

Growth prospects of alloy and special steel in India

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Introduction

The alloy steels research committee has adopted the following definition: "Carbon steels are regarded as steels containing not more than 0.5% Mn and 0.5% Si; all other steels are alloy steels."

During the last few decades, there has been a growing demand for steel with higher and higher tensile strength coupled with adequate formability, weldability etc. The majority of this demand has come from applications where lightness is desirable, as in the automobile and aircraft industries. Even increasing the carbon content in plain carbon steel cannot improve the maximum strength beyond 680–700 MPa (in the heat treated condition) without loss in ductility and impact resistance.

Plain carbon steels have a number of limitations such as :

- They cannot be hardened over 700 MPa without loss in ductility and impact resistance.
- Depth of hardening is limited. As such, only thin sections can be hardened throughout.
- Poor resistance to corrosion and oxidation.
- Hardening of carbon steels often necessitated water quenching to obtain a fully martensitic structure, accompanied by the danger of distortion and cracking.

In order to overcome these engineering limitations, a number of alloy steels have been developed, which are tailor made to meet different requirements.

General effects of alloying elements

- Alloying additions may induce one or more of the following effects:
- Solid solution strengthening.
- Formation of hard carbides such as Cr₇C₃, W₂C, Mo₂C, VC
- Reduction in critical velocity for formation of martensitic phase. As such strength may be increased without resorting to severe quenching.
- Dispersion of fine carbides of certain elements slows down grain growth and thus improves creep properties.
- Alteration of eutectoid composition and temperature.
- Certain alloying elements such as Cr, Al, Si and Cu tend to produce adherent passive oxide films on the surface resulting in resistance to corrosion and oxidation.

Different agencies have classified alloy and special steels in many ways suiting to particular requirement or need.

Broad classification of alloy and special steels are as follows :

- i) Carbon Constructional Steels (CCS)**
These include high carbon, carbon tool and carbon constructional steels.
- ii) Alloy Constructional Steels (ACS)**
These include ball and roller bearing and other alloy constructional steels.
- iii) Spring Steels (SPS)**
These include carbon, silico-manganese and chrome-vanadium spring steels.
- iv) Free Cutting Steels (FCS)**
These include lead bearing and

sulphur bearing free cutting steels.

v) Heat Resistant and Stainless Steels (STS)

These include valve steels, martensitic, austenitic and ferritic stainless steels.

vi) Alloy Tool and Die Steels (ATDS)

These include hot work, cold work and shock resisting steels.

vii) High Speed Steels (HSS)

These include tungsten base, molybdenum base and other types of high speed steels

viii) Die Blocks (DB)

These include chromium, nickel, molybdenum and vanadium alloy steels from which die blocks for the forging industry are manufactured.

The carbon constructional steels are generally hypoeutectoid steels (Carbon below 0.8%). Low carbon grades (rimming type) have a ferritic structure and high ductility, which is acquired by keeping the silicon content as low as possible as it intensively hardens ferrite. These are used for cold formed parts. Other grades, by virtue of their structures, find applications in variety of uses i.e. from small machine parts not subjected to severe stresses to machine parts requiring high strength (connecting rods, gears, etc.) in either normalized condition or after hardening followed by tempering at a high temperature.

Carbon constructional steels with higher manganese content have higher hardenability. An increase in manganese content increases the wear resistance, tensile strength and



weldability. Carbon constructional steels are also used in the form of cold drawn bars, where the strength is increased by work hardening but ductility is reduced.

Alloy constructional steels are widely employed for parts subjected to both static and dynamic loads. The alloying elements strengthen the ferrite, increase hardenability by delaying the phase transformations, thus reducing the severity of the quench required. A combination of one or more of the alloying elements such as Mn, Ni, Cr, Mo, V etc. is generally used for the purpose. The total amount of alloying elements varies from about 2% to 6% depending upon the desired properties.

Spring steels are generally of three type's viz. carbon, silico-manganese and chrome-vanadium. They require high elastic and fatigue strength and generally care is taken during heat treatment to avoid decarburisation, as it subsequently reduces the fatigue limits.

Free cutting steels are used where easy machining is the primary requirement. The distinguishing features of free cutting steels (high machinability and high quality surface finish after machining) are due to high sulphur /lead content. Sulphur exists in free cutting steels in the form of manganese sulphide, which stretches out in the direction of rolling. Its existence promotes the formation of

short brittle chips, reduces the friction during machining of surface and enables a satisfactory surface finish at high cutting speeds. Phosphorus is dissolved in the ferrite and increases its brittleness. Lead is also used in the range of 0.2-0.5% in free cutting steels, as it's very fine suspension like distribution permits obtaining of short chips and clean surfaces.

Steels resistant to heat and corrosion are called heat resistant and stainless steels. These include valve steels, martensitic steels, austenitic steels and ferritic steels. The valve steels retain its strength and resistance to corrosion at elevated temperatures. Austenitic steels contain both chromium and nickel, total not exceeding about 50% and are most familiar in utensils and cutlery industry. Martensitic stainless steels contain chromium 12-18% and can be heat treated to high hardness. These steels after addition of selenium, sulphur or phosphorus give free machining quality of treatable stainless steels. Ferritic steels are heat resisting stainless steel.

Alloy tool and die steels which contain varying percentages of tungsten, molybdenum, vanadium and chromium are used for making tools and dies for shaping materials in cold and hot state. These steels are characterized by good wear and shock resistance, high toughness, good strength and cutting properties

through the formation of carbides. Alloy tool and die steels with low carbon content have good machinability and moderate hardenability. High carbon, high chromium tool and die steels have higher corrosion and wear resistance, deep hardenability and poor machinability.

High speed steels are mostly of tungsten or molybdenum base containing varying percentages of chromium, vanadium and cobalt. These steels possess superior wear resistant properties along with deep hardenability and fair machinability. These steels retain hardness, strength and cutting properties at high machining speeds.

End-uses

Alloy and special steels find applications in practically all economic sectors through different kinds of products and machinery fabricated by the industries. All machinery and transport equipment need alloy and special steels for original components and spare parts. The use of alloy and special steels is as pervasive as ordinary steels because even if the alloy and special steels are not directly needed in the manufacture of components, the process of cutting and shaping of ordinary steels and other metals into desired form needs tools made of alloy and special steels.

Market Analysis

Analysis

Alloy steels are indispensable both in the form of cutting and shaping tools for the manufacture of equipment and as components of various machinery, equipment and appliances. In addition, production of alloy and special steels is strategic not only from the point of view of critical requirement of industrial growth of the country, but also from its application in the defence needs. While major emphasis was laid for the production of mild steels in sixties and seventies, the efforts towards production of alloy and special steels were inadequate to meet the country's requirements of alloy & special steels. This has resulted in imports of large quantities of various categories of alloy and special steels in the country in the past, causing drainage of valuable foreign exchange. However, in recent years India has started exporting of alloy & special steels to various countries. Besides, during the last one decade, globalization has propelled growth in Indian economy and industries resulting higher domestic demand of steel. In view of this, it is necessary to analyse market scenario of alloy and special steels and its growth prospects to meet the growing needs of the manufacturing and other engineering industries in the country as well as export demand.

Since alloy and special steels are used either as input material for production of components in various engineering industries or as tools and accessories to shape metals and other materials, its demand would depend on the demand for the finished products of these consuming industries. As such, an overview of end-using industries and its future potential for development is required to look into. The past consumption pattern of alloy and special steels has been analysed. The demand forecasting has been done based on the past growth pattern and future prospects of the end using industries. Besides, imports and

exports also have been analysed.

In order to analyse supply, the alloy and special steels producers were identified and their existing capacity and past production were also analyzed based on available information. The availability projections are worked out based on the existing/upcoming capacity, present capacity utilization as well as future capacity utilization in the light of higher anticipated future demand.

This paper deals with respect to alloy and special steels excluding stainless steel.

Foreign trade in alloy and special steels

With industrialization in the country, the requirement of all kinds of machinery, transport equipment, metal based goods, etc. has been rising steadily. Further, large export endeavors of engineering goods require larger inputs of alloy and special steels. However, the expansion of alloy and special steels industry during the recent years has taken place commensurate with the increasing demand. However, the production has been lagging behind in respect of some special quality of steel as compared to its demand for which the country has to dependent to a considerable extent on imports for meeting such domestic demand. During the recent past, India has also started exporting a substantial quantity of alloy and special steels to various countries. The imports and exports of alloy & special steel in India are elaborated in the following paragraphs.

Imports

The major drawback in compiling the import data in case of alloy and special steels is the lack of sufficient statistical details. The statistics is compiled for broad product groups and the nomenclature "alloy steel" is often used for all types of alloy and special steels without indicating the type, characteristics, usage etc. Sufficient efforts have been made to

rationalize the data under proper categories of alloy and special steels to the extent possible.

The proper import in the country covers almost all the broad categories of alloy and special steels viz:

- Carbon Constructional Steels
- Alloy Constructional Steels
- Spring Steels
- Free Cutting Steels
- Heat Resistant Steel and Stainless Steel
- Alloy Tool and Die Steels
- High Speed Steels
- Die Blocks

The imports of alloy and special steels (excluding Stainless Steel) during the period 1998-99 to 2007-08 are furnished in table-1 The lion share of imports of alloy and special steels (excluding Stainless Steel) are long products viz. bars & rods and bright bars of free cutting steel, spring steel and tool steels etc.

Table-1
Import of Alloy & Special Steel)
(Excl. Stainless Steel)
(In 000 tonnes)

Year	Import
1998-99	34
1999-00	23
2000-01	24
2001-02	27
2002-03	34
2003-04	216
2004-05	329
2005-06	448
2006-07	554
2007-08	761

Source: DGCI & S, Govt. of India

Countries from where India is importing alloy & special steels are Australia, Austria, Belgium, China, France, Germany, Italy, Japan, Korea RP, Slovak Republic, Slovenia, Sweden, Switzerland, UK, Ukraine & USA.

Exports

The exports of alloy and special steel (excl. Stainless Steel) for a period

1998-99 to 2007-08 are furnished in table-2. Exports of alloy and special steels (excl. stainless steel) had been in the range of 157,000 tonnes to 448,000 tonnes during the period 1998-99 to 2007-08. The major products exported from India are bars & rods and cold rolled high speed steels in coils.

Table-2
Import of Alloy & Special Steel)
(Excl. Stainless Steel)
(In 000 tonnes)

Year	Import
1998-99	157
1999-00	201
2000-01	201
2001-02	174
2002-03	448
2003-04	223
2004-05	129
2005-06	166
2006-07	105
2007-08	197

Source: DGCI & S, Govt. of India

Countries where India is exporting alloy & special steel including stainless steels are Albania, Argentina, Australia, Belgium, Canada, China, Congo, Cyprus, Egypt, Ethiopia, France, Ghana, Guinea, Hongkong, Indonesia, Iran, Israel, Italy, Kenya, Malawi, Malaysia, Morocco, Mozambique, Poland, Portugal, Qatar, Russia, Saudi Arabia, Syria, South Africa, Sudan, Srilanka, Tanzania Uganda, USA and Vietnam.

Demand analysis

Alloy and special steels, in particular, are strategic materials needed in smaller quantities essentially for intricate and sophisticated applications, where improved mechanical properties, high strength characteristics, high resistance to heat, wear and corrosion, excellent surface finish, etc. are called for.

The growth of consumption of alloy and special steels depends on the growth of performance of the end-using industries, development and

education of small users and qualitative shift in consumer attitudes. The alloy and special steels keep the wheels of industries moving, promote the growth of manufacturing and engineering industries, enhance the degree of self reliance and make more sophisticated and strategic materials available to the nation. Alloy and special steels are indispensable to industrial growth as tool for production of machinery and as components of machines because of their high modulus of elasticity, and tensile strength. Also alloy and special steels form strategic basic materials for country's Defence needs.

Alloy and special steels find major usage in sectors such as forging industry, Automobiles & auto component manufacturers, Railways, Defence, Spring manufacturers, Bearing manufacturers, Bright bar manufacturers, Seamless pipes/tubes, HT fasteners and Dies & tools. Out of the above sectors, lion share of alloy

& special steels is consumed by forging and automobile industries.

Market Analysis of alloy and special steels

(excl. stainless steel)

Domestic demand

The apparent consumption of alloy and special steel (excl. stainless steel) for the period from 1998-99 to 2007-08 is furnished in table-3.

It is revealed that there is a growth of about 12% per annum in demand for alloy and special steels during the period 1998-99 to 2007-08. It has recorded an annual growth rate of about 16% during 2002-03 to 2007-08.

Major End-using Industries

The data available for alloy and special steels reveal that about 49% of total demand is consumed by auto and auto ancillary industries. The second largest share in demand is of spring manufacturers (about 11%) followed by seamless steel tubes and pipes manufacturers (about 7%) which are

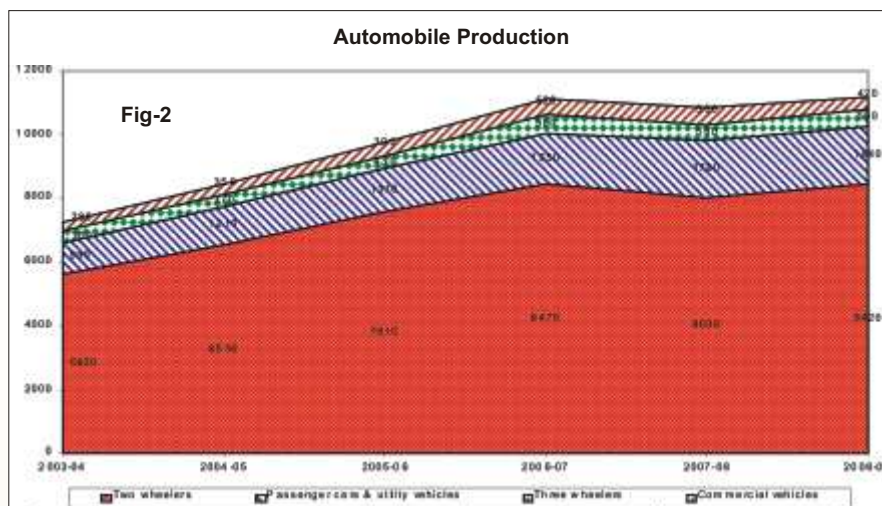
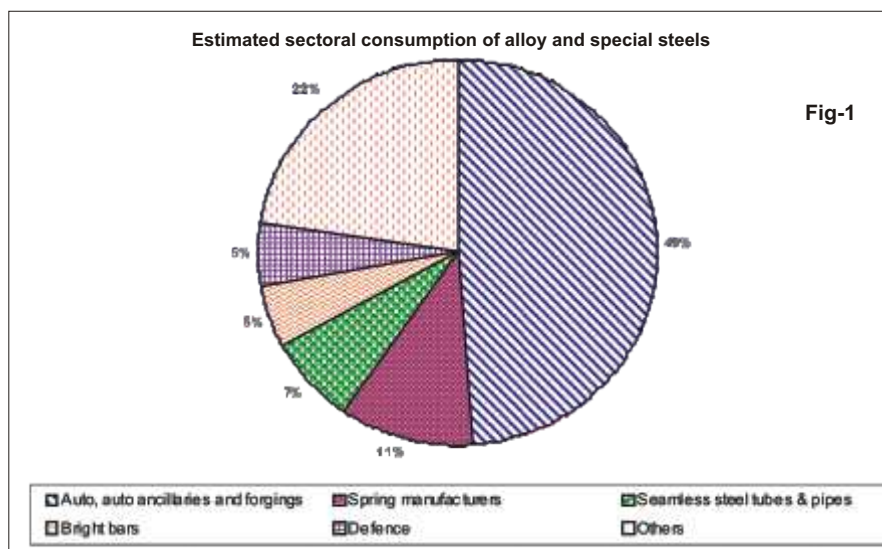
Table-3
Apparent Consumption of Alloy and Special Steels

(In 000 tonnes)

Year	Production	Imports	Exports	Apparent consumption
1998-99	1365	34	157	1242
1999-00	1510	23	264	1269
2000-01	1736	24	201	1559
2001-02	1855	27	174	1708
2002-03	2074	60	448	1686
2003-04	2286	216	223	2279
2004-05	2271	329	129	2471
2005-06	2298	448	166	2580
2006-07	2500	554	105	2949
2007-08	2900	761	197	3464

Table-4
Industry-Wise Demand for Alloy and Special Steel

Sl. No.	Industry category	% Distribution
1	Auto, auto ancillaries and forging	49%
2	Spring manufacturers	11%
3	Seamless steel tubes & pipes	7%
4	Bright bars	5%
5	Defence	5%
6	Other Engg. Industries	22%
	Total	100.0%



having very high demand due to higher growth in its consuming industries like petroleum and petro-products. The other good consumers of alloy and special steels are defence, bright bar manufacturers, railways, fasteners and ball & roller bearing manufacturers. The percentage consumption of major consuming

industry of alloy and special steels are furnished in table-4 along with a graphical presentation in fig-1.

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The demand for alloy and special steels depends mainly on the growth of consuming industries. Therefore, it was thought necessary to have a critical look for growth of major consuming industries like auto industry, auto components industries, capital goods, intermediate goods and consumer durable goods industries for projecting the demand for alloy and special steels.

Automobile Industry

The Indian automobile market is gearing towards international standards to meet the needs of the global automobile giants and become a global hub. Players are strategizing to consolidate their position and gradually increase market penetration with the launch of new models

Table-5
Production of Automobiles

		(In '000 nos.)					
Sl. No.	Type of vehicle	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
1.	Two wheelers	5620	6530	7610	8470	8030	8420
2.	Passenger cars & utility vehicles	990	1210	1310	1550	1780	1840
3.	Three wheelers	360	370	430	560	500	500
4.	Commercial vehicles	280	350	390	520	550	420
5.	Total	7250	8460	9740	11100	10860	11180

Source: SIAM (2009)

targeting different segments. Last five years have not only witnessed faster production but also the technological upgradation, increase in number of players in each segment/categories and change of models over previous years. All the international manufacturers like the Hyundai, Daewoo, General Motors, Mitsubishi, Volvo, Honda, Ford India Ltd., Mitsubishi Motors etc. have entered into Indian economy and have found acceptable production base for themselves. The production of automobiles for a period from 2003-04 to 2008-09 is furnished in table-5 and is depicted graphically in fig-2.

The above table reveals an all round increase in production of all categories of vehicles. Two wheelers have recorded a growth of around 8.4% during the period 2003-04 to 2008-09, while the same for passenger vehicles, three wheelers

and commercial vehicles have been around 13.2%, 6.8% and 8.4% respectively. The growth in the automobile sector as a whole has been of the order of 9.0%.

Keeping in view of the rate of growth of economies and past production of automobiles, it is expected that demand for all these categories of

India has gradually become a sourcing hub of auto-components for the auto companies worldwide. Among the companies outsourcing from India are Volvo, Fiat, Ford, Renault-Nissan, DaimlerChrysler, Toyota, Delphi, Bosch and Cummins to name a few.

It is experienced that India's competitive advantage does not come

Table-7
Index Number of Industrial Production (INIP)

Year	Capital goods	Intermediate goods	Consumer Durable
2003-04	201.5	199.0	265.4
2004-05	229.6	211.1	303.5
2005-06	265.8	216.4	349.9
2006-07	314.2	242.4	382.0
2007-08	370.8	264.1	378.0
2008-09	396.8	256.6	394.8

Source: Planning Commission, Govt. of India.

Table-8
Projected Domestic Demand of Alloy and Special Steels

(Excl. stainless steel)

Sl.No.	Category	Projected Demand	
		2011-12	2016-17
1.	Carbon construction steel & alloy construction steel	3195	4410
2.	Spring Steel	964	1423
3.	Ball Bearing Steel	203	285
4.	Free cutting Steel	330	427
5.	Others (Die blocks, Tool steels, etc.)	380	569
		5072	7113

Table-6
Auto-Component Production and Exports

(Billion USD)

Year	Turnover	Exports
2003-04	6.73	1.27
2004-05	8.70	1.69
2005-06	12.00	2.47
2006-07	15.00	2.87
2007-08	18.00	3.62

Source: 1. Auto Component Manufacturers' Association.

automobiles will increase in the similar fashion in subsequent year.

Auto components

from cost alone, but from its Full Service Supply (FSS) capability. A number of Indian companies with global ambitions are gradually moving towards creating a niche in the world market. The turnover and exports of the auto-components industry have grown with an annual rate of growth of about 28% and 30% respectively during the period 2003-04 to 2007-08 as shown in table-6 and fig-3.

Despite the relatively small share of Asia in the global pie, India is managing to up the numbers. During 2007-08, auto component exports from India were valued at around \$ 3.6 billions and the Automotive Mission Plan (2006-2016) has predicted that this figure will be around US \$ 20-25

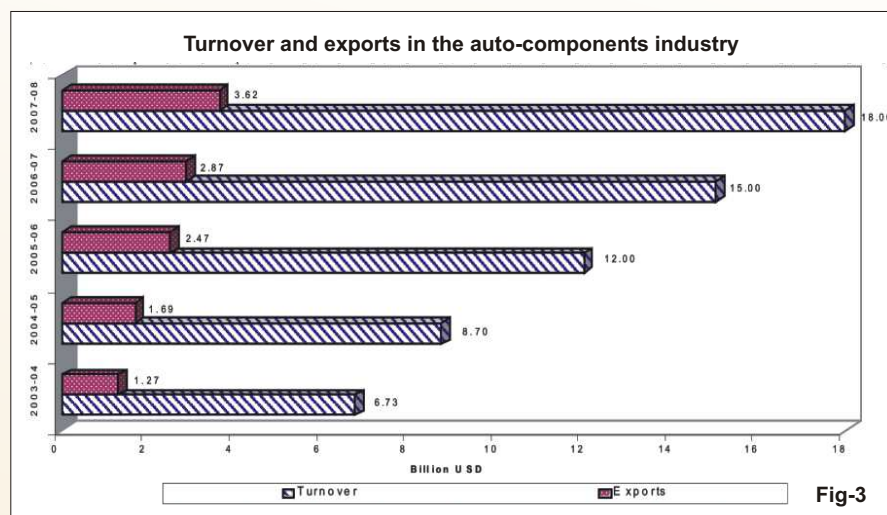


Fig-3

Analysis

billion level by 2015.

Index of Industrial Production (IIP)

The growth of industries is being expressed by index of industrial production (IIP). The use-base

clarification of industrial production has following four components :

- i) Basic goods
- ii) Capital goods
- iii) Intermediate goods
- iv) Consumer goods

- Consumer durable
- Consumer non-durable

It is experienced that alloy and special steels are mainly consumed in the industries like capital goods, intermediate goods and consumer durable. The data on the index number of industrial production of these components for the period 2003-04 to 2008-09 are furnished below. It reveals that all the three categories have recorded a quite high rate of growth rate during the past two years as indicated in table-7.

INIP for Capital goods has recorded a CAGR of 14.5% during the period 2003-04 to 2008-09 whereas the CAGR in INIP for intermediate goods and consumer durables during the same period was of the order of 5.2% and 8.3% respectively.

In view of past growth in consumption of alloy and special steels and emphasis on development of automobile and other engineering industries in the country, the future demand of various alloy and special steels have been worked out considering annual growth rate of 10% upto milestone year 2011-12 and 7% thereafter and presented in table -8.

The category-wise demand has been estimated based on the past demand trend. The total demand for alloy and special steels (excl. stainless steel) works out as around 5.1Mt and 7.1Mt for the milestone years 2011-12 and 2016-17 respectively.

Demand (with exports)

The exports as percentage of apparent consumption of alloy and special steels are ranging between 5% and 27% during the period 1998-99 to 2007-08. The Government of India is making all efforts to boost the exports. For the purpose of projecting demand with export provision, a share of 10% of the domestic demand has been considered and the resultant demand is furnished in table-9.

The projected demand is furnished graphically in fig-4

Table-9

Projected Demand for Alloy and Special Steels

(with Exports) (Excl. stainless steel)

Sl.No.	Category	Projected Demand	
		2011-12	2016-17
1.	Carbon construction steel & alloy construction steel	2477	4851
2.	Spring Steel	839	1565
3.	Ball Bearing Steel	66	313
4.	Free cutting Steel	205	469
5.	Others (Die blocks, Tool steels, etc.)	508	626
	Total	4095	7825

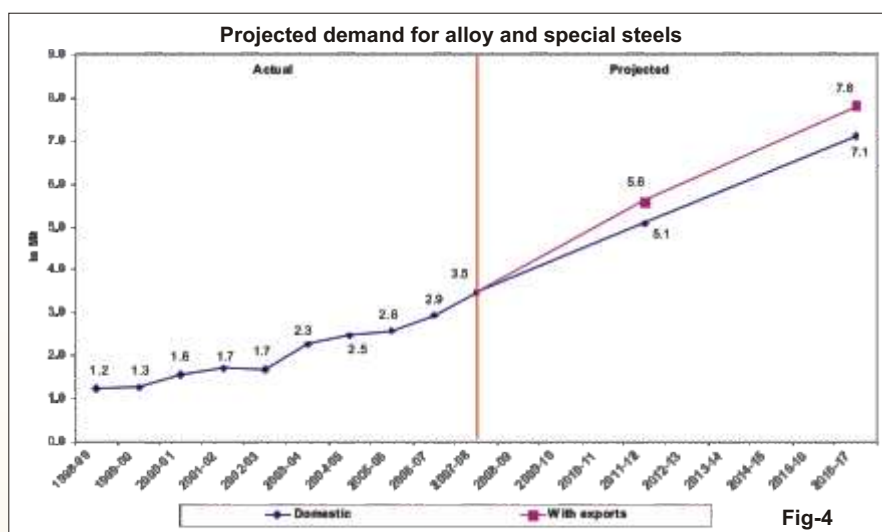


Fig-4

Table-11

Projected availability of alloy & special steels

(excl. stainless steel) (In'000 tonnes)

Sl.No.	Category	Projected Availability	
		2011-12	2016-17
1.	Carbon construction steel & alloy construction steel	3515	2859
2.	Spring Steel	1060	969
3.	Ball Bearing Steel	223	76
4.	Free cutting Steel	363	236
5.	Others (Die blocks, Tool steels, etc.)	418	586
	Total	5579	4725

Table-10
Capacity and Estimated Production of Alloy and Special Steel Units during 2007-08

Sl. No.	Producers	Capacity, t/yr	Production (tonnes)
1	Aarti Steels Ltd.	256000	
2	Adhunik Metalics Ltd.	250000	100000
3	Bhushan Power & Steel Ltd.	500000	30000
4	Bhushan Steel Ltd.	150000	250000
5	Facor Steels Ltd.	60000	50000
6	ISMT (Steel Division)	500000	52000
7	Jayaswals Neco Ltd (SPD)	150000	260000
8	Jindal Steel & Power Ltd.	400000	40000
9	JSW Steel Ltd. (SISCOL)	300000	80000
10	Kalyani Carpenter Special Steels	150000	60000
11	Kalyani Steels Ltd.	200000	140000
12	Mahindra Ugine Steel Co Ltd.	200000	160000
13	Marmagoa Steel Ltd.	110000	125000
14	MID India Power & Steel Ltd.	110000	50000
15	Modern Steels Ltd.	100000	30000
16	Mukand Ltd.	570000	68000
17	Panchmahal Steel Ltd.	150000	286000
18	RL Steels Ltd.	150000	50000
19	Remi Metals Gujarat Ltd.	150000	130000
20	SAIL-Alloy Steel Plant	246000	40000
21	SAIL- Visvesvaraya Iron & Steel Plant	260000	140000
22	Starwire India Ltd.	100000	133000
23	Sunflag Iron & Steel Co Ltd.	500000	45000
24	Upper India Steel Mfg. & Engg. Co Ltd.	100000	250000
25	Usha Martin Ltd.	330000	56000
26	Vardhaman Special Steels	100000	200000
27	Others (Est.)	484000	72000
	Total	6276000	225000

AVAILABILITY

An account of producers of alloy and special steels (excl. stainless steel) along with their current capacity and their estimated production is furnished in table-10.



The total production of alloy and special steels (excluding stainless) was around 2.9 million tonnes during 2007-08, while the total capacity is around 6.3 Mt. At present, the alloy & special steel industry as a whole is operating at around 46% of the overall capacity. As the market is picking up, capacity utilization of 65% during 2011-12 and 75% during 2016-17 are assumed for projecting the future availability of alloy & special steel. Based on the above, the

projected availability of alloy & special steel has been worked out and presented in table-11. The category-wise availability of alloy and special steels is estimated based on the past production ratios.

Table-11 reveals that projected availability of alloy and special steels (excl. stainless steel) during 2011-12 is 4.1 million tonnes which goes up to 4.7 Mt by 2016-17. Category-wise projected availability may be considered as indicative, as producers may produce various categories of alloy and special steels as per market scenario.

Above deliberations indicate that the country needs capacity expansion to meet the shortfall between demand and supply of alloy and special steels.

Conclusion

In view of the growing demand for alloy and special steels in the country due to progress in industrialization and development of high technology industries, the production of alloy and special steels is increasing.

With the globalization of the world economy, the Indian alloy and special steel manufacturers are facing stiff competition from their counter parts worldwide. Under the circumstances, the indigenous manufacturers should make concerted efforts on the development of high tech, high value special steel products to increase not only their proportion in the international market, but also to curb the growth in imports of such steels in the domestic market.

To meet the above objectives, manufacturers may be advised to restructure and renovate their production line and streamline the process flow towards intensive processing and upgrading the quality of products as well as installing Greenfield units with cost effective state of art technology to meet wide range of customer demand.