RESEARCH ARTICLE OPEN ACCESS

A-Well defined raw material specifications of product and its components, a key of successful new product design. A critical evaluation by case study

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Abstract

New product design and development indeed needs long termvision for better product life and hence to have better product features the design team has to take into consideration various techno-commercial aspects todesign and develop most adequate new product. Normally in case of new product design all related activities are initiated by the team of technicians under the directive jointly given by top and marketing management of the concerned organization. Due to global competition in the market the product requirements are needed to be carefully identified so as to make the product more user friendly to the customers. Considering this it is quite obvious that top priority is for product performance considerations at the same time they have to establish the product cost to make it more competent in the market. Due to these constraints recently the design and development function has no more remained the responsibility technocrats but it has become techno-commercial activity. One should treat this as design and development joint activity to be performed by the dedicated team of techno-commercial people who are well equipped with sound technical knowledge so as to design the best possible product. Due to this reason the primary design activity is seen to be interfacing with various departments such as Marketing, Materials, Tool room ,Manufacturing, Vendor development and many other related departments and valuable in puts from them are badly needed at the initial phase of product design and development. This helps in identifying the product needs at various manufacturing stages well in advance. This ultimately helps the design department to deliver the most adequate product with no operational problems and product is ready to satisfy customer's needs which ultimately leads to growth of organization through smooth product life cycle management.

Key words: Product requirements, Functional considerations, PLCM.

Abbreviations: PLCM-Product life cycle management.

I. Introduction

The new product design and development is vital area which operates as new business development center for related enterprises and hence provide growth for business organization. They are always playing very important role in keeping good image of the company by the way of development of new excellent products .This is the origin hence the organizations have to put their best efforts to make this activity more and more strong. Making this area stronger and stronger will reduce various probable losses due to design defects and boost the profits by providing more satisfactory product to customers.

The Problem Statement

This includes following elements which are briefed as below.

1 Background and

2 Brief history of the problem.

1Brief background of the research- This research paperis hard core experience of the author which he has come across when working as design and development manager in one of the reputed and

foreign collaborated company engaged manufacturing wide range of electrical power hand tools. This is the case study which justifies the importance of selecting raw material at the initial design stage of the new product development. This is the case study of product failure which he has come across when he joined as Manager Design /Development in the said organization.

II. Brief back up of the product failure-

Engineering enterprises who are launching new products in the market they have to perform important task of design, develop and subsequent manufacturing of new product so as to supply the products in the open market. In this continuous cyclic process of businessdevelopmentthevery initial and basic step is to **design and develop the new** product. I as a design person believe this is the most crucial phase during which the middle and top management have to be more analytical and precise as far as product needs are concerned. Even a minor mistake in the design of the product can spoil the projected life of the product and the concerned organization have tosuffer heavy losses.Therefore the design must be competent enough to stand successfully in the highly competitive market. This article gives a real picture of the situation the company has to face when newly designed product fails in fulfilling customers need by the way of functional failure. If this takes place at the customer end at the launching stage of the product the situation is so alarming that this makes the organization to land in to grave trouble.This case becomes so crucial that company has no option to put special efforts at extra cost and carry out further improvements in the product. By the time this is done there is every chance that the brand name of the product in the market is spoiled because of functional failure and this is long term loss for the organization.

Background of the product failure and hence problem statement-

Document for reference – The origin of the problem statement is the customer complaint register maintained at the marketing office of the said company. With reference to this register it was noticed that the customer has made complaint that the brush holder of D. C. Motor of the marble cutter is melting after running of the product for a time span of 45 minutes approximate and due to this the marble cutter stops working and the work of customer in the field is stopped.

Product market Potential –

There is substantial market in India for product marble cutter. Presently this product is manufactured and marketed by two more competitors other than this company .In this situation if this complaint is not resolved immediately then the company may lose market share of the product. At this juncture the company has made substantial investment of funds in the design and development of the product.

Looking at the very critical situation the author approached to the top management and taken approval for additional technical man power along with necessary assurance for availability of funds so as to perform all activities without any delay. The desired target of this special assignment so as to find the root cause of the failure and take all corrective actions so as to carry out all design changes at the earliest and further to launch modified efect free product in the market as soon as possible.

Quote –Customer complaints are the books where product improvement opportunities are made available without making extra marketing survey.

Research Methodology-There is no special methodology used for the purpose of this design improvement but following steps were decided to execute which lead to the solution of the problem. But in the generalized sense PDCA cycle is the only research methodology used.

To solve the complaint a plan was made under which following steps are to be taken this is the research methodology used in this case study.-

1 To identify probable root causes due to which product failure at customer end has occurred for this the most effective tool is brain storming meeting of all team members.
2 Confirming the identified probable causes through literature review and previous practical case studies in the similar products already developed by concerned organization.
3 To identify all the probable alternative solutions which will lead to design improvement and remove the problem of product failure which has occurred in this specific case.
4 Selecting the best adequate solution out of all probable solutions identified in the previous step.
5 Plan, execute and implement the best out of all selected probable solutions till successful completion and confirmation of the product performance.
6 Test reliability of the solution by practical trials on the improved product after implementing them in product.
7 Confirmation of product improvement and declaration of the fool proof product making necessary changes in the related design documents and product catalogues.

After making detail study as mentioned above the technical and managerial tools required during execution of the product improvements were identified.

The table no-1 below gives the extract of the same.

Step No-	Technology used	Management tool.
1	Study of basic electrical insulating materials.	This is literature review.
2	Study of field and armaturegap and its relationship with temperature rise.	Thermal changes due to change in air gap.
3	To allocate probable alternative solutions.	An overview of reasons due to which failure has occurred.
4	From above to select the most adequate one.	Using mgmt. pyramid
5	Plan and execute the best possible alternatives.	PDCA cycle at each sub step.
6	Proving reliability.	Reliability testing.

Mechanical design, development and manufacturing teams were gathered together for brain storming meeting agenda of the meeting was informed in advance and every team member has freedom to express his opinion on the present product failure problem. If their opinion is relevant then will be considered as probable potential solution irrespective of the management position of the suggesting member. The main advantage of the brain storming meeting is more contributions by members and quicker and accurate solution to the problem.

The important outcomes of probable solutions given by the all team members was recorded and documented as basic reference document on which further PDCA cycle will be used e to take further actions and sort out the product failure problem.

Step3-Once the confirmed cause is known the remedy can be found out by most suitable alternative solution.

Step4-Compare probable alternatives and to identify the most adequate one.

Step5-This is the actual development of the part which is responsible for the product failure.

Step 6-After completion of satisfactory development actual trials for reliability are carried out the samples are approved.

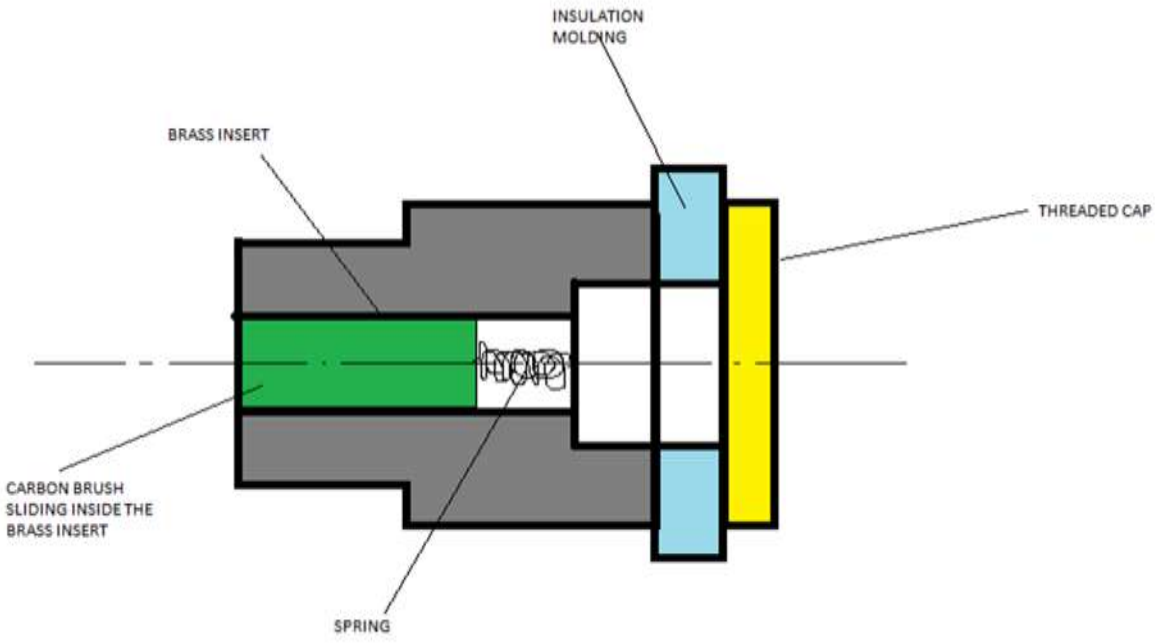
Step-7 Design changes are confirmed and forwarded assurance to the customer.

In this specific case of power tool the heat generation is taking place in two zones as mentioned below-

1 Where the carbon brush comes in contact with commutation.
2 If the field and armature rubs on each other generates enormous amount of heat during rubbing.

From above 1 and 2 reasons it is seen that first reason is more justified and in this case the failure is occurring due to the same.

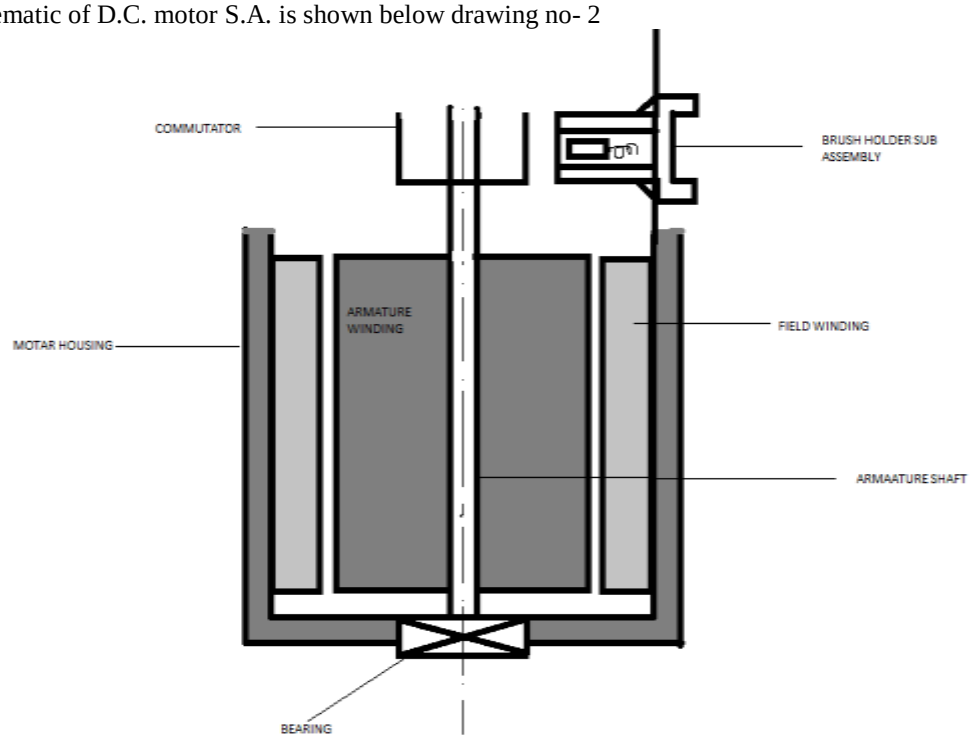
So we decided to have a overall concentration on the brush holder S.A. which has failed at customer end. The drawing below shows the technical specifications of the brush holder S.A.



The bill of material of the brush holder S.A. is as specified in the table below-

No	Material.	Specification	Q/Set.
1	Insulting molded material.	Present Arnite.	2
2	Insert	Brass	2
3	Carbon rush S.A.	Spring,Carbon Brush.	Q/Assly.

The brush holder S.A. is as specified in the drg.1 below--
The schematic of D.C. motor S.A. is shown below drawing no- 2



The schematic of the D.C motor assembly is as shown in the drg-3

The schematic drawing of the Brass Brush holder insert is shown in the Drawing-3.

Drawing No-3

From above discussion it is seen that the overheating and thereafter melting of brush holder SA is taking place because of the following reason the temperature at the carbon brush and commutator contact zone is above the melting point of ABS Material.----------
1We cannot reduce the air gap further due to design constraints.

2 The another temperature generating zone is at the end of the rush holder SA where the carbon brush come in contact with com.In this zone there is hardly any scope for modification or alteration in the design. Looking at the survey of the new product we concluded that the temperature control parameters are already taken care and to sort out this problem the only way to select the insulating material which has melting point higher than the temperature of the Brush holder S.A.

In a light of this we have to select the material out of plastic insulating materials which can satisfy above need for further improvement of the Design and hence resolution of the customer complaint.

III. Literature review-

Related to selection of alternate insulating material for the brush holder S.A.Upon completion of the necessary literature review it was decided to select the Phenolic range of thermoset plastics which has following properties by virtue of which our problem can be sorted out.

Very high thermal stability. This has poor mouldability as compared to thermoplastics however can be molded by using compression and transfer molding like processes. The recent trends show that these can also be injection molded however it has certain practical limitations related to injection molding machines.

Can withstand up to temperature without deformation.

This decision was accepted by total design team so that it was acceptable solution which will give desired results and resolve the necessary complaint.

Before making permanent design changes it is very muchessential to develop prototypes or samples by the most suitable and economical method so as to study DFM concept carry out reliability trials on the power tool assembly so that the problem of brush holder melting is sorted out on long term basis and confirmed before any major investment is done in Transfer molding dies. As an introductory part of the development a single cavity compression molding die was developed and the sample lot of brush holder S.A. was produced and tile cutter assembly was tested for 20 Hrs under full load and results were very much satisfactory and tile cutter was operating without any problem. As a precaution few assembled tile cutters were also sent to field trials and feedback has been taken whish was extremely satisfactory as expected.For this thefield trials were conducted under full load and continuously for 20 hrs. Following points were required to be taken care so as to have the successful completion of the new development of the Brush Holder S.A.

Literature review-Literature review shows that in comparison with thermoplastics molding of thermoset plastics is more complicated process due to the main reason that the mold life is less .This is on account of the abrasion property of the plastic material to be molded.

The another important part of the brush holder S.A. is brass insert. After subsequent molding of the plastic material there will be sizable pressure getting developed on the insert and due to this insert may get deformed. As such it is very much essential at the latter stage that how thiscan be made in one piece so that it will not collapse due to plastic l coating material pressure.

The development plan steps are required to be decided very carefully this is to be done bydesigning and developing the single cavity die andby using the process of the compression molding technology.

Overall steps required to be taken for complete development and successful prototypes or molded samples of the Bakelite brush holder S.A.

1 To assess minimum two vendors with capability to develop new Brush holder Bakelite molding for brush holder S.A. having both facilities compression and transfer molding o that the new development can be more cost effective.

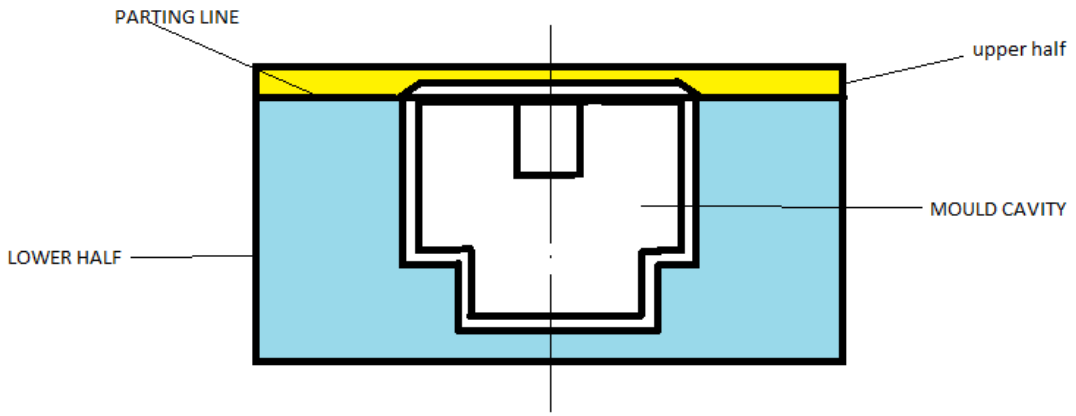
2 To negotiate and give one most suitable vendor written purchase order so as to develop initially the Single cavity compression molding die and after completing and reliability testing of the brush holder the same supplier to have develop the transfer molding multicavity die for the commercial production of the brush holder S.A. so as to supply minimum 10,000 nos of brush holder S.A. per month required for the production of tile cutter assembly in house.

In this point of view it was decided to assess two or three potential vendors having total infrastructure facilities to fulfill the production needs to satisfy the requirements of brush holder assembly on monthly basis.

This was completed on top priority by the team of development engineers and necessary commercial formalities were completed and development work was undertaken.

As a first phase of the development compression molding die with single cavity was developed and molded brush holder S.A. samples were produced and taken to the reliability testing and the functional trials were conducted and pleased to note here that the tile cutter was operating under full load for successively 20 hours under full load which was the indication of the successful development of the subject brush holder S.A.

Schematic of compression moulding die-
MOLDING DIE-(Coating die)



A separate compression molding die is made for threaded cap please note. This is very small die that is the reason it has been demonstrated in drg.

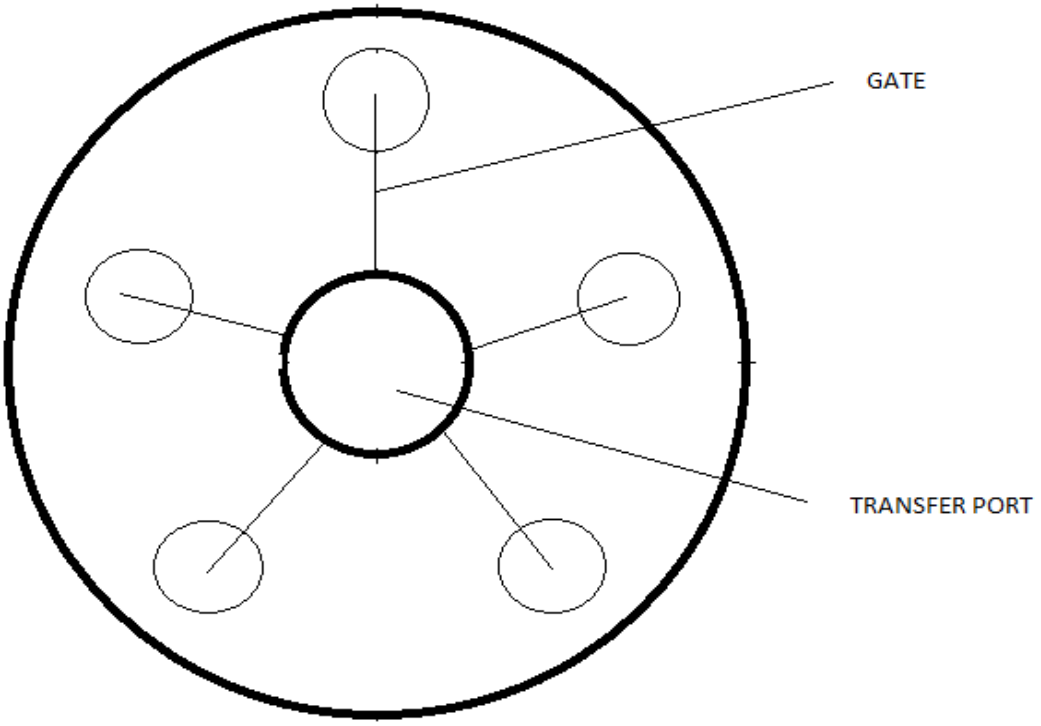
For confirmation of the concrete development five modified tile cutter assemblies were sent to the customer for conducting rigorous practical trials on the tile cutter.

The feedback which we receive from customer was quite encouraging and satisfactory.

Subsequently it was proven that the failure of the tile cutter assembly was occurring due to the wron selection of the insulating material of the brush holder S.A. This is the indication that the solution found was satisfactory.

After the complete development of the multi cavity molds the commercial production of two lots of 1000 nos of brush holder S.A. was done at suppler send and the customer complaint as resolved and remarked as closed in the customer complaint register accordingly.

IV. SCHEMATIC OF TR.MOLDING MULTY CAVITY DIE-



After continuous monitoring of the customer complaint of tile cutter it was seen thatfurther there is no complaint for the tile cutter from thesingle customer.On the contrary recent dealers meet it was a feedback from various customers that they are quite comfortable due to better performanceof the tile cutter. After successive monitoring of the customercomplaint for six months it was seen that no complaint has been registered and the improvement in tile cutter was satisfactory.

Over the period of time we conducted joint review meeting with Marketing and development dept. Following commercial advantages are derived due to this design change.

Following is the extract-

1 Sales value projected at the time of proposal of design and development of the tile Cutter-Rs-1.35 Crore per month.

Sales value for the month after serious failure complaint was Noticed-Rs 35 Lakh recordedon paper but may be returned by customer after trial and failure.

Sales value for next month –Rs o.oo since due to such seriouscomplaint the company decided to stop the sale of tile cutter for one month to avoid the further loss of product reputation in the market.

Following is the table indicating rise in the sales value of the product after design changes implemented and regular commercial supplies of the product have started-

Month Number	Sales value (Rs. in Lakh Rounded off.)
1	o
2	5
3	15
4	30
5	45
6	60
7	75
8	90
9	105
10	135

The analysis of losses suffered due to this eventof the design failure-

Loss of sales value for almost 10 months-

Rs. 1,35,00000=00

Interest on the investment for the idle investment worth of Rs.1.50 crore for the period of almost 10 works out roughly Rs. 20 Lakh which is additional loss to the organization. In addition this event has spoiled the reputation of the company which is major long term loss.

We cannot ignore commercial impact of research we have studied cost of brush holder S.A. prior and after the research these are as tabulated below.

New Design Cost.	Rs. 6.70/Pc
Old design Cost	Rs 5.50/Pc.

If we look into economical approach we see that the total rise in the assembly cost is Rs. 2.40 since 2 no of brush holders required per assembly of the tile cutter. This costis not more as compared to the product assembly cost.To be very precise on the product cost this cost difference can be further compensated by revising the minimum batch quantity of the lot of tile cutter so that the extra cost can be taken care indirectly.

The rise in the customer satisfaction is noticeable as per the information given by the marketing department.-

Customer satisfaction index at the time of customer complaint was raised-0.15 as per the information provided by the marketing department. This after subsequent design modification has gone up to 0.85 ina period of six months.

V. Further scope of the research-

The present process used for brass insert is press tool technology refer drg -3 . If the extrusion process is used for the manufacturing of the brush holder insert as against the present press tool technology thepresent problem of low productivity and collapsing of the insert due to Molding pressure can be sorted out.If the deformation of the insert goes beyond the limit then this can affect the movement of the Carbon brush.

This improvement proposal is forwarded to the management and necessary approval is obtained and shortly development work is to be started.

The all range of products of power tools where similar problem may be experienced in such cases the same remedial short research can be used to sort out the problem.

VI. Conclusions

1 Organizations should have very strong Design and development department and they should be equipped with techno commercial people to avoid the product failure and keep consistent growth of the organization.Even a minor failure in design will lead to losses of the organization.

2 The product design should be validated for more strong tests which are equivalent to field product usage conditions so that product has to pass through real reliability requirements and will not fail even under tough circumstances.

3 The company has to pay very high cost of quality if the product design remains defective.

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2 Brief back up of the product failure-

Engineering enterprises who are launching new products in the market they have to perform important task of design, develop and subsequent manufacturing of new product so as to supply the products in the open market. In this continuous cyclic process of business development the very initial and basic step is to **design and develop the new** product. I as a design person believe this is the most crucial phase during which the middle and top management have to be more analytical and precise as far as product needs are concerned. Even a minor mistake in the design of the product can spoil the projected life of the product and the concerned organization have to suffer heavy losses. Therefore the design must be competent enough to stand successfully in the highly competitive market. This article gives a real picture of the situation the company has to face when newly designed product fails in fulfilling customers need by the way of functional failure. If this takes place at the customer end at the launching stage of the product the situation is so alarming that this makes the organization to land in to grave trouble.This case becomes so crucial that company has no option to put special efforts at extra cost and carry out further improvements in the product. By the time this is done there is every chance that the brand name of the product in the market is spoiled because of functional failure and this is long term loss for the organization.

Background of the product failure and hence problem statement-

Michael Page UK Jobs

- **London(4004)**
- **Hertfordshire(2781)**
- **Manchester(602)**
- **Birmingham(550)**
- **Leeds(400)**
- **Bristol(379)**
- **Cardiff(176)**
- **Edinburgh(167)**
- **Reading(145)**
- **Glasgow(139)**

The main aim of an insulating material is to separate electrical conductors without passing current from one to the other and to safeguard individuals from electrically energized wires and parts. A complete knowledge of insulating materials and standards for safe working practices is required.

Why electrical insulation is required

Electrical shock caused by the flow of current through the human body can result in physiological effects raging from fatal injuries resulted by involuntary moments to death from ventricular fibrillation (the rhythmic pumping action of the heart ceases) or muscular contraction.

DC voltage up to 40 volts and AC voltage up to 60 volts are considered safe limits, in the best circumstances, for the human body, but beyond this is consider a hazard, and to prevent it electrical insulation is required. Resistance to the electrical current is measured in ohms. Metals react with very little resistance to the flow of electrical current and are called conductors. As previously mentioned, materials like asbestos, porcelain, PVC, dry wood react with a high resistance to flow of electrical current and are called insulators.

Dry wood contains a high resistance, but when wet with water, its resistance drops and it may allow electricity. The same thing is applicable for human skin. When skin is dry, it has a high resistance to electric current, but when it is moist, there is a drop in resistance. Therefore any electrician should take precautions when water is present in the environment or on the skin and necessary insulating materials should be used. The best remedy to safeguard individuals from electrically energized wires and parts is through insulation.

Application of insulating materials Cables and transmission lines:

Insulating material is generally used as a protective coating on electrical conductor and cables. Cable cores which touch each other should be separated and insulated by means of insulation coating on each core, e.g. polyethylene, cross linked

polyethylene-XLPE, polyvinyl chloride-PVC, Teflon, silicone etc. Hanging disk insulators (bushings) are used in high voltage transmission bare cables where they are supported by electrical poles. Bushings are made from glass, porcelain, or composite polymer materials.

Electronics systems

All electronic appliances and instruments widely contain PCB (printed circuit boards) having different electronics components on them. PCBs are manufactured of epoxy plastic and fiberglass. All electronics components are fixed on the insulated PCB board. In SCR (semiconductor rectifiers), transistors and integrated circuits, the silicon material is used as a conductive material and can be converted into insulators using a heat and oxygen process.

Power systems

Transformer oil is widely used as an insulator to prevent arcing in transformers, stabilizers, circuit breakers, etc. The insulating oil can withstand insulating properties up to a specified electrical breakdown voltage. Vacuum, gas (sulfur hexafluoride), and ceramic or glass wire are other methods of insulation in high voltage systems. Small transformers, power generators, and electrical motors contain insulation on the wire coils by the means of polymer varnish. Fiberglass insulating tape is also used as a winding coil separator.

Domestic portable appliances

All hand held electrical appliances are insulated to prevent their user from electrical shock hazard.

- Class 1 insulation contains only basic insulation on the wire and the metal body is earthed at the main grounding system. The third pin on the power plug shall be for the grounding connection.
- Class 2 insulation denotes a device with "double insulation." All internal electrical components shall be totally enclosed within an insulated body which will prevent any shorting with conductive parts.

Electrical cable insulating tape

PVC tapes are widely used to insulate electrical wires and other live conductive parts. It is made of vinyl as it stretches well and provides effective and long-lasting insulation. Electrical tape for class H insulation is made of fiberglass cloth.

Personal protective equipment:

PPE protects humans from the hazards of shock withelectrical circuits. PPE such as insulating head protection, eye and face protection, and insulating gloves are necessary for protection against all common electrical hazards. Insulated tools and protective shields are must for an electrician's safe working. Dielectric shoes (non-metallic safety footwear) or electrical hazard footwear is made with non-conductive, electrical shock-resistant soles and heels.

Electrical rubber mats:

Insulating mats for electrical purposes have a wide application in various substations, power plants, etc. The mats are used for floor covering below control panels to provide for the safety of workman due to any possible leakage of current.

List of some common insulating materials

- A.B.S.
- ACETATE
- ACRYLIC
- BERYLLIUM OXIDE
- CERAMIC
- DELRIN
- EPOXY/FIBERGLASS
- GLASS
- KAPTON
- KYNAR
- LEXAN
- MERLON
- MELAMINE
- MICA
- NEOPRENE
- NOMEX
- NYLON
- P.E.T. (Polyethylene terephthalate)
- **PHENOLICS**
- POLYESTER (MYLAR)
- POLYOLEFINS
- POLYSTYRENE
- POLYURETHANE
- PVC (Polyvinylcloride)
- SILICONE/FIBERGLASS
- SILICONE RUBBER
- TFE (TEFLON)
- THERMOPLASTICS
- ELECTRICAL INSULATING PAPERS, TAPES, and FOAMS
- NEOPRENE
- POLYSTYRENE
- POLYURETHANE
- SILICONE
- VINYL
- LAMINATES

Electrical Insulating Material Standards

ASTM's insulating material standards are instrumental in specifying, evaluating, and testing the electrical and physical properties of materials used primarily as electrical insulation in devices and related equipment. These properties include dielectric breakdown voltage, dielectric strength, AC loss, permittivity (dielectric constant), DC resistance and conductance, dissipation factor, ion exchange capacity, ionic resistivity, and other physical properties. These electrical insulating material standards allow manufacturers, particularly those in the semiconductor industry, to examine and asses such materials and equipment to ensure their qualification for safe use.

Conclusion

The control of electrical hazards is an important part of every safety and health program. A complete knowledge of insulating materials and standards for safe working practice is required for an electrician. Everyone has the right to work in a safe environment.

References

Author's own experience

ASTM D1711 - 11a Standard Terminology Relating to Electrical Insulation

EXPERIMENT- 7(A) AIM:- To prepare phenol formaldehyde resin. (Bakelite)

CHEMICALS USED:- Glacial acetic acid, 40% form aldehyde solution, Phenol, conc. H2SO4.

APPARATUS REQUIRED:- Glass rod, beakers, funnel, measuring cylinder, dropper and filter paper.

PRINCIPLE:- Phenol formaldehyde resins (PFs) are condensation polymers and are obtained by condensing phenol with formaldehyde in the presence of an acidic or alkaline catalyst. They were first prepared by Backeland, an American Chemist who gave them the name as Bakelite.These are thermosetting polymers.

Thermosets:- The polymers which on heating change irreversibly into hard rigid and infusible materials are called thermosetting polymers. These polymers are usually prepared by heating relatively low molecular mass, semi fluid polymers, which becomes in fusible and form an insoluble hard mass on heating. The hardening on heating is due to the formation of extensive cross-linking between different polymeric chains. This lead to the formation of a 3-Dimnesional network of bonds connecting the polymer chains. Since the 3D network structure is rigid and does not soften on heating, the thermosetting polymers cannot be reprocessed. Some important examples of thermosetting polymers are Urea-Formaldehyde resin and Melamine-Formaldehyde resins.

Properties:- Phenol- formaldehyde resins having low degree of polymerization are soft. They possess excellent adhesive properties and are usually used as bonding glue for laminated wooden planks and in varnishes and lackuers.
Phenol- formaldehyde resins having high degree of polymeriz ation are hard, rigid, scratch- resistant and infusible. They are resistant to non-oxidising acids, salts and many organic solvents. They can withstand very high temper atures. They act as excellent electrical insulators also.

Uses:- They are used for making moulded articles such as radio and TV parts, combs, fountain pen barrels, phonograph records etc. They are used for making decorative laminates, wall coverings etc.
They are used for making electrical goods such as switches, plugs etc.
They are used for impregnating fabrics wood and paper.
They are used as bonding glue for for laminated wooden planks and in varnishes and lackuers.
Sulphonated phenol-formaldehyde resins are use as ion-exchange resins.

Unit learning objectives of Mechanical System Design.

Unit No.	**Unit Name**	**Objectives**
Unit No-1	**Aesthetic and ergonomic considerations in design**.	1 Types of product forms. 2Making product designs for better appearance and shape. 3Importance of finishes proportions in design and to make it better. 4Knoledge of Morgan color code and its applications in design. 5 Importance of Ergonomics and how to make man machine relationship more effective in design. 6 Practical applications of ergonomic and aesthetic considerations in design.
Unit No-2	**System Approach to design**	Students to gain knowledge about following design aspects-- 1 System in the view point of design. 2 Formulating mathematical model for the system design. 3 Lumped and distributed system. 4 Mathematical modelling of systems containing masses, elasticity, inertia and Damping and friction.
Unit No-3	**3Pressure vessel Design**	Students to gain knowledge about the following design aspects- 1 Design criterion for thin and thick pressure vessel classification. 2use of Lames, Birnies and Clavarinos equations for the cylinder design. 3 Autofrattage andcompound cylinders design. 4Classsification and design of pressure vessels as per IS-2825,1969, 5Effec of openings and nozzle shell and covers and compensating method of design. 6 Types of pressure vessel supports, selection and design.
Unit No-4	**Brakes and clutches design**	**Students to gain knowledge about-** Design considerations in all brakes as specified in the syllabus. Design considerations for friction clutches, Torque transmitting capacity of all clutches specified in the syllabus.
Unit No-5	**Statistical considerations in design**	Students to understand about histograms, frequency polygon, Normal distribution, Central tendency, Design of gearbox for machine tool applications-application of statistics for DFA, Statistical analysis of tolerances, Mechanical reliability and factor of

		safety.
Unit No-6	**Design of Gear Boxfor machine tool applications**	1Determination of speed range. 2Graphical representation of speed range-structure diagram, ray diagram. 3 Selection of optimum ray diagram. 4Analysis of twelve speed gear box. 5Through gear box assembly drawing students to know about gear box design.
Unit No-7	**Design of material handling system**	Students to gain knowledge about Chain drives and belt conveyers. Power required for operation of the system through pulley drive.
Unit No-8	**Optimum design**	Students to understand about 1 Optimization design. 2Johnsons method of optimization. 3Concepts and differentiation between adequate design and optimum design. 4Mathematical knowledge about design equations. 5 Optimization of simple machine elements like tension bar, transmissionshafts, helical springs. 6 Optimization of design with Langarange multiplier.

Subject- Mechanical System Design.

Unit No.1 -Aesthetic and ergonomic considerations in design.

Objectives of unit-

Students to gain knowledge about

1 Types of product forms.
2 Making product designs for better appearance and shape.
3 Importance of finishes proportions in design and to make it better.
4 Knoledge of Morgon color code and its applications in design.
5 Importance of Ergonomics and how to make man machine relationship more effective in design.
6 Practical applications of ergonomic and aesthetic considerations in design.

Unit No-2SystemApproach to design-

Students to gain knowledge about following design aspects--

1 System in the view point of design.
2 Formulating mathematical model for the system design.
3 Lumped and distributed system.
4 Mathematical modelling of systems containing masses,elasticity,inertia and Damping and friction.

Unit No-3Pressure vessel Design.

Students to gain knowledge about the following design aspects-

1 Design criterion for thin and thick pressure vessel classification.
2 use of Lames,Birnies and Clavarinos equations for the cylinder design.
3 Autofrattage and compound cylinders design.
4 Classsification and design of pressure vessels as per IS-2825, 1969,
5 Effect of openings and nozzle shell and covers and compensating method of design.
6 Types of pressure vessel supports, selection and design.

Unit no-4-Brakes and clutches design.

Students to gain knowledge about-

Design considerations in all brakes as specified in the syllabus.

Design considerations for friction clutches, Torque transmitting capacity of all clutches specified in the syllabus.

Unit no-5-Statistical considerations in design-

Students to understand about histograms, frequency polygon, Normal distribution, Central tendency, Design of gearbox for machine tool applications-application of statistics for DFA, Statistical analysis of tolerances, Mechanical reliability and factor of safety.

Unit No-6–Design of Gear Box for machine tool applications-

1 Determination of speed range.
2 Graphical representation of speedrange-structure diagram, ray diagram.
3 Selection of optimum ray diagram.
4 Analysis of twelve speed gear box.
5 Through gear box assembly drawing students to know about gear box design.

Unit-7 Design of material handling system –

Students to gain knowledge about Chain drives and belt conveyers.

Power required for operation of the system through pulley drive.

Unit -8-Optimum design-

Students to understand about

1 Optimization design.
2 Johnsons method of optimization.
3 Concepts and differentiation between adequate design andoptimum design.
4 Mathematical knowledge about design equations.
5 Optimization of simple machine elements like tension bar, transmission shafts, helical springs.
6 Optimization of design with Langarange multiplier.

Unit learning outcomes

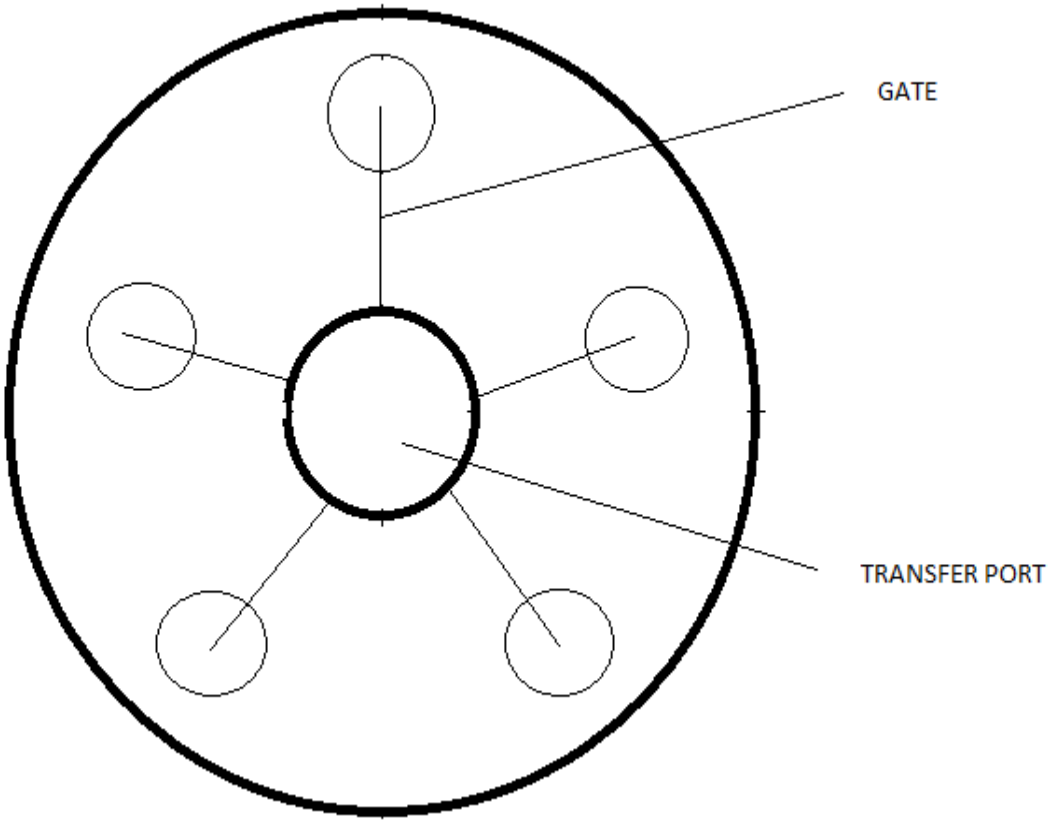
Unit1- Students have capability of improving the product design by application of Aesthetic and Ergonomic considerations.
Unit2- Students have substantial knowledge about modelling and analysis of the same for design purpose.
Unit3- Students have overall knowledge of pressure vessel design assembly so that in practice they should be able to design pressure vessel assembly.
Unit 4- Students should be able to select suitable clutches and brakes to the equipments.
Unit5- By using statistical knowledge students should be able to design tolerances.
Unit6- Students should be able to design entire machine tool gear box assembly.
Unit7- Students are in position to select the suitable material handling system and design the most suitable one.
Unit8- The system design with various options should be optimized by students to select the best possible design.

Course learning objectives

1 To introduce students about system design concept.
2 To introduce students about design concepts such as DFM, DFA and Optimization.
3 To have a clear knowledge about design considerations in assembly, manufacturing of parts and other areas interfacing with design principles.
1 To learn about the concept of economy on design through optimization technique.
2 Students should be able design the total material handling system for concern industry to fulfil the requirement.
3 At various design stages students should be able to optimize the designs for various selected parameters.

Course learning outcomes

1 Students should be able to design various mechanical system in the optimized and most suitable way.
2 The feasibility of design should be well understood by students at concept stage so that design becomes more practicable.
3 The simplification of various systems should be done by students at various stages of design. Mapping between Program outcomes to objectives.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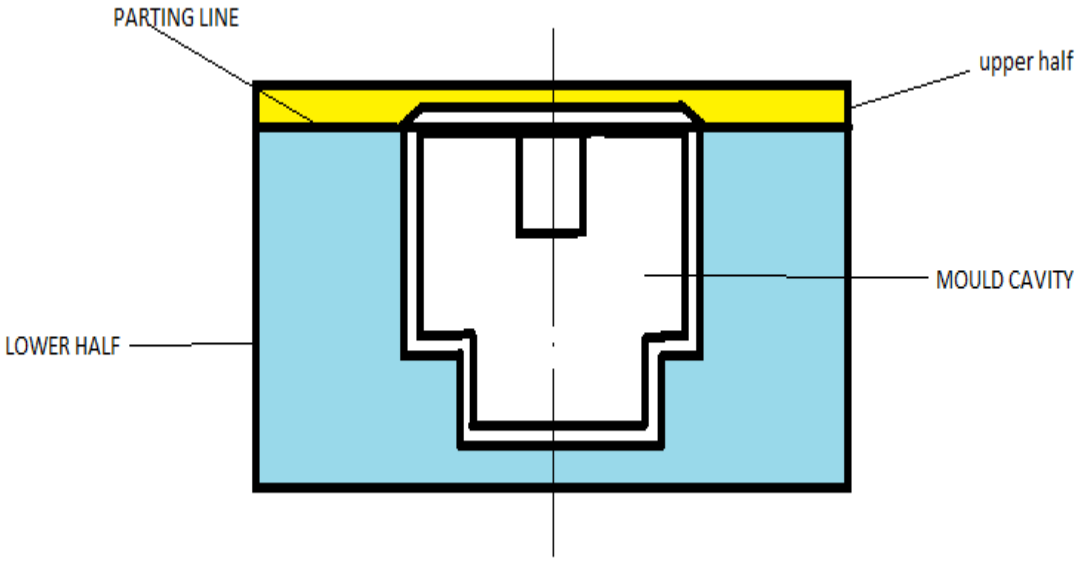
PARTING LINE
upper half
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