



Harshwardhan Gupta's Design Tips-1

Assembly with Adhesives

Industrial adhesives have come a long way from being used to paste stickers in aircraft toilets. Did you know that almost all parts of the Boeing 747-400 wings are assembled with industrial adhesives? These wing assemblies have proven themselves to be more reliable than the older ones with mechanical fasteners. Industrial adhesives have been finding increasing uses for the last 3 decades. They have grown from the ubiquitous Araldite and M-seal to hundreds of varieties for specific purposes.

Most important, if used properly, they can replace more expensive parts and processes, and save money for you. Many adhesives may appear "expensive" to a first-time user, as they are rather expensive on a per-gram basis, but you often need just a drop or two to do the job. Almost all adhesives are vibration resistant, and will hold fast even under severe vibrations. Many are so strong that they will not give way before the parts themselves are destroyed. In this piece I have restricted myself to joining adhesives, and have not covered compounds used for sealing – they are a family unto themselves.

Industrial adhesives can be classified into the following major categories:

1. **Anaerobic Adhesives:** These remain liquid in air indefinitely, but harden as soon as air is excluded – as in a push-fit assembly. These do an excellent job of producing a press-fit in round parts, and are fairly useless in joining large flat surfaces. To achieve a good press-fit; a close sliding fit should be specified on the parts, not a press fit. A well designed and a well-made joint can REALLY be as strong as a keyway or a shrink-fit.
2. **Epoxy and other 2-component adhesives:** These are the strongest of the lot, but they need time to set. Most of the viscous 2-component liquid epoxies first become absolutely fluid as they set, then become solid, so it should be kept in mind that unless restrained, the adhesive will leak out before setting – or the parts might move. Though epoxy putties are often used to fill up blowholes in castings, it is not a good practice to use defective parts in new machines.
3. **Solvent-based adhesives:** These have a limited strength, compared to anaerobic or epoxy adhesives. They should be used in such a way that the solvent has time and breathing space to evaporate. The rubber-based ones are a rather unusual – they have to be applied on BOTH surfaces, and have to be almost dry BEFORE pasting. Using them is a one-shot job; and once even a small portion is pasted, it is impossible to separate and re-position the parts if you have made a mistake. Variants of solvent-based glues are often used as sticker glues with a release paper.
4. **Room Temperature Vulcanizing Rubbers (RTVs):** These cure in the air once they are out of the squeeze-tube. They are often used to hold small parts and fasteners in place, especially under vibrations. Extremely effective and can really reduce service calls originating from assemblies long under vibrations coming apart, and save costs in locking fasteners like spring washers, etc.
5. **Instant Glues:** These are cyanoacrylate-based glues. They cure within a few seconds by absorbing moisture from surrounding air, once applied. They are not very strong, and should be used only where allowing setting time is not possible.
6. **Hot-melt adhesives:** These need a complex melting system to apply, but are one of the cheapest and extremely strong adhesives. They gain full strength within seconds - as soon as the little dab is cooled. They can be used in assembly lines and can replace mechanical fasteners.

Besides these, there are ever-newer types making their appearances everyday.

Keep the following points in mind while designing with; and while using adhesives:

1. CLEAN, REALLY CLEAN the surfaces to be joined with a strong solvent like trichloroethylene, acetone (but not nail-polish remover) or NC thinner. Do NOT use kerosene or common thinner to clean, as these may leave a film of oil and not allow the adhesive to bond with the surface. Clean plastic parts by washing with detergent and drying thoroughly. Ensure good ventilation, as solvent vapors are toxic.
2. It is a good idea to test the cleaning solvent by evaporating a few drops on a mirror to check that it does not leave oily residues behind.
3. Use a freshly WASHED dry cloth for cleaning. Most cotton waste and/or commercially available rags are full of oil themselves even if they are fresh.
4. With rolling bearings, etc., clean ONLY the surfaces to be joined, not the whole bearing. If you do, then immediately lubricate the whole bearing again after the adhesive sets.
5. Follow the instructions on the pack to the letter. Do not invent your own homegrown ways.
6. Make full preparations to do the job in one shot. These are not mechanical fasteners that can be undone easily if you make a mistake.
7. If you apply the adhesive in the bore, the excess will come out from the far end. If you apply the adhesive on the shaft, the excess will come out from the front end. Decide beforehand where you will have better access to wipe the excess glue, and work accordingly.
8. Just as in painting, wherever possible, you can use masking to prevent adhesives going into wrong places.
9. Use appropriate solvents for ungluing the (metal) parts; do not try to tear them apart. Ask the manufacturer for the type to be used.
10. You can design out mechanical fasteners, and save space, material, fastener costs and assembly time. Adhesives often simplify a complex fastening assembly.
11. With some lateral thinking, you can even make part-assembly adhesives play the role of static seals.
12. Look beyond the price on the carton. Even if you are a small manufacturer, you can still benefit and save money by using new adhesives.

Do grow out of the tendency to nonetheless use mechanical fasteners with the glue, "just to be safe"! Learn to trust adhesives and you will never come unstuck! Happy gluing!

Next Month: Timing Belt Drives

The author is a graduate of I.I.T. Mumbai in mechanical engineering. He has been designing machines for the last 28 years. He is the founder of Neubauplan Machine Design Studio, an independent consulting machine-design firm in 1981 in Pune. His achievements are showcased in his website at www.neubauplan.com. Suggestions for topics for future pieces, queries and comments can be sent to neubauplan@eth.net.