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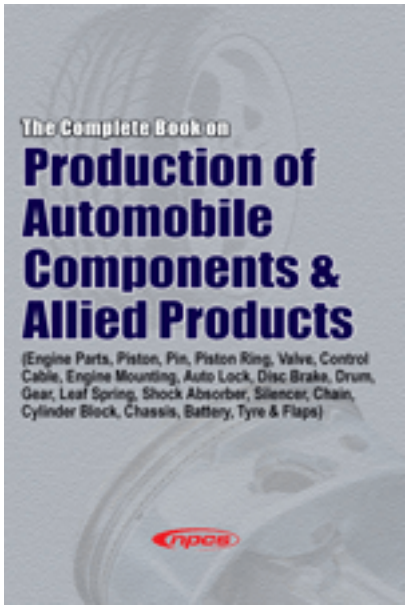
The Complete Book on Production of Automobile Components & Allied Products



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The Complete Book on Production of Automobile Components & Allied Products
(Engine Parts, Piston, Pin, Piston Ring, Valve, Control Cable, Engine Mounting, Auto Lock, Disc Brake, Drum, Gear, Leaf Spring, Shock Absorber, Silencer, Chain, Cylinder Block, Chassis, Battery, Tyre & Flaps)
The rapid urbanization, coupled with an overwhelming growth in the middle class population, has created a market that is extremely conducive for the automobile industry to flourish. It is inferred from the demand, the investment in the automobile industry is estimated at over hundredths of billions in the vehicles and auto components segment. The auto market is thought to be made primarily of automakers, but auto parts makes up another lucrative sector of the market. The major areas of auto parts manufacturing are: Original Equipment Manufacturers (OEMs) - The big auto manufacturers do produce some of their own parts, but they can't produce every part and component that goes into a new vehicle; Replacement Parts Production and Distribution - These are the parts that are replaced after the purchase of a vehicle.
The book provides a characterization of vehicles, including structure, load, fuel used, requirement of various components, fabrication and so on. It will prove to be a layman’s guide and is highly recommended to entrepreneurs, existing units who wants to diversify in production of automobile and allied products, research centers, professionals and libraries, as it contains information related to manufacturing of integral parts of an automobile and practices followed in the finishing of the products.

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INTRODUCTION

Automobile engineering is the one of the stream of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically all the types of vehicles works on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines.

LAYOUT OF AN AUTOMOBILE CHASIS

It contains the source of power, i.e. engine, the frame, which supports the engine, wheels, body, transmission, the braking system and the steering. It also gives support to suspension system and springs. Besides these parts

FUNCTIONS OF MAJOR COMPONENTS OF AN AUTOMOBILE

Chasis and Frame

The chasis is formed by the frame with the frame side members and cross members. The frame is usually made of box, tubular and channel members that are welded or riveted together. In addition to this, it comprises of the springs with the axles and wheels, the steering system and the brakes, the fuel tank, the exhaust system, the radiator, the battery and other accessories. Along with this the frame supports the body.

Engine or Power Plant

An engine consists of a cylinder, piston, valves, valve operating mechanism, carburetor (or MPFI in modern cars), fan, fuel feed pump and oil pump, etc. Besides this, an engine requires ignition system for burning fuel in the engine cylinder.

Transmission System (Clutch and Gear Box)

The power developed by the engine is transferred to the wheels by transmission system.

Clutch

The purpose of the clutch is to allow the driver to couple or decouple the engine and transmission. When clutch is in engaged position, the engine power flows to the transmission through it (clutch). When gears are to be changed while vehicle is running, the clutch permits temporary decoupling of engine and wheels so that gears can be shifted.

Braking System

Brakes are used to slow down or stop the vehicle. Hydraulic brakes are generally used in automobiles, where brakes are applied by pressure on a fluid. Mechanical brakes are also used in some vehicles, leavers, linkages, pedals, cams, etc. Hand brake or parking brake is usually a mechanical brake. These are used for parking the vehicles on sloppy surfaces and also in case of emergency.

Gear Box

Gear box contain gearing arrangement to get different speeds. Gears are used to get more than one speed ratios. When both mating gears have same number of teeth, both will rotate at same number speed. But when one gear has less teeth than other, the gear with less number of teeth will rotate faster than larger gear. In a typical car, there may be six gears including one reverse gear. First gear gives low speed but high torque.

Front Axle

Front axles are mounted at the end of front axle. A part of the weight of vehicle is transmitted to the wheels through this axle. The front axle performs several functions.

It carries the weight of the front of the vehicle and also takes horizontal and vertical loads when vehicle moves on bumpy roads. When brakes are provided on front wheels, it endures bending stresses and torsional stresses. It is generally made from steel drop forging. It is robust in construction.

Suspension System

Shock absorbers are provided in the vehicles for this purpose. It is in the form of spring and damper. The suspension system is provided both on front end and rear end of the vehicle.

A suspension system also maintains the stability of the vehicle in pitching or rolling when vehicle is in motion.

Materials Used in Automobiles

Introduction

In later sections it reviews the history of development of the materials in automotive from the most traditional to the most recent ones. In the class of the metallic materials, steel, aluminium and magnesium and the most recent alloys of these used in the automotive are explained. Some of the properties, manufacturing and joining processes for these metals are described. The advantages and problems of using each of these materials are also reported.

Requirements of the Materials in Automotive

The materials used in automotive industry need to fulfil several criteria before being approved. Some of the criteria are the results of regulation and legislation with the environmental and safety concerns and some are the requirements of the customers. In many occasions different factors are conflicting and therefore a successful design would only be possible through an optimised and balanced solution.

Lightweight

As there is a high emphasis on greenhouse gas reductions and improving fuel efficiency in the transportation sector, all car manufacturers, suppliers, assemblers, and component producers are investing significantly in lightweight materials Research and Development and commercialization. All are moving towards the objective of increasing the use of lightweight materials and to obtain more market penetration by manufacturing components and vehicle structures made from lightweight materials.

Frontal Offset Crash Test Details

Today’s passenger vehicles are designed to be more crashworthy than they used to be. Still, about 30,000 passenger vehicle occupants die in crashes on US roads each year. About half of the deaths occur in frontal crashes.

It also has been a major contributor to the crashworthiness improvements that characterize recent passenger vehicle models.

The very success of the New Car Assessment Program means remaining differences in performance among most new vehicles in full-width tests are small. This doesn’t mean important crashworthiness differences no longer exist.

Side Impact Crash Testing/Ratings Criteria

Today’s passenger vehicles are more crashworthy than they used to be, especially in frontal crashes. As occupant protection in frontal crashes improves, the relative importance of protection in side impacts increases. From the early 1980s until 2000, driver death rates per million cars registered decreased 47 percent. Most of this improvement was in frontal crashes, in which driver death rates decreased 52 percent.

Rollover Evaluations

Other tests on the safety of the vehicle include the Rear crash protection/head restraint ratings which focus on how well seat/head restraint combinations protect against whiplash injury. The necessary first attribute of an effective head restraint is good geometry. If a head restraint isn’t behind and close to the back of an occupant’s head, it can’t prevent a “whiplash” injury in a rear-end collision.

Also Electronic stability control (ESC) significantly reduces crash risk, especially the risk of fatal single-vehicle crashes, by helping drivers maintain control of their vehicles during emergency manoeuvres.

Recycling and Life Cycle Considerations

One of the major growing concerns in all the industries including automotive, is an increased awareness for

environment. Issues such as ‘protection of resources’, ‘reduction of CO2 emissions’, and ‘recycling’ are increasing the topics of consideration.

While the United States has not issued regulations concerning automotive end-of-life requirements, European Union (E.U.) and Asian countries have released stringent guidelines.

As the results of the new legislations, no discussion of new materials in the automotive industry should conclude without a consideration of recycling. Considerable R&D efforts are now focused on developing materials with greater potential of recycling and re-use or developing ways of recycling and re-use of the current materials. This includes both metal and composite materials. The composition and forming processes of the metal materials are changing to accommodate this recycle and re-use demand. This also justifies the great attention towards natural fibre based composites and new high temperature resistant thermoplastic resins.

The option selected depends on the economic benefit to the parties/entities associated with each option. It should be noted that often times a vehicle undergoes multiple use cycles (i.e., the first option is selected repeatedly) before the user considers the other options. After multiple use cycles, the value of the vehicle to the user (and other potential users) approaches zero.

It should be noted that the choice of material plays an important role on the fuel economy of the vehicle. For example, use of lighter-weight material such as aluminium as opposed to steel is usually considered a positive choice in terms of fuel economy. As an approximation, a 10% reduction in mass produces a 5% improvement in fuel economy. However, it should also be noted that lighter-weight materials might not always be the most sustainable choice from a total life cycle perspective. For example, in a study to determine the potential benefits of lighter materials such as aluminium, it was found that substantial change in the existing manufacturing and assembly technologies would be needed. It was found that the current equipment and processes are well suited for steel-based components and a complete redesign of this equipment and processes would be needed to manufacture aluminium components.

Current Materials in Use and Their Future

The current materials used in automotive industry both categories of metals and composites are reviewed. The advantages and disadvantages of each material are discussed. Also the most recent topics of research on development of new compositions, manufacturing and characterisations of these materials for the specific purpose of use in automotive is presented.

New Grades of Steel and Alloys

Materials are often described by properties such as yield- and tensile strength, elongation to fracture, anisotropy and Young’s modulus but shape is not a material property. A sheet metal component is a material made into a certain shape through a forming process. Depending on loading condition, a material-and-shape combination resists the applied load best. Components in a BIW structure should also be able to absorb or transmit impact energy in a crash situation. Certain tests should be performed to decide about the suitability of the materials for automotive application.

In axial tensile loading of components, the shape is not as important as the cross-sectional area since all sections with the same area will carry the same stress. The strength of a component that should be under axial loading is related to the mechanical properties of the material.

Advances in Manufacturing and Joining Technique

Advances in fabrication and assembly technique are just as important as advances in materials. For lightweight steel technology, key process advances include *laser welding, hydroforming,* and *tailored blanks.* Both tailored blanks and hydroforming allow parts counts to be reduced, providing significant savings on tools and dies, simplifying later stages of assembly, and improving the integrity of components, subassemblies, and body structures. These processes can be combined in the production of any one component or subassembly. Compared to conventional welding processes, *laser welding* creates a very

clean and strong weld seam with minimum excess material.
to provide further increases in stiffness and other structural performance attributes.
Tailored blanks combine different grades and thicknesses of steel into a single blank, referring to a piece of material that is inserted into a stamping press or other piece of forming equipment. They allow optimizations of strength, crash performance, and dent resistance with minimal material use and therefore lower weight than attempting to make a similarly performing part from a blank of uniform grade and thickness. Tailored blanks also permit reduced major parts counts and simplified assembly. Instead of two or more different gauges being welded together to achieve the desired component, an integral component can be stamped or hydroformed from a tailored blank.

Aluminium Alloys for Body-in-white Applications

Up to now the growth of aluminium in the automotive industry has been in the use of castings for engine, transmission and wheel applications, and in heat exchangers. The cost of aluminium and price stability remains its biggest impediment for its use in large-scale sheet applications. Aluminium industry has targeted the automotive industry for future growth and has devoted significant resources to support this effort.
The updated examples of these two types are Ford P2000 and Audi AL2. Both of them could reduce weight about 40% on the BIW basis. The extruded space frame developed for Audi A8 is believed most appropriate for low volume production. The structure of Audi AL2 is a modified space frame with aluminium extrusions already developed for A8. Audi AL2 model is produced with an all aluminium body structure. In the AL2, there are fewer aluminium cast joints, which were extensively used in A8 since they are replaced with direct bonds.

Aluminium Alloys for Brazing Sheet Applications

During the brazing process the Al-Si alloy melts and seals joints in the heat exchanger between the different sheet components. The brazing sheet can be clad on one or both sides with the Al-Si alloy and in some cases one side is clad with a different alloy to provide corrosion protection on the inner (water-side) of the a radiator.
During 1970 vacuum brazing was developed to solve the problems associated with old techniques of dip brazing. It was an environmental friendly approach but requires significant capital investment. It became the main method for manufacturing heat exchangers in the 1980s and still remains the preferred brazing method for evaporators and charge air coolers. It is gradually being superseded by controlled atmosphere brazing (CAB).

Magnesium

Magnesium is 33% lighter than aluminium and 75% lighter than steel/cast-iron components. The corrosion resistance of modern, high-purity magnesium alloys is better than that of conventional aluminium die-cast alloys. As well, porosity-free die-cast AM501 AM60 can achieve 20% elongation, or over three times that of Al A380, leading to higher impact strength; but magnesium components have many mechanical/physical property disadvantages that require unique design for application to automotive products.

Mechanical Properties of Mg Alloys

The specific stiffness of Al and Fe is higher than Mg only in the ratio of 0.69% and 3.7%, respectively. On the other hand, the specific strength of Mg is considerably higher than that of Al and Fe in the ratio of 14.1% and 67.7%, respectively.
Because of its too low mechanical strength, pure magnesium must be alloyed with other elements, which confer improved properties. The Mg-Al-Zn group of alloys contains aluminium, manganese, and zinc. These are most common alloying elements for room temperature applications. AZ91D magnesium alloy has been shown to creep at ambient temperature under initial applied stress of only 39% of its yield stress. The commonly used die-casting alloy AZ91, starts creep at temperatures above 100°C and has a maximum

operating temperature at 125°C.

Magnesium-thorium alloys display excellent creep properties at elevated temperature (350°C). However, these alloys have cast disadvantages due to expensive rare earth additions. The Mg-Al-Sr system is a recently developed alloy for the heat-resistant lightweight Mg alloys. The Mg- Al-Sr system is used by BMW for the manufacturing of die-cast engine blocks. This system has excellent mechanical properties, good corrosion resistance and excellent castability. Mg alloys with Sr addition have better creep resistance than other alloy systems as seen in Figure 4. Corrosion resistance of the Mg- Al-Sr alloys is similar to AZ91D and better than AE42, which indicates that strontium does not have adverse affect on corrosion properties.

Technical Problems and Solutions for Use of Magnesium Alloys in Automotive Industry

In roughing cuts the chips are generally thick and not likely to get hot enough to ignite. However, the thin chips produced in the finishing cuts are more likely to heat up and ignite. Similarly, the dust in grinding can ignite, even explode, if heated to melting temperatures. The fire hazard can be eliminated by avoiding fine cuts, dull tools, high speeds; using proper tool design to avoid heat build up; avoiding the accumulation of chips and dust on machines and cloths; and using coolants.

Thermoplastic/Thermoset Polymers

The manufacture of natural-fibre composites includes the use of either a thermoset or thermoplastic polymer binder system combined with the natural fibre preform or mat. In automotive applications, the most common system used today is thermoplastic polypropylene, particularly for nonstructural components. Polypropylene is favoured due to its low density, excellent processability, mechanical properties, excellent electrical properties, and good dimensional stability and impact strength. Vinylester resins is a relatively new addition in the family of thermosetting resins which combine excellent chemical resistance, good thermal and mechanical properties, and the relative ease of processing and rapid cure characteristics of polyester resins. These have better moisture resistance than epoxies when cured at room temperature. Vinylester resins are similar in their molecular structure to polyesters, but differ in that the reactive sites are positioned at the ends of the molecular chains, allowing for the chain to absorb energy. This results in a tougher material when compared to polyesters.

Composite Processing

The primary drivers for the selection of the appropriate process technology for natural-fibre composite manufacture include the final desired product form, performance attributes, cost, and ease of manufacturing. Several factors must be considered in selecting a process. The control of moisture in the fibre and the effect of moisture after moulding are primary considerations in natural-fibre composites in automobiles. Similarly, the ability to eliminate water absorption during service of natural-fibre-based composite components is paramount in industrial applications.

Thermoforming is mainly used to produce natural-fibre-mat thermoplastic composites. The process takes pre-cut layers of fibre (or preformed mats that could comprise random fibres or roving) and polymer sheet that are inserted in a heated mould, and consolidates the material as heat is transferred through conduction to melt the thermoplastic. The thermoplastic flows to penetrate the fibre component, with pressure applied during the heating and cooling phases. After reaching the melt temperature in a hot press, the molten hybrid material is consolidated into a composite in a cold press, with very rapid processing times possible via combined heating-cooling presses in parallel. Compression moulding using thermoset polymer matrices is another major platform used to manufacture large parts for the automotive industry, producing light, strong, and thin panels and structures. The primary advantage of this process is low fibre attrition and process speed.

Materials and Technology for Automobiles

Steel Sheets

High Strength Steel Sheets

New Precipitation-hardened High Strength Hot Rolled Steel Sheet "NANO-Hiten"

Since the hot rolled steel sheets used in the under-body parts are usually press-formed by complexed deformation modes which include stretch forming, burring and other types of stretch flange forming, the sheets must have the sufficient balance of elongation and hole-expansion ratio.

High Strength Galvannealed Steel Sheets

(1) SFG Hiten

In the automotive exposure panels, excellent deep drawing property and uniform good appearance are required. Recent years, high strength galvannealed steel sheets with a high drawability comparable to the mild steel has also been demanded for automobile outer panel, contributing to the weight reduction of body in white.

To meet these requirements, JFE Steel successfully developed a completely new type of fine-grained high strength steel sheet, SFG (super fine grain), with high deep drawability and suitability for galvannealing, which effectively employs hardening both by grain refinement and by dispersion of precipitates. This was achieved by increasing the carbon content approximately 3 times higher than that in the conventional IF steels and adding Nb exceeding the equivalent amount to encourage precipitate fine Nb carbides.

(2) Low Carbon Equivalent Type Hiten

Generally, high strength is easily obtained in steel sheets by adding the necessary amounts of relatively inexpensive solid solution hardening elements such as C, Si, Mn, P, etc. However, a failure in weld metal occurs more easily with the increase in addition of elements which increase hardenability, such as C, Si, and Mn, and the elements which cause embrittlement in weld metal, such as P and S. Thus, from the view-point of spot weldability, the amount of these elements should be minimized. On the other hand, from the viewpoint of coatability, the excessive addition of Si and Mn tends to cause the enrichment of these elements on the sheet surface in the form of oxides, reducing product quality by deteriorating wettability of Zn, while P impedes the diffusion of Fe atoms at grain boundaries, reducing the alloying rate in galvannealing. Considering these various problems, the reduced addition of these elements is desirable.

High Formability Ultra-high Strength Cold Rolled steel Sheets

By stabilizing quench strengthening with a low alloying design using the CAL water quench (WQ) process, JFE Steel successfully commercialized ultra-high strength cold rolled steel sheets (Ultra Hiten) with strengths from 980 MPa to 1470 MPa. The Ultra Hiten is applied to safety reinforcement parts such as bumper reinforcements and door impact beams, and also to roll forming and pipe forming parts.

High Carbon Steel Sheets with High Formability

JFE Steel, therefore, developed a non-oriented high carbon cold rolled steel sheet with extremely small anisotropy in the sheet plane in addition to high formability and hardenability to enable the application of high carbon steel sheets to the hard-to-form and high dimensional accuracy parts of this type. Earring after deep drawing of cup cylinder type is significantly reduced by refining cementite and controlling the recrystallization texture, making it possible to apply the material to rotating parts which must be free of eccentricity and display high circularity.

For these requirements, a high carbon hot rolled spheroidizing-annealed steel sheet with an excellent hole expansion property was developed using microstructure control through the application of high accuracy controlled cooling in the hot rolling process.

Evaluation and Application Technologies for Automotive Steel Materials

Tailor Welded Blanks

Tailor welded blanks (TWB) are those in which sheets of different thickness and/or properties are joined by laser, seam or plasma welding before press forming. Since TWB makes it possible to manufacture parts with the optimum arrangement of materials using a smaller number of press dies, it is an indispensable production technology for realizing high performance and weight reduction in automobiles.

Application Technologies of Hydroforming

The most important tasks for achieving the same level of acceptance in Japan are a reduction of equipment costs and a large reduction in cycle time. A steady progress can be seen in this respect, as various new HF machines have recently been developed, and the cycle time has been reduced to less than the 20 s level. From the technical viewpoint, the following can be mentioned as key items for successful HF: (1) optimization of HF processes with the pre-forming and establishment of the evaluation system of forming allowance, (2) optimization of the loading path and adequate control technology, (3) development of tubes with high HF formability, and (4) lubrication.

Application Technologies for High Strength Steel Sheets in Press Forming

To meet the needs of safety and weight reduction, particularly in auto parts, higher strength has been desired in materials. However, from the viewpoint of formability, a variety of press forming defects tend to occur more easily when high tensile strength steel is used, including material rupture, wrinkles and surface deflection, and poor dimensional accuracy.

The most important problem in forming automotive structural parts is dimensional accuracy in the formed parts. The countermeasures to this problem now being studied from the viewpoint of forming technology include the methods of reducing springback by adopting tension control forming or changing the forming mode from drawing to bending. The methods of optimizing the die shape using numerical simulation are also under study. Figure 16 shows an example of the results of a tension control forming technology using an optimized die profile.

Application of CAD-CAE Systems

A significant progress has been achieved in the computer-based simulation technologies in recent years through the development of advanced finite element method (FEM) techniques and improvement of computer performance, making it possible to apply simulation techniques to the analysis of press-forming and other processes which had been difficult with the conventional methods. Car makers are also making extensive use of these technologies as tools for studying the functions and press-formability of parts in the auto body development process.

High Frequency Electrical Materials for Cars of the Future “Super-Core”

JFE Steel’s Super-Core, which is a core material based on a 6.5% Si-Fe alloy, is already beginning to be adopted in high frequency parts in the electric/electronic industries. The following describes its application to automotive parts.

Automotive Applications

Stationary Equipment

In particular, the low magnetostriction JNEX is unaffected by the conditions in which stress is applied to the core after fixing, for example, when a resin molding is used for insulation protection, and therefore is free of property change and similar problems.

Since JNHF has lower core loss than JNEX, it is the optimum material for the applications in which cores are used in the frequency range higher than audible frequencies, where noise is not a problem.

Rotating Machinery

In the generators and motors of the future, it appears likely that high torque and extreme reductions in size and weight will he required due to the increase in the number of poles.

In motor cores, it is necessary to reduce core loss in a wide range of frequency distributions to cope with the high frequency ripple generated by converter/inverters, as well as in the basic frequency components of rotation.

Other Electrical Applications

The conventional mechanical and hydraulic drive devices are currently being superseded by electromagnetic actuators, and as hydraulic piping is replaced by copper wiring, current transformers (CT)

are now essential items. The current transformers must measure DC current values including high frequency components under severe temperature conditions. The JNEX is also expected to demonstrate excellent properties in cores for CT.

Steels for Exhaust Manifolds

The JFE409L is used in low temperature applications, while JFE430LMN with improved high temperature strength obtained by Nb addition is used in high temperature applications. In many cases, high formability is also required in order to design complex manifold shapes to fit the limited space of the auto body. In response to this need, JFE Steel established a high r-value technology for ferritic stainless steel and developed JFE429EX with a dramatically improved r-value. Based on the composition of JFE429EX, the company also developed JFE-MH1, in which high temperature strength is further improved by Mo addition and optimization of the Si content. These developed steels are beginning to be adopted by car makers. These steel grades are suitable not only for exhaust manifolds, but also for other high temperature parts such as the front pipe and converter case.

Bar Products for Automotive Use

Bearing Steels “NKJ”, “KUJ7”

Bearings are essential components in the rotating drive systems of industrial machinery and automobiles. Bearings are being progressively downsized, but they must still provide service life equal or superior to that of the conventional ones. JFE Steel focused on the maximum dimension of non-metallic inclusions in the steels, which have remarkable effect on the service life of bearing.

Graphite Steel “HFC1 Steel”

Good machinability is required for the steel in the manufacturing processes of automotive and OA parts. The machinability of steel can be improved by adding Pb to steel. However, Pb is one of the quite harmful elements for the environment. Considering such situation, the needs for Pb-free steels are increasing. This steel also has the enough fatigue strength after quenching and tempering. The developed steel shows particularly outstanding properties for the applications to the process consisting of cold forging and machining, followed by quenching and tempering.

BN Free Cutting Steel “CCBN Steel”

The BN free cutting steel, in which hexagonal BN crystals are formed by adding more than 50 ppm of B and more than 100 ppm of N, is a new type of the Pb-free free cutting steel with machinability equal or superior to that of the Pb-added free cutting steels over a wide range of cutting conditions from low speed drilling to high speed cutting with carbide tools. Figure 27 shows the relationship between flank wear and cutting speed in cutting with a carbide tool. Since wear properties are satisfactory, this material is recommended for high speed cutting applications.

In terms of the size, BN is similar to MnS. Therefore, the mechanical properties, fatigue properties, cold and hot forgeability and other properties of BN free cutting steel are virtually equivalent to those of the base steel before BN addition.

Lightweight Composite Material for Automotive Headliner “KP Sheet”

The KP Sheet is a composite material for press forming use consisting of glass fiber (GF) and polypropylene (PP). It is manufactured and sold by a JFE Steel Group member, K-Plasheet Co. It has attracted an attention for its light weight, good formability and shape stability. Since around 1997, it has been widely adopted as automotive interior parts, particularly as a base material for formed headliners. Since the elastic slope, which is an index of rigidity in headliner base materials, is correlated with the second moment of area, the materials with higher expansion ratios are advantageous for improving rigidity. In a new product, KP Sheet UL, which was developed in 2001, the expansion ratio is increased by as much as 30%, and as a result, the clastic slope is 1.5 times greater than that of the conventional product, at 7.2 N/mm (formed thickness: 4 mm) with unit weight of 800 g/m2. This means that a weight reduction of 20%

can be achieved with the same elastic slope, making KP Sheet UL an outstanding product for either part weight reduction or improved rigidity performance. An acoustic product with a high sound absorbing property is also under development.

Use of Aluminium in Automobiles

Due to the reasons mentioned above, light metals are promising a big opportunity in decreasing the total weight of a car. Using aluminium alloys provide 30-40% lighter automobile body when compared to steel. Despite the lower stiffness and strength of aluminium in comparison to the conventional steel chassis, it can be compensated with changing thickness and design of structure to a space frame geometry. Also the number of parts and welding sections can be reduced. In an aluminium space frame, straight extrusion profiles and complex casting parts are joined together to create a rigid structure. The behavior of chassis against static and dynamic loadings must be in safety region while designing a rigid structure.

Exposed Loads on Chassis

In addition to being important design criteria of cost, production method and volume, the most critical factor for chassis is to maintain the overall shape against exposed loads. When designing an aluminium chassis, it is important to take into account structural dynamics, static stiffness, crash performance and weight optimization. An automobile is subjected many loads and vibrations internally and externally.

Static Loads

Prior to movement of the vehicle, chassis must be a solid structure against loads (engine, luggage and passengers weight) and meet the forces that are transmitted from suspension. In this reason, stiffness is the major property for structures which is desired as high as possible and described with two parameters; bending and torsional stiffness. With a high stiffness, handling and vibration characteristics are improved. During the design, cost and weight are also considered to achieve a sufficient rigidity.

Space frame type of chassis shows high roll stiffness and becomes higher with the number of frames increases but weight should be kept in view. High stiffness also increases handling performances otherwise poor handling may cause fatigue by the effect of rotation on the chassis and result a failure in a short period.

Dynamic Loads

For this reason, aluminium is widely used in frontal impact parts with their high energy absorption properties. The critical factor in energy absorption is the stress - strain characteristics and determining with the area under the curve. But in the cases with the dynamic property, strain rate sensitivity becomes more important during the crash because of non-linear loads. Materials with high strain rate sensitivity, absorbs more energy. These types of collisions with high strain rate are obtained with finite element modeling accurately. In the NCAP (New Car Assessment Program) Standard, crash speed is assumed as 64 km/h which is the maximum speed for fatal injuries during the collision as a passenger.

Fatigue

Materials that are subjected to dynamic loads undergo progressive and local structure damage. If the loads are above the specific level, microscopic cracks start to occur on material surface. In time these cracks will reach a critical size and failure in structure occurs. The shape of the structure is affected the fatigue life significantly. Stress range and number of cycles are also effected the fatigue strength.

For mean stress calculation three methods have been developed; Goodman, Gerber and Soderberg which are shown in Figure 7. While Goodman is a good choice for brittle materials, Gerber is suitable for ductile materials and Soderberg is used generally for low ductility materials. The Gerber theory also treats negative and positive mean stresses the same.

Welding

Aluminium welding is most widely used joining process in space frame technology. Compared to steel, some of the features that are unique to the material should be considered when welding aluminium

materials. Aluminium has higher electrical conductivity than steel so cannot show enough resistance in spot welding to provide joint, in this reason fusion welding is more preferred for aluminium. On the other hand with a higher thermal conductivity of aluminium, removal of gases from welding pool is also delayed.
The wide range of solidification is the most important reason for the hot cracking formation, from there pure and eutectic alloys show less tendency to hot cracking. Because solidification is occurred at constant temperature in eutectic alloys and they are exposed less stresses.

Stress Corrosion Cracking

Stress corrosion cracking is a fracture of material under corrosion with a static tensile stresses that are formed by external loads or residual stresses. In this form of corrosion, resistance is reduced with creating cracks in the material. Fracture occurs by the stress corrosion cracking is usually sudden and not predictable. So the material which is placed in corrosive environment under tension of sufficient magnitude will fail in lower stresses than expected. Process is undergoing in three steps respectively; crack initiation, crack propagation and fracture.

Use of Plastics in Automobiles

The average vehicle uses about 150 kg of plastics and plastic composites versus 1163 kg of iron and steel - currently it is moving around 10-15 % of total weight of the car.
The automotive industry uses engineered polymer composites and plastics in a wide range of applications, as the second most common class of automotive materials after ferrous metals and alloys (cast iron, steel, nickel) which represent 68% by weight; other non-ferrous metals used include copper, zinc, aluminium, magnesium, titanium and their alloys.
PP - polypropylene is extremely chemically resistant and almost completely impervious to water. Black has the best UV resistance and is increasingly used in the construction industry. Application: automotive bumpers, chemical tanks, cable insulation, battery boxes, bottles, petrol cans, indoor and outdoor carpets, carpet fibers,
PUR - polyurethane materials are widely used in high resiliency flexible foam seating, rigid foam insulation panels, microcellular foam seals and gaskets, durable elastomeric wheels and tires, automotive suspension bushings, electrical potting compounds, hard plastic parts (such as for electronic instruments), cushions,
PVC - poly-vinyl-chloride has good resistance to chemical and solvent attack. Its vinyl content gives it good tensile strength and some grades are flexible. Colored or clear material is available. Application: automobile instruments panels, sheathing of electrical cables, pipes, doors, waterproof clothing, chemical tanks,
ABS - acrylonitrile-butadiene-styrene is a durable thermoplastic, resistant to weather and some chemicals, popular for vacuum formed components. It is a rigid plastic with rubber like characteristics, which gives it good impact resistance. Application: car dashboards, covers,

Technology Activities and Priorities

Plastics industry is very important in supporting the automotive industry. Automobile engineers are working together closely to optimize other systems, integrating injection and blow molded parts offering a better product without expensive assembly work. Plastics are also finding their way into the structural design of the cars (the most complicated design problem the tank fuel system has been solved thanks to plastics).
Powertrain & Chassis - research in this area focuses on components that generate and deliver power and include the frame and its working parts. R&D priorities include pursuing significant advancements in engineering and research capabilities for designing with plastics, exploring new ways to optimize safety and fuel efficiency, expanding predictive modeling capabilities for composite materials, and developing the new safety components that will be required for future alternative vehicles and powertrain options.
Lightweighting - for example the marketplace offers new ultra light-weight wheel trims successfully, which provides innovation in products with high rigidity and low weight (these components had to put through high testing due to control of resistance to the weather conditions and long lifetime).

Focusing on safety of travelers is also a very important area plastics playing part in. As the population of older drivers increases, improved counter measures and crash performance systems will be needed to keep these passengers safe. Many older drivers have lower biomechanical tolerances and require special safety features to avoid injury. With targeted research, highly versatile plastics may enable important advances in safety features that are needed to protect the 65-and-older population.

Designing vehicles with recycling in mind further reduces the solid waste stream. It also makes it easier and cheaper to dismantle vehicles when they reach end-of-life. Using materials that are cost effective to recycle plus documenting how to remove valuable parts helps promote recovery. The real challenge now for each participant is to work together to develop new assemblies that not only meet cost/performance requirements but also allow easier dismantling and recycling. In the context of a realistic experiment, a nonsignificant result becomes meaningful for unraveling an ecological pattern.

Manufacturing of Engine Parts

1. Manufacturing of Auto Piston

Introduction

The automobile Industry manufacturing Motor Cycles, Scooters and Mopeds has made fast progress with the liberalization of two wheeler policy in 1980. The break-through for auto components came around the year 1960 when a number of Small Scale Units started manufacturing auto components like forgings, castings, sheet metal components etc. The auto components industry has a wide range of components and this project profile envisages the manufacture of graded C.I. Auto Pistons.

Quality Control and Standards

Auto Pistons are produced to serve specific mechanical properties, chemical composition and micro structure. Accordingly, a close control of quality at each stage of manufacturing is essential. Quality control methods usually applied are carbon equivalent determination, hardness determination, tensile strength test, determination of other alloying elements by chemical analysis, etc.

2. Manufacturing of Pins for AutoMobiles

Introduction

Automobile is an emerging sector in India. With the influx of multinationals like SUZUI, HONDA, MAZDA, FORD, KAWASAKI, DAEWOO, MERCEDEZE, VESPA etc. in Indian Automobile Industry, a floor of various vehicles i.e. cars, motorcycles, scooters, tractors, & commercial vehicles with their different models and designs has come in the market.

The automobile manufacturers mostly manufacture major parts of the vehicles themselves whereas various small & ancillary parts/components are procured from outside sources including ancillary units.

PRODUCTION TARGET (PER ANNUM)

The project profile envisages the manufacture of following items :-

a. Gudgeon pins for scooter, M/cycle Moped & three wheelers - 200000 Nos.
b. Engine pins like case shaft pins, valve, pump slip and gear pins - 400000 Nos.
c. Two wheeler/four wheeler & commercial pins like hub, gear, tie rod, shaft, valve pins etc. - 200000 Nos.
d. Gudgeon pins for four wheelers & commercial vehicles - 100000 Nos.

3. Manufacturing of Piston Ring

Introduction

Piston ring is one of the most important part of the Deisel/Petrol engines. It is an open-ended ring that fits into a groove on the outer diameter of a piston in a reciprocating engine such as an internal combustion engine or steam engine. The principal function of the piston rings is to form a seal between the combustion chamber and the crankcase of the engine. The goal is to prevent combustion gases from passing into the crankcase and oil from passing into the combustion chamber

Quality Control

The procured blanks castings should be checked very carefully as per given requirement (size, grade etc.). This is the very first step in quality control. The product should be monitored after completion of each stage so that chance of rejection at the end is eleminated. Piston rings should be manufactured as per IS: 5791-1971 & IS: 8422 for IC engines. The entire operation of surface treatment/coating should be closely controlled. For the inspection process proper callibarated gauges should be used.

4. Manufacturing of Lead Storage Battery

Introduction

Lead Acid Storage Batteries is an electro-chemical system that converts electrical energy into direct current electricity. It is also known as storage batteries and has wide applications in Automobiles, UPS/Inverters, Traction/Electrical Sub-Station, Telecommunication, Solar Photovoltaic system etc.

Market Potential

Lead Acid Storage Batteries have many applications as stated above and automobile sector consumes the bulk of lead acid batteries. The recent growth in the automobile sector has given tremendous boost to the demand of lead acid batteries. The market size is approximately Rs. 1,300 crores and is growing @ 18-20%. The major automobile batteries manufacturing units are Exide, Amar Raja, Standard Furuka, etc. There are many registered small scale units engaged in manufacturing of these batteries like Sahni Batteries, Premier Batteries, Gupta Batteries etc.

Technical Aspects

I. Process of Manufacture

The manufacturing process consists of stacking of positives and negative plates in the container alongwith PVC separator sheet in between the plates and connecting the plates in parallel and cells in series by soldering. The battery plates are initially procured from outside and manufacturing of these plates may be undertaken in-house subsequently. After connecting the plates, positive and negative leads are brought out and terminals formed by pouring molten lead alloy metal on the top cover of the plates with the help of positives and negative die. The top cover is then sealed with bitumen and testing as per the IS Specification: 7372-1995 is performed. The procedure is applicable to all sizes of the batteries and charging of batteries may be done as per requirement.

5. Manufacturing of Valve and Valve Seat

Introduction

The exhaust valve is the component that located in the cylinder head whereas exhaust valve seat insert is component that fitted into the cylinder head. Both are working at the similar environment and have a closed relationship as ultimate goal of both of them are to control the exchange of gases in internal combustion engine. They are intended to seal the working space inside the cylinder against the manifolds.

Exhaust valve is precision engine components used to open to permit the burned gases to exhaust from cylinders. Therefore exhaust valve are exposed to serve thermal loads and chemical corrosion. Exhaust valve are opens and closes as many as 2000 times per mile (1.6km)

Exhaust valve seat insert is the surface against which an intake or an exhaust valve rests during the portion of the engine operating cycle when that valve is closed. It is critical component to ensure complete sealing of the combustion chamber so that the required compression and ignition pressures can be generated inside cylinder.

Generally the material for manufacturing exhaust valve and exhaust valve seat insert basically have properties of working at high temperature continuously and resistance to corrosion due to their surrounding environment that expose to them.

Process involved for both products also basically need high dimensional accuracy and heat treatment since both have direct contact during functioning in cylinder to ensure complete sealing of the combustion

chamber.

Wear Resistance Treatment

Ferritic Nitrocarborizing

After the exhaust valve seat insert is precision formed, it is treated to increase the wear resistance of the insert. However, the wear resistance treatment should preferably produce a minimum amount of dimensional distortion to the precision formed exhaust valve seat insert. The wear resistance treatment typically produces less than 0.05 mm dimensional change on the surface of the insert. Ferritic nitrocarburizing is a thermochemical diffusion process whereby nitrogen and carbon are simultaneously introduced into the surface of ferrous metals to develop or enhance particular engineering properties and thus increase performance.

6. Manufacturing of Automobile Silencer

Introduction

Automobile Silencer is a device used to reduce the noise produced by the engine. Silencer is used in automobile vehicles to reduce the noise produced by the exhaust gases of the engine. Silencer is also used in many other engines and generators. The size, shape and construction varies according to the type and size of the engine.

Market Potential

The automobile industry all over the world is growing at a very high rate and different vehicles are always seen on the road. The production of silencer thus has a very good potential as it can be sold as original equipment and also in the replacement market. With the growth of the economy and increase in road transport, the demand of silencer is growing.

Energy Conservation

The energy conservation of this unit is on the low side since the low power motors are used in the production activity. The workers of the unit should be made aware of the need to conserve energy by switching off the energy sources when not required. Capacitors may be used at suitable points. All presses and machinery should be lubricated properly and regularly.

10. Manufacturing of Automobile Control Cable

The Auto control cables are the fast moving spares used in two/three wheel vehicles and have very good replacement market. These cables enable the driver to control the various vehicle functions, and have a very wide market all over the country. The machines, equipment and raw material for manufacturing these cables are easily available and the technology is fully indigenised. The Unit can be set up in all major cities or near the city area and requires very nominal investment in plant and machines.

Market Potential

Auto control cables have a very wide and never ending replacement market, as the various control cables have to be replaced in any Scooter, Motorcycle, Auto Rickshaw, Moped etc. These are always required by Mechanics and Service stations. Different cables for different end use are packed in printed poly bags and marketed in dozen packing through the Auto part dealers/shops.

Quality Control and Standards

The Bureau of Indian Standards has laid down following Indian Standard for Auto Control Cables IS 1978.

Motive Power

Power requirement for the unit will be 5 HP (approx.) with single phase supply.

11. Manufacturing of Engine Mounting PAD

Introduction

Engine Mountings play an important role in the efficient functioning of automobile systems and vehicles. These mountings are not only used in original equipment but also required for subsequent replacements as well. It is a heartening fact that the automobile sector is expanding very rapidly not only in the existing

capacities but also in the creation of new capacities.

Technical Aspects

Process of Manufacture

The engine mounting consists of two parts namely metallic and rubber. First of all, metallic part is made from the suitable iron plates, according to size and thickness desired as per standard specifications of the end product. For making the rubber compound, first of all various chemicals are checked for their respective percentage purity. Subsequently, they are mixed with rubber on a standard Mixing Mill as per standard weights and formulations adopted. Some chemicals are added to soften the rubber or sometimes rubber is warmed to lighten the load on the Mixing Mills before mastication process.

Mixing mills generally consist of two steel rollers or chilled cast iron rolls which rotate towards each other at different speeds so that any material passing between the rollers is subject to tearing action.

After the pre-mixing, usually the raw compound sheets are stored for one day. For final mixing, raw-compounded sheet is again mixed for 10 to 15 minutes. Subsequently, these sheets are pasted on metallic part with rubber solutions as per size and weight required. These are then placed in suitable mould in a press and cured. Finally, these mountings are inspected for any defects, tested for physical parameters and then packed.

Manufacturing of Automobile Chassis

1. Manufacturing of automobile Body

Automobile Body Manufacturing Processes

Car body assembly is a process in which stamped sheet metal parts are brought together and then permanently joined by welding, gluing, hemming, tabbing, etc. The automobile at this stage is usually called Body-In-White (BIW). As the BIW is assembled, a number of body openings are geometrically formed, e.g., motor compartment, windshield, decklid, and doors opening. The panels (e.g., hood, decklid, doors, etc.) to be fitted in such openings undergo, to a large degree, the same manufacturing processes as the body.

Door Hanging Process

To hang a door on the body side opening, the position of the door to the side opening needs to be determined and its six degrees of freedom need to be constrained. The constraining of the six degrees of freedom for both the rear and front doors relative to the body side opening is realized using the nets in the fixture, as shown in the Figure 5.

Door Fitting

When a door is hung on the side opening with the hinge, any further fitting action has to be accomplished by distorting the door to obtain the required appearance. Since the hinges have been tightened to the body, it is mostly the flushness, especially in areas remote to the hinge location, that is being changed by the manual door twisting. The correction in F/A and H/L direction is not prominent. The twisted doors tend to spring back, which results in dimensional inconsistency. Different personal preference also results in inconsistency in the dimensional quality.

Technical Aspects

Process of Manufacture

Metal sheets are cleaned and derusted for grease/oil if any. Then sheets are cut to size for forming different parts and these parts are formed on press brake. Now different parts and their sub-assemblies are fabricated as per their design and size. These parts and sub-assemblies are fabricated-together to make them a complete bus body. The complete body is painted as per the requirements of the customer. Shower test is carried out for leakage etc.

Production Capacity (per annum)

Quantity	:	108 Nos.
Value	:	Rs. 162 Lakhs.

Motive Power 85 HP (Approx.)

2. Manufacturing of Disc Brake

Introduction

The disc brake is a device for slowing or stopping the rotation of a wheel. A brake disc (or *rotor* in US English), usually made of cast iron or ceramic, is connected to the wheel or the axle. To stop the wheel, friction material in the form of brake pads (mounted in a device called a brake caliper) is forced mechanically, hydraulically or pneumatically against both sides of the disc. Friction causes the disc and attached wheel to slow or stop.

These brakes offered greater stopping performance than comparable drum brakes, including resistance to “brake fade” caused by the overheating of brake components, and recovered quickly from immersion (wet brakes are less effective). Unlike a drum brake, the disc brake has no self-servo effect and the braking force is always proportional to the pedal force being applied by the driver.

Many early implementations located the brakes on the inboard side of the driveshaft, near the differential, but most brakes today are located inside the wheels. (An inboard location reduces the unsprung weight and eliminates a source of heat transfer to the tires, important in Formula One racing.)

Grey Cast Iron as Material for Production of Disc Brake

Cast iron is the first product obtained in steel making when smelting iron ore. It is the result of the reduction of ferrous oxides under the action of the carbon in metallurgical coke. Molten cast iron is in reality a carbon solution in molten iron. When it is cooled a very small part of the carbon remains in the ferrous solution whereas the majority of it precipitates to form small nodules scattered throughout the structure of the metal. Usually this unrefined cast iron is not suitable for the majority of applications but must undergo both physical and chemical processes in order to create the vast and well-known range of ferrous alloys.

The graphite exist in form of flakes which are normally surrounded by an a-ferrite or pearlite matrix. Because of these graphite flakes, a fractured surface takes on a gray appearance, hence its name. The metal expands slightly on solidifying as the graphite precipitates, resulting in sharp castings. The graphite content also offers good corrosion resistance.

Graphite acts as a lubricant, improving wear resistance. The exceptionally high speed of sound in graphite gives cast iron a much higher thermal conductivity. Since ferrite is so different in this respect (having heavier atoms, bonded much less tightly) phonons tend to scatter at the interface between the two materials. In practical terms, this means that cast iron tends to “damp” mechanical vibrations (including sound).

All of the properties listed in the paragraph above ease the machining of grey cast iron. As far as grey cast irons are concerned the Brinell hardness values lie between 170 and 250 HB.

The conductivity, heat capacity and temperature resistance of the rotor material should all be optimised in order to accommodate the frictional heat generated at the rubbing interface. Grey cast iron satisfies these requirements but its relatively high density means that the rotor mass is significant (typically over 5 kg for the front disc of a normal passenger car).

Aluminium as the Material for the Holder

For the holder the material we have selected is Aluminium alloy. This is because aluminium have many characteristics that is needed for the holder. The important characteristic are their high strength to weight ratio, resistance to corrosion by many chemicals, high thermal conductivity, nontoxicity, and ease of formability and of machinability.

Cold Chamber

This is the method that is used in the manufacturing of the holder for the disc brake. Cold Chamber process is primarily for the alloys with higher melting temperatures. In a cold chamber process, the molten metal is ladled into the cold chamber for each shot from an external furnace. There is less time exposure of the

molten metal to the plunger walls or the plunger.

Hot Chamber

In a hot chamber process the pressure chamber is connected to the die cavity which is immersed permanently in the molten metal. The inlet port of the pressurizing cylinder is uncovered as the plunger moves to the open (unpressurized) position. This allows a new charge of molten metal to fill the cavity and thus can fill the cavity faster than the cold chamber process. The hot chamber process is used for metals of low melting point and high fluidity.

Holding, Moving and Guiding the Cutting Tool

The bed is the foundation of a lathe. All other parts are fitted to it. Ways are integral with the bed. The V-shape maintains precise alignment of the headstock and tailstock, and serves as rails to guide the travel of the carriage. The cutting tool is mounted on the carriage.

The quick change gear box is arranged between the spindle and the lead screw. It contains gears of various ratios which makes it possible to machine various pitches of screw threads without changing loose gears. Longitudinal (back-and-forth) travel and cross (in-and-out) travel is controlled in the same manner. An index plate provides instructions on how to set the lathe shift levers for various thread cutting and feed combinations. It is located on the face of the gear box. The large numbers on the index plate indicate the number of threads that can be cut per inch or pitch of metric threads. The smaller figures indicate the carriage longitudinal movement, in thousandths of an inch or in mm for each spindle revolution.

The lead screw transmits power to the carriage through a gearing and clutch arrangement in the carriage apron. Feed change levers on the apron control the operation of power longitudinal feed and power cross feed.

For Disc Brake

Facing. Facing is the producing of a flat surface as the result of a tool's being fed across the end of the rotating workpiece. Unless the work is held on a mandrel, if both ends of the work are to be faced, it must be turned end for end after the first end is completed and the facing operation repeated. The cutting speed should be determined from the largest diameter of the surface to be faced. Facing may be done either from the outside inward or from the center outward.

To produce the disc brake the best process is the hot chamber process. In the hot chamber process the molten metal will be forced to enter the cavity using the piston. The average pressure to be used is 15MPa. The molten metal will be held under the pressure until it solidifies. The passageways are built in the die to aid in rapid metal cooling. The cooling materials that be used is water and oil. For the production of the disc brake holder the best process is the cold chamber process. The molten metal will be poured into the injection cylinder (shot chamber). The metal is forced into the die cavity at high pressure usually in between 20MPa to 70MPa.

3. Manufacturing of Brake Drum

Introduction

Brake drum castings are made up of S.G. cast iron which has high strength, ductility, shock and wear resistance, good castability, excellent machinability and overall durability of the component.

Market Potential

With the start of the automobile revolution in the country the brake drum castings are expected to increase manifold in future.

The S.G. brake drum castings are replacing even forgings. The brake drum casting units have good scope in small scale industries due to the excellent technical base available at the small foundry units.

Pollution Control

The units manufacturing brake drum foundry comes under category of Government classification. Hence the pollution control clearance is a must for these units. The unit has to take care of all statutory

regulations.

4. Manufacturing of Gear Blank

Introduction

Gear Blanks are produced by forging process of Metal forming in which hot metal at particular temperature, where the metal having the plastic state, is pressed in die. Forging can be carried out either in open or closed die. Dies are prepared by special steels like hot work tool steels and suitably heat treated to have proper hardness and toughness so that the dies can be capable of pressing hot metal without any deformation in the die during forging. The properties of forged Gear Blanks are considered to be better properties than any other metal forming process. Machined Forged Gear Blanks are used in Automobile sector for Two-Wheeler and Three-Wheeler.

5. Manufacturing of Gear

Introduction

Gears are used extensively for transmission of power. They find application in: Automobiles, gear boxes, oil engines, machine tools, industrial machinery, agricultural machinery, geared motors etc. To meet the strenuous service conditions the gears should have: robust construction, reliable performance, high efficiency, economy and long life. Also, the gears should be fatigue free and free from high stresses to avoid their frequent failures. The gear drives should be free form noise, chatter and should ensure high load carrying capacity at constant velocity ratio. To meet all the above conditions, the gear manufacture has become a highly specialized field. Below, we shall discuss the various materials and manufacturing processes to produce gears.

Gear Manufacture by Casting Method

Gears can be produced by the various casting processes. Send casting is economical and can take up large size and module, but the gears have rough surfaces and are inaccurate dimensionally. These gears are used in machinery where operating speed is low and where noise and accuracy of motion can be tolerated, for example, farm machinery and some hand operated devices. Send casting is suitable for one off or small batches. Large quantities of small gears are made by “Die - Casting”.

For phosphor bronze worm wheel rims, “centrifugal casting” is used far more extensively than any other method. Centrifugal casting is also applied to the manufacture of steel gears. Both vertical and horizontal axis spinners are used.

Methods of Forming Gears

Roll Forming

In roll forming, the gears blank is mounted on a shaft & is pressed against hardened steel of rolling dies. The rolls are fed inward gradually during several revolutions which produce the gear teeth. The forming rolls are very accurately made & roll formed gear teeth usually home both by not and cold. In not roll forming, the not rolled gear is usually cold -roiled which compiles the gear with a smooth mirror finish.

Stamping

Large quantities of gears are made by the method known as stamping ‘blanking’ or ‘fine blanking’. The gears are made in a punch press from sheet; up to 12.7mm think such gears find application in: toys, clocks 4 timers, watches, water & Electric maters & some business Equipment. After stamping, the gears are shaved; they give best finish & accuracy. The materials which can be stamped are: low, medium & high carbon steels stainless steel. This method is suitable for large volume production.

Gear Generating Process

Gear Hobbing

Hobbing is the process of generating gear teeth by means of a rotating cutter called a hob. It is a continues indexing process in which both the cutting fool & work piece rotate in a constant relationship while the hob is being fed into work. For in route gears, the hob has essentially straight sides at a given pressure angle.

The hob and the gear blank are connected by means of proper change gears. The ratio of hob & blank speed is such that during one revolution of the hob, the blank turns through as many teeth.

Principal of Gear Planning

The cutter during its cutting stroke is in contact with several teeth at the same time but with different part of each tooth, it planes comparatively a narrow strip on each tooth at each stroke and a different part of each tooth is submitted to the action of the cutter at the next stroke.

6. Manufacturing of Gear Box Housing

Introduction

The automobile industry comprising four wheelers, motor cycles, scooters, mopeds along with machinery components especially, achieved a fast progress in 1980 with liberalization policy. Small scale units started manufacturing almost every type of machines indigenously in India. Especially for mechanical machines like Lathe, Milling, Gear Hobbing, Shapers Machines etc. Gear Box is an integral & most important component for transmission of speed.

Technical Aspects

a. Production Details and Process of Manufacturing

The various operations in a foundry are pattern making, mould making, sand preparation, core making, melting, knockout, fettling and finishing. The combination of all these operations will produce castings.

Pig Iron and return scraps are malted in oil fired rotary furnace and the composition of the bath is adjusted by suitably added Ferro alloy, steel scrap, petroleum coke etc. as per the requirement. However, Ferro chrome and inoculants as per requirement are added in the laddle during transfer of molten metal from rotary furnace to laddle. The moulds are made of fluid sand, binding material and additives. Cores made of special sand are dried before the metal is poured in. The castings from fluid sand moulds are taken out and when cold are fettled, inspected, machined and dispatched.

b. Quality Control & Standards

Graded C.I. castings for automobile components such as Gear Box Housing are produced to serve specific mechanical properties, Chemical composition and micro-structure. Accordingly, a close control of quality at each stage of manufacture is essential. IS: 210-2009 is followed for various specificational requirements for Gear Box Housing.

Energy Conservation

These days energy conservation efforts are needed to be strengthened Substantially. The potential for conservation however, is must large and all efforts needed to be made the individuals to realize it to the extent possible. The energy audit is an integral part of an energy conservation project and is the key to a systematic approach for decision.

Various factors which affect fuel economy in industrial furnaces are:

- Complete combustion with minimum excess air.
- Proper heat distribution.
- Operating at the desired temperature
- Reducing heat losses from openings, Minimizing wall losses
- Waste heat recovery from fuel gases, Control of chimney draught.

The principles of good combustion for the proper selection and maintenance of fuel oil, burner is very important and it has the main role. So standard and good quality burners should be used for better conservation of oil fuel.

So the efficiency of a furnace will depend on how efficient the combustion system is and secondly how best the generated heat is utilized.

7. Manufacturing Process of Leaf Spring

History of Leaf Spring

There were a variety of leaf springs, usually employing the word “elliptical”. “Elliptical” or “full elliptical” leaf springs referred to two circular arcs linked at their tips. This was joined to the frame at the top center of the upper arc; the bottom center was joined to the “live” suspension components, such as a solid front axle. Additional suspension components, such as trailing arms, would be needed for this design, but not for “semi-elliptical” leaf springs as used in the Hotchkiss drive. That employed the lower arc, hence its name. “Quarter-elliptic” springs often had the thickest part of the stack of leaves stuck into the rear end of the side pieces of a short ladder frame, with the free end attached to the differential, as in the Austin Seven of the 1920s. As an example of non-elliptic leaf springs, the Ford Model T had multiple leaf springs over its differential that was curved in the shape of a yoke. As a substitute for dampers (shock absorbers), some manufacturers laid non-metallic sheets in between the metal leaves, such as wood.

Mechanical Properties of Leaf Spring

Steels of the same hardness in the tempered martensitic condition have approximately the same yield and tensile strengths. Ductility, as measured by elongation and reduction in area, is inversely proportional to hardness. Based on experience, the optimum mechanical properties for leaf spring applications are obtained within the hardness range 388 to 461 HBN. A specification for leaf springs usually consists of a range covered by four of these hardness numbers, such as 415 to 461 HBN.

The mechanical performance of vehicle leaf Spring is influenced, in a complex way, by the number of material and processing details, for example, spring steel is typically subjected to hot farming and heat treating operations followed by mechanical processing such as shot penning and presetting. Each of these steps can significantly affect the structure and properties of the material as well as the residual stress patterns built up in surface layers. Service loading may also alter original residual stress levels as a result of cyclic stress relaxation.

8. Manufacturing Process of Shock Absorbers

Adoption of Hydraulic Telescopic Dampers

In the post-world war II years, the trend to coil springs and softer rides favoured shock absorbers of telescopic form. This form of dampers is now used in a wide range of damping applications; everything from automobiles to tanks, locomotives and even bridges. Most commonly used configuration is still non-pressurised twin tube hydraulic type. However, recently pressurised type is making rapid inroads specially in the passenger car market.

Non-pressurised Twin Tube Telescopic Hydraulic Dampers

A twin tube telescopic non-pressurised hydraulic damper consists of a cylinder with a piston moving inside it. The piston has various designed orifices to allow fluid to flow between the compression and rebound chambers. To store the displaced oil by the piston rod movement, a storage tube is provided. The mechanical energy absorbed by the damper is converted into heat. Heat so produced is dissipated to the atmosphere through the storage tube.

Gas Charged Shock Absorbers

Gas charged shock absorbers are essentially hydraulic dampers with the addition of gas under pressure to improve the working efficiency. They are sometime also called ‘gas shock absorber’. Only gas cannot be used as damping medium. Oil is a must. Pressurising the shock absorber oil allows elimination of cavitation (foaminig of oil) a problem inherent in hydraulic dampers. Elimination of cavitation allows better control at all piston speeds and movements. This leads to better vehicle control, improved ride quality and quicker operation.

Cross (Bias) - and Radial-ply Tyre Features

Many textile cords are criss-crossed and embedded to provide strength to the cross-ply tyre in the rubber. These cords are arranged in layers, usually referred to as plies, which perform two jobs. Firstly they have to make the walls strong enough to contain the air pressure and yet leave them as supple as possible for

deflection. Secondly they have to support the tread. These two requirements conflict each other because to obtain sufficient bracing of the tread, the ply must be reasonably stiff, which then means that the walls has to be rigid. Radial plies perform only one job that is to make the wall of the tyre strong enough to contain the air pressure. They do not support the tread. So they do not require to be criss-crossed, instead are laid readily following the natural profile of the tyre.

Characteristics

Ride Comfort

The bending of the walls of cross-ply tyres requires a shear action to change the criss-cross ply angle, which makes the wails very stiff, and hence the bounce on rough roads is not properly cushioned. Radial-ply tyre construction provides a supple wall due to the natural direction of radial-ply cords. These tyres bend readily and hence can absorb a great deal of extra bounce. The radial-ply tyre is more comfortable at higher speeds because of its shock-absorbing deflection characteristic, which is 25% greater than that of the cross-ply type. However at lower speeds the cross-ply tyre provides more smooth riding and the steering is also lighter, so that it is more suitable for parking.

Tyre Material

The efforts are continuously being put to improve the existing tyre materials and to introduce new materials for meeting tyre requirements better. Several types of fabric cord materials are in use for tyre piles. Rayon was introduced in 1938 as a tyre cord material to replace cotton. This material was much more durable, produced a soft ride, and was more resilient and less expensive than cotton. It has tensile strength of 648,110 kN/m2. Subsequently to improve its characteristics and to reduce its cost several modifications have been introduced. In 1947 two forms of nylon were introduced as tyre cord material, which has tensile strength of 841,160 kN/m and is more heat and water resistant than rayon. The tread compound is chosen as compromise to provide the properties required for each tyre application. The impregnated rubber used for side wall and ply is a more flexible rubber compound than tread rubber. The side wall must be sufficiently flexible to deflect as it passes the tyre contact patch on each revolution and also to absorb any shock produced by road surface irregularities. It must have sufficient strength to transfer all the acceleration and braking torque between the wheel rim and tyre tread, and to withstand cornering forces that are applied to the automobile.

Challenges

Environment, Health & Safety

There is reluctance by a number of industry executives to discuss nanotechnology in tyres, in an effort “to avoid any possibilities of misinterpretation and misunderstanding”. This reluctance seems to relate to the argument that the reinforcing fillers used for the production of rubber articles should not be categorised as nanomaterials, since they are practically always sourced and handled in aggregated forms and their dimensions range from approximately 0.1 mm to several millimetres.

According the related ERTMA position paper: *“Due to the strength of the bonding forces between individual particles in an aggregate, and between the polymer and filler in rubber compounds, it is not physically or chemically possible to obtain individual nano-object forms during rubber article life cycle. As a result, there is no human or environmental exposure to nano-object forms of carbon black or amorphous precipitated silica used as fillers to reinforce rubber.”*

Transport: Nanotechnology in Automotive Tyres

EU Competitive Position

The automotive tyre sector in the EU appears to be very strong. Three out of five major tyre OEMs are European (Michelin in France, Continental in Germany, Pirelli in Italy) with a combined global share of about 25%. In Europe, 12 tyre corporate companies have production lines in 91 tyre plants situated across 20 European countries. Chemical giants Evonik (Germany) and Rhodia (France) are also based here, while

Lanxess in Germany is one of the leaders in nanotech innovations for tyres. With Nanoprene, its new line of rubber nanoparticles, Lanxess hopes to secure a very competitive position in the European and global tyres market.

10. Manufacturing of Auto Tubes and Flaps

Introduction

The manufacture of auto tubes and flaps is possible well within the investment limit of small-scale industries and a good number of such units are working successfully in different parts of the country. Automobile continues to be the most popular conveyance for the masses and this is going to be so also for a long time to come. In a developing country like India, automobile forms an important mode of transport.

Heat Treatments of Automobiles

Introduction

Automotive gears represent another important category of components that are heavily stressed and require high levels of performance in the areas of both fatigue and wear resistance. Effective and appropriate heat treatment and surface modification technologies are utilized to optimize properties of virtually all types of metallic components with durability featuring prominently in a great number of applications.

Beginning with raw metal products leading all the way to final component assembly, various types of heat treatment and surface engineering processes are applied in the manufacture of automotive components. Heat treatment processes impart the required strength or hardness properties as dictated by the given component application. Other processes involved in metal processing may include forming, machining as well as quench and tempering, carburizing and hardening and nitriding during production. Surface modification, when properly applied, yields optimum surface properties enhancing corrosion and wear Resistance while improving frictional properties.

Materials Used in Autovehicles

In spite of tremendous efforts being made to develop vehicles made of all aluminium auto body, most automobiles today are composed of iron and steel (70%), aluminium (6%), plastics (9%), rubber (4%), glasses (3%) and miscellaneous other materials (8%). To fulfill the fuel economy targets, it is necessary to reduce vehicle body weight while also improving engine and rolling energy losses. These improvements are being achieved through the use of high strength steel sheets and/or in conjunction with even greater increased usage of aluminium, magnesium and titanium alloys having lower specific weights compared with iron and steels.

As shown in Table 1 the possibility of weight reduction via the use of ultra high tensile strength sheet steels has been achieved. These ultra-high-temile strength steel sheets are produced using advanced steel strength steel sheets are produced using advanced steel mill technologies characterized by controlled rolling and cooling technologies and heat treatment.

HEAT TREATMENT

Types of Heat Treatment

Selection of steel types and grades and appropriate heat treatment methods are very important to produce components of reliable quality. The control of a given alloy’s chemical composition and the inclusion content of steel have an impact upon and can create variance in an alloy’s properties. Other contributing factors impacting the quality and reliability of final components include refining, casting, rolling and cooling methods.

Processing Technology in Heat Treatment

Since the advent of gas carburizing processing, various improvements in furnace, atmosphere and their control methods have been achieved and hundreds of continuous heat treatment furnaces are utilized in the production of automotive vehicles. Improvements in-furnace design have enabled considerable savings

in energy to be achieved. Also considerable improvements have occurred in moving toward the application of reduced pressure controlled processing methods.

Powder Metallurgy and Sintering

Powder compaction and sintering process are finding wider applications. Transmission and engine components such as clutch hub, timing sprockets and gears are typical examples made of iron powder. The powder processing technologies are advancing further to introduce more powder metallurgy products.

Valve seats in cylinder head are excellent example of powder products that enabled the introduction of specially designed valve seat materials necessary to fit with severe engine operating condition.

Powder forged connecting rods were developed and used in BMW Engines. Toyota also developed powder forged connecting rods in engines. Variable valve timing gears used for Engine are also made from iron based powder alloy. The most advanced powder metallurgical application is in the manufacturing of Titanium valve produced via compaction, sintering, extrusion, and swaging to form valve seat face.

KEY ISSUE IN HEAT TREATMENT: ATMOSPHERE CONTROL

Protective atmospheres used for various heat treatment processes have experienced considerable changes over the past decade. Gas atmosphere generation started from charcoal, natural gas and liquid petroleum gases (LPG) have been used widely. While the generation of protective atmospheres used generators to convert its source gas to mixture of N2, CO and H2 which has been used up to date, in-situ gas generation methods have been developed and partly applied in industry. These have enabled the reduction of source gas consumption and processing costs.

Carbon Potential Control

Gas Carburizing Processes

Control of heat treatment atmosphere is quite important to produce quality products whether it is traditional gas or vacuum processes. However, the carbon potential (CP) control of protective atmospheres is not done well in spite of long history for quenching, carburizing and carbonitriding that require precise atmospheric controls to prevent the occurrence of de-carburization, over carburizing and to introduce optimum compressive residual stresses.

The up date technology that enables the more reliable results is an Infrared or a Laser gas analyzer for multiple elements, or in-situ carbon potential measurement method.

Reduced Pressure Carburizing (Vacuum Carburizing)

Vacuum carburizing technology has advanced considerably. Continuous measurement of the carburizing condition under reduced pressure becomes possible through the emergence of newly developed in-situ or gas sampling methods (much the same as-gas carburizing) and enables precise control of the carburizing process.

Diffusion speed of carbon is directly affected by heat treatment temperature with higher temperatures increasing diffusion speed. The high temperature carburizing condition usually results in grain growth during treatment and necessitates the use of improved case hardening steel that enables the prevention of excessive grain growth to some extent.

SURFACE MODIFICATION AND HYBRID HEAT TREATMENT

Different surface modification technologies available today to enhance the properties of components are listed in Tables 8 and 9. It has also necessitated the use of hybrid processes to fulfill the, needs of this category of components. Dual heat treatment or heat treatment combined with an additional surface modification method are applied to meet special property requirements and applications. Most specifically, there are many popular combinations of surface modification methods such as phosphate treatment, vapor deposition and or solid lubricant coatings that have potential to satisfy unique combined property needs.

A unique economical coating available with heat treatment is a coat quench technology, including the one which has been used to improve surface friction coefficient for more than thirty years, and other methods to

prevent rusting by forming surface oxide film during cooling into aqueous solutions.

Forging Technology of Automobile Parts

INTRODUCTION

Metals and alloys have the ability to be formed into useful shapes by Plastic Deformation. In this process they also develop a wide range of properties particularly strength and toughness. The working of the metals into shapes by means of forging methods refines grain structure, develops inherent strength giving characteristics, improves physical properties and produces structural uniformity free from hidden internal defects. Moreover, the special feature of flow lines along the contour of the forging produce marked directional properties. These features in forgings give the automobile designers increased confidence regarding the reliability of the vehicle.

STEPS FOR THE DESIGN OF FORGED PART

Parting Line

Die parting line is the plane which divides the top and bottom dies in a close die forging. This depends upon the ease of die filling, forging equipment, grain flow, jib locations and trimming facility.

Proper parting line avoids deep impressions that might cause die breakage. This also avoids side thrusts which could cause excessive mismatch in forgings.

Flash Land and Flash Gutter Design

Flash land is the zone outside the forging impression which plays a vital part in the forging process. On the one hand it restricts the metal from running out without filling the die cavities and on the other hand excess metal extrudes through the constriction after filling up i.e at an intermediate stage the flash land restricts the side ways metal flow and at final stages it allows the excess metal to come out after filling these impression.

To prevent chopping of the blocked use by finisher die impression this is made narrower !by 0.5 to 1.0 mm and for ensuring filling up this reduced width is compensated by depth of the blocker impression greater than that of the finisher by 1 to 1.5 mm.

Trimming Die Design

Trimming operation is done to remove the flash from the forging. Piercing operation also performs this function in round forgings. This is divided in three categories — Close Trimming, Normal Trimming and Loox Trimming.

The trimming punch is made to suit the forging profile and the trimming die profile matches with the parting line profile (priphens).

FORGING EQUIPMENTS

Although there are various types of equipment including auxiliary equipment, the main forging equipments can be grouped into three categories.

— HAMMERS which are energy restricted machines.

— MECHANICAL FORGING PRESSES - which are stroke restricted machines.

Painting Technology of Automobiles

Introduction

Vehicle construction has gone through significant changes since its inception at the turn of the century. At the present time the substrate is generally of mild steel but may also contain other alloys and include plastic components; the shape is inevitably complex and certain parts of the vehicle are almost inaccessible and difficult to paint.

Practical Considerations

In practice the process simply involves the passing of a direct current between the workpiece (anode) and the counter-electrode (cathode). The resultant coating deposited on the workpiece is insoluble in water and will not redissolve.

The film is compact, almost dry, and has very high solids which adhere strongly to the pretreated (zinc phosphate) metal substrate. It is covered by a very thin dip layer which is easily removed by rinsing. After stoving (165 °C) the resin cures to form a tough, durable polymeric film.

Deficiencies of Anodic Electrocoat Primers

The two main deficiencies are phosphate disruption and poor saponification resistance.

During anodic electrodeposition very high electrical field forces occur which rupture many of the metal-phosphate bonds (phosphate disruption). This leads to a weakening of the adhesion of the phosphate coating to the steel substrate.

Performance Characteristics

Cathodic technology rapidly replaced anodic products in North America since results from test track evaluations, and the field, confirmed the superior corrosion protection of cathodic systems. Where the cathodic system is particularly good is in its throwing power, being better than most anodics, and in its thin film (~12 µm) performance particularly on unpretreated steel. This is found to be extremely important in box sections, etc., where the durability of the product is most vulnerable.

As far as resin systems are concerned a variety of alkyds were used in earlier products. These were superseded by epoxy-modified alkyds, epoxy esters, and more recently by polyester and polyester/polyurethane resins. Although solvent-based surfacers still tend to predominate, water-borne materials, because of their pollution advantages and good levelling, are attracting more and more attention and are now widely used in Europe. Water-borne surfacers are described in more detail later.

Electro Powder Coating (EPC)

This is another example of a reverse process but incorporating cathodic electro-primer. Originating in Japan, EPC is essentially a process in which a powder surfacer carried as slurry in water is electrodeposited in a matter of seconds on to the phosphated carbody. Since the EPC has little or no throwing power it is confined to the outer skin panels. After rinsing and a set-up bake the car body is then cathodic electrocoated.

The cathodic electrocoat does not deposit on the electrically insulated EPC surfacer but rather is used to maximum effect in protecting the floor area, box sections, etc., and formulated accordingly.

Alkyd or Polyester Finishes

Basic Chemistry

Alkyd finishes are based on a class of resins produced by the reaction of alcohols (glycerol, glycol, etc.) and dibasic acids (phthalic anhydride), and modifying with a natural or synthetic oil to give the designed balance of durability, flexibility, hardness, etc.

Thermosetting Acrylic/NAD Finishes

The use of thermosetting acrylic finishes has decreased significantly in recent years although the technology forms the basis of clearcoat formulations. In addition, NAD technology, i.e. the stabilization of discrete polymer particles in organic solvent, originated in the automotive sector and has since been extended into water-borne systems.

Basic Chemistry

Thermosetting acrylics are based on complex acrylic copolymer resins produced by the reaction of a number of acrylic monomers selected to give the desired balance of properties. The required crosslinking reaction, with a suitable melamine formaldehyde resin, is facilitated by the presence of hydroxyl groups in the polymer backbone. The hydroxy-containing polymers are readily prepared by the use of hydroxy-acrylic monomers.

Application/Process

The basecoat is applied as a two-coat wet-on-wet process with a short air drying time between coats. This is necessary to give acceptable opacity and evenness of appearance. After application of the second coat

of basecoat has been completed, a short air drying time (2-3 min) is allowed, sometimes supplemented by a warm air blow, before the clear is applied in one or two coats. Typical film thicknesses for the system are:

- Basecoat: 15 µm,
- Clearcoat: 35-50 µm.

Stove for 30min at 130-150°C to effect crosslinking.

Low-pressure Hot Spray

This technique has found some use in the application of primer surfacers, but it is rarely used in modern installations and is probably now more or less obsolete in the automotive sector.

Airless Spray

This procedure is often used for applying anti-chip coatings to sills, lower sections, etc. Atomization is produced by a combination of pressure and heat. The high pressure forces the paint through the gun nozzle at a greater velocity than the critical velocity of the liquid coating breaking it into small droplets (i.e. atomizes the stone-chip primer).

The anti-chip coating can be heated to reduce viscosity to improve atomization, care being taken to control temperature thermostatically. It is most likely applied automatically with the guns located in fixed positions.

Electrostatic Spray

The principle of electrostatic spray is simple. If paint particles are atomized in an electric field they will become charged and drawn towards the article to be painted, which is usually at earth potential. There are many different types of electrostatic spray systems but the most widely used in the motor industry are rotating bells or discs, covering the whole range of undercoats and topcoats.

Figure 10 represents a typical system. The paint is pumped to the atomizers from pressure feed containers via a hollow drive shaft. The rotation of the atomizers spins the paint to the periphery where it is partially atomized by centrifugal force but mainly by the electrostatic field.

As the paint particles leave the atomizer, under the attraction of the electrostatic field, they are drawn to the unit being painted. Any particles which pass are attracted to all sides giving electrostatic its very high efficiency of paint utilization. Generally adopted parameters are rotation speeds of 30,000-40,000 rpm and high voltages in the region of 90-110 KV for maximum efficiency. The reduced overspray also means less efficient and expensive spraybooths with reduced effluent. This system also lends itself to full automation with the attendant benefits.

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