information on sealants everyone should know

Most engineers and contractors have heard the complaint more than once: a duct system is leaking and the problem seems to be the sealant; the same sealant that looked great in the sales literature, even in the same laboratory and at the time the duct erected. What happened?

The sealant manufacturer may have relied on outdated specifications that do not begin to meet today's technological requirements. Most of the current specifications were developed years ago for other industry groups. It is not uncommon to find "Sigma, AMMA, federal, MIL, and ASTM' specifications being used as guides for sealants in the sheet metal industry.
Many of these specifications call for the use of good test procedures but fail to cover the most critical *performance* criteria. Instead, tests are needed that are designed specifically for the industry; tests that will demonstrate how a material will perform under critical conditions in one, five, ten or even twenty years after installation in a duct system.

It's possible for unscrupulous or unknowing chemists to cover up deficiencies with additives, enabling a sealant to pass a lab test before being used in the field. As a result, many of today's sealants have only short-term effectiveness. This, along with poor design and inadequate application technique, causes leakage and energy loss, serious problems in duct construction.

Users are often tempted to simply ignore specifications and testings and instead *purchase on impulse and price*. This isn't a solution to the problem. Users need to become more discerning in selecting proper tests for prospective sealants.
It's important to have a basic understanding of key terms used in the industry. Understanding the vocabulary used by sealant manufactures as well as learning how to perform some very simple tests can help the user select the best product.
The following terms are widely used:

adhesion
Adhesion occurs when one material sticks to another. The key issue is how *long* the mating will last.

tack
Tack gives the sealant its quick binding capability. It's only good for a short time and is only necessary until a permanent bonding occurs. Tack is achieved through a careful formulation of elastomers, polymers and resins. These ingredients must be carefully selected to enable the sealant to permanently bond later. Otherwise, the tack may be fine but other problems such as plasticizer migration, cold flow, loss of tensile strength, long term ageing, and instability will crop up. All of these can cause sealant deterioration relatively fast.
To achieve tack, some sealant manufactures resort to using, a lot of oils, plasticizers, by-products and low cost hydrocarbon resins. When used to extreme these cause the problems listed; in moderation, the imbalance will only effect reliability slightly. But the user will not necessarily be able to tell to what extent the compound has been compromised.

specific adhesion
Specific adhesion is almost never identified in test procedures. It means, of course, that the sealant has been formulated to adhere to a specific surface. To achieve the right mechanical or chemical adhesion, a sealant manufacturer must work to blend the elastomers, polymers and resins with the ultimate end in mind. Otherwise, the sealant can have tack and the appearance of adhesion and good

quality but may deteriorate rapidly in the field. Specific adhesion creates the real bond between particular substrates, allowing the sealant to work compatibly with them over a long period of time. It's not, however, a static condition and should not be measured alone. Cold flow and creep must also be measured in any relevant tests.

cold flow

Cold flow can occur at all temperatures. Cold flow is a material seeking its lowest level with respect to gravity, such as water does. A thermoplastic material has hot flow when it's melted or is above its softening point. Most thermoplastic materials cold flow *below* this softening point, especially when they have been combined with plasticizers and oils. Some materials cold flow quickly; others take years to develop this condition.

Generally, in testing for cold flow a material is placed in an oven at high temperature for a short time to check for any deformities in the material. *The problem with this test is that it can be made ineffective by adding fillers such as asbestos and talc to the sealant*. In the new material this can make it appear that no cold flow is occurring when the opposite is true. An exception is when the material that would *cold flow is being totally absorbed by the asbestos and talc*, in which case the adhesion would age rapidly.

All cold flow is not bad. A lightly crosslinked polymer, when combined with proper fillers, will result in a low force to compress material that will only slightly cold flow. *such a material will wet through dirty, oily and damp surfaces; a definite advantage*. This material will have a lower tack with a slower but more lasting bond to the surface. A sealant must be constantly monitored however, to prevent too much cold flow. In testing for this, one must be careful to not confuse the desirable low force to compress characteristics with what might appear to be cold flow.

polymer

Polymer is an ambiguous term often used to describe the backbone or primary structural member of a sealing compound. The use o the term generally means the manufacturer has used some type of thermoplastic material in the compound. Such materials can easily be affected by heat, cold and ultra violet light. There are several "plastic-acrylic polymers" on the market today that are not always cured to an elastomeric level.

These are perfect examples of this misuse of terms. Such products are vulnerable to a reversion of cure, not only back to the level of the original polymer. They can easily be identified by a strong odour, usually apparent after a prolonged exposure. These same problems frequently occur in other so-called "polymers"made of non-cured butyl or butyl cured with resins. Remember that the term "polymer" can be widely misused by sealant manufactures to disguise a lot of undesirable proprietary materials.

elastomer

Elastomer describes the thousand of rubber polymers, both crosslinked and uncrosslinked, that are used in the industry. In a curd state (crosslinked), most rubber elastomers age better by eliminating the unsaturation in the compound. This creates a highly resilient lattice structure.
In the uncured state, some elastomers behave like a thermoplastic polymer, but this undesirable action isn't always evident. An elastomer *should* be the mainstay of any sealant used in a dynamic situation. It should meet the specific requirements of the job, although there is no single elastomer or combination of elastomers that will meet all conditions.

plasticizer migration

Plasticizer migration occurs when the materials that make a compound flexible leave the compound through bleeding, evaporation thermal decomposition or oxidation. The remaining material is less elastic than originally intended. The main concern is that the ***migrating*** material ends up as the material that interfaces with the surface to which the sealant is bonded and becomes its weakest link. This gives the sealant little or no tensile strength, leading to an eventual breakdown of the bond; in other words, separation.

Plasticizer migration even affects silicones. It causes them to pick up dirt and lose adhesion over a period of time. A well-formulated material will have NO migration or bleed at all. Gelling agents can mask plasticizer migration, but a good ageing test will detect this. Long term exposure to the elements will also reveal the use of such agents.

service and shelf life

A good sealant, when properly packaged, should have shelf life equal to its service life. (An exception would be that of a crosslinking liquid sealant whose shelf life can *only* equal the shelf life of the catalysing and curing agents in the product.) a compound with a solids content of one hundred percent should *never* have a shelf life less than its service life.

Some manufacturers advertise a long service life but only a one-year shelf life. This is probably for fear of a reversion of cure, oxidation, cold flow, or other dangers. Products on the shelf can be readily scrutinised. Once installed in the field, though, they are not visible and the engineers or contractors often overlook such problems.
The following simple tests can help the layman determine how effective a sealant may be. The only requirements are time, refrigeration, water and oven :

Take a sample of the sealant currently being used and place it outside where it's exposed to the elements, particularly to the sun. Keep duplicate samples inside that are packaged just as they were when received from the manufacturer. Check both the stored and exposed samples in six months to determine how much the material has bled, hardened, changed colour, developed an odour, become soft, begun to cold flow, or just seems usable. Difference in appearance alone will indicate a great deal about the sealant lasting qualities.

To test cold temperature formulations, place samples of both the sealant and the substrate to which it will be bonded in a refrigerator at 0°C for twenty-four hours. Later, assemble them, as they would be used in the field to check for ease of assembly. A material that can be assembled well at cold temperatures is obviously the most desirable buy one must remember that such materials are generally the most susceptible to failure at high temperatures. Another sample should therefore be tested simultaneously at high temperatures.

heat is the acid test for any sealant It can cause migration, oxidation, cold flow or a reversion of cure. Place sealant samples in an oven at 90°C. for seventy-two hours and observe how the sealant performs. Look for discoloration, a gaseous condition or a mass with no body. A sealant that performs extremely well will generally have some problems at the cold temperature level.

A high mark on any one test will not necessarily assure the user of having a good sealant. Generally, the one exhibiting the least amount of deterioration overall in these visual tests will be the one that performs the best. The objective, naturally, is to get one that performs well above average in all categories.

percent of solids content

This property provides an indication of how much a sealer may shrink from its wet state to its final dry state. The curing of most sealers and adhesives is either by solvent evaporation or polymerised chemical crosslinking. As the sealer cures, the solvent materials evaporate and a matrix of solid materials distributes itself across the covered area. Since less material is distributed over the same area, voids may appear and some of the sealer could pull away/ from various surfaces. The higher percentage of solids content, the less shrinkage will occur however, one must take note of sealers and adhesives that are filled with asbestos or talc. If the sealer has too much filler in them, it will age fast and tend to crack off of the surface.

fire rating test

There is more demand today for fire hazard classification in sealants than ever before. However, most of the manufactures have side-stepped this issue, especially the manufactures in the solvent-based adhesives and sealants. These sealants are highly volatile in their wet state and it is difficult to get a good fire hazard classification on them. Underwriters' Laboratories is by far the best criteria. However, tests may be conducted with ASTM E-84 or NFPA 255 and as stated, the UL 723. The optimum in fire hazard classification is to have sealers such as nitrile acrylic adhesives that do not burn in the wet or dry states. It is the writer's opinion that the acrylic nitrile materials available today have the best fire hazard classification. They present no fire hazard in the wet state as well as the dry state.

Most engineers and contractors should be well acquainted with the source of adhesives and sealants used and not hesitate to ask that the manufacturer of these various materials be prepared to warranty their materials to do a specific job.

How can the buyer get a good sealant? Start by working *with* the sealant manufacturer. It's necessary for a sealant to be compounded with a specific application or set of conditions in mind. Think of the sealant as an integral part of the duct system and not just an afterthought to be purchased like an –off the shelf- item. If the sealant manufacturer understands what the duct designer is trying to accomplish and what materials are to be used, it's much easier to formulate the correct sealant.

Establish tough internal specifications and instigate the necessary checks, balances and tests to see that they are enforced. See that the supplier periodically shows proof of performance and also tests internally for added protection.

Finally, insist that the purchasing department buys for performance and reliability, which means long term, cost effectiveness and not just for price alone. Do this by arming them with a set of rigid specifications and an internal test program. This allows them to determine if the supplier is meeting the requirements on continuing basis and not just at the outset of the program.

Learn to recognise poor quality and help the sealant industry rid it self of those suppliers who offer cosmetically attractive but functionally inferior products.

The most effective way to achieve these goals is to establish up to date stringent tests and specifications for the sealant industry. Conscientious and competent sealant manufactures would welcome the opportunity to have their products measured against such guidelines.

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