inseto	ADHESIVES - ALL THINGS CONSIDERED	
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- SCOPE: The Total Processing Costs: 10 Things to Factor in, besides the actual adhesive costs.

When selecting an adhesive for use in a manufacturing scenario, i.e. on a production line, the starting point is to consider the properties of the materials you're planning to bond, the desired bond strength and the end application's environment, such as the presence of heat and/or chemicals.

Having identified the ideal adhesive type, it is all too tempting to then start shopping around for the most attractive per-volume cost; or for your company's purchasing department to set about the task.

However, it is essential to consider the bigger picture. There may be costs associated with transportation, storage and curing of the adhesive. Also, as 'time is money' it too should be factored in. In short, the adhesive with the lowest cost per volume may not be the lowest cost to use. So, what should be considered when determining the total processing cost?

Much is driven by how the adhesive cures, which will be in one of three ways:

- With the application of high intensity light (either broad spectrum or UV);
- With the application of heat; or
- At room temperature (RT).

Regarding the last of these, and for the purpose of this article, RT-cured shall also be taken to mean 'air-cured' and 'moisture-cured'.

In addition, we do not explore dual-cure adhesives in any great depth, but the pros and cons can still be derived in what follows.

#1 - Adhesive cost

As a rule, light-cured adhesives tend to be quite expensive, due to the high cost of the photoinitiator that is responsible for speed of cure. Comparatively, heat-cured adhesives, might be less or more expensive, depending on the chemistry, and RT-cured adhesives tend to be the lowest cost. Also, whatever the curing method, be mindful of minimum order quantities (MOQs). As a minimum, you should perform volume-for-volume comparisons and, for short shelf-life adhesives, expired stock should not be used and should be

disposed of; which for certain adhesives can prove costly.

#2 – Transportation

Neither light- nor RT-cured adhesives should incur particularly expensive transportation costs, however different countries have varying regulations on what can and can't be put through their postal services. Heat-cured adhesives quite often require refrigerated or frozen transportation.

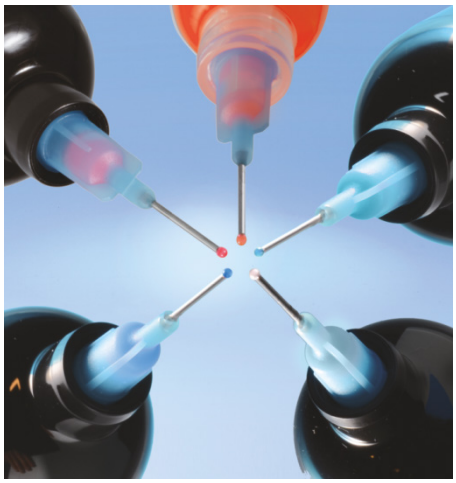
#3 - Storage temperature

As per the transportation issue, heat-cured adhesives usually require cold or frozen storage; so there will be running costs associated with a refrigerator or freezer (see #10), plus the capital outlay if you don't already have one. This can be particularly expensive if the adhesive needs to be stored at -40oC, in which case an industrial freezer is required. Light- and RT-cured adhesives normally require only standard cabinet storage.

#4 - Adhesive preparation time

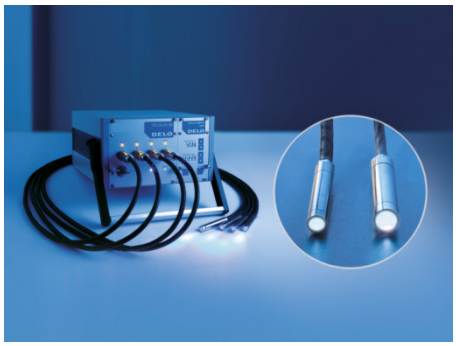
RT-cured adhesives, such as silicones, have minimal preparation time, but for two-part systems, the component parts (i.e. the resin and the hardener) will need to be mixed. One-part epoxies are simply dispensed, but may need to be conditioned from frozen, whether from -18 or -40oC (the two usual storage temperatures). This could take several hours, and the thawing process cannot be expedited due to the possibility of moisture getting into the adhesive. Careful, well-timed planning is required to ensure that there is no disruption to the production process and that only the necessary volume (or slightly more to err on the side of caution) is defrosted. Light-cured adhesives normally require no preparation time.

#5 - Dispensing equipment



This is normally dependent on the manufacturing requirements, including the level of control needed with regards ambient temperature and desired drop bead size. Simple time-pressure systems are most often the easiest and simplest way to dispense an adhesive, especially one-part adhesives, but low viscosity adhesives are susceptible to small changes in ambient temperature, and a relatively expensive volumetric system may be required. Again, this is very application-specific. For higher volume users, two-part adhesives can require expensive dispensing equipment to ensure that the correct ratios of resin and hardener are dispensed.

#6 - Curing equipment



Understandably, RT-cured adhesives (which include anaerobics) require no specialist equipment. Heat-cured adhesives require ovens, with their associated running costs and capital outlay (if you don't already have one). Where light-cured adhesives are concerned there are trade-offs to be made. For instance, halogen lamps emit light across the full optical spectrum and can be used for curing a wide variety of adhesives. The lamps tend not to cost too much but the bulbs (with their lifetime of about 1,000 hours) do. Conversely, LED lamps have a higher capital outlay but far lower running costs because the bulbs draw less power and have longer lives (>10,000 hours). Be mindful of the fact that the LEDs emit light of a specific wavelength (typically 365, 400 or 460nm) so the bulbs may need to be matched to the adhesive being used.

#7 - Curing time

Adhesives cured by high intensity light will do so in seconds, and in a production scenario this easily offsets the higher cost of the adhesive. Heat-cured adhesives can require that the product spend up to two hours in the oven. NB: heat-cured adhesives will have a minimum cure temperature. It is advised not to set the oven to this temperature though. It is most likely that the oven won't be of a uniform temperature throughout. Accordingly, tests should be performed to determine the optimal oven temperature that is above the minimum cure temperature of the adhesive. RT-cured adhesives require the longest curing time; from 24 to 72 hours.

#8 – Overall process cycle time (includes dispensing time)

Whilst Tip #7 discussed the curing time (important in its own right), there are other factors to consider. In general, the higher the number of parts to be assembled, the shorter the cycle time needs to be. So, all things considered, light-cured adhesives will always provide the shortest cycle time, given their speed of cure. At the other end of the scale, RT-cured adhesives will always have the longest cycle time, simply because they take longer to cure.

Sometimes the cure time can be reduced by adding heat, and a general rule-of-thumb is that for every 10oC increase in curing temperature, the curing time halves. The converse is also true, so RT-cured adhesives can be even slower than normal in ambient cooler temperatures, e.g. in a non-temperature-controlled environment in winter. One-part adhesives fall somewhere in between these two extremes, depending on the cure temperature that is specified on the technical data sheet.

#9 - Work in progress space and jigs.

Tips #7 and #8 discussed curing times and cycle times. These will have a direct bearing on not only the space required but, for some builds, you may not be able to commence a build stage if jigs are unavailable. Again, light-cured adhesives cure so quickly that work can be moved on at a pace and jigs are not tied up for too long. Projects for which heat-cured adhesives are used can take longer (an hour or two) and projects for which RT-cured adhesives are employed will typically require at least 24 hours. Note: dual-cure adhesives (specifically light and heat) are proving to be a popular means of freeing up jigs. The adhesive can be 'flash cured' (normally with UV light) so that the assembly can be handled and taken to the oven.

#10 - Utility costs

Here, we're mainly talking about your electricity bill. As RT-cured adhesives don't require any special storage or curing equipment the electricity requirements are minimal. Light-cured adhesives incur a small to medium charge depending on whether LED or halogen bulbs are used. Heat-cured adhesives have the largest electricity overhead because of refrigerator/freezers for storage and ovens for curing.

Summary

As outlined above, there myriad factors to be considered – collectively rather than in isolation - when choosing the best adhesive for an application. Following these guidelines will ensure that the most cost-effective solution is delivered for each and every application. Also, as per our opening gambit, the starting point must still be a consideration of the properties of the materials you're planning to bond, the desired bond strength and the end application's environment. These, combined with the above 10 tips, will ensure you end up with a fit-for-purpose adhesive (chemistry) plus a cost-effective curing method to meet your manufacturing and business goals.