EXPERT SYSTEM FOR SELECTION OF ADHESIVES

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Abstract

Adhesive bonding is gaining importance as they are lightweight and less costly and even the use of load bearing adhesives are on the increase. Nowadays adhesives are commercially available for both industrial and domestic applications. Any adhesive cannot be used for a given bonding requirement as the type of materials that can be joined by an adhesive is limited. Since the varieties of adhesives commercially available are large and have different properties, the user is normally confused to select the apt type of adhesive for a given bonding requirement. As the right type of adhesives can be selected only with expert advice, an expert system for the selection of adhesives is developed.

Introduction

Adhesives are compounds capable of holding objects together in a useful location by surface attraction. Adhesive joints are often less costly, more easily produced, able to resist fatigue and corrosion than mechanical fasteners or welds. In some cases, adhesives are the only practical means of assembly. A variety of adhesives with different physical and chemical properties are available today. These adhesives are classified according to their property. Adhesive properties like high temperature strength, moisture & corrosion resistance, flexibility, transparency etc. may vary depending on the type of adhesives. Given two materials to join, any type of adhesive cannot be used. Most of the adhesives are suitable for joining certain materials only. The type of materials that an adhesive can join varies depending on its physical and chemical properties. Depending on the materials to be joined, the service environment and the bond strength requirement, suitable adhesive has to be selected. A large number of adhesives are available commercially. Choosing the right adhesive requires expert advice which is hard to find. To overcome such difficulties it will be much useful if an expert system is built for the selection of adhesives. An expert system is a software that addresses problems in narrow domains. In this expert system, various adhesives that can bind different metals, alloys, building materials and other materials are considered. The inputs to the expert system are the materials to be joined and the desired property of the adhesive. Depending upon these inputs from the user, the suitable adhesive is selected by the Expert system and is displayed on the computer screen along with surface preparation instructions.

The Bonding Process

Bonds are made by positioning a film of liquid or semi liquid adhesive between the parts and immobilizing the assembly until the adhesive solidifies. The adhesive may be applied in the solid or molten stage or as a pure liquid or solution. Conversion to the final solid form may require heating, cooling, evaporation or a combination of these. The cure may require seconds,

hours or days and is usually accelerated by increasing the temperature. Ease of assembly is closely related to the technique of adhesive application and cure.

Typical characteristics of adhesive bonding

Adhesive bonding is apt to be employed in preference to other joining methods when one or more of the following characteristics are important.

1). When there are limitations to the weight of the assembly.
2). When porous, fragile, or heat sensitive materials must be joined.
3). When the appearance of other fastening methods not be satisfactory.
4). When it is necessary to provide sound deadening or vibration attenuation in the finished assembly.
5). When the parts to be joined must be electrically insulated from each other to avoid galvanic corrosion or for other reasons and
6). When materials of dissimilar composition, thickness or modulus must be joined together.

Although adhesive bonded joints can be engineered for high strength, adhesive bonding may not be suitable, if strength requirements or temperature variations are extreme. Parts bonded generally must tolerate a surface cleaning operation prior to bonding and they must be stable chemically in the intended service environment. Adhesive bonds resist shear, tensile and compressive forces better than cleavage or peel. If the bonded materials have greatly different coefficient of thermal expansion, an adhesive primer or a double face adhesive system may be advisable. The majority of adhesively bonded parts are not load bearing because other assembly techniques have historically been more economical for these applications. This situation is changing, however, and there is now increasing use of load bearing adhesives in the automotive, aircraft construction industries and electronic industry.

The Adhesive Expert System

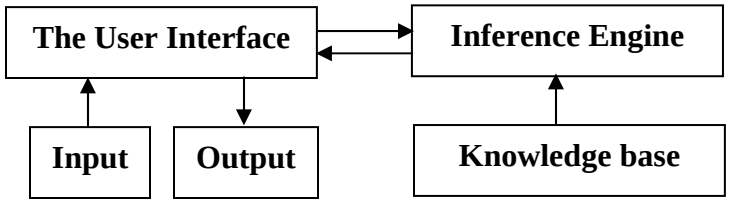

Fig 1. Typical layout of an expert system

Expert system is an intelligent computer program which uses expert knowledge to reach a level of performance that is achievable by skilled human experts. A typical layout of the expert system is shown in Fig 1. The user has to give inputs through the user interface. The inference engine collects the inputs from the user interface and searches the knowledge base for suitable adhesive that can suit the user requirements and displays the results in the screen through the user interface. The system uses breadth first search for searching the knowledge base. The

knowledge base is the vital part of an expert system. The knowledge base can be constructed by extracting data from experts or Handbooks etc. In this expert system, the data is collected from handbooks.

The adhesive expert system is built based on the data given in Table-1 and Table-2. In this expert system, 17 types of adhesives are considered. The materials are divided into two broad classifications namely, Metals & Alloys and Building materials & others. In each division, 9 materials are available for selection. Depending on the selection of material, another menu with the properties of adhesives that can be used for the selected material is displayed. On selection of the required adhesive property, the expert system gives the adhesive that can be used.

Table 1. Adhesives and the materials that they can bind

	MATERIALS	ADHESIVES																
		a	b	c	d	e	F	g	h	i	j	k	l	m	n	o	p	q
METALS AND ALLOYS	STEEL	X	X	X	X	X			X	X			X					
	ALUMINIUM AND ITS ALLOYS	X	X	X	X	X	X	X	X	X								
	COPPER AND ITS ALLOYS	X		X		X			X	X				X				
	CHROMIUM					X												
	LEAD	X										X						
	MAGNESIUM	X				X	X		X	X								
	NICKEL					X		X						X				
	TIN					X												
	SILVER					X		X						X				
BUILDING MATERIALS AND OTHER MATERIALS	STONE/BRICK	X			X	X												
	CERAMICS					X					X	X	X					
	CONCRETE	X				X												
	GLASS	X		X	X						X	X	X					
	LEATHER							X				X	X	X	X			
	PAPER	X				X		X	X		X	X	X		X	X	X	
	WOOD														X	X	X	X
	PVC - RIGID	X				X		X										
	POLYETHYLENE	X	X					X										

Conclusion

The proposed adhesive expert system effectively provides results for different material-combinations and properties. A large number of combinations of materials and properties are covered. The knowledge base can be further enriched with different materials and new types of adhesives. Such expert systems can provide better guidance for adhesive users.

Table 2. Adhesives and their properties

REFERENCE	ADHESIVES	PROPERTIES
a	Polyester, Epoxy Polyester, isocyanate modified	Strong bond
b	Nitrile-phenolic Neoprene-phenolic	Inexpensive, strong and durable bond, corrosion resistant.
c	Alpha-cyanoacrylate	Fairly strong but brittle.
d	Epoxy-phenolic, Nylon epoxy	Strong bond with moisture resistance & strength retention at 150-250 º C
e	Epoxy, amine-, amide-, anhydride-cured	High tensile strength but low peel strength high temperature strength, moisture & corrosion resistant.
f	Nylon-epoxy	High tensile strength & peel strength.
g	Flexible adhesives: Natural rubber, butadtene-acrylonitrite, neoprene, polyurethane, polycrylates, silicones.	Flexible, limited load bearing ability, Expensive, good low temperature tensile. Shear & impact strengths.
h	Polyamides	Good strength and fairly tough at ambient temperature.
i	Polyvinyl-phenolic	Excellent durability, low cost.
j	Cellulose esters	Low cost, Rigid, Low strength & Sensitive to heat.
k	Vinyl chloride-vinyl acetate.	Fairly flexible.
l	Polyvinyl butyral	Tough, transparent & flexible
m	Polyhydroxyether	Flexible & moderate strength.
n	Polyvinyl acetate	Dries quickly, flexible, strong bond, low resistance to heat & moisture.
o	Animal glue or starch glue.	Low cost , strong bond, poor moisture resistance.
p	Ureaformaldehyde,melamine formaldehyde,resorcinol formaldehyde,phenol formaldehyde.	Low cost & low moisture resistance
q	Ethylene-vinyl-acetate	Low cost.

References

1. Handbook of product design for Manufacturing, James G. Bralla, McGraw Hill Book Co. 1986.
2. www. Expertise2go.com