots get size reduced to proper shape achieving the desired directional strength, refining the grain structure and developing the optimum grain flow, which imparts desirable directional properties such as tensile strength, ductility, impact toughness, fracture toughness and fatigue strength. The forged blanks for crane wheel are having structural integrity like absence of internal voids and porosity with uniform mechanical properties and predictable response to heat treatment. Forged crane wheels have advantages over cast wheels (earlier production practice):

1. Reduce maintenance cost of wheels and wheel assemblies,
2. Improve the life of rail on which wheels move,
3. Provide an additional 40% load carrying capability over rim toughened wheel.
4. About 25% higher tensile strength (indicator of normal load bearing capacity before wear and erosion) and 35-40% higher fatigue strength than cast crane wheel.

Initial stage of forging crane wheel is shaping hot ingot into blanks and cut to sizes by band saw working out final forged shape keeping tolerances for expected material loses in process and machining. The forging temperature depends on steel grade and composition (In case carbon is in higher side, temperature preferably to be kept at lower side) e.g. 1200 (+ 50)? C in carbon steels 45/55/60C8, C45Mn75, C55Mn75 ,C60 and finishing temperature 850?C. In case of alloy steels like 42CrMo4/ 42CrMo5, AISI4140, 34/40CrNiMo6, forging temperature is 1150 (+30) ?C and finishing temperature 950?C ( closer gap is preferred between starting and finishing temperature) The forged blank is heat treated at pre-finishing stage as normalizing or annealing depending on steel grade. The turnaround time of production depends on the amount of blanks to be produced, the grade specification and equipment availability.

Closed-die design forging is also adapted by some industries where sufficient power is necessary to achieve the dramatic reduction ratios and material flow which are essential in high quality forgings. Crane wheels produced in closed-die forging are used in heavy duty applications like locomotive traction drives, wind turbines, speed reducers, and mining machineries. In this process, after the die cavity is filled, the pressure is intensified to eliminate any microscopic porosity that may have existed in casting process which provides a homogeneous grain structure while the forging. The heat

treatment of closed-die forged wheel can significantly improve the mechanical properties, by imparting specific hardness, strength, and wear characteristics to meet the requirements.

## Heat Treatment Technology for Crane Wheel:

Heat treatment is an operation or combination of multiple operations carried out by heating the material to desired temperature and cooling of the same to alter its properties by different ways. In addition to other properties, the mechanical properties decide its applicability for a particular condition and at specific place. Heat treatment processes are commonly used to enhance the properties of particular grade of steel product. The property enhancement may be due to transformation in existing room temperature phase or chemical composition change with or without the phase changes or controlled phase transformation coupled with strain hardening induced by internal mechanical deformation. It is seen that hardened steel products of DIN 42CrMo4/ AISI4140 are hardest but an increase in brittleness is observed with the increase in hardness, with the conventionally hardened specimen displaying the least impact strength. Unfortunately, many industries are not fully aware about the importance and criticality of the process and fail to get optimum balanced properties i.e. desired level of hardness and toughness.

| Tempering Temp. | Phase / Structure |
|---|---|
| Low – Upto 200°C | Martensite, very hard constituent, forms when the cooling rate from austenite is too fast. Unlike decomposition to ferrite and pearlite, the transformation to martensite does not involve atom diffusion, but rather occurs by a sudden diffusionless shear process. |
| At Medium Temp. | Bainite forms when austenite is cooled rapidly in correct ways and then it possesses some of the extreme hardness of martensite, as well as the tough structure of pearlite. The bainitic microstructure consists of ferrite, like in pearlite, and a minute dispersion of cementite also. At medium temperature, sorbite i.e. very fine pearlite, forms with good strength and toughness. |
| At Very High Temp. | Special Type of Steel |

Hardening involves heating of the product keeping at an appropriate temperature until transformation of all pearlite taken place into austenite, and then quenching the product rapidly in air, water or oil. The temperature at which austentizing takes place depends upon the carbon content in the steel. The soaking time should be increased ensuring that the core will also be fully transformed into austenite. The microstructure of a hardened steel part is martensite with or without proeutectoid carbides. Tempering is almost always required after hardening to reduce the brittleness and to increase toughness to a desirable level. The process of quenching and tempering involves two processes in sequence to incorporate, hardness, toughness after hardening and tempering.

Temperature in the tempering process is, normally, followed for general purpose to obtain structural phases as

After hardening operation, the material is to be tempered as quickly as possible to minimize the extent of stabilization of unwanted retained austenite formed during hardening. The process Austempering and Martempering does involve secondary heat treatment, known as tempering. Hardened steel is used to make objects that are subject to high levels of force or stress. For example, most automotive parts, crane wheels are made from this material.

Differentially Hardened Wheel technique produces forged wheels with tread and inner flange hardness up to 60 Rc but with ductile outer flanges for increased fracture toughness.

Two key factors influence the “toughness” of overhead crane wheels:

1. The hardness of the raw material used to make the wheels—such as alloys, low-carbon steel or medium-carbon steel.

2. The heat treating techniques/ practices used to enhance the metal's properties.

For most crane wheels, medium-carbon steel is the most commonly employed material, due to its wide availability and lower cost. As a general rule, the greater the carbon content of steel, the greater the hardness potential. The advances in heat treating technology, the hardness of crane wheels made with medium-carbon steel has been increasing. This toughness counts most where the crane wheel meets the rail, the crane wheel tread. A hardened crane wheel tread reduces wear and extends the life of crane wheels. On the other hand, crane wheel flanges should not be hardened. Flanges require ductility so that they can bend, and not break, when subjected to lateral forces, such as a misaligned rail.

While many manufacturers heat treat and harden crane wheels, results may vary from one vendor to another. While procuring crane wheels, deep hardening, the most difficult aspect, of the crane wheel tread must be ensured this particular area is either neglected or ignored. In case, hardening doesn't go deep into the wheel tread, the crane wheel is subject to spelling i.e. metal fragments breaking off the surface, shortening a wheel's life. However, t a wheel's lifespan depends on more than hardness alone. The portion of the crane wheel making direct contact with the runway is the weakest link in the entire structure. It is advisable for periodic inspection as safety measure to detect premature wheel wear and provide clues to correct problems before they can cause substantial damage.

Some mini steel plants supply wheels in a wide variety of hardness and toughness, by utilizing different forms of heat treatment like -

- Rim Quenching
- Flame Hardening
- Induction Hardening

However, hardened steel crane wheel is specially designed and heat treated to maximize its resistance to the damaging forces at work in heavy industrial applications providing a uniform contour hardness in the tread and inner flange maintaining a ductile core to resist shock loads wear, pitting/ spalling or flange fracture. Different types of wheels for cranes, machines and mechanisms are used in heavy/ medium/ light industries, machine building industries where forged blanks as raw materials normally vary in sizes between 500mm to 1000mm. (Martensite, Bainite & Sorbite Structure shown in the Figures)

Most of the user industries prefer **Sorbitizing** treatment for crane wheels, the special type of heat treatment process where products are heated above the upper critical temperature and then cooled at the rate of 100-600 ?C/minute either under air/ steam or in liquid medium heated to 300-500 ?C. This treatment makes homogeneous structure as sorbite in crane wheel. **Tempering in the fine-pearlite (troostite) and sorbite phase** takes place at temperatures between 350 and 500°C. According to the chemical composition of steel and the selected temperature, martensite transforms into fine pearlite or sorbite. After this type of tempering, the hardness significantly reduces and toughness significantly increases. Internal stress is fully eliminated, thus significantly improving the strength of crane wheel. The tempering in this phase is suitable for alloy steels and products that must have good strength and toughness which is the requirement for crane wheel.

## Inspection of Product Quality:

To maintain the quality standard of crane wheel at national and inter-national level, standard process in steel making, degassing, ingot teeming, forging and heat treatment should be strictly followed when the durability and performance will, hopefully, be ensured. While steel making in IF, melter should pay attention on the followings -

1. The induction furnaces are the ideal tool for melting charge having the approximately the same composition as that is required in mini steel plants.
2. Beside from gas elimination, very little refining is possible because the slag is colder than the metal and the protective refractory of the furnace is very thin.

3. Slag erosion due to the induction stirring is accelerated and may result in early failure or poor life of furnace walls.

Because of importance of teeming process in casting ingot, enough care has to be taken by pourer/ teeming operator. If pouring is carried out at too low a temperature, the metal may start to freeze before the moulds are filled, causing misruns and many other associated defects. At the same time, if pouring is carried out at too high a temperature, the metal may react with the mould material, causing gaseous inclusions in casting ingot. Optimum levels of the pouring or tapping temperatures are to be calculated and chosen in operation so that these problems are avoided.

Crane wheels are replaced because of flange wear, flange breakage, and mechanical overloads characterized by pitting and spalling. Each of these, in-service, factors must be carefully considered before the combination of wheel design, material selection, hardness pattern and selection of heat treating process technology.

The most frequent used technique for quality evaluation of forged blank, almost in every forge shop, to make crane wheel is macro-etching where etched sample is evaluated at low magnifications and sample rated against series of standard photographs showing the incidence and type of defects .e.g. inclusion, flake, pipe, segregation, crack etc.

**Causes of Forging Defects & Remedial measures are briefed below:**

1. Dendritic ingot structure at the interior of ingot/ stock is not broken during forging due to insufficient forging penetration where actual forging takes place only at the surface may be due to use of light rapid hammer blows and at the same time the stock may not be fully soaked with forging temperature. In such case, use of press forging is the solution or proper heating/ soaking/ forging sequence should be proper in hammer forging
2. Cracks on surface of blank may form due to excessive working on the surface or may be too low forging temperature, same can be controlled by increasing the work temperature (within maximum specified range )
3. Cracking at the flash penetrates into the interior after flash is trimmed off may be due to very thin flash which can be controlled by increasing flash thickness, relocating the flash to a less critical region of the forging, hot trimming and stress relieving.
4. Two surfaces of metal during forging as fold against each other in the stock without welding completely may be due to cold shut, sharp corner (less fillet), excessive chilling, high friction which can be eliminated increasing fillet radius on the die.
5. Some section of die cavity not completely filled by flowing of stock metal as unfilled Section (Unfilling/Underfilling) may be due to improper design of the forging die or using forging techniques, less raw material, poor heating. This can be minimized using proper die design, proper raw material and proper heating. The root cause of fish-bone diagram defect in the forged blank is underfilling.
6. Mismatch of die at flash line may cause from shifting of die, misalignment of forging at flash line, misalignment of the die halves, proper alignment of die halves is the solution.
7. Scale Pits (Pit marks) may form due to irregular depurations on the surface of forging, which can be controlled by forging operator/ smith.
8. Irregular wear on the surface of the rim flange in crane wheel is caused by abrasion from the tire chafer and sidewall. Rim flange wear happens most often in applications with heavy or shifting loads. The specially treated sorbitized, significantly, reduce rim flange wear. In case rim flange wear is excessive, wheel has to be replaced after inspection. The wheel-rail contact in boundary condition is highly nonlinear complex problem, which need to accurately track the wheel-rail movement and the interaction contact stress between wheel-rail before and after the occurrence of wheel-rail contact Stress distribution and fatigue distribution characteristic of all parts in the crane wheel should be studied.

**Conclusion:** Hardness and toughness of crane wheel are the key factors for achieving the desired properties of crane wheel. Selection of

proper steel grade and production process for specific application areas is to be decided jointly by the users and producers. The steel for making crane wheel should be clean with low level of unwanted residuals, free of detrimental inclusion and gases for which liquid steel has to be vacuum degassed. The uphill teemed ingots produced from liquid steel should be sound and defect free. During forging operation, standard process parameters like heating/ soaking standard, forging practices, disposition of forged ingot/ blanks are to be ensured to get defect free product. In the heat treatment area, both hardening and tempering parameters are to be closely monitored to get sorbite structure in the crane wheel balancing optimum level of hardness and toughness.

## Route wise, Region wise- No. of units, Capacity and Crude Steel Production (2014-15)

*Capacity & Production ('000tonnes)*

| STATE | BOF | | | ELECTRIC ARC FURNACE | | | INDUCTION FURNACE | | | ROLLING MILL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EASTERN REGION | | | | | | | | | | | | |
| | No. of units | Capacity | Production | No. of units | Capacity | Production | No. of units | Capacity | Production | No. of units | Capacity | Production |
| Arunachal Pradesh | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 74 | 11 | 3 | 194 | 33 |
| Assam | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 290 | 168 | 16 | 1228 | 315 |
| Bihar | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 1135 | 593 | 4 7 | 770 | 679 |
| Jharkhand | 3 | 15410 | 13443 | 4 | 1024 | 1004 | 126 | 1870 | 1277 | 54 | 1913 | 563 |
| Meghalaya | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 308 | 98 | 4 | 143 | 49 |
| Odisha | 2 | 5320 | 2929 | 7 | 6674 | 5077 | 93 | 3604 | 3956 | 37 | 1974 | 760 |
| Tripura | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 30 | 13 | 1 | 20 | 16 |
| West Bengal | 2 | 4302 | 2204 | 8 | 1002 | 1577 | 78 | 4169 | 4045 | 39 | 3060 | 1912 |
| Region Total | 7 | 25032 | 18576 | 19 | 8700 | 7658 | 365 | 11480 | 10161 | 201 | 9302 | 4327 |
| Western Region | | | | | | | | | | | | |
| Chhatisgarh | 1 | 3925 | 4807 | 2 | 2420 | 2832 | 66 | 3576 | 2939 | 189 | 6366 | 5354 |
| Dadra & Nagar Haveli | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 342 | 215 | 8 | 280 | 168 |
| Daman & Diu | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 133 | 32 | 0 | 0 | 0 |
| Goa | 0 | 0 | 0 | 1 | 110 | 0 | 19 | 606 | 471 | 16 | 606 | 280 |
| Gujarat | 0 | 0 | 0 | 4 | 9275 | 3867 | 56 | 1437 | 966 | 137 | 1800 | 1918 |
| Madhya Pradesh | 0 | 0 | 0 | 1 | 2 | 1 | 14 | 265 | 202 | 45 | 862 | 1290 |
| Maharashtra | 0 | 0 | 0 | 10 | 7829 | 7295 | 64 | 3819 | 3291 | 145 | 4823 | 6784 |
| Region Total | 1 | 3925 | 4807 | 18 | 19636 | 13995 | 258 | 10178 | 8116 | 540 | 14737 | 15794 |
| Northern Region | | | | | | | | | | | | |
| Chandigarh | 0 | 0 | 0 | 1 | 75 | 20 | 2 | 22 | 22 | 2 | 85 | 34 |
| Delhi | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 14 | 10 | 2 | 19 | 7 |
| Haryana | 0 | 0 | 0 | 3 | 747 | 1126 | 12 | 112 | 83 | 8 | 94 | 60 |
| Himachal Pradesh | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 620 | 557 | 8 | 289 | 229 |
| Jammu&Kashmir | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 166 | 115 | 19 | 1519 | 225 |
| Punjab | 0 | 0 | 0 | 4 | 340 | 299 | 125 | 2440 | 2073 | 353 | 4360 | 5112 |
| Rajasthan | 0 | 0 | 0 | 0 | 0 | 0 | 64 | 1194 | 908 | 99 | 1544 | 1285 |
| Uttar Pradesh | 0 | 0 | 0 | 1 | 12 | 3 | 100 | 1892 | 1174 | 98 | 2311 | 2030 |
| Uttarakhand | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 1057 | 234 | 7 | 202 | 212 |
| Region Total | 0 | 0 | 0 | 9 | 1174 | 1448 | 353 | 7517 | 5176 | 596 | 10433 | 9194 |
| Southern Region | | | | | | | | | | | | |
| Andhra Pradesh | 1 | 2910 | 3296 | 0 | 0 | 0 | 35 | 1600 | 858 | 33 | 1730 | 562 |
| Karnataka | 3 | 10481 | 9912 | 0 | 0 | 0 | 25 | 1025 | 513 | 21 | 800 | 557 |
| Kerala | 0 | 0 | 0 | 1 | 20 | 24 | 38 | 618 | 1148 | 42 | 815 | 1212 |
| Puducherry | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 506 | 261 | 14 | 406 | 212 |
| Tamil Nadu | 2 | 1180 | 980 | 0 | 0 | 0 | 110 | 2429 | 1267 | 119 | 3626 | 2604 |
| Telangana | 0 | 0 | 0 | 0 | 0 | 0 | 46 | 1441 | 782 | 64 | 1672 | 887 |
| Region Total | 6 | 14571 | 14188 | 1 | 20 | 24 | 272 | 7619 | 4829 | 293 | 9049 | 6034 |
| All Region Total | 14 | 43528 | 37571 | 47 | 29530 | 23125 | 1248 | 36794 | 28282 | 1630 | 43521 | 35349 |

# ROUTE WISE, YEAR WISE CRUDE STEEL PRODUCTION

| Sl. No | ITEM/PRODUCER | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16* |
|---|---|---|---|---|---|---|
| PRODUCTION | | | | | | |
| I | CRUDE STEEL | | | | | ('000tonnes) |
| OXYGEN ROUTE | | | | | | |
| | BSP | 4901 | 5008 | 5136 | 4807 | 3709 |
| | DSP | 1914 | 2034 | 2019 | 2063 | 1455 |
| | RSP | 2170 | 2209 | 2291 | 2792 | 2042 |
| | BSL | 3647 | 3757 | 3776 | 3831 | 2579 |
| | ISP | 330 | 135 | 127 | 141 | 615 |
| | SSP | 96 | 73 | 91 | 125 | 101 |
| | VISL | 91 | 64 | 13 | 46 | 34 |
| | RINL | 3128 | 3071 | 3202 | 3296 | 2741 |
| | TSL | 7128 | 8130 | 9155 | 9331 | 7399 |
| | JSW Steel Ltd | 7442 | 8518 | 9257 | 10178 | 7791 |
| | Other Oxygen Route | 379 | 350 | 455 | 961 | 687 |
| | TOTAL | 31226 | 33349 | 35522 | 37571 | 29153 |
| ELECTRIC ROUTE | | | | | | |
| | ASP | 200 | 131 | 122 | 104 | 68 |
| | Essar SteelLtd | 4348 | 4163 | 3245 | 2854 | 2454 |
| | JSW Steel Ltd/Ispat Ltd | 2466 | 2711 | 2971 | 2958 | 1611 |
| | Jindal Steel & Power Ltd | 2759 | 3032 | 2836 | 3557 | 2478 |
| | Lloyds Steel Ltd | 620 | 601 | 566 | 658 | 584 |
| | Jindal Stainless Ltd | 752 | 1107 | 1111 | 1907 | 1431 |
| | Bhushan Steel Ltd | 0 | 0 | 1084 | 2180 | 1692 |
| | Bhushan Power & Steel Ltd | 0 | 0 | 1714 | 1213 | 1403 |
| | Other Electric Arc Furnace | 7984 | 7637 | 4944 | 7694 | 5113 |
| | TOTAL | 19129 | 19382 | 18593 | 23125 | 16834 |
| ELECTRIC INDUCTION FURNACE | | 23936 | 25685 | 27579 | 28283 | 21090 |
| GRAND TOTAL | | 74291 | 78416 | 81694 | 88979 | 67077 |
| II | PIG IRON FOR SALE | | | | | |
| | ISP | 502 | 674 | 552 | 920 | 878 |
| | Other Producers | 4869 | 6196 | 7398 | 8774 | 6324 |
| | | 5371 | 6870 | 7950 | 9694 | 7202 |
| III | SPONGE IRON | | | | | |
| | GAS BASED | 5166 | 3940 | 2683 | 2354 | 1593 |
| | COAL BASED | 19805 | 19067 | 20189 | 21889 | 14656 |
| | TOTAL | 24971 | 23007 | 22872 | 24243 | 16249 |
| IV | FINISHED STEEL FOR SALE | | | | | |
| | Bhilai Steel Plant | 3279 | 3614 | 3470 | 3321 | 2416 |
| | Durgapur Steel Plant | 621 | 612 | 620 | 573 | 371 |
| | Rourkela Steel Plant | 2041 | 2111 | 2057 | 2110 | 1580 |
| | Bokaro Steel Plant | 3128 | 3274 | 3330 | 3207 | 1620 |
| | IISCO Steel Plant | 221 | 134 | 186 | 120 | 274 |
| | Alloy Steel Plant | 46 | 40 | 9 | 11 | 8 |
| | Salem Steel Plant | 298 | 270 | 375 | 359 | 297 |
| | Visvesvaraya I &S Plant | 58 | 47 | 25 | 26 | 19 |
| | SAIL Conversion Agent | 0 | 0 | 556 | 553 | 608 |
| | Rashtriya Ispat Nigam Ltd | 2831 | 2717 | 2811 | 2552 | 2033 |
| | | 12523 | 12819 | 13439 | 12832 | 9226 |
| | TATA Steel Ltd | 5456 | 6427 | 8756 | 8967 | 6993 |
| | ISP Majors | 21955 | 23220 | 22965 | 25021 | 18203 |
| | | 39934 | 42466 | 45160 | 46820 | 34422 |
| | Other Producers | 44472 | 47156 | 50417 | 53862 | 39243 |
| | TOTAL | 84406 | 89622 | 95577 | 100682 | 73665 |
| | Les:IPT/Own Consumption | 8708 | 7940 | 7902 | 8525 | 5954 |
| | TOTAL FINISHED STEEL | 75698 | 81682 | 87675 | 92157 | 67711 |

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