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Parametric Study and Development of Different Plastics and It's Welding Techniques

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Abstract - *The objective of this paper is to gain better understanding of different of plastic materials and their joining by different techniques. Plastics are becoming highly desired engineering material but their joining techniques are not used at a satisfactory level instead they are recycled. Advance and developed joining techniques help to joint the product and repair, parametric study of different techniques helps to know the pros and cons. It will help to know material requirement for its joining. Right type of joining techniques will help to form a reliable and strength joint which will fulfil the demand as per application. This paper will help to know about most widely used plastics and role of plastic welding in different industries.*

***Key Words*: Captivating, Parametric, Pliable, Prevailed, Ameliorate.**

1. INTRODUCTION

Word polymer is derived from the classical Greek words poly meaning "many" and meres meaning "parts" Simply stated, a polymer is a long-chain molecule that is composed of a large number of repeating units of identical structure[11]. Polymers are uniquely captivating material because of effort less process able qualities and their density is comparatively low as compared to other materials. The integrative branch of material science has sorted engineering materials into four dominant groups metals, polymers, ceramics, and composites. Polymers has various pros over conventional materials, the most significant is being high strength to weight proportion.

Plastics are distinct type of polymer which involve structure of long chain. Plastic is a material comprising of a wide range of semi-synthetic or synthetic organics that are malleable and can be molded into solid objects of different shapes[6]. Plastics is a ruling material in the production and packaging, in today world there is demand of both high density as well as low density plastics. Plastics have prevailed over conventional stuffs such as wood, stone, glass, metal, leather and ceramics. Lightness is one of the dominant ascribe of plastic, as light weight materials take less energy to transfer and ordain. Plastics have transmute the work in the field of space scrutiny, nanotechnology, medical and engineering, it trace to be a phenomenal materials.

Plastic welding is the process of bonding the materials (plastic) by heating them to a acceptable temperature, sometime a affixing solution is also used. There are different category of plastics accessible which are vended and cover a wide range of properties like stiffness, resistive, soft, ductile, brittle etc. Due to wide range of variety, joining of plastic components plays an critical steps during manufacturing and other activity related with the process. Joints are necessary as part integration is impossible because of complexity and use of different materials in same components. Joining is generally a crucial step in any fabrication cycle. The effectiveness of joining operations have large influence on application of materials, that's why variety of joining techniques are used for plastics. Joining process should be efficient with the manufacturing procedure for improved production work. Joining of plastics are categorized into different methods as per the constituent of plastics they are used, interrelation of process with heat, pressure, time plays an important role.

1.1Types Of Plastics

Plastics are synthetic materials made from wide range in combination of polymer with different filler materials, composition of filler changes as per applications or requirement. As per their chemical bonding and properties they are classified as Thermosetting plastics, Thermoplastics and Elastomer.

In which the use of thermoplastics is became important due to its application in engineering fields such as mechanical, civil, aerospace engineering.

When thermoplastics are heated their physical characteristics get amend and they become a homogenized fluid and can be modified, remolded and resized. Most thermoplastics have a high molecular weight.

1.2 ENGINEERING PLASTICS

A. ***Polycarbonate***:-Polycarbonate have some striking engineering properties include smash strength, low moisture absorption. Polycarbonate have finite scratch and chemical defiance propensity. Polycarbonates do not have a unique plastic rapport code. Polycarbonate procure

from bisphenol second largest sales volume engineering thermoplastics.

B. *Polypropylene*:- Polypropylene is usually durable and pliable, particularly when copolymerized with ethylene. This permit polypropylene to be utilized as an engineering plastic. Polypropylene with higher MFR will fill the plastic mold more comfortably throughout the injection or blow-molding production process.

C .*Polybutylene Terephthalate*:-PBT is defiance to solvents, contract immensely little during devise, it is instinctive strong, heat-resistant and can be treated with flame retardants to make it non-flammable. Polybutylene terephthalate is a thermoplastic engineering polymer, that is used as an insulant in the electrical usage.

D. ***Acrylonitrile Butadiene Styrene***:- ABS is derived from acrylonitrile, butadiene, and styrene. Acrylonitrile is a synthetic monomer produced from propylene and ammonia.[1] The pros of ABS is that this material integrate the strength and rigidity of the acrylonitrile and styrene polymers with the toughness of the polybutadiene pliable, A variety of alteration can be made to ameliorate impact resistance, firmness, and heat resistance.

E. ***Polyethylene***:- Polyethylene is a thermoplastic polymer comprised of long chains engender by integrating the ingredient monomer ethylene the name hails from the constituent and not the genuine chemical resulting. Depending on the crystallinity and molecular weight, a melting point and glass transition may or may not be observable[1]. The temperature at which these belimp differ strongly with the type of polyethylene.

F. ***Polyimide***:- Thermosetting polyimides are known for thermal stability, good chemical resistance, excellent mechanical properties. [1] Polyamides are also unavoidably defiance to conflagration combustion and do not generally mixed with flame retardants.

G. ***Polyvinyl chloride:-*** PVC is widely used plastic in different fields it has ample of suitable properties. By annexation of plasticizers PVC can be made mushy and pliable, which can mostly used in phthalates. By adapting this form it can be applicable in various applications like paddings, line insulations, air filled products and different usage by replacing rubbery stuff.

Sr No.	Thermo plastics	Abbreviation (coding)	Welding (tool) temperature in kelvin	Density (g/cm^3)
1	Polycarbonate	PC	623	1.20-1.22
2	Polypropylene	PP	573	0.89-0.92
3	Polybutylene Terephthalate	PBT	623	1.31
4	Acrylonitrile Butadiene Styrene	ABS	623	0.9-1.53
5	Polyethylene	PE	543-573	0.97
6	Polyimide	PA	673	1.42
7	Polyvinyl chloride	PVC	573	1.38

Table no.1 Properties of thermoplastics

2. Plastic joining techniques

The recent drive towards diaphanous construction in the different industries has led to increased utilization of lightweight metallic and non-metallic materials with the seek of achieving targeted optimized adaptiblity. Hence, suitable joining methods are necessary in order to improve joining capabilities of dissimilar materials and to integrate them in engineering structures. Many joining techniques have been evolved to weld thermoplastic polymers.

2.1. *Adhesive bonding*:- It is a solid state joining technique that relies on the formation of intermolecular forces between the work pieces and the polymeric adhesive itself for joint formation [11]. Adhesive bonding implicate the use of a polymeric sealer, which goes through a chemical or physical reaction, for terminal joint genesis. . The work piece surface properties in an adhesive bond play a vital role in the bonding process, and bond strength and joint durability can be significantly ameliorate by surface treating

2.2. *Mechanical fastening*:- It is a joining techniques by ancillary fixture of components without actual amalgamating the joining surface. It depends on the use of supporting members such as screw and rivets for ultimate joint formation. During the riveting process surface and component are heated to required temperature so that during cooling action shrinkage can occur which provides a tight closed joint. Different kinds of mechanical fastening methods still exists due to the simplicity of the process.

2.3. Hot plate welding:- It is a welding technique which is generally used for joining plastics. Heat source of energy is used for melting of plastic surface, hot plate act as a welding tool which melt the surface to be joint for a specific period of time and then removed allowing the joining of surface. The cycle time for the hot plate depends on

composition of plastic and weld bead to be produce at interface.

2.4. *Hot gas welding*:- It is a method in which external filler material in form of rods are heated by hot gas stream up to plastic state and fused together with the joining surface. The strength of the joint totally depends on bonding properties of filler stuff with actual surface. In the operating action of welding the welding baton and a weld groove are concomitantly heated for carrying out the activity. The air mass flow and the temperature can be regulated in specified range.

2.5.*Ultrasonic Welding*:- It is a type of joining process in which two components affixed together by application of high frequency ultrasonic vibrations. Working principle of ultrasonic welding is that high frequency ultrasonic vibration are transmitted by horn in a focused approach by which heat energy is created and use for joining purpose. This oscillatory vibration creates friction between parts which cause accumulation of heat at contact area.

2.6. *Laser welding*:- It is a contact free process uses concentrated beam of light which is focused at one point and heat energy is generated. laser is obtainable in different outputs having range able wavelength . The intensity of laser which have to be used depends on composition of plastics and its thickness. It also suitable for making complex weld joints.

Sr no	Welding technique	Advantages	Limitations
1	Adhesive Bonding	Avoid damage to product and improve the aesthetics. Allow joining of different geometry and composition	Joints cannot be dissembled without damage. Environmental degradation due to moisture, temperature.
2	Mechanical fastening	No need of forming chemical bonding in two parts. Product can be dissembled simply without damaging.	Stress concentration leads to distortion of joints. Joints can get loosen due to vibrations.
3	Hot plate welding	Fast process due to fast heating ability. Strong joints can be made along with automating the system	Warping can occur during joining stages. Overheating surface degradation.
4	Hot gas welding	Leak proof joints Welds are stronger and lighter.	Weld quality totally depends on skill operators. Thermal degradation and oxidation can occur.
5	Ultrasonic Welding	No external heat generation. No toxic fumes are produced.	Thickness of sheet is limited. Welding beads are produced on one side of surface.
6	Laser welding	Extremely small welds can be produced. Clean welds are produced.	The input energy requirement is high. Working cost is high.

Table no.2 Comparative Study Of Welding Techniques

3. Role of Plastic Welding in Different Industry

Plastic is been used world-wide, in different utilizations include bottles, receptacle, toys etc. So different industries has adopted plastic usage instead of traditional materials. As materials changes, the techniques which is to be used for various operations also changes.

The real plastic insurrection in automotive industry has began in the starting phase of 1952, which increase the consumption of plastics in form of different compositions to be used in automobiles. An estimated data about 60% to 65% of gross high working capability plastics used in premium vehicles. This help in evolution of of plastic welding techniques, different industry use plastic joining methods in a wide manner. Plastic welding helps in repairing of the object instead of recycling which play important role in energy saving. Interior of automobiles predominately made up of thermoplastics, and they are joint together by implementing ultrasonic welding and adhesive bonding methods. Superficial parts of automobile

are also fabricated by plastics like poly carbonates, in instance of damage they can be rectify by hot sealing techniques.

Airliner industries utilize different polymer and high grade of plastics composites for their manufacturing, as 42% to 46%(approx) of air craft interior is made up of composite materials due to their light weight properties. In this ultrasonic welding as well as laser welding are used in a extensive manner due to their clean and reliable welds propensity. Plastic like ABS is mostly use in interior of the aircrafts, so there joining is carried out by different methods.

In construction industries water supply is carried out by using large PVC pipes, as a solution for permanent joint they are welded using hot plate or hot gas welding methods. Which provide it with leak proof joint without adding extra temporary attachments. Construction industries also use plastic sheets for different work joining of this sheet, plastic welding techniques are used along with mechanical fastenings methods.

4. CONCLUSION

Thermoplastics plastics like Acrylonitrile Butadiene Styrene, Polyethylene, Polycarbonate, PVC are used over large scale in different industries, due to which development of joining techniques have been evolved. In which hot gas welding and ultrasonic welding plays an vital role in most of the fields for plastic joining. It is essential to use this techniques instead of recycling the product, as repairing of the product will consume less energy as compared to recycling the product and the product can be used to a larger extend.

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