

Introduction

Forging is the product of work on plastic metal to a desired shape by application of pressure. The working of metal into the shape by means of modern forging methods refines the grain structure, develops its inherent strength, improves the mechanical properties and produces the structural uniformity free from hidden internal defects. Steel has come out as a prime material in forging industry mainly due to its versatility of providing a wide range of tailor made properties by choosing the appropriate composition/processing to exhibit high strength for

in the development of wide variety of steels made it possible to select the best suitable steel for the required product; through the appropriate forging process with heat treatment for production of steel forgings to meet the application requirements.

Forgings are much superior compared to castings/rolled products due to the directional strength, structural integrity, high impact, toughness and fatigue properties conferred by them. Also, the superior strength and durability of forgings make them ideal for applications where reliability and safety are a concern. Not

Precision Forging.

The key driver of demand of forgings is the automobile industry consisting of two wheelers, three wheelers, utility vehicles, passenger cars, commercial vehicles, tractors and the auto ancillaries. About 65% of the total forging production is utilized in this sector. Thus, the fortunes of the forging industry are undoubtedly dependant upon the growth of the automobile industry. Other industries that consume forgings include the engineering industry, Railways, Defence, Chemical process industries, Oil exploration, Cement, Steel industry etc.



Potential and Prospects of Indian forging industry

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load bearing components, toughness for usage in extreme temperatures, high hardness for use as cutting tool, low hardness for machining, shaping & drilling operations and high temperature resistance for application in power plants. Also, steel is favoured because of its recyclability coupled with favourable price compared to other materials. Modern technologies

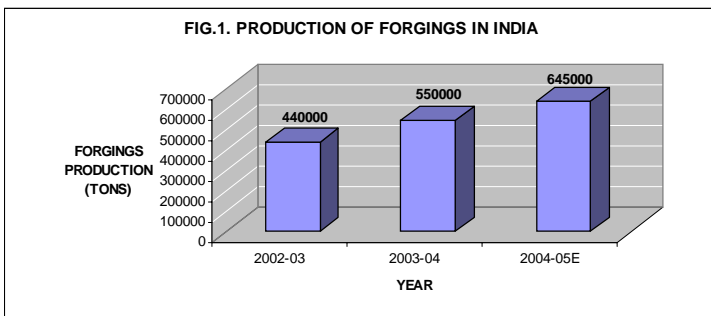
the least, forgings can be economically produced from essentially in almost any size or shape and hence offer great design flexibility. This industry is one of the oldest and the most indispensable one influencing people in their day-to-day life. Forgings are produced through various methods which include Open Die Forging, Closed Die Forging and Near Net Shape/

The domestic forging industry is characterized by fragmented capacities. The unorganized sector has major presence in Open Die Forging segment, which has lower capital costs, while the organized players dominate the Closed Die Forging segment. Out of the total forgings produced in the country, 70% is through Closed Die Forging, 15% by Open Die Forging and the balance 15% for

meeting precision forging products.

The industry has turned out to be highly capital intensive with increasing globalization. In this context, the total investment in the large and medium forging sectors is estimated at around Rs 2500 crores. To meet the global competition demands, the small scale units too are hovering at technology and quality up gradation through increase in capital investment for broadening the areas of demand for forgings.

The total capacity of forging industry in India is about 8,00,000 tonnes per year. The forging production has grown from a mere 188,000 tons in 1987-88 to roughly about 645,000 tons in 2004 - 05. The overall production of the forging industry is expected to have risen by 17.27% in 2004 - 05 with considerable improvement in overall capacity utilization and excellent performance of the automotive sector. The production figures are illustrated in Fig.1.



The Indian Forging Industry has emerged as a major exporter contributing to the manufacturing sector of the Indian economy. The industry has shown a commendable performance by registering an export growth of about 30% in 2003-04 and is estimated to have performed in similar way during 2004 - 05 catering forgings to USA, Europe, China etc.

With not more than 20 to 25 manufacturing units engaged in direct exports, the technology gap is therefore constantly bridged thereby attracting more forging units towards the export market. Also, the progress made in the field of technology, cost competitiveness caused by low labour cost coupled with the strict pollution control norms levied in the developed countries led to increased growth in exports. It is to be noticed that India hardly imports 5% of the total requirement of forgings which consists of sophisticated forging.

There has been a steady progress made by the forging industry to cater forging quality steel requirements for Defence, Railways, Oil refinery, Power plants, Machine tool sector etc. However, the growth in the forging

industry can be attributed to capacity expansion, modernization and cost cutting measures with the global buyers looking at India as a major outsourcing market especially for automotive components.

Influence of Automotive Sector on Forging Industry

It is beyond doubt that the excellent growth of the forging industry that one sees today is attributed to the great recovery of the automotive sector in the country. As 65% of the

forgings produced are utilized by the automotive sector, one can imagine the influence of this sector on the fortunes of the Indian Forging industry. The forged products that are applied in automobiles are front and rear hubs,

Segment	Consumption [KGS.]	No. of Parts
HCV	400 - 450	60 - 70
LCV	300 - 325	60 - 70
Tractors	300 - 350	60 - 70
Two Wheelers	25 - 30	50
Passenger Cars	50	60 - 70

differential cases and housing, engine and control mounting brackets, levers, spring shackles, cam shaft, crank shaft, spring hanger brackets, intake and exhaust manifolds, leveling gear box, clutch release fork, bearing cage, life rod yoke, axle housing, steering gears, propeller shafts, brake assemblies, transmission shafts, connecting rods, axle beams etc. The approximate consumption of forgings in various segments of the Automobile Industry is shown in Table1 below.

The automobile production has grown by 17.03% in 2004 - 05 compared to the previous year. The highest production growth has been observed in the two wheeler category where the growth was 16.03% in 2004 - 05 compared to 10.81% in 2003 - 04. Among the various other automobiles, commercial vehicle production rose by 27.18%, the utility & multi purpose vehicles grew by 20.49% and the passenger car segment witnessed a growth of 22.86% in 2004 - 05 compared to 2003 - 04.

The domestic sales of automobiles increased by 16.21% in 2004 - 05 compared to last fiscal. It has been observed that the medium, heavy and light commercial vehicle sales

improved by 22.31% in 2004 – 05 caused by improved infrastructure, excellent economic growth and shift towards road freight. The Two wheeler sales rose by 15.73% in 2004-05 due to a slew of new model launches. These trends in the automotive sector led to higher growth of forgings and speaks volumes about the influence of this sector on overall performance of the forging industry in India.

Constraints faced by Indian Forging Industry

In spite of the commendable performance of the forging industry in India, the industry still faces the problem of increased cost of forging quality steel, high energy consumption, inefficient economies of scale, inadequate backward/forward linkages & overseas marketing support facilities, poor R & D cum technological advancement and so on adding pressure on the margins to meet local and global demands. The various issues of concern are listed below.

Cost & availability of forging quality steel

Forging quality steel is the major input for the forging industry. The industry was grappling with increasing cost of forging quality steel and has been trying to put its best efforts to get best bargain from the steel makers. Also, the industry started facing shortage of this steel on account of closing of many mini steel plants and discontinuation of the production of forging quality steel by some of the major steel plants. A major cause of worry is that our country lacks captive resources of key ingredients for forging quality steels like Nickel, Molybdenum

Oxide, Vanadium etc. which are sourced through imports by the alloy steel producers. The prices of these key constituents of forging quality steel have skyrocketed in the past two years. This upsurge in the cost of metallics coupled with reduced availability has made the situation challenging for the alloy and special steel producers to supply forging quality steels to the market at competitive prices.

There has been increasing trend of using continuous cast blooms for forging for reducing the overall forging



cost in many large and medium forging units engaged in Closed Die forging. However, majority of the steel makers are shifting from the erstwhile ingot route to continuous casting route for reducing the production cost which led to restricted availability of ingots/large size blooms for Open Die forging units.

Technological backwardness of the forging units

There are too many small & tiny forging units which are unorganized and possess conventional technology with inadequate testing and inspection facilities making them unable to cater

the forging quality steel requirement of the automobile industry. Also, there is also lack of expenditure on R & D leading to delay in absorption of new technologies by the existing units leading to inefficient economies of scale affecting the productivity. Also, poor automation and application of computer technology in the areas of tooling, forging process, heat treatment, quality verification & process technology is a big constraint that can affect the prospects of Indian forgings in the global market.

High cost of energy inputs & Non-application of energy efficient technology

The energy costs are increasing day by day. One can see the price rise in fuel oil and the high electricity cost affecting the energy economies of the forging units. Compared to the western world, many forging units do not possess energy recovery systems, system of delivering hot forgings to the heat treatment furnace, broader application of induction heating systems that reduce energy use, application of micro-alloyed steels that avoid heat treatment and so on.

Absence of research partnership between Forging units, Material manufacturers & Educational Institutions

There is absence of extensive research partnerships between forgers, steel makers, material manufacturers and educational institutions to reduce the cost of manufacturing and improve the quality of the forgings. This includes untouched research topics like development of new materials for die, alternatives to graphite as lubricant in closed die/extrusion forging, cheaper

substitutional steel grades for a given application, developing heating systems that eliminate scale formation etc.

Excessive loss of metal leading to low yield of forged products

This is having a major impact on the price of the forged product. The concept of near net shape forging has not evolved much in the forging industry. Also, excessive dimensional tolerances of the forged products led to increased machining adding cost to the final product. Not the least, the generation of high amount of scale hampers the yield.

Inadequate adherence of forging units to environmental norms

One of the most disturbing factor for the forging units is high pollution. This could be attributed to usage of environmentally foe lubricants, excessive scale formation/accumulation, improper energy recovery systems, high temperature operations etc.

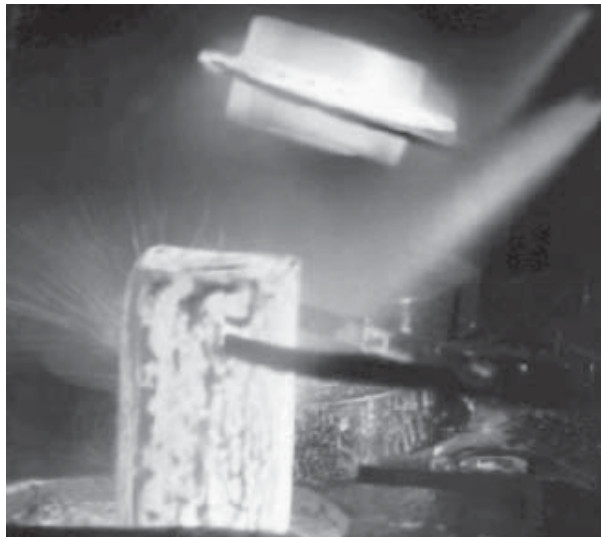
Absence of overseas marketing support facilities & slow recovery of tractor segment

Absence of a structured overseas marketing support facilities can hinder export growth of forgings. Also, tractor segment which consumes large amount of forgings though showed signs of recovery and turnaround in last fiscal, the recovery is slow.

Growth Strategies for Indian Forging industry

There has been continuous efforts by the forging units world wide to

establish technological goals in tooling, materials utilization, energy consumption, environmental performance, productivity and quality. To meet the escalating customer demands, there has been continuous thrust to lower cost, decrease cycle time (time from receipt of the metal by the forger to the time the end product is shipped to the customer), zero rejects and zero in-service



failures. To make the Indian Forging Industry competitive in the global market, technological advancement shall play an important role to improve productivity, boost energy efficiency, enhance environmental quality and create new, innovative forging products and processes. The various growth strategies that can sustain the present global market and bring laurels to the Indian Forging industry in future are proposed below.

Improving operational efficiency of the forging units

In the unorganized sector, capital investment should be limited to technological up gradation for overall

operational efficiency through maintaining consistent surface quality requirements of the product and meeting strict pollution control norms only. Testing and inspection facilities can be outsourced for these units. Forging units of the organized sector which adopt Closed Die forging technique should maximize usage of continuous cast steel products from steel majors of repute to cut down cost.

There is a growing awareness and demand for close shape forging of steels through processes like cold forging and warm forging to reduce machining cost, improve material yield and obtaining superior properties arising out of precise grain flow. The close shape forging is possible with steels possessing low oxygen content, good cleanliness and soft microstructure and finds major application in fastener manufacturing requiring cold headed quality steels wherein the steel undergoes high amount of deformation without cracking. The application can be extended to precision cold forging of many automotive parts.

The forging units should involve in reduction in plant inventory through just in time procurement and ensure prompt delivery commitment of the products for sustainable confidence of automobile manufacturers.

Focus on R & D

Lot of stress has to be given on R & D activities for the Indian Forging Industry to meet the global demands. Establishment of a dedicated and /or distributed R & D center to address the technical needs of the Indian forging

industry is an absolute necessity. For improved efficiency of the units, extending die life through development of new materials, surface coatings and heat treatments is essential. Reducing the set up times to minutes is another criterion for improved productivity. There is a need to adopt/develop advanced forging systems that can continuously monitor critical process variables that automatically adjust the process maximizing efficiency and minimizing the process variation. On the environmental front, research needs that are essential include development of environmentally benign lubricants, waste heat recovery systems, heating systems and advanced coating materials that avoids oxidation preventing scale formation.

High quality research is felt absolutely necessary to develop real time hot dimensional measuring capabilities, optimization of the forging process for achieving desired mechanical properties, closed loop process control for hot forging to getting the required shape/size/dimension in the finished forgings to meet global challenges.

Application of micro-alloyed forging quality steel grades

With stiff competition from alternate materials and ever increasing demands from manufacturing processes, the steel suppliers are under constant pressure to innovate and make available forging quality steel grades of a very high quality for the auto sector. The demand is on increasing yield strength beyond 750 Mpa, ultimate tensile strength more than 1000 Mpa coupled with reduction area in excess of 50% and high fracture toughness. The conventional forged components were heat treated

for high strength applications but, however, suffered from cost penalties apart from other shortcomings.

This led to the evolution of medium carbon micro-alloyed steel grades wherein the components can be used in as forged condition. Initially, steel grade 49MnVS3 was developed with vanadium as micro-alloying element which could result in yield strength of 540 Mpa and ultimate tensile strength of 850 Mpa on air cooling. Also, though these second generation forging quality steels though seem to be attractive since there is no further heat treatment, the strength level i.e. yield strength is rather limited and the room temperature impact toughness was as low as 20 Joules.

Due to the safety requirements imposed by the automotive manufacturers, improved toughness became a major requirement for micro-alloyed forging steel. These developments paved way for V-Ti micro-alloyed 38MnSiVS5 + Ti steel in as forged condition to achieve yield strength of 670 Mpa, ultimate tensile strength of 900 Mpa with room temperature toughness of min. 40 J. This improvement in toughness is attributed to combination of V, Ti and N. Vanadium coupled with high nitrogen level and stoichiometric Ti : N ratio resulted in producing a very useful strength - toughness combination.

Further developments took place through Nb-V micro-alloyed forging steel wherein the advantage of the triple role of niobium to refine grain size, reduce pearlite inter-lamellar spacing along with contribution through precipitation strengthening. These steels in as forged condition claim benefits of high tensile strength exceeding 700 Mpa, improved impact

toughness & fatigue limit. Components such as connecting rods, crankshafts, camshafts etc. are now commercially made with this steel elsewhere in the world.

Recent development of low carbon micro-alloyed steels in direct quenched condition have attracted the attention of automotive manufacturers in view of their fulfilling properties without post forge heat treatment, amenability to surface treatments such as induction hardening/nitriding and generation of properties over large section sizes & uniformity across the cross section. These steel forgings are directly quenched from dies and some of such micro-alloyed steels are of Mn-Mo-Nb, Mn-Mo-Nb-Ti-N or Mn-Cr-Ti-B bearing varieties. Here, Recrystallization Controlled Forging is applied which involves achieving fine grain size, repeated deformation & recrystallization in austenite and control of the transformation products. The steels hence should have high grain coarsening temperature during reheating, low re-crystallization temperature & low grain coarsening rate after deformation. The presence of TiN precipitates coupled with solute drag effect caused by Nb is believed to attain sufficient strength without sacrificing toughness by direct quenching.

All these efforts have helped in saving energy, operation time, material handling etc. towards production of automotive components at much lower costs in the western world and similar actions can be taken up in India .

Restructuring business & development of research partnerships

Horizontal consolidation with small/tiny forging units concentrating

on individual specific forged product rather than making different types of forgings as a means to convert them into organized sector. The forging units have to emphasize on value added operations as OEMs are expected to reduce the supply base necessitating forging companies to integrate additional operations such as machining and assembly.

However, vertical consolidation between the steel producer, forging unit and the automobile manufacturing unit is the need of the hour. Forging industries with Open Die forging facility should involve in making MOUs with steel plants for consistent supply of ingots/large blooms. Collaboration on research and sharing of technology from the developed world needs to gain momentum.

With the demand for net shape and near net shape surfaces continuing to grow shall require the forging industry to move from hot to warm and warm to cold forging techniques. Research partnerships between the forgers, steel makers, material suppliers, educational, research institutions and the Government would help to maximize investments for solving industry wide technical problems and develop more cost efficient, high performing products and processes.

The forging units should look into signing contracts with innovative sales agreements on quarterly basis with the automobile manufacturers. Better price realizations will neutralize higher input costs.

Eyeing the export market of automotive components

The automotive components are looked upon as a thrust sector and Government of India is promoting the

export of these components through a specific sectoral strategy. It is estimated that in the next 10 years, exports from low cost component producing countries will reach US\$225 billion.

With increased role of outsourcing in an integrated global economy and India being considered as a low cost automotive component producer possess a greater edge in the global market aspiring to capture 10% share of the opportunity. This translates into an export target of US\$20 billion by 2015 for the Indian forging industry.

Going by the current trends in the domestic automotive industry, it is expected that the indigenous demand for auto components will also reach US\$20 billion. The estimated demand of forgings for export is about 16.30% per annum. The Indian forging industry needs to capitulate on this by capacity expansion & modernization of the units to meet the global quality standards.

Advanced training programs for workmen & information between forging units

The training needs of the persons working in this industry has to be looked into to create a highly skilled work force and keeping them abreast with the latest technologies to run a successful forging industry. Also, the technological gap that still exists needs to be met with fast pace through conduction of interactive sessions and seminars for sharing information between the existing forging units for initiating steps towards cost reduction aiming to meet global market requirements. Hence, efforts in the form of workshops, participation in trade fairs/exhibitions abroad, buyer-seller meets etc. would help in long term sustainability of the forging

industry.

Reorienting marketing strategies

The forging units have to identify various other sectors which include Railways, Defence, Oil Exploration, steel, Cement, Sugar, Material handling, Ship Building etc that consume forgings. For instance, chemical process industries, oil exploration and Cement industry are perennial source of revenue for the forging industry. This is because, these industries periodically go for a shut down and during this period, the critical parts are changed without waiting for their obsolescence.

Also, the individual forging units should reorient their product mix and specialize in making few end products rather than involving in all types of forgings. Introduction of Key Account Management System for major customers would help in a big way. Overseas marketing support facilities needs to be provided in form of agents/agencies for high export growth.

Conclusions

Forging Industry Technological Roadmap needs to be made to make the Indian forging industry, a world leader in customer focused, efficient and cost effective supplier of high quality forged products. With estimations of increased domestic demand by 16% and exports above 25% over last fiscal for automotive components, the forgings demand is expected to be at 16% per annum and the future looks bright for the Indian Forging Industry.

