THE INDIAN INSTITUTE OF METALS - DELHI CHAPTER

IIM
Metallurgy
Materials Engineering

NEWSLETTER

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K L Mehrotra - Chairman, Delhi Chapter | **S C Suri** - Editor-in-Chief (IIM-DC Newsletter)

SPECIAL ISSUE

ON

STAINLESS STEEL, SPECIAL STEELS

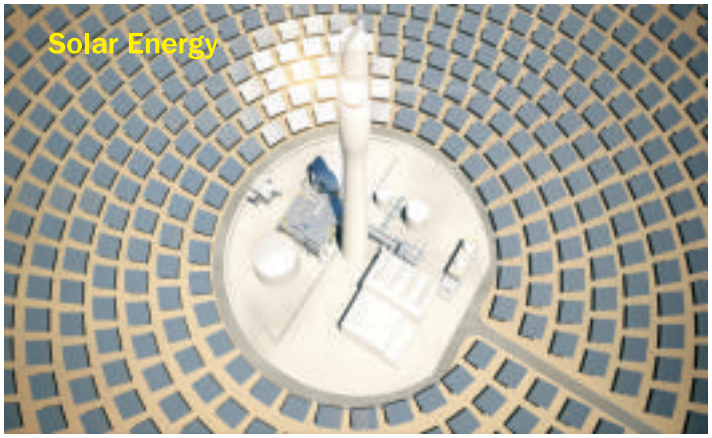
AND

SUPER ALLOYS

HELD AT INDIA INTERNATIONAL CENTRE
NEW DELHI

ON 2nd APRIL 2016

Offering you a full palette of innovative stainless steel



We are the global leader in advanced materials, with our heritage going back over 100 years to the very invention of stainless steel.

We are in a unique position to work closely with our customers and partners around the world, to create materials for the tools of modern life.

We believe in delivering best in product quality and technical expertise while becoming even better at customer orientation, speed and reliability.

Outokumpu wakes every day with the mission to make its long lasting materials as sustainable as possible, because our goal is a world that lasts forever.

India.sales@outokumpu.com
Outokumpu.com

outokumpu
working towards a world that lasts forever

CONTENTS

FOREWORD

Stainless Steel, Special Steels and Super Alloys play an important role in meeting the critical requirements of our strategic sector. The requirement of these varieties of steel and super alloys is expanding. A need was being felt for a long time to organise a seminar in this sector. We all know that these special grades of steel have special metallurgical properties,viz, corrosion resistance, impact toughness, creep, fatigue value etc.

The Delhi Chapter of The Indian Institute of Metals (IIM), organised a one day Seminar on 2nd April 2016 at India International Centre, New Delhi. Technical Papers on these subjects were presented by experts in these areas.

Looking at the importance of the subject, the Delhi Chapter has brought out a special issue containing the proceedings of the Seminar. It is felt that this special issue will be informative and serve as a useful reference material and widen the perspective of readers in the area of stainless steel/special steels and super alloys.

K L Mehrotra
Chairman

PREFACE

Alloy and Special Steel Sector plays a significant role in meeting the critical needs of the strategic sector. Although the share of contribution of production of stainless steel/special steels and super alloys is small vis-à-vis carbon steel, the role and importance of these grades is so critical to the development needs of the strategic sector of our country.

As this sector is growing in usage in varieties of new and critical applications, the Delhi Chapter organised a one day Seminar on Stainless Steel/Special Steels and Super Alloys at India International Centre, New Delhi, on 2nd April 2016. A number of luminaries in the above areas presented their papers in the Seminar. The presentations made in the Seminar evoked a lot of interest to the participants.

The Delhi Chapter has compiled the proceedings of the various technical papers presented in the Seminar.

It is hoped that the contents of this Special Issue will be informative and serve as useful data base and reference material for readers.

SC Suri
Chairman
Technical Committee

Growth of Stainless Steel Industry
&
Its End Use Transformation in India

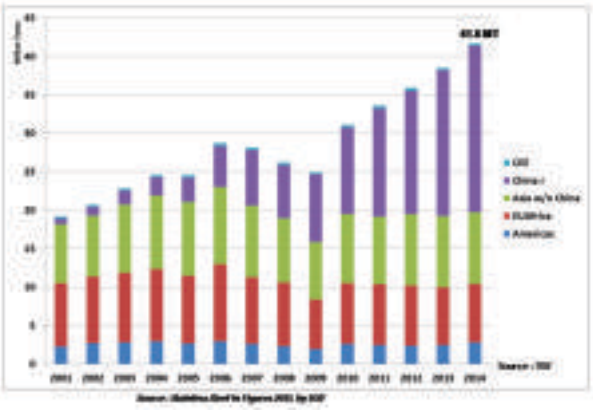
N C Mathur
President
Indian Stainless Steel Development Association

OUTLINE

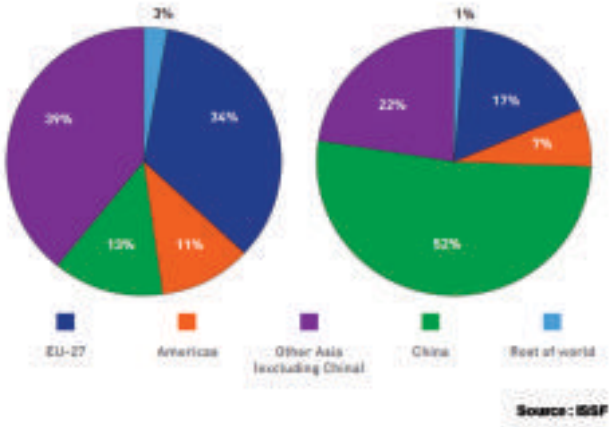
- Global Stainless Steel Industry Overview
- Analysis of Indian Stainless Steel Industry
- Stainless Steel End Use
- Global & Indian Economy
- Conclusion

Global Stainless Steel Industry Overview

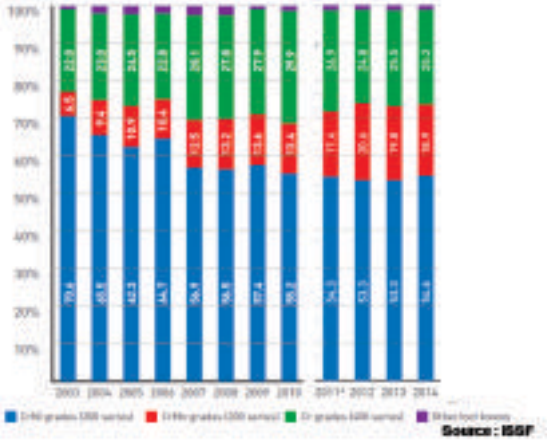
World Stainless Steel Melt Production



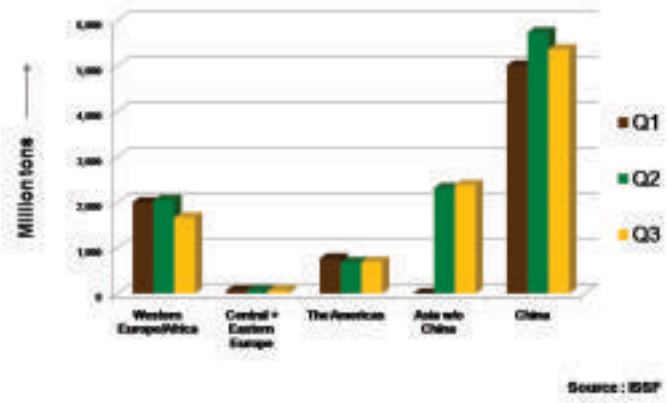
Regional share of stainless steel production: 2005 (left) and 2014 (right)



Stainless melt shop production (slab/ingot equivalent) by grade: 2003-2014

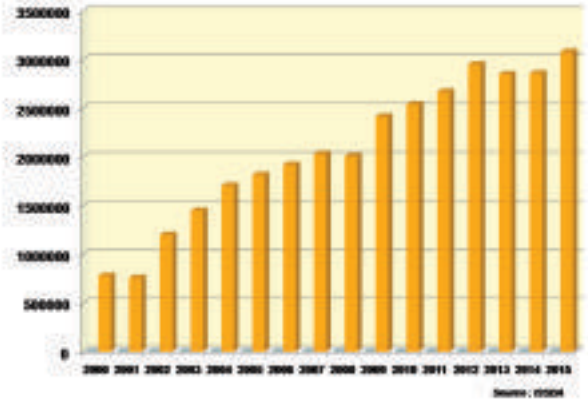


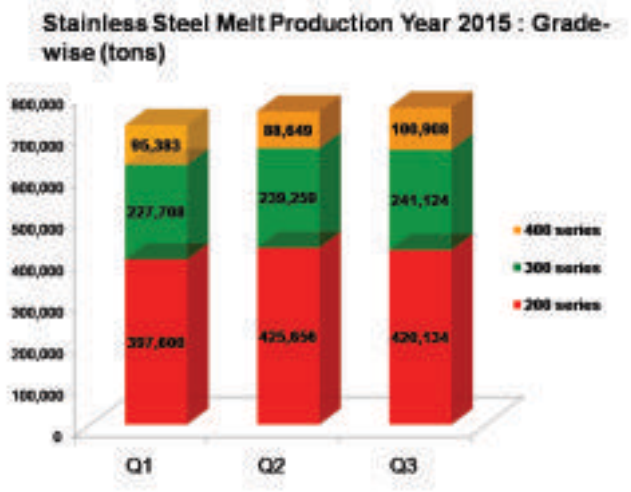
World Stainless Steel Melt Production - Year 2015 ('000 tons)

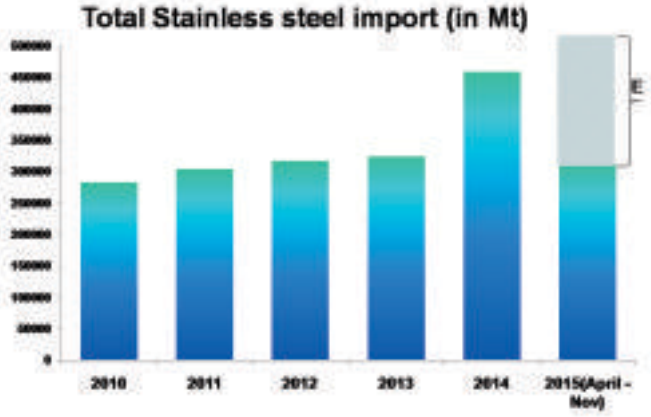


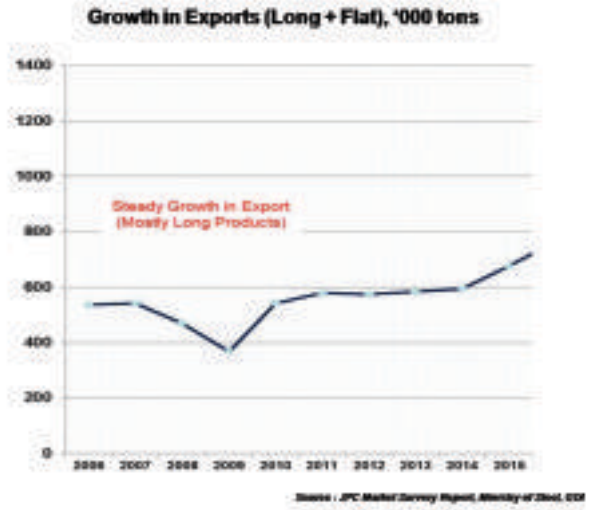
Analysis of Indian Stainless Steel Industry

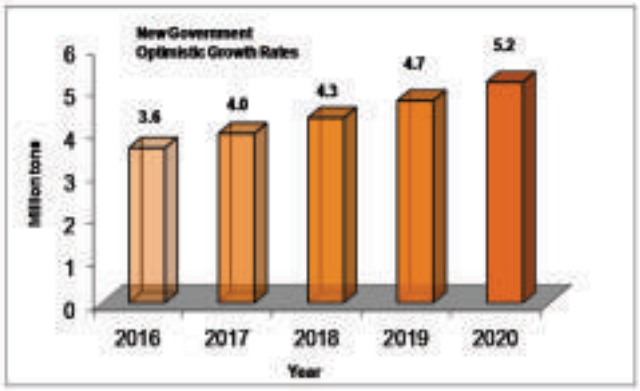
Stainless Steel Melt Production (tons) : India

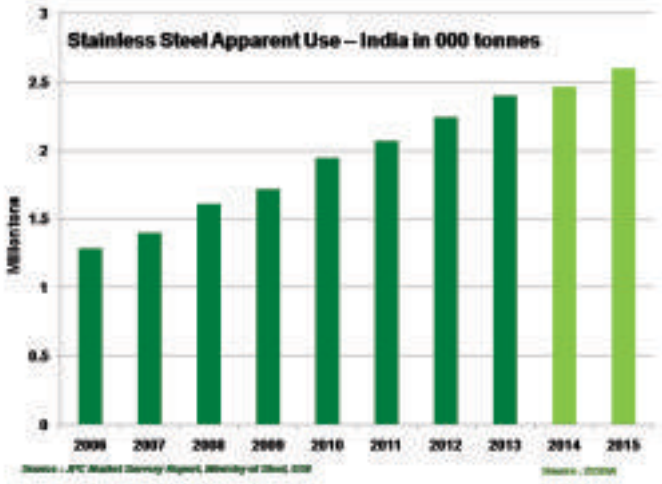


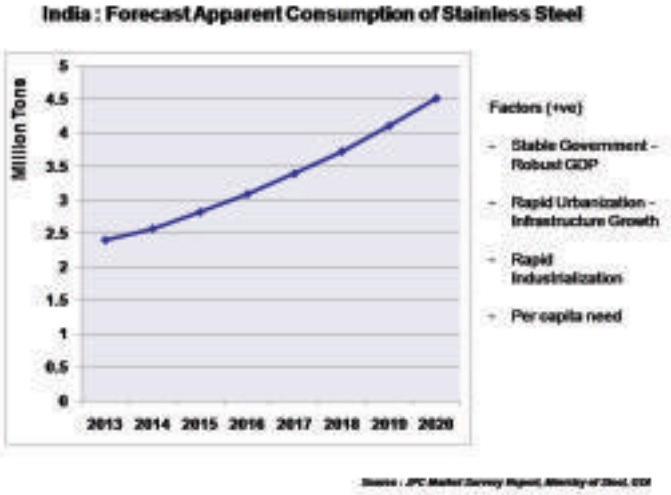

Stainless Steel Melt Production Year 2015 : Grade-wise (tons)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
95,383
227,708
337,608
88,649
239,259
425,656
100,908
241,124
420,134
400 series
300 series
200 series
Q1
Q2
Q3


Total Stainless steel import (in Mt)
2010
2011
2012
2013
2014
2015(April - Nov)


Growth in Exports (Long + Flat), '000 tons
1400
1200
1000
800
600
400
200
0
Steady Growth in Export
(Mostly Long Products)


India : Forecast Stainless Steel Melt Production
New Government
Optimistic Growth Rates
Million tons
6
5
4
3
2
1
0
3.6
4.0
4.3
4.7
5.2
2016
2017
2018
2019
2020
Year


Stainless Steel Apparent Use – India in 000 tonnes
Millions tons
3
2.5
2
1.5
1
0.5
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015

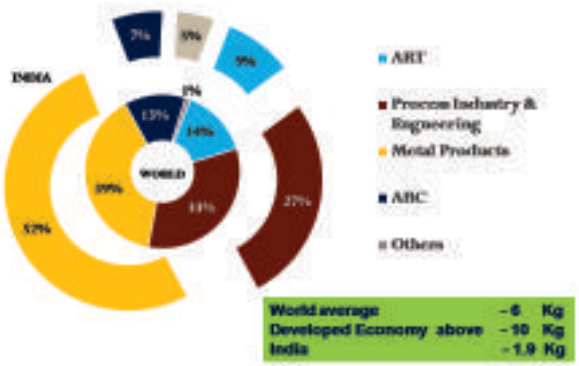

India : Forecast Apparent Consumption of Stainless Steel
Million Tons
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
2013
2014
2015
2016
2017
2018
2019
2020
Factors (+ve)
- Stable Government - Robust GDP
- Rapid Urbanization - Infrastructure Growth
- Rapid Industrialization
- Per capita need

Role of Stainless Steel Development Association

Market Development	• Jointly work with Industry to develop new application areas – example – Railways etc
Free Technical help	• Handle Queries • Offer solutions
Educational Programmes	• Workshops & Training for various end user segment • For fabricators , Students at technical colleges • Publications in magazines
Involvement with Government of India	• Support Industry • Bridge between Industry and Government
Standardization	• Work with Bureau of Indian Standards in formulation and revision of standards for stainless steel and its products
Sourcing Material	• Help users in sourcing material or products
Coordination with ISSF & other SSDA's around the world	• Global Unifying point • Learn from each other on market development activities

Stainless Steel End Use

Stainless Steel End-Use : World - India



World average	~ 6 Kg
Developed Economy above	~ 10 Kg
India	~ 1.9 Kg

Indian Railways will remain a growth driver

ICF Chennai
RCF Kapurthala
RCF Rae Bareli

All long distance passenger cars to be converted into stainless steel in a phased manner

Stainless steel type LHB German design coaches offers better speed, space and safety

power cars to provide electricity inside the coaches

ICF : 360 SS EMU coaches for Mumbai suburban network

Rail Coach Interiors: Innovation, Safety, Comfort

National Institute of Fashion Technology and National Institute of Design are in the process to design of the coach interiors.

Upper berths will come with newly designed ladders

Dustbins in all 60,000 coaches soon

Vacuum Toilets

Bio Digesters

FREIGHT CARS

Indian Railways : Wagons -

- Stainless Steel Wagons – BCNHL, BOXNHL & others
- BCNHL – Goes back to High Strength Steel
- BOXNHL – Working Well
- ISSDA and Members helping RDSO & Railways workshops to solve maintenance related & other issues

Dedicated Freight Corridor will increase the demands for wagons by many fold

Wider rails – More tare weight – Bigger Wagons – Stainless Steels

FREIGHT CARS

DFCC

85 per cent of land required for the project has been acquired

The 56-km stretch Operational Before Decem

DFCC will divert 70 per cent of the one-billion tonne freight traffic from Indian Railways

Increase in Wagon requirements

Indian Railway Stations Development Corporation Limited

Indian railways move more than 23 million passengers in a day and maintenance of passenger facilities and amenities has always been a big challenge

400 railways stations in metros and major cities to be redeveloped

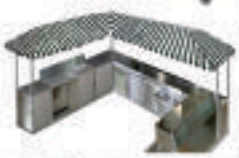
Stainless Steel to be used in hand rails, ticketing counters, dividers, bollards, claddings , elevators, escalators, dust bins, vending machines (ticket, water) , Gates & Grills, chairs, signage boards etc

Potential to be used in roofing's including rain water harvesting, Structural usage, water storage tanks, sanitation facilities, Vendor facilities etc

Model Railway Stations

ISSDA to promote - In all Food Contact Item at Railway Stations

- Food Kiosk – Single Vendor, Outlets & Others
- Serving area, Chairs, tables



End -Use

All Kitchen services for food preparation for Indian Railways – Stainless Steel

Metro Rail

COACHES – Stainless Steel a success already

16 cities gearing up for Metro rail

STATION AREA – Inside , Outside

Stainless Steel for Water Tanker

Water and Stainless Steels are made for each other.

Maintains purity of water

Unpainted, Hygienic and Easy to clean

Stainless Steel for BUS Body

ISSDA and its member companies Promoting use of stainless steel for BUS body

Stainless Steel for exhaust systems

Figures in million units	2005-06	2013-14	AMP 2006-16 growth % - Planned	Actuals 2006-14 growth % - Actuals
Passenger vehicles	1.3	3.1	12.0	11.3
Commercial vehicles	0.39	0.7	10.0	7.5
2 wheelers	7.6	16.8	10.0	10.5
3 wheelers	0.40	0.80	11.0	8.4
Automotive component	USD 10.8	USD 28.1	14.3	9.5
GLOBAL RANKING				
PV	13th	6th		
CV	8th	4th		
2 wheelers	2nd	2nd		
3 wheelers	1st	1st		

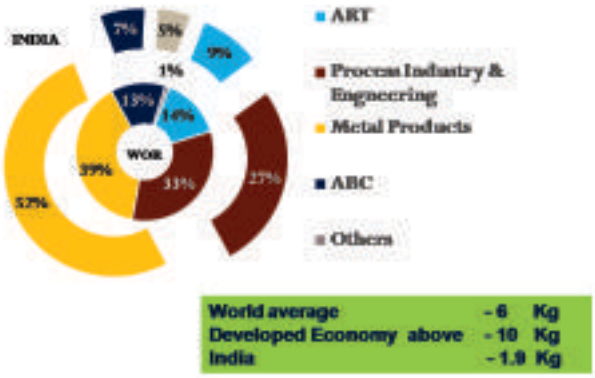
Source: Ministry of Heavy Industries and Public Enterprises

Automotive Mission Plan AMP 2016-26 to roll out soon

BS V emission norms to be adopted by 2019; BS VI emission norms to be implemented by 2023 for passenger vehicle

Increase in Demand

Stainless Steel End-Use



World average	- 6 Kg
Developed Economy above	- 10 Kg
India	- 1.9 Kg

Metal Goods

ABC – Huge Potential

End -Use

- Hand Rails, Building Interiors Furniture's , Sinks , Builders Hardware, Escalators & Lifts, Gates etc on high demand
- Roofing, Plumbing, Cladding, Wall panels, windows on rise
- Reinforcement Bars, Facades and use of colored stainless steel started but more promotion is required.
- New Innovative uses on rise

Focus on promotion of new designs, surface finishes

- No Painting
- Higher Strength
- Vandalism Proof design
- Cleanliness & Maintenance minimal
- Can be used in combination with Wood

Promotion linked to green building concept

Facades, Claddings and Wall column claddings for Aesthetics , Long Life and Security

Roofing

Promotion based on Case Studies

Roofing in SS @ AIRPORTS, STATIONS

Promoting the use of of Stainless Steel Hollow sections for structures

Lighter, Stronger, Long Life

Promoting Plumbing in Stainless Steel

Hospitals & Hotel Industry

Case Studies : Life Cycle Cost & Project Cost

Water Supply Pipelines : in stainless steel

Overhead Water storage tanks : Quality Product – ISI mark

- Hygienic – Water remains in its natural form and microbiological safe
- Reduces risk of water borne disease
- Compact and aesthetic design
- No algae/fungus formation
- Value for money for years
- Easy to clean and practically maintenance free
- Total drain out provision provided at bottom of tank for easy cleaning.

Campaign Clean India

A National level campaign by the Government of India covering 4041 statutory towns to clean the streets, roads and infrastructure of the country

A vision of 'cleaner India' by 2 October 2019, 150th birthday of Mahatma Gandhi and is expected to cost over 62000 Cr (US$10 billion)

Public Sanitation facilities in Stainless Steel

Zoo Chennai

The Big Boost --

Creation of *100 smart cities*

- 24x7 availability of high quality utility services like water and power
- Transport system that emphasizes on public transport
- Proper facilities for entertainment and the Safety and Security of the people
- State-of-the-art Health and Education facilities
- Recycling of waste materials, Water conservation

Source : ENN

Airport Authority of India

200 Low-cost airports in next 20 years

→ Challenge for stainless industry to offer low cost solutions

Expansion of High Flier Density Airports

→ Challenge for stainless industry to introduce new application areas such as stainless steel roofings and structural Innovation – Show additional benefits such as rain water harvesting, solar compatability etc

Process Industry , Power and Engineering – High Potential for quality grade consumption

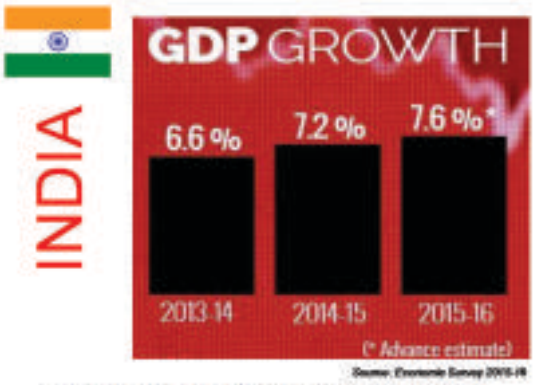

Pulp and Paper Industry


Oil and Gas , Petrochemical Industry


Dairy Industry

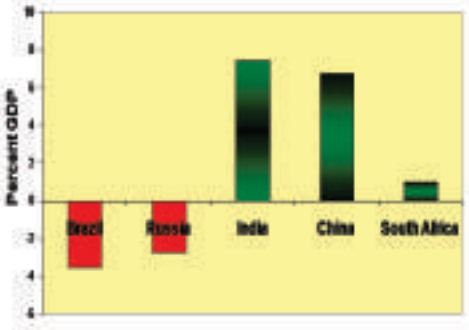

Food Processing Industry

Global & Indian Economy



*Moody's says India less exposed to external factors

Country	GDP Growth (2015)
Brazil	▼-3.6%
Russia	▼-2.7%
India	▲7.5%
China	▲6.8%
South Africa	▲1%



Big Spend on INFRASTRUCTURE

Allocates **2.21 trillion rupees (31 billion $)** for infrastructure development for 2016/17, up 22.5 percent on last year

Allocation for roads and highways development at **550 billion rupees (8 billion $)**

Capital expenditure on roads and rail development at **2.18 trillion rupees (32 billion $)**

Conclusion

1. India is likely to have highest GDP growth among large economy
2. stainless steel demand likely to grow by 8-10 % each year in next 2-3 year.
3. Government program's of **Smart City**, **Infrastructure spending** and **Make in India** are positive for Stainless demand
4. **Low per capita** use sign of future growth

Presentation on
An Overview of Stainless Steel Industry – Challenges and Prospects

Sushim Banerjee
Director General
Institute for Steel Development & Growth (INSDAG)

Outline

- **Stainless Steels and its classification**
- **Overview of Stainless Steels Market**
- **Overview of future growth prospects**
- **Challenges and Opportunities**

Stainless Steel

Stainless Steel is defined for a number of different steels primarily for their resistance to corrosion. Minimum percentage of Chromium of 10.5%, Nickel and Molybdenum are added to improve corrosion resistance. Stainless Steel is expensive compared to Mild Carbon Steel and represents a small but valuable niche market.

The Structural Stainless Steel is classified into :

- Ferritic (30% Chromium with no Nickel and little Molybdenum)
- Austenitic (17-18% Chromium and 8-11% Nickel)
- Martensitic (12-15% Chromium, Molybdenum 0.2 - 1%, no Nickel and Carbon 0.1 – 10.2%)
- Duplex (21 – 26% Chromium, 4 – 8% Nickel, 0.1 – 4.5% Molybdenum) - twice the strength compared to austenitic stainless steel and more resistance to corrosion

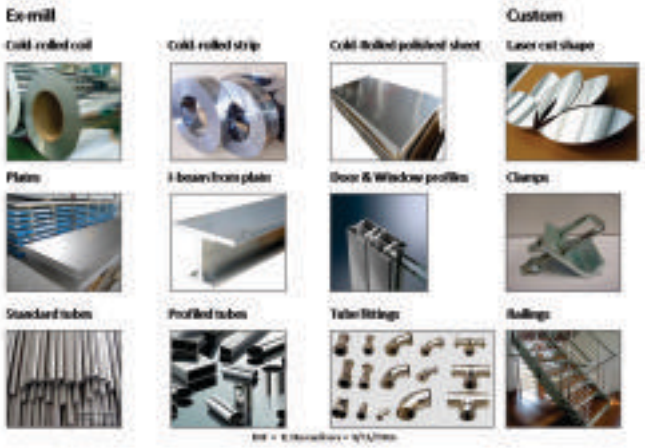
Stainless Steel

Attributes

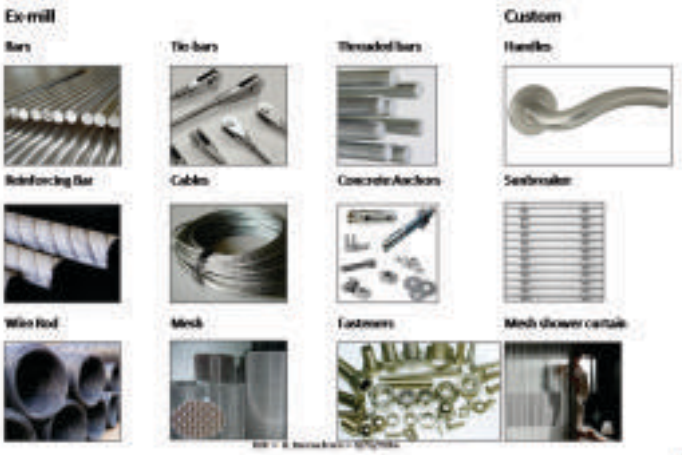
- Excellent corrosion resistance – does not require coatings
- Excellent elongation / formability
- good looks with other materials -stone, wood, concrete, glass
- Available in a wide range of surface finishes
- Excellent fatigue resistance
- Easy to clean – hygienic
- 100% recyclable
- Good strength – the strength of steel
- High rigidity (Young's Modulus) – the rigidity of steel
- Low thermal conductivity
- Good high temperature resistance

It is available in various forms

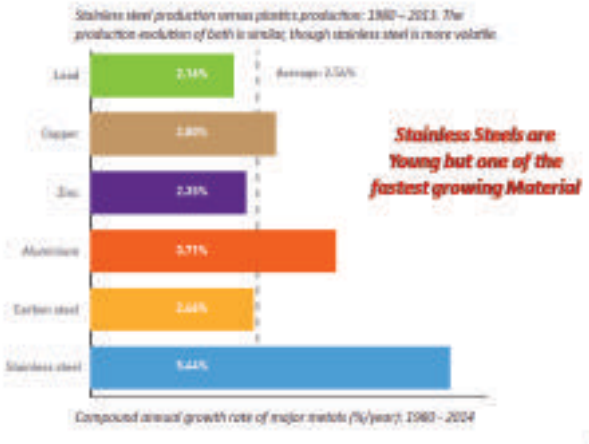
Flat products



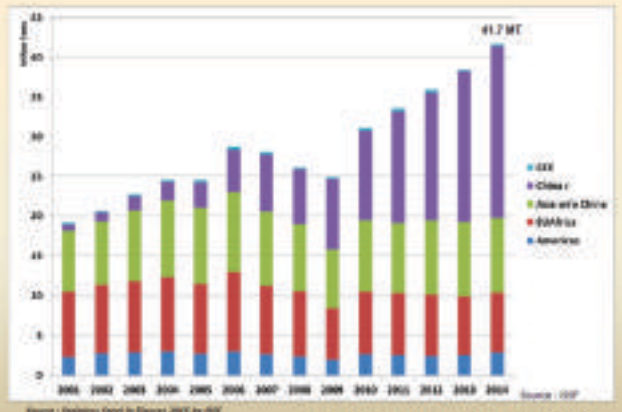
Long Products



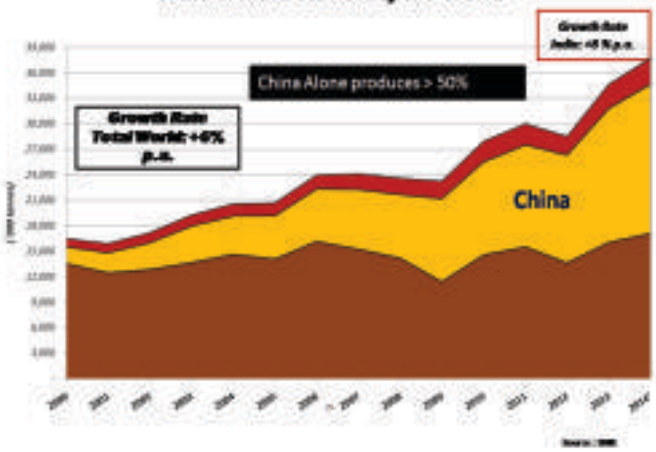
Metals – Annual Growth



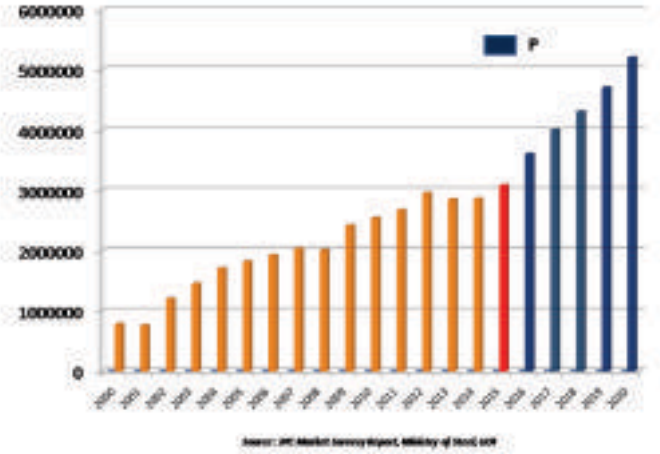
World Stainless Steel Melt Production



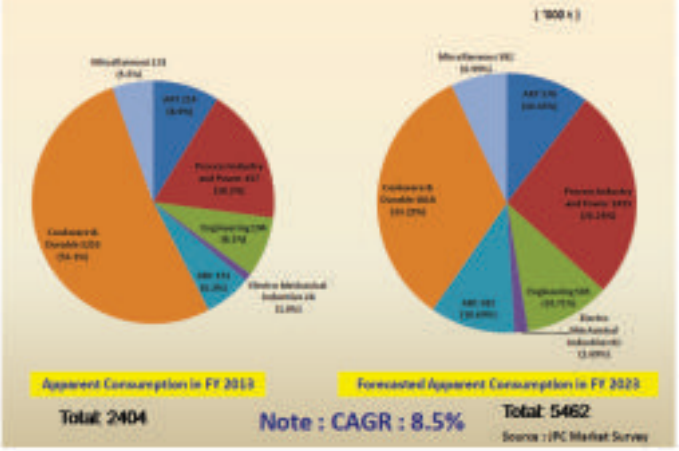
Stainless Steel Consumption Growth
China & India vs. Rest of the World



Indian SS Melt Production : Past, Present & Future



Apparent Consumption and Projected Consumption



Grade-wise Pattern of Apparent Consumption

Grade	Share in FY '13	Projected Share in FY '23
400 series	16.0%	17.9%
300 series	28.6%	40.6%
200 series	54.3%	39.9%
Duplex	0.4%	0.6%
Other Special	0.7%	1.0%
	100.0%	100.0%

The Stainless Steel End Use Sector in India

GROWTH DRIVERS

Union Budget 2016:

Rs 2.21 lakh crore for infrastructure sector

Ministry of Urban Development :

Urban infrastructure sector offers Rs.73 lakh crore investment opportunity for private sector and PPP investments over the next 15 years.

End –Use Growth Centers

Effluent and Water Treatment systems	Effluent treatment, Municipal waste & sewage treatment plants Water treatment (with Desalination plants)
Electronic and Electro Mechanical Industries	Washing Machines: Electrical Appliances: Optical Fiber Cables Micro wave ovens:
Engineering Industry:	Pumps Valves Welding wires and Electrodes: Fasteners: Solar Heaters: Watches Pipe fittings: Machine tools/machined parts
Oil and gas	Refineries Petrochemicals Oil and Gas exploration LNG Re-gasification CNG Application
Process Industry	Fertilizers Chemicals Dairy Industry Brewery and Distillery Sugar Food Processing Drugs and Pharma Paper and Pulp
Power Sector	Thermal Power Plants Nuclear, Solar
Metal Goods	Utensil and Kitchenware pressure cookers Cutlery/Kitchen tools and gadgets Commercial kitchen equipment Gas stoves Life Style products Induction cookware Kitchen chimney
Other areas	Surgical Instruments Hospital Furniture Household, Office and garden furniture Coinage

Some Important Application Growth area

Architecture Building & Construction (ABC)

Mostly driven by growth in Indian real estate & infrastructure sector

Residential real estate, commercial real estate, Retail space, hospitality projects and SEZs

Shopping malls, Multiplexes, Airports, Rail Metros Stations, IT parks, Commercial Complexes, Hotels, Fast food restaurants, High Quality Residential accommodations, Hi tech town ships and showrooms

Products :

Sinks
Elevators and escalators
Street furniture
Builder hardware:
Architectural Products
Railings, Barriers, Signage's, Spiders, Claddings
Facades
Plumbing
Roofing
Reinforcement bars

Share of this application increased almost 3 times over the last 8 years to reach 6.7% of the overall consumption of Stainless steel.

Creation of *100 smart cities*

DEMAND

Key Features of these cities will be

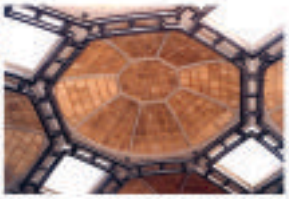
- 24x7 availability of high quality utility services like water and power
- Transport system that emphasizes on public transport
- Proper facilities for entertainment and the Safety and Security of the people
- State-of-the-art Health and Education facilities
- Recycling of waste materials, Water conservation

'Stainless Steel usage in many areas'

Structural Use of Stainless Steel is Increasing

Parliament Library

2003



Building entrances, canopies

Takes minimum space.

Easy to do maintenance

Structural Applications of Stainless Steel Rebar

Stainless steel rebar should be used in:
Marine structures, piers, off-shore-platforms.
Bridges, Tunnels, dams, sea and river wall defence systems
Rock-face/Reinforcements
Aggressive environments
Sewage and chemical treatment plants
Structures with sensitive electronic equipment
Restoration of historic buildings
Quake resistant structures

Automotive Railways & Transport (ART)

The share of ART segment in last 8 years has grown by almost 5 times
from 2% to almost 10% in 2015.

ART will remain a growth driver

Metal Goods / Food & Hygiene

Mid Day Meal Scheme : Stainless Steel for Hygiene

Serving 120,000,000 children in over 1,265,000 schools

Largest such programme in the world

Challenges

Challenges in Raw-material Sourcing

Key Raw-materials for Stainless Steel

- Ferro chrome, Ferro Nickel (Import), Pure Nickel (Import), Ferro Molybdenum (Import), Charge Chrome, Melting Scrap (Import)

Raw material	BCD in India	BCD in China
720260 Ferro Nickel	2.5%	1%
750210 Pure Nickel	2.5%	0
720270 Ferro Moly	5%	2%
720421 Stainless Steel Scrap	2.5%	0%
720449 Steel Scrap	2.5%	0%

Finished Goods	Brazil	China	India	Turkey
Stainless Steel Cold Rolled Flat Products	14%	10%	7.5%	0%
Stainless Steel Hot Rolled Flat products	14%	10%	7.5%	0%

Basic Customs Duty on all the key raw materials in India must be reduced to zero to ensure level playing field and Basic Customs Duties on Finished Goods should be aligned with rates applicable in China.

Recommendation :

Reduce Import duty on key raw materials like Ferro Nickel, Pure Nickel, Ferro Moly to NIL

Remove import duty on MS Scrap and SS scrap imported for use in stainless steel industry

Trade related issues

Free Trade Agreements : Current Scenario

FTA partner	MFN duty	Preferential duty
ASEAN	7.5%	NIL Duty
Japan	7.5%	0.8%
Korea	7.5%	1.88%

On stainless steel flat products covering HS Codes 7219 and 7220

Preferential duty of Japan and Korea will be NIL by 2016-17

Recommendations

India has not benefitted from these FTAs. The signing of the FTAs has only lowered protection levels on finished goods without giving any corresponding benefits in Raw Material or Investment. Therefore, urgent review of all existing FTAs must be taken.

NO tariff concessions to be granted to China on Stainless steel products under RCEP negotiations

Provisions of the Rules of Origin must be followed strictly to avoid mis-declaration and circumvention of duties.

Issues of Concern

- Non-availability of Nickel and high price
- Shrinking margin
- Rising imports of cheap Stainless Steel – China and FTA countries
- Unorganized sector – low quality cheap production – No refining facilities (AOD / VOD)
- Power shortage
- Poor logistics and port infrastructure
- Inadequate R&D
- Inverted Duty structure
- Poor fabrication quality

Opportunities to Explore

- Oil & Gas Sector requiring corrosive resistant steel, high pressure, high stresses and requirement of harsh environment
- High width HR > 1500 mm
- High demand for ferritic goods in consumer durable / process equipment, sugar, paper and chemicals, refineries
- Duplex grade in sophisticated use in oil & gas
- Major demand for 200 / 300 series CRC for non-critical application of 304 in Kitchen wear, Architecture, Refrigerator, Elevators
- High Speed fabrication facility for Architecture application
- LCA consideration of Stainless Steel

Indirect Imports Containing Stainless Steel

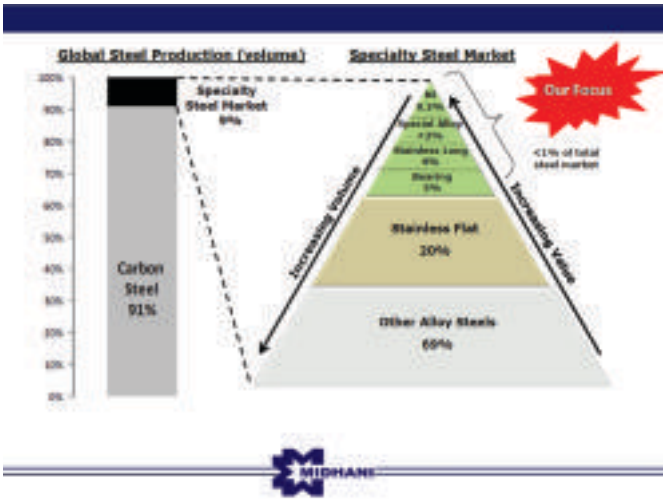
- Large Boilers
- Thermal Power equipment – Boiler, Pressure Vessels
- Process Pumps
- Industrial Machinery – Sugar, Paper, Chemical, Brewery, Diary, Food
- Refrigerator & Freezing equipment
- Heat Exchangers
- Dish Washing Machine
- Utensils
- Sinks
- Kitchen & Household articles
- Builders Hardware
- Auto Exhaust
- Surgical Instruments

65,000 t Stainless Steel indirect imports in 2011-12
62,000 t Stainless Steel indirect imports in 2012-13

Emerging trends in Steels, Superalloys and Titanium alloys

Dr D.K. Likhi
CMD, MIDHANI

MIDHANI



How to meet the challenges?

- Understanding the customer requirement
- Develop new product, process for meeting the requirement
- Address management – technology interface

Aim – To meet well identified commercial application

Trends for Materials Development – Nuclear and Thermal power

- Develop new core materials that can face high stress, temperature, corrosive environs and high flux of neutrons.
- To devise methods for safe disposal of the active materials once they have performed.
- In thermal power plants with the increase in steam temperatures above 600°C advanced ferritic/ martensitic steels with sufficient long term creep rupture strength is being developed. For temperature above 650°C Oxide Dispersion Strengthened Ferritic Steels is receiving attention.
- Selection depends on screening of materials based on sound knowledge about their behavior in conventional environments, theoretical and experimental simulation and actual existing experience with materials under irradiation environments.

Superalloys

Metal Processing

Machining process inherently wasteful – near net shape desirable.

- Forging of rounds / bars on Long Forging Machine with small machining allowance than on conventional open die forging press / hammer.
- Close die forging of component
- Near net shape forging of components

Improved casting (more accurate / precise) would result in less machining

- Investment casting
- 3 D Printing

PARTITIONING OF ALLOYING ELEMENTS and strengthening of Superalloys

1) *Solid solution strengthening*
2) *Precipitation hardening*
3) *Grain boundary strengthening*

Criticality of melting high end superalloys

Superni 718

Ele	Wt%	Ele	Wt%	Ele	Wt%
C	0.08max	Mn	3.0-3.3	Pb	0.0005max
Mn	0.35max	Nb	4.75-5.5	Bi	0.0000Smax
Si	0.35max	Ti	0.65-1.15	Sc	0.0005max
P	0.015max	Al	0.2-0.8	Sn	0.005max
S	0.015max	Co	1max	Ag	0.001max
Cr	17.21	B	0.006max		
Ni	50.55	Cu	0.3max		

- Where control of no. of alloying elements to much tighter levels required.
- Where low level of high-vapor-pressure elements required by specification
- Where considerable reduction in oxygen and nitrogen contents. Accordingly, with fewer oxides and nitrides formed, the micro cleanliness improves
- Where recovery of oxide forming elements (Ti, Al, Nb) required

Melting Routes for some of Superalloys

AIM + ESR : Inconel 600, 601, 690, 800, 825 etc

VIM + VAR : Inconel 706, 718, 750, 263, 80A etc

VIM + ESR : Inconel 617, 625, L605

VIM + ESR : Inconel 706, 718 etc + VAR

Ni-based Superalloys for Kaveri Engine

Alloy	Max Application Temp. °C	Typical Components
SUPERNI 263A	800	Flame tube, combustion chamber, reheat system, Thrust deflector system, casing, exhaust ducts, bearing housing, cooling rings, flanges.
SUPERNI 718A	700	Compressor blades, turbine discs, compressor disc, flanges, shafts, casings, rings, housing.

Cast Alloys

All cast super alloys can be grouped as

- Conventionally Cast (CC) Superalloys.
- Directionally Solidified (DS) Superalloys.
- Single Crystal (SC) superalloys.

Few examples: CM247, ReneN6, CMSX4,TMS 162, TMS 138, CMSX 10 etc.,

Titanium Alloys

Equiaxed polycrystalline | Directionally solidified columnar grains | Single Crystal

Gas Turbine Blades and Vanes

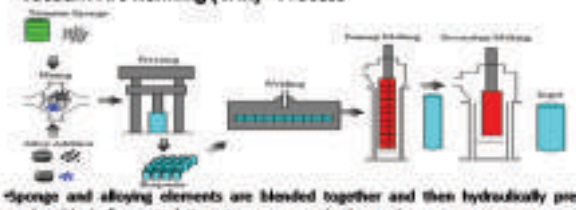
Advantages of titanium alloys

Production of titanium alloys

- **Melting processes**
  - Vacuum Arc Remelting (VAR)
  - Electron Beam Melting (EBM)
  - Skull Melting
- Casting processes
  - Casting : investment casting
- Forming processes
  - Rolling, extrusion, forging.
- Heat treatments

Melting of titanium alloys

Vacuum Arc Refining (VAR) - Process

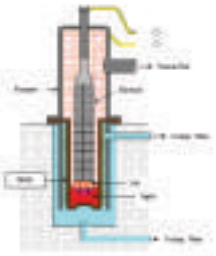


- Sponge and alloying elements are blended together and then hydraulically pressed to produce blocks (briquette). Revert or scrap can also be used.
- The briquettes are welded together to produce first melt electrode or 'stick'.
- The electrode is double or triple melted in the VAR furnace to produce sound ingot.

Melting of titanium alloys

Vacuum Arc Refining (VAR) - melting

- Electrode made from compacted briquette of nominal alloy composition is held in the VAR by a stub and first melted in a water-cooled copper crucible.
- A molten metal pool is on the top of the new ingot.
- The melting variables such as melting rate, molten pool depth, stirring, contamination is carefully control to obtain homogeneity and soundness of ingots.

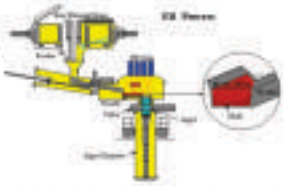


VAR furnace

Melting of titanium alloys

Electron Beam Melting (EBM)

- The floating metal is on the top of the skull, giving a sound ingot.
- Material is fed through the hearth and melted by heat source provided by electron beam.



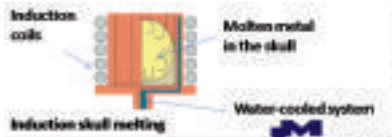
EBM ingot

Note: Used for melting of reactive materials such as Ti, Ni, Ta, Zr.

Melting of titanium alloys

Induction Skull Melting

- A water-cooled copper crucible is used to avoid contamination of reactive materials.
- Metal is charged inside the crucible by induction power source applied by magnetic field.
- The charge is melted and freeze along the bottom and wall, producing a shell or skull with molten metal in it.
- Revert or scrap can be used.
- Low cost, high quality titanium alloy production.



Charged metal melted with ISM

Classification of titanium alloys

1. Alpha and near alpha titanium alloys
2. Alpha-beta titanium alloys
3. Beta titanium alloys

Different crystal structures and properties allow manipulation of heat treatments to produce different types of alloy microstructures to suit the required mechanical properties.

Commercially pure (CP) titanium and alpha/near alpha alloys

Microstructure contains HCP α phase and can be divided into;

- Commercially pure titanium alloys
- Alpha titanium alloys
- Near alpha titanium alloys

Characteristics:

- Non-heat treatable
- Weldable.
- Medium strength
- Good notch toughness
- Good creep resistance at high temperature.

Alpha titanium alloy

α stabilisers are more soluble in the α phase and raise the β transus temperature.

- Al and O are the main alloying elements, which provide solid solution strengthening. O and Npresent as impurities give interstitial hardening.
- The amount of α-stabilisers should not exceed 9% in the aluminium equivalent to prevent embrittlement due to ordering.
- 5-6% Al can lead to a finely dispersed, ordered phase (α2), which is coherent to lattice deleterious ductility.
- Sn and Zr are also added in small amount to stabilise the α phase and give strength.

Alpha-beta titanium alloys

- Alpha-beta titanium alloys contain both α and β.
- α stabilisers are used to give strength with 4-6%
β stabilisers to allow the β phase to retain at RT after quenching from β or α+β phase field.
- Improved strength and formability in comparison to α -Ti alloys.
- Ti-6Al-4V (IMI 318) is the most widely commercially used.

Forged Ti-6-4 blades

Beta titanium alloys

- Beta stabilisers are sufficiently added to retain a fully β structure (avoid martensite formation) when quenched from the β phase field.

Advantages	Disadvantages
– high strength/density ratio	– high density
– low modulus	– low modulus
– high strength/high toughness	– poor low and high temperature properties
– high fatigue strength	– small processing window (some alloys)
– good deep hardenability	– high formulation cost
– low forging temperature	– segregation problems
– strip producible – low-cost TMT* (some alloys)	– high springback
– cold formable (some alloys)	– environmental embrittlement
– easy to heat treat	– poor corrosion resistance (some alloys)
– excellent corrosion resistance (some alloys)	– interstitial pick up
– excellent combination resistance (some alloys)	

* TMT: thermomechanical processing

Applications of titanium alloys

AEROSPACE
- Civil
- Military
- Space

MEDICAL
- Orthopaedic Implants
- Bone Screws
- Trauma Plates
- Dental Fixtures
- Surgical
- Instruments

MEDICAL
- Petrochemical
- Offshore
- Subsea
- Metal Finishing
- Pulp & Paper
- General Engineering

SPECIALIST
- Body Jewellery
- Ultrasonic Welding
- Motor Racing Components
- Marine
- Bicycle
- Sports Equipment

MIDHANI has contributed to low-cost import substitute titanium bio-medical implants

135 types of Implants in 1061 varieties ready for commercial supply

Steels

MDN59

MDN59 is a 0.05 % C, 14.5% Cr, 5.5 % Ni, 1.5 % Mo, 1.5 % Cu, 0.5% Nb Precipitation Hardenable Martensitic Stainless Steel.

Delta ferrite is high temperature phase.

The phase forms either during solidification or soaking at a temperature above 1200 °C.

Closed die forged components

MDN 403 End Fitting Forgings

MDN 403 is specially used for making end fittings. The component is generally used in hardened and tempered condition. This grade fulfils the fundamental requirements such as:

- Corrosion resistance, resistance to hydrogen embrittlement, wear resistance
- A combination of strength, toughness and hardness
- Maintaining properties when exposed to irradiation
- Additionally to minimize thermal stresses and maintain a leak tight rolled joint, the end fitting should have a thermal coefficient of expansion as close as possible to the Zirconium alloy pressure tubes

ITER

Reduced Activation Ferritic / Martensitic Steel

Element	Content, wt. %
Cr	8.00 - 9.00
C	0.10 - 0.12
Mn	0.30 - 0.60
V	0.15 - 0.25
W	1.20 - 1.40
Ta	0.06 - 0.08
N	0.01 - 0.04

Element	Content, wt. %
O	< 0.01
P	< 0.005
S	< 0.005
B	< 0.001
Ti	< 0.005
Nb	< 0.001
Mo	< 0.005
Ni	< 0.005
Cu	< 0.005
Al	< 0.005
Si	< 0.01
Co	< 0.005
As	
Sn	
Sb	< 0.01
Zr	

- Radiation damage
- Mechanical properties
- Chemical compatibility
- Fabrication and joining

Special Steel for Naval Applications

- Low alloy steel forgings, characterized by high cleanliness, structure homogeneity and fine scale microstructure were developed to achieve exceptionally high toughness at sub-zero temperatures and resistance to dynamic loading.

Grade	Steel Type	Application
AK1PK	Low Alloy	Forgings for pressure hull
AK1PKM	Low Alloy	Forgings for pressure hull, bearing casing
AK1A6A	Low Alloy	Plates for structural applications
MDN 514(3)	Austenitic SS	High pressure hydraulic piping
12X18H10T	Austenitic SS	High pressure hydraulic pipeline
MDN 13	Austenitic	Non-magnetic hull for Mine sweeper
MDN 12	Austenitic	Ballast weights

Century of Innovations in Stainless Steel

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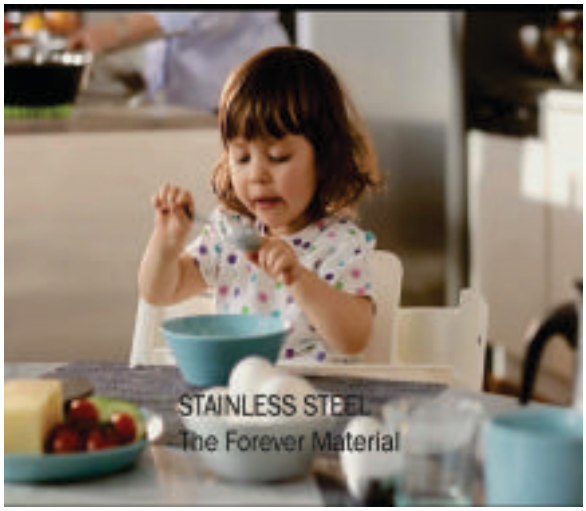
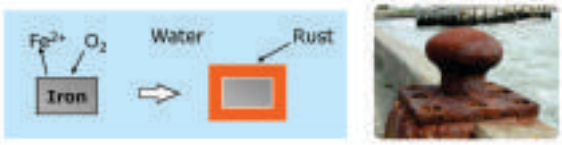
Yatinder Suri
MD & Country Head
Outokumpu India P Ltd



We can serve our customers everywhere

Corrosion of steel - Rust

Degradation of a material by a chemical reaction with its environment



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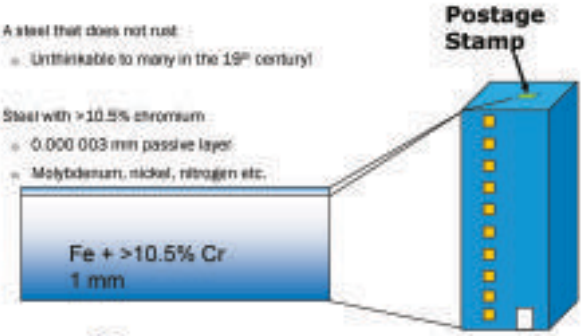
What is stainless steel?

- A steel that does not rust
  - Unthinkable to many in the 19th century!
- Steel with >10.5% chromium
  - 0.000 003 mm passive layer
  - Molybdenum, nickel, nitrogen etc.



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What happened in 1912?

- German researcher patent stainless steel 1912
- Harry Brearley in Sheffield, England, made similar findings at the same time
- Both birthplaces are part of Outokumpu.

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The early days and applications

- The first applications were introduced by Brearley
  - Cutlery and knifes
- Thorough characterization was required before stainless steel could find a broader use
- Research on stainless steel increased rapidly and improvements and data were coming fast.

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The 1920's

- The success came in the 1920's
- Efficient production processes were developed
- Many companies began producing the alloys
- The austenitic (nickel-alloyed) grades became dominating
- Intergranular corrosion was the big drawback for stainless steel

- The Avesta catalogue from 1927.

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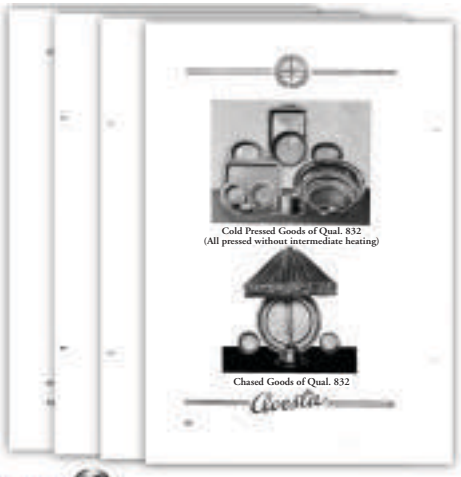

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Outokumpu's mill in Avesta

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The 1930's

- Stainless steel becomes an established product
- Avesta introduce the Duplex Stainless Steel
  - Combines the beneficial properties of ferritic and austenitic steels
- The American Iron and Steel Institute (AISI) standardize stainless steel (e.g. 304, 316)
- R&D makes continuous improvements
  - E.g. the Ti and Nb stabilized grades solves the problem with intergranular corrosion until the low carbon grades

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Autoclave in duplex 4535 for production of gunpowder (1933).

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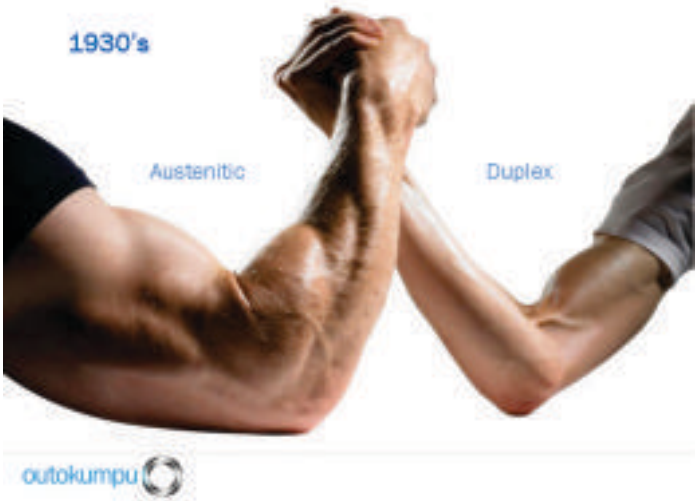

Outokumpu Contributing to the rapid Development

No other Stainless Steel producer can match Outokumpu's technical knowledge

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The 1940's

- Precipitation hardened (PH) martensitic grades, e.g. 17-4 PH and 17-7 PH, are developed in the USA
  - High mechanical strength
  - E.g. aerospace and military applications, press plates, springs

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The 1950's

- Nickel shortages led to development of less expensive manganese alloyed stainless steels
  - Manganese replace Nickel as austenite former
  - Strong but limited corrosion resistance
  - Used for cutlery, pots and pans

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The 1950's – The Avesta mill


Ingot casting


Hot rolling


Cold rolling

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The 1950's - Process innovations

- Process development
  - Steckel mill – thinner and faster hot rolling
  - Sendzimir mill – thinner cold rolling with better tolerances

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The 1960's – Process innovations

- The ADD converter is introduced
  - Low carbon "L"-grades are made possible
    - 304L & 316L - C ≤ 0,030%
    - "L" grades can replace Ti and Nb alloyed grades with respect to preventing intergranular corrosion
  - Alloying with nitrogen made possible which leads to new possibilities

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The 1960's

- Continuous casting of stainless steel is introduced

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Stainless steel growth 1950 - 2010

- ~5.5% annual growth

Source: ISSF – International Stainless Steel Forum

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The 1970's

- Micro alloying lead to innovations in high temperature grades, e.g. 253 MA
  - Twice the strength of 310S
  - e.g. automotive, energy and heat treatment application

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The 1980's – Innovations reach a new level

- 6 Mo grades for the booming off-shore industry
  - Superaustenitic 254 SMO
    - High molybdenum and nitrogen

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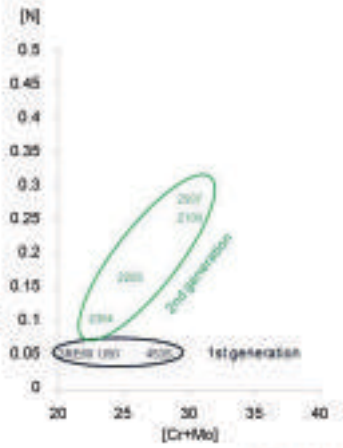
The 1980's

- Development of the 2nd generation of Nitrogen alloyed duplex grades were made possible by the AOD converter
  - 2304
  - 2205
  - 2507
- Duplexes are found suitable for many applications thanks to excellent strength and corrosion resistance



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Duplex Era starts in 1980's

Drinking Water from sea water
Desalination needs Super Duplex Stainless Steel

2205 have great success in chemical tankers

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The 1980's

- Life Cycle Cost considerations starts to make stainless steel interesting as a substitute to coated carbon steel
- Continued development of the successful micro alloyed grade for high temperature applications
  - 153 MA
  - 353 MA

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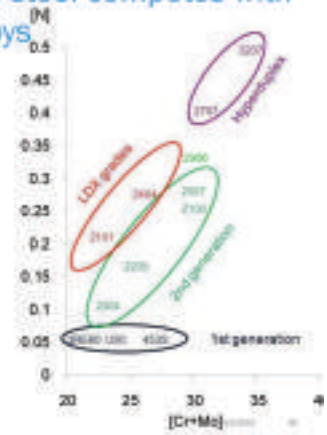
The 1990's – Stainless steel competes with nickel and titanium alloys

- Continued development of duplex grades
  - Hyperduplex
    - 2707 HD
    - 3207 HD
  - Lean Duplex grades
- Super austenitic grades
  - 654 SMO
  - 866



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Superaustenitic stainless steel

- Improving the chemical industry

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The 1990's – Stainless steel competes with carbon steel as a constructions material

- Stainless viewed as a construction material
- A result of
  - More efficient production – price relation to other materials improve
  - High strength duplex grades
  - Life Cycle Cost thinking
  - Applications varies from
    - Beams in trams and trains
    - Bridges
    - Car components
    - Storage tanks

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The 2000's – Lean Duplex grades

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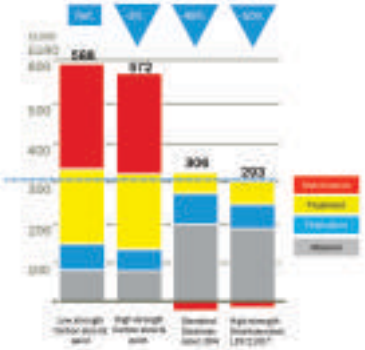
Benefit with high strength stainless steel

Life cycle cost comparing with painted carbon steel, real case

Customer benefits:
- Stainless steel = No paint
- High strength = Lower cost
- 2 meter wide = Lower cost
- Maintenance free
- Higher flexibility of utilization of the tank
- More environmentally friendly



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The 2000's

- Stainless steel makes solar power affordable

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State of the Art

- Formable duplex - A new duplex concept from Outokumpu
  - Outokumpu FDX 25 and FDX 27
- Outokumpu 4420 – New improved alternative to 316
- EDX 2304 – Improved 2304
- Outokumpu 4622 – New ferritic grade from Outokumpu
- New surface finishes – $2R^2$ and more!

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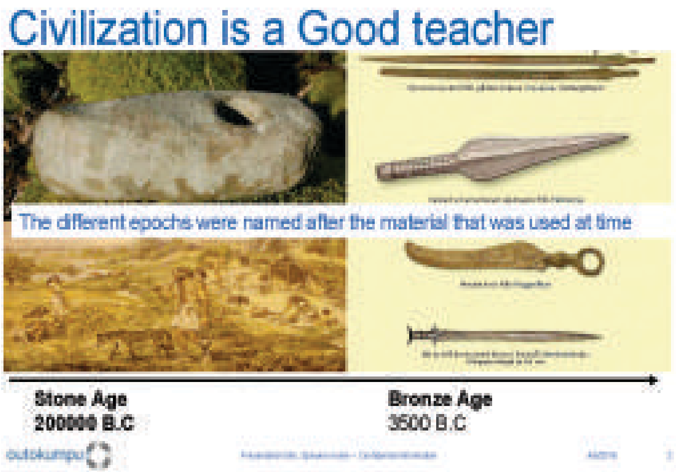
Deepak Vaidya
Outokumpu India


Civilization is a Good teacher
The different epochs were named after the material that was used at time
Stone Age
200000 B.C
Bronze Age
3500 B.C
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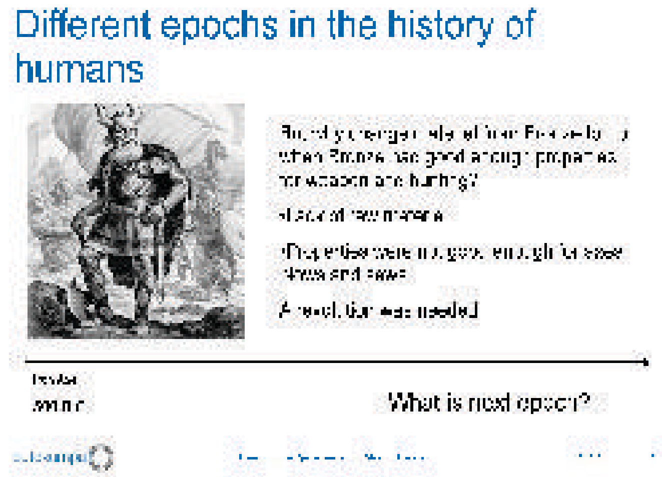
Different epochs in the history of humans
What is next epoch?
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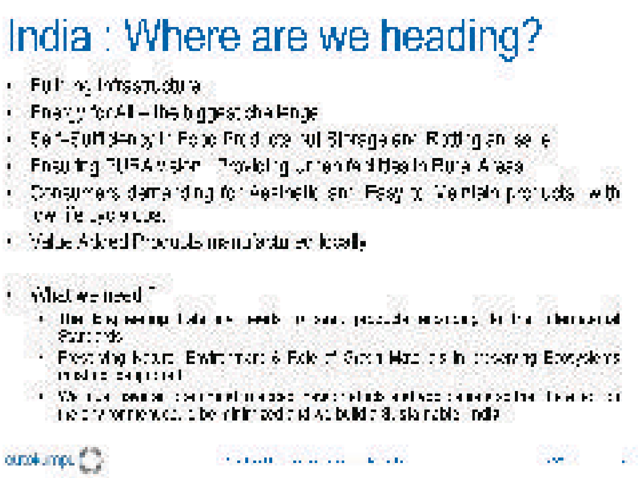
India : Where are we heading?
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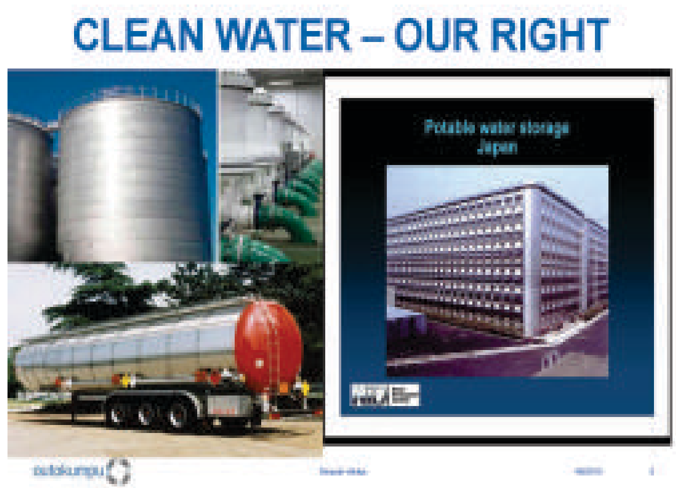
CLEAN WATER – OUR RIGHT
Potable water storage
Japan
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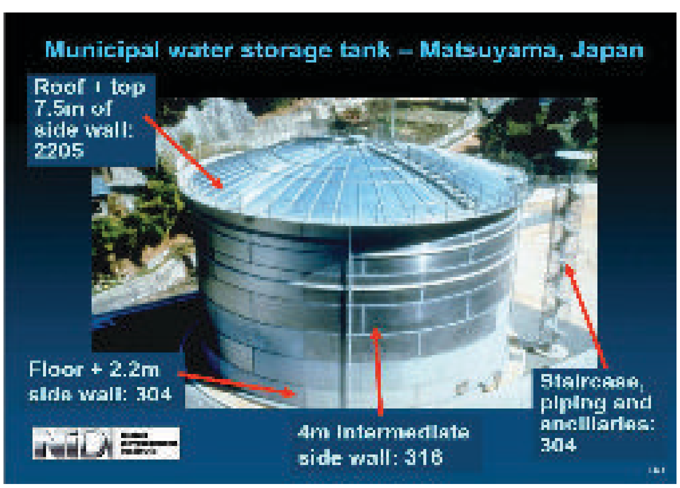
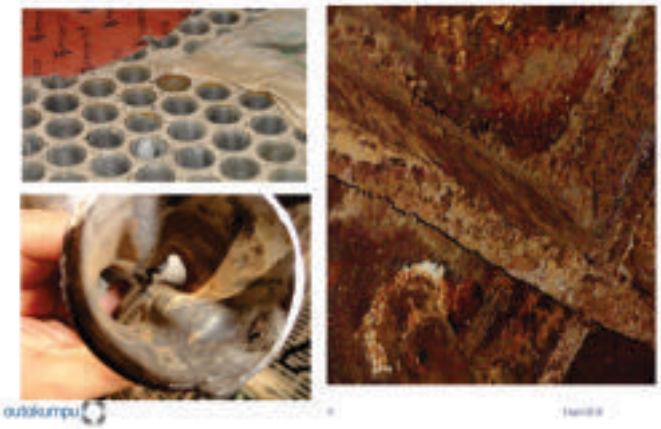

Municipal water storage tank – Matsuyama, Japan
Roof + top 7.5m of side wall: 2205
Floor + 2.2m side wall: 304
4m intermediate side wall: 316
Staircase, piping and ancillaries: 304


OUTOKUMPU
Is Committed to the environment

This is not INDIA of our dreams

Heritage : more than 1000 years of life

Food .. Let us stop rottening it




Stainless Product Forms
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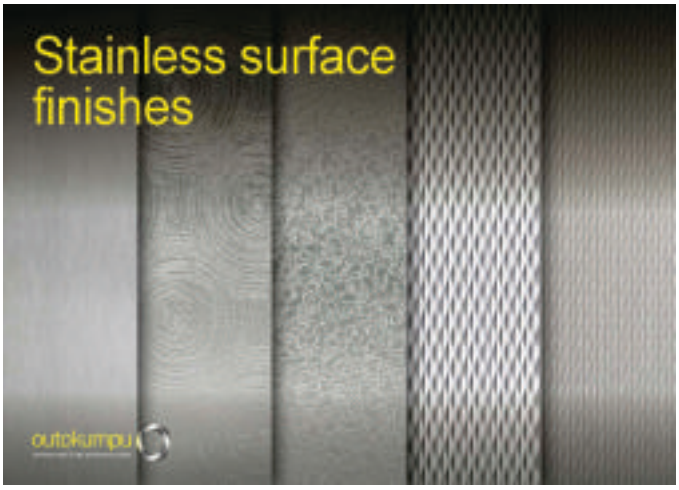
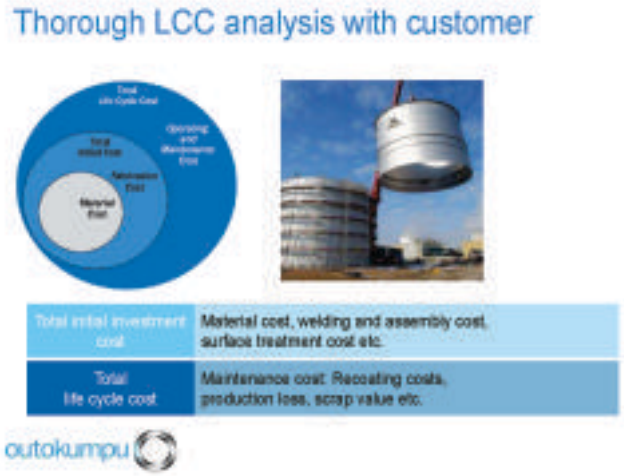
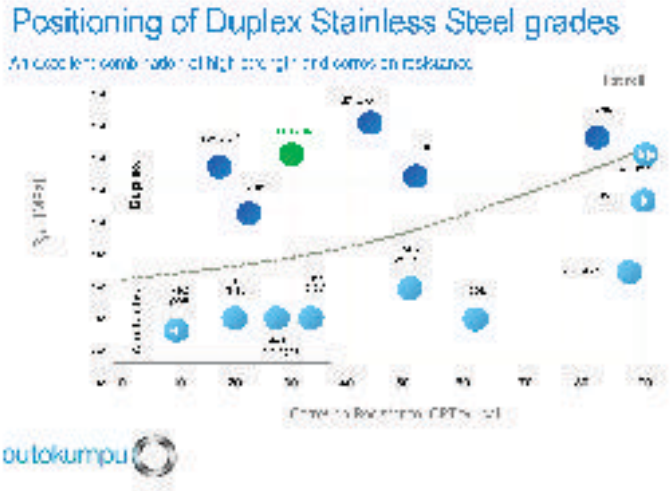
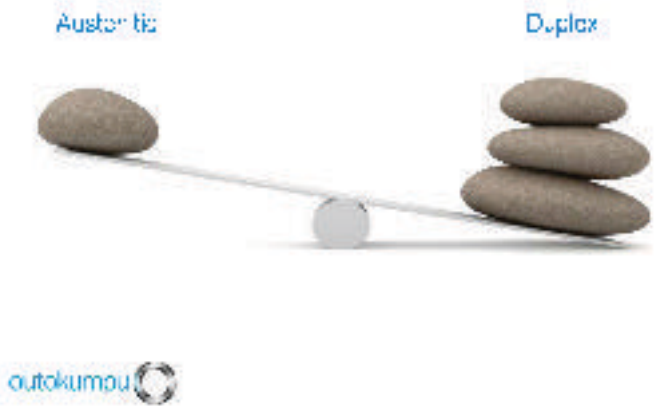

Stainless surface finishes
outokumpu


Thorough LCC analysis with customer
Total initial investment cost
Material cost, welding and assembly cost, surface treatment cost etc.
Total life cycle cost
Maintenance cost: Recoating costs, production loss, scrap value etc.
outokumpu


Positioning of Duplex Stainless Steel grades
Duplex
outokumpu


Austenitic
Duplex
outokumpu


The world's first foot bridge in Outokumpu Duplex LDX 2101®
outokumpu

First stainless railway bridge in the world!

outokumpu

Duplex Stainless Steel in Bridges

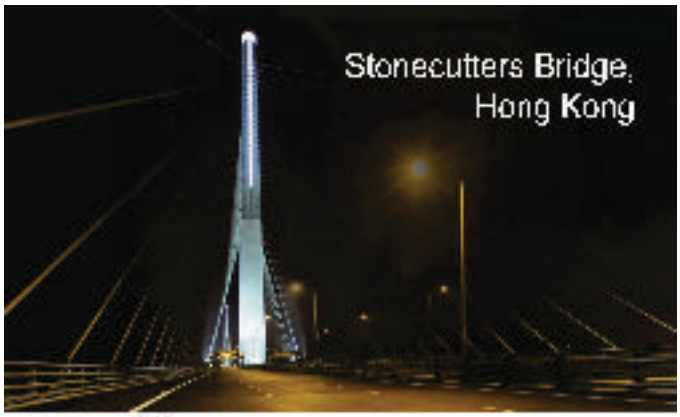
Over the last 10 years stainless steel has emerged as a material in all areas of bridge construction.

For instance

- Critical components
- Loadbearing structures
- Reinforcement
- Or simply as a material for the complete bridge

During this development one class of stainless steel has come to the forefront ... The Duplex Stainless Steels

outokumpu



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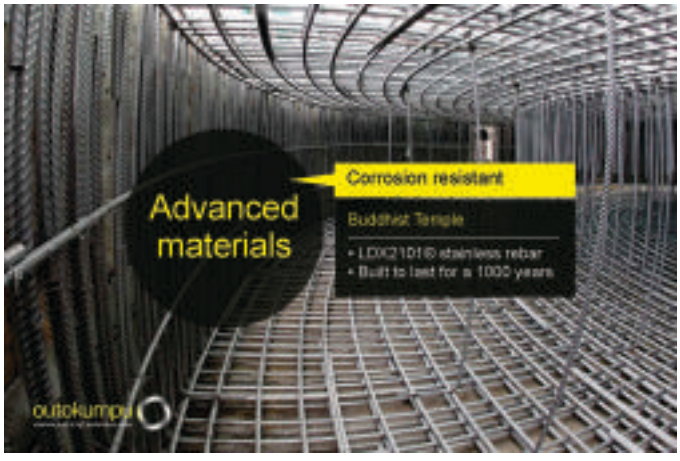
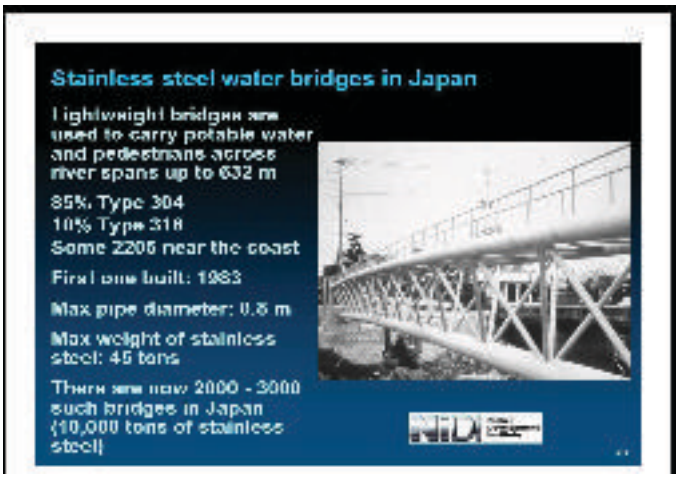



Advanced materials
Aesthetic material
Birmingham's New Street station


Advanced materials
Cost efficiency
Chrysler building


Stainless Steel for Elevated Structures
Skywalk Railings – Safety – light weight structure – low maintenance – elegant look

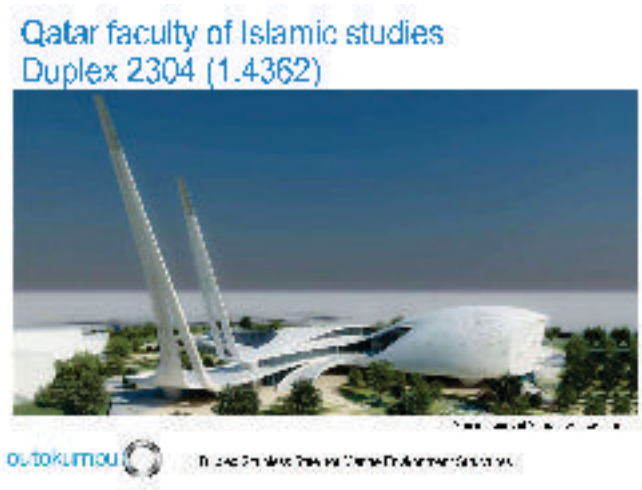

Stainless steel water bridges in Japan
Lightweight bridges are used to carry potable water and pedestrians across river spans up to 632 m
85% Type 304
10% Type 316
Some 2205 near the coast
First one built: 1983
Max pipe diameter: 0.8 m
Max weight of stainless steel: 45 tons
There are now 2000 - 3000 such bridges in Japan (10,000 tons of stainless steel)


Outokumpu LDX 2101 replacing carbon Steel! Footbridge in India, length 42 meter
Calculated safe weight saving is 32%

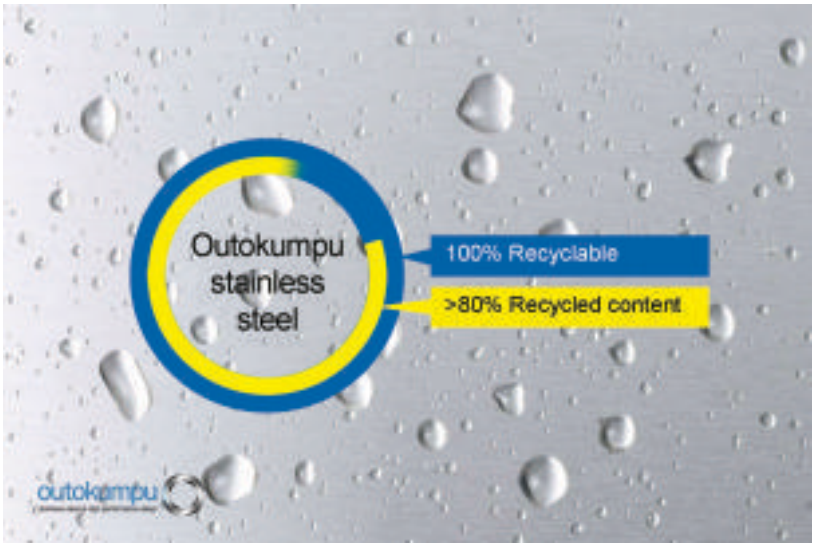

Bus Shelters, India
Outokumpu LDX 2101 versus type 304
Weight saving 20% when selecting LDX 2101
Also better corrosion resistance!


A new Duplex Steel landmark


Qatar Foundation New Headquarters
Outokumpu Added value in a nutshell


Qatar faculty of Islamic studies
Duplex 2304 (1.4362)


Outokumpu leads in sustainability in stainless industry
Recycled content of Outokumpu steel is 90% against the industry average of 60%.
Dow Jones Sustainability Index: Outokumpu is an industry benchmark in environmental dimension; Best environmental score globally.
Dow Jones Sustainability Indexes


Outokumpu stainless steel
100% Recyclable
>80% Recycled content


Some things
should last
forever.
outokumpu

voestalpine Bohler Application Technology Centre

Roshan Rampure

What is Stainless Steel?

- Iron alloy bearing >11% Chromium and <0.12% Carbon
- Build-up of a self-healing surface layer (passive layer ~ 0,0025 µm) which provides the corrosion resistance

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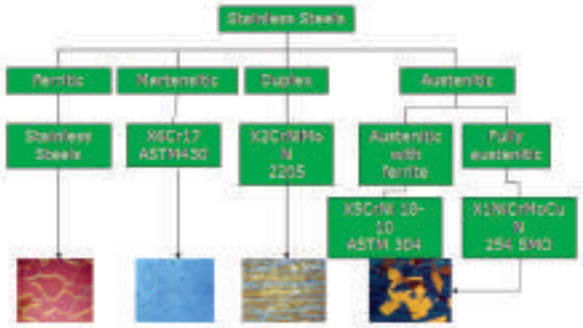
Microstructure



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Welding of austenitic stainless steels

Austenitic steels are very well suited for welding, but unsuitable handling can cause problems in the base material and in the weld metal:

- Sensitisation, i.e. a reduction in the resistance to corrosion due to the formation of chromium carbide
- Hot cracking, i.e. separation of grain boundaries during solidification, or in the highly heated HAZ when rigidly fixed
- Embrittlement, i.e. the precipitation of intermetallic phases such as sigma phase through exposure to high temperatures or annealing

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Welding of austenitic stainless steels

Welding technology:

- Only grades corresponding to the base material and ferrite contents of 5-15 FN should be used. The ferrite content ensures sufficient resistance to hot cracking.
- Preheating is generally not necessary; interpass temperature should not exceed 150°C.
- Heat treatment after welding should be avoided.
- Chipping hammers and brushes made from stainless steel are necessary

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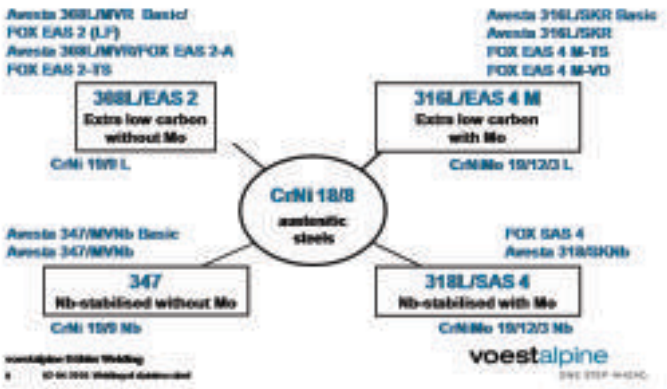
High-alloyed stick electrodes for common austenitic stainless steels



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Effects of Delta-ferrite

The effect of Delta-ferrite in an austenitic weld metal (basically, also applies to the steel material):

Reasons		Consequences when exceeding critical limit	
Delta ferrite content is unwanted			
• Requirement for non-magnetic weld metal	FN=0	• Magnetizability	
• Particular corrosion stress	FN=0.5	• Selective corrosion	
• Use at very low temperatures	FN=0.5	• Loss of toughness	
• Use at very high temperatures	FN=0.5	• Phase precipitation	
Low delta ferrite proportion is advantageous			
• High resistance hot cracking, including thick-walled components		• Risk of hot cracking	FN=3
• Usage temperatures between -196 and +400°C	FN=3-15	• Loss of toughness	FN=5
		• Phase precipitation	FN=15
• Non-corrosive chemical stress		• Selective corrosion	FN=15
High delta ferrite content is required			
• Resistance to stress corrosion cracking	FN=30-75	• Reduced resistance to stress-corrosion cracking	FN=30
• Increase in strength	FN=30-75	• Reduced toughness	FN=75
• Compensation for the dilution when welding dissimilar joints	FN=15-25	• Reduced strength	FN=30
		• Risk of hot cracking from dilution	FN=15

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Welding dissimilar joints

Base and filler material	C	Si	Mn	Cr	Ni	Mo	Nb	Cr-Eq.	Ni-Eq.	Pr
1.0114 S235JO	0,15	0,50	1,0	-	-	-	-	0,75	3,0	A
1.4580 X6CrNiMoNb17-12-2	0,05	0,50	1,2	17,0	11,9	2,2	0,5	20,2	14,0	B
Avesta 309L	0,02	1,0	1,2	23,0	12,0	-	-	24,5	13,2	C

Cr-Equivalent = % Cr + % Mo + 1,5 x % Si + 0,5 x % Nb

Ni-Equivalent = % Ni + 30 x % C + 0,5 x % Mn

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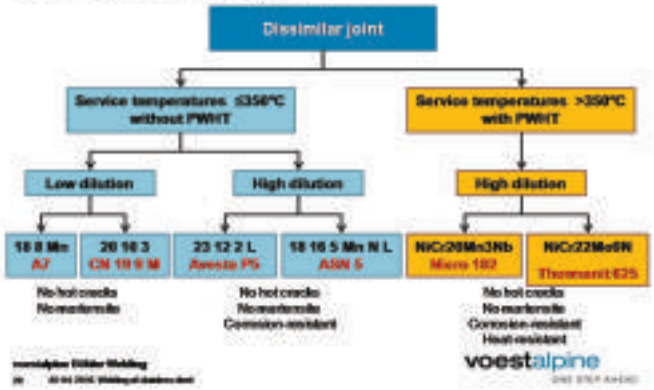
Welding dissimilar joints



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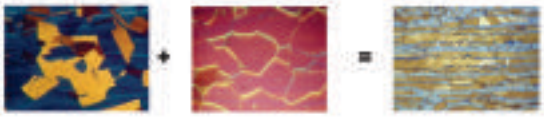
DUPLEX STEELS - Microstructure



Austenitic | Ferritic | Duplex

Duplex steels combine the austenitic and ferritic properties

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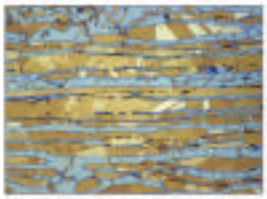
DUPLEX STEELS - Microstructure

BASE MATERIAL
Controlled cooling
-> Ferrite 50%

WELD METAL
Cooling rate can vary
-> Ferrite 20-70%



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DUPLEX STEELS - Chemical composition

Grade	ASTM	EN	Chemical composition (typical values wt-%) C (max)	N	Cr	Ni	Mo	Mn
LDX 2101®	S32101	1.4162	0.02	0.22	21.5	1.5	0.3	5
Filler LDX	-	(23 7 N L)	0.03	0.16	23.5	7	<0.5	0.8
2304	S32304	1.4362	0.02	0.10	23	5	<0.3	1.5
Filler 2304	-	(23 7 N L)	0.02	0.12	24.5	8	<0.3	0.8
2205	S32205	1.4462	0.02	0.17	22	6	3.1	1.5
Filler 2205	E2209	22 9 3 N L	0.02	0.16	23	8.5	3.2	0.8
2507	S32750	1.4410	0.02	0.27	25	7	4	1.5
Filler 2507	E2594	25 9 4 N L	0.03	0.23	25.5	10	4	1.2

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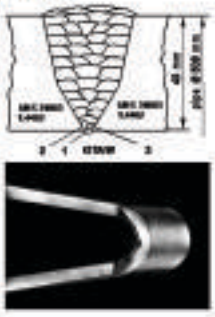
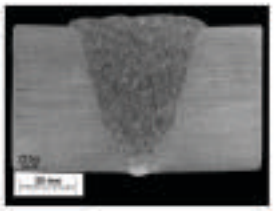
Pipe welded with CN22/9PW-FD Ø1,2 mm





- Shielding gas: Ar + 20%CO_2
- IPT: 150°C (300°F)
- Preheating: ~100°C (~210°F)
- Welding position: 5G

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Stainless Steel – Passive layer

Is stainless steel always stainless?

- Above 11% Chromium ⊃ Thin invisible surface of chromium oxide = passive layer
- Passive layer ~ 25 Å (0,0025 µm)

- Local break-down of passive layer or disturbance of the self healing process gives ⊃

⇒ CORROSION

Answer: NO!

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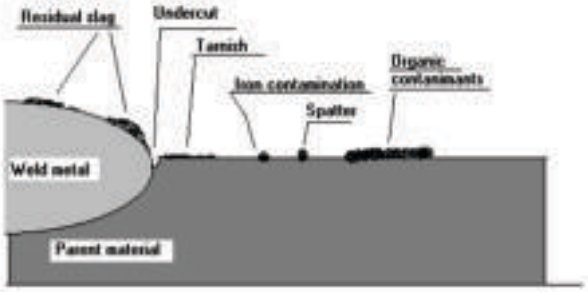
Stainless Steel – Surface defects



Stainless Steel – Chromium depleted zone

Heat treatment or welding disturbs the chromium content of the metal

1. Heat oxide 50-60 wt % Cr
2. Chromiumdepleted zone <10 wt % Cr
3. Base metal >18 wt % Cr

Layers 1 and 2

MUST BE REMOVED!

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Chemical method: Pickling

Removes surface defects through a controlled corrosion that selectively removes the least corrosion resistant areas, (the chromium depleted zone).

- Removes heat oxide, Chromium depleted zone and Iron contaminations.
- The acid combination of Hydrofluoric/ Nitric acid penetrates the heat oxide and dissolves the weak points through corrosion.
- Finally promotes the reformation of the passive layer.

PICKLING DOES NOT DISSOLVE OIL AND GREASE.

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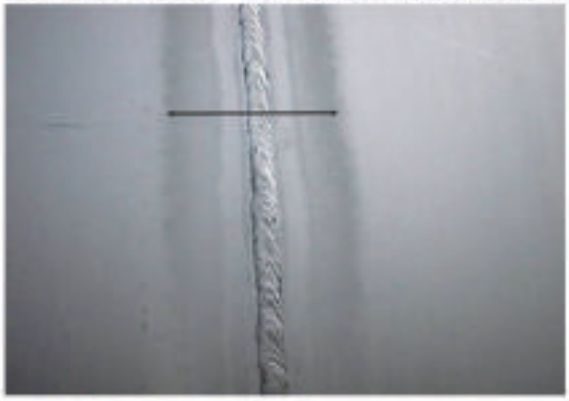
Stainless Steel – Chromium depleted zone



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Cleaning methods – Comparison

GRINDING POLISHING PICKLING

talpine

Pickling - Applications

voestalpine Böhler Welding

voestalpine
ONE STEP AHEAD.

Complete range of products for pickling and cleaning stainless steel

- Paste / Gel
- Solution
- Bath
- Cleaning
- Neutralising
- Passivating
- Accessories

All pickling products conform to international standards:
ASTM A-380, BSI CP-3012, KWU RE-AVS 8, RCCM F-5000-6000

voestalpine Böhler Welding
21 02-04-2016 Welding of stainless steel

voestalpine
ONE STEP AHEAD.

DEMAND/ AVAILABILITY SCENARIO FOR STAINLESS STEEL IN INDIA

INDUSTRIAL DEVELOPMENT SERVICES PVT. LTD.

Partners for Business Excellence

Mr. D.P. Gupta
Director

This presentation is based on in-house research carried out by the IDS team.

BRIEF HISTORY OF SS IN INDIA

Production of SS commenced in India with the setting up of Alloy Steel Plant, Durgapur in mid- 60s.

Domestic capacities increased with the setting up of units like Bihar Alloy Steels (Patratu), Shri Ishar Alloy Steels (Indore), Mukand (Kalwe), Jindal Stainless (Hissar), Ahmedabad Advance Mills (Ahmedabad), etc. during the early to mid 70s.

Salem Stainless Steel Plant (Salem) was commissioned during early 1980's. Panchmahal Steels also commenced production of SS during this period.

1980s witnessed mushroom growth of induction furnace units – many of these exclusively for the manufacture of stainless steel. Such units were spread over Delhi, Haryana, Indore and Ahmedabad.

BRIEF HISTORY OF SS IN INDIA (CONTD...)

Shah Alloys & Viraj Profiles took up the manufacture of SS in early 1990s.

Domestic production of stainless steel increased from a modest 25 Th.T in 1975-76 to almost 2.8 Mn.T in 2014-15, at an ACGR of 12.5% per annum.

Kitchenware accounted for over 90 percent of the aggregate consumption of SS in the country till the year 2000. Its share has gradually reduced to a current level of around 65 percent.

India currently accounts for a share of around 7 percent of world consumption of stainless steel.

MAJOR CATEGORIES OF PRODUCTS IN STAINLESS STEELS

- **Flat Products**
  - Slabs
  - HR Coils/Sheets
  - CR Coils/Sheets
- **Long Products**
  - Primary
    - Blooms/Billets
    - Rolled Bars
    - Wire Rods
    - Structurals
  - Down Stream
    - Bright Bars
    - Drawn Wires
    - Flanges
    - Fasteners

MAJOR PRIMARY MANUFACTURES OF SS FLAT PRODUCTS

Northern Region	• Jindal Stainless Steel Ltd., Hisar (Haryana)
Western Region	• Shah Alloys Ltd., Kalol (Gujarat)
Eastern Region	• Jindal Stainless Steel Ltd., Jajpur (Odisha)
Southern Region	• Salem Steel Plant, SAIL, Salem (Tamil Nadu)

MAJOR PRIMARY MANUFACTURES CAPACITY OF SS FLAT PRODUCTS

Name of Company	Capacity (Th TPA)
Northern Region	
Jindal Stainless Steel Ltd, Hisar	800
Western Region	
Shah Alloys Ltd, Kalol	300
Eastern Region	
Jindal Stainless Steel Ltd, Jajpur	1000
Southern Region	
Salem Steel Plant, SAIL, Salem	180

COMPANY-WISE PRODUCT MIX FOR SS FLAT PRODUCTS

Company	HR Coil	HR Sheet / HR Plate	CR Coil	CR Sheet
Northern Region				
Jindal Stainless Steel Ltd., Hisar	•	•	•	•
Western Region				
Shah Alloys Ltd., Kalol	•	•	•	•
Eastern Region				
Jindal Stainless Steel Ltd., Jajpur	•	•	•	•
Southern Region				
Salem Steel Plant., Salem	•	•	•	•

Major primary manufacturers of SS Long Products

Northern Region

- Ambica Steels Ltd., Sahibabad(Uttar Pradesh)
- Rimjhim Ispat Ltd. ,Kanpur(Uttar Pradesh)
- Rathi Udyog , Ghaziabad(Uttar Pradesh)
- Rathi Super Steel ,Ghaziabad(Uttar Pradesh)

Western Region

- Chandan Steel Ltd., Umergaon (Maharashtra)
- Facor Steels Ltd., Nagpur(Maharashtra)
- Girodia Special Steels, Khopoli (Maharashtra)
- India Steel Works, Khopoli (Maharashtra)
- Laxcon Steel Ltd., Ahmedabad(Gujarat)
- Shah Alloys Ltd., Kalol(Gujarat)
- Mittal Corp, Pithampur(Madhya Pradesh)
- Mukand Ltd., Mumbai(Maharashtra)
- Panchmahal Steels Ltd., Kalol (Gujarat)
- Rajputana Stainless Steel Ltd., Jodhpur(Rajasthan)
- Ratnesh Metal, Ahmedabad(Gujarat)
- Shree Jay Jagdamba SS Ltd., Thane(Maharashtra)
- Sunflag Iron & Steel Ltd., Nagpur (Maharashtra)
- Viraj Profiles Ltd., Boisar (Maharashtra)

Eastern Region

- Arcese, Howrah(West Bengal)

Company-wise Aggregate Installed Capacity for SS Long Products

Name of Company	Capacity (Tk TPA)
Northern Region	
Ambica Steels Ltd., Sahibabad(Uttar Pradesh)	80
Rimjhim Ispat Ltd ,Kanpur(Uttar Pradesh)	120
Rathi Udyog , Ghaziabad(Uttar Pradesh)	30
Rathi Super Steel ,Ghaziabad(Uttar Pradesh)	30
Western Region	
Chandan Steel Ltd., Umergaon (Maharashtra)	60
Facor Steels Ltd., Nagpur(Maharashtra)	20
Girodia Special Steels, Khopoli (Maharashtra)	20
India Steel Works, Khopoli (Maharashtra)	80
Laxcon Steel Ltd., Ahmedabad(Gujarat)	60
Shah Alloys Ltd., Kalol(Gujarat)	100
Mittal Corp, Pithampur(Madhya Pradesh)	120
Mukand Ltd., Mumbai(Maharashtra)	100
Panchmahal Steels Ltd., Kalol (Gujarat)	150
Rajputana Stainless Steel Ltd., Jodhpur(Rajasthan)	40
Ratnesh Metal, Ahmedabad(Gujarat)	20
Shree Jay Jagdamba SS Ltd., Thane(Maharashtra)	20
Sunflag Iron & Steel Ltd., Nagpur (Maharashtra)	60
Viraj Profiles Ltd., Boisar (Maharashtra)	528
Eastern Region	
Arcese, Howrah(West Bengal)	20

Company-wise Product Mix for SS Long Products (Primary Products)

Name of Company	Primary Products		
	Blooms / Billets/ Rolled Bars	Wire Rods	Structurals
Northern Region			
Ambica Steels Ltd.	*		*
Rimjhim Ispat Ltd.	*	*	
Rathi Udyog	*	*	
Rathi Super Steel	*	*	
Western Region			
Chandan Steel Ltd.	*		*
Facor Steels Ltd.	*		
Girodia Special Steels	*		
India Steel Works	*	*	
Laxcon Steel Ltd.	*		*
Shah Alloys Ltd.	*	*	
Mittal Corp.	*	*	
Mukand Ltd.	*	*	
Panchmahal Steels Ltd.	*	*	
Rajputana Stainless Steel Ltd.	*	*	
Ratnesh Metal	*		*
Shree Jay Jagdamba SS Ltd.	*		
Sunflag Iron & Steel Ltd.	*	*	
Viraj Profiles Ltd.	*	*	*
Eastern Region			
Arcese	*		

Company-wise Product Mix for SS Long Products (Downstream Products)

Name of Company	Downstream Products			
	Bright Bars	Wires	Plungers	Fasteners
Northern Region				
Ambica Steels Ltd.	*			
Rimjhim Ispat Ltd.	*	*		
Rathi Udyog				
Rathi Super Steel				
Western Region				
Chandan Steel Ltd.	*	*	*	
Facor Steels Ltd.				
Girodia Special Steels				
India Steel Works	*	*		
Laxcon Steel Ltd.	*			
Shah Alloys Ltd.	*	*		
Mittal Corp.				
Mukand Ltd.		*		
Panchmahal Steels Ltd.		*		
Rajputana Stainless Steel Ltd.				
Ratnesh Metal				
Shree Jay Jagdamba SS Ltd.	*			
Sunflag Iron & Steel Ltd.				
Viraj Profiles Ltd.	*	*	*	*
Eastern Region				
Arcese				

Aggregate Capacity

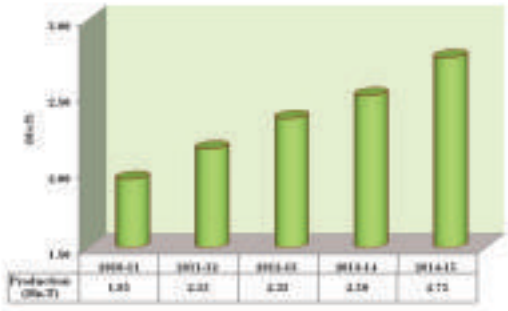
Current Hot Metal Capacity – 6.0 Mn.T/Annum

Break-up of Hot Metal Capacity based on Type of Furnace

Leading Players

Segment	Market Share
a) SS Flat Products	
Jindal Stainless Steel Ltd.	47 %
b) SS Long Products	
Viraj Profiles Ltd.	38 %

Domestic Production of SS



Production increased @ACGR of 8.8%

Apparent Domestic Consumption of SS

(Mn.T.)

Year	Domestic Production	Import	Export	Apparent Consumption
2010-11	1.95	0.07	0.03	1.99
2011-12	2.15	0.08	0.04	2.19
2012-13	2.35	0.09	0.04	2.40
2013-14	2.50	0.14	0.05	2.59
2014-15	2.75	0.20	0.05	2.90
				(ACGR 9.7%)

Major Export Destinations : 2014-15

Exports are mainly of manufactured products like Drawn Wire, Flanges and Fasteners to the following countries:

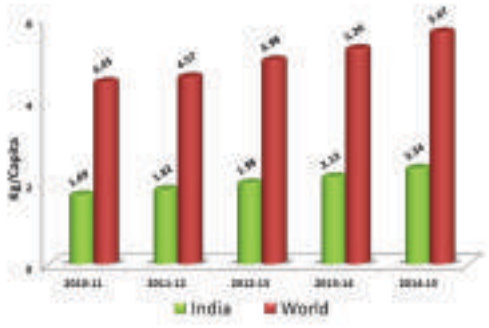
- AUSTRALIA
- BELGIUM
- BRAZIL
- CANADA
- FRANCE
- GERMANY
- ITALY
- KOREA RP
- MEXICO
- NETHERLAND
- RUSSIA
- TURKEY
- U S A

India's Share in Global Consumption

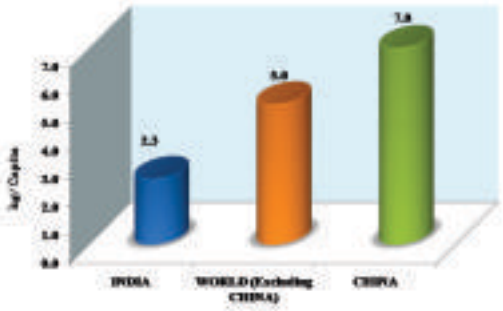
(Mn.T)

Year	India	World	India's Share (%)
2010-11	2.0	30.7	6.5
2011-12	2.2	32.0	6.9
2012-13	2.4	35.4	6.8
2013-14	2.6	38.1	6.8
2014-15	2.9	41.7	7.0

Per Capita Consumption : 2010-11 to 2014-15



Per Capita Consumption of SS : 2014-15



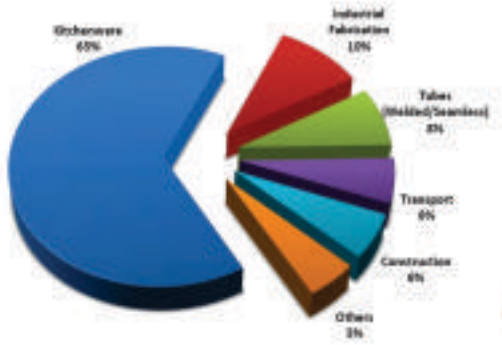
Current Pattern of Domestic Consumption: 2014-15

a) Aggregate Consumption	2.9 Mn. T
b) Break up by Categories	
Share of Flat Products	72%
Share of Long Products	28%
c) Break up by Grades	
Grade/Series	
300	57%
200	28%
400	15%
Others	Neg

Series Wise Applications of Stainless Steel

200	300	400
Utensils, cutlery and cookware	Storage vessels and pipes for corrosive liquids	Petrochemical equipments
Dishwashers and washing machines	Mining, chemical, food and beverage equipment	Automotive exhaust systems
Furniture, hardware, stair ace and sinks	Cryogenic and pharmaceutical equipment	Heat exchangers and furnaces
Automotive components	Furnace, kiln and catalytic converter components	Food processing equipment and Appliances
	Pressure vessels and piping	

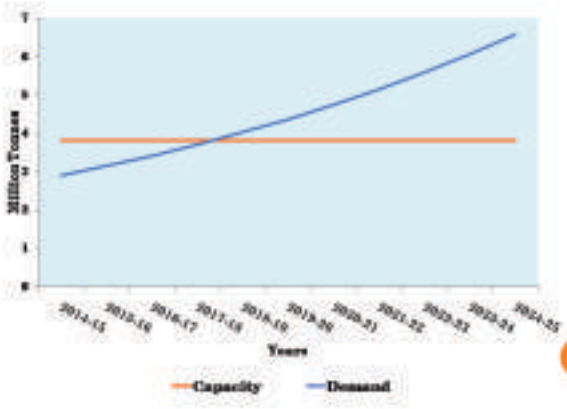
End-use wise pattern of domestic consumption: 2014-15



Demand Projections

ACGR (2010-11 to 2014-15)	9.7 %
Projected Growth Rate 2014-15 to 2024-25	8.5 %
Projected Consumption 2024-25	6.5 Mn.T

Rolling Capacity vs Demand Analysis



Emerging Demand Availability Scenario

Existing capacities appear to be adequate to meet the projected requirements of SS in the country till the year 2017-18.

The domestic availability is likely to fall short of the emerging demand from the year 2018-19 onwards.

Additional domestic capacities therefore need to be created in the post 2017-18 period.

Pictorial Glimpses of the Seminar Proceedings





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