STABILANT 22

D.W. ELECTROCHEMICALS LTD.
70 Gibson Drive, Unit 12
Markham, Ontario
L3R 4C2   CANADA
Phone: (905) 508-7500
Email: dwel@stabilant.com

Number 29

APPLICATION NOTE

Use of Stabilant 22 in Severe Outdoor Environments

Introducing Stabilant 22

Stabilant 22 is an initially non-conductive block polymer that when used in a thin film within contacts switches to a conductive state under the effect of the electrical field. The field gradient at which this occurs is set such that the material will remain non-conductive between adjacent contacts in a multiple pin connector environment.

Thus, Stabilant 22 provides the connection reliability of a soldered joint without bonding the contacting surfaces together!

Contacts are generally the weakest link in any piece of electrical/electronic equipment whether it be in low current devices found in computers or higher current circuits found in automotive and aviation applications, to name only a few. The use of Stabilant 22 or its isopropanol diluted form, Stabilant 22A, will make contacts from 10 to 100 times more reliable, eliminating costly service call-backs and ensuring customer satisfaction.

What are some of the environmental conditions that cause connector failure?

Typically, these are those found in coastal regions where a combination of salt-spray and high winds combine with fog, rain, and large temperature variations to produce an environment which is very hard on electrical connectors.

What are some of the reasons for connector failure under these conditions?

There are two areas of failure, physical failure of the connector, and electrical failure of the connector. While there are some designs in which only one or the other failures will occur, normally a combination of failures wilt take place.

Physical Failures
The physical failures generally result from the use of connectors which are not designed for the environmental conditions encountered. Unfortunately, even with all the thousands of designs on the market today, it is often very difficult to find a connector which will survive some severe environments, and when one is found, the limited market for such a design usually results in very high costs.

The engineer specifying the connector has to face the decision of first cost vs replacement/maintenance costs and it is not unusual for the initial cost of the connector coupled with an apparently low replacement cost to account for the choice of connectors. But sometimes environmental effect costs due to increasing pollution levels are underestimated in the same way that long term maintenance costs due to rising labor costs are underestimated.

The most common physical failure results from corrosion eating away the parts of the connector holding the male and female components together. The result is that the connector simply disconnects. The cause of the corrosion is usually a lack of resistance of the connector body material and/or finish to the combination of salt/water and/or chemicals in the environment. The corrosion can be hastened by the use of materials which are incompatible galvanically, or by the use of the connector shell as both a physical coupling and a current carrying element.

Assuming that the connector cannot be replaced with a type more suitable for the climate, and that the connector is still functioning, the usual solution is to clean all traces of salt/corrosion from the connector, and re-assemble it, finishing by enclosing it in such a way as to prevent the entry of the contaminants. This may consist of "buttering" over the connector body with a high viscosity silicon grease and enclosing it in some sort of protective sleeve which will prevent the grease from being eroded away.

A second vulnerable area is the connection between the wire or cable and the connector itself. Many physical failures take place because salt water has penetrated into that part of the connector where the wires are crimped or soldered onto the pins. Quite apart from the electrical effects of the corrosion products, these products frequently occupy much more volume than the metal upon which they feed. Occasionally enough pressure can be generated to rupture a shell that has already been weakened by corrosion.

Sometimes it is necessary to use a supplementary means of cable/wire strain relief in order to minimize the effects of wind-induced vibrations in the cable in causing a "grinding" action between the two halves of the connector.

A third type of failure is the exposure of the connector to unusual corrosive liquids or gasses not normally encountered in the environment, but which might be occasionally generated by other failures in the operating plant. This can also extend to corrosion-inducing chemicals being liberated from connector components subject to over-heating due to thermal runaway of contact-wire junctions.

This latter also suggests that we must also consider the possibility of other types of electric-current-induced physical failures. If the shell is being used as a conductor is there going to be sufficient heat rise caused by the combination of electrical resistance and current flow across the mechanical connection to cause physical failure of any of the other connector components, such as strain relief boots, seals, thermoplastic insulations, etc.? Could there be enough heat rise to cause failure of the electrical wire/cable connection to the connector?

It must be remembered that there are two elements involved in the electrical failure of a connector: the insulation, and the conductor/contacts/connections; in other words, the problem may involve the non-conductive parts and/or the conductive parts.

Dealing for the moment only with the part of the connector that is meant to disconnect and reconnect (and not with the parts that are attached electrically or otherwise, to the cable/wire; any connector may be broken down into a male-female or hermaphroditic component which is designed to mate with an equivalent part, and thereby pass electric current, and the parts needed to hold the former in alignment. The latter are usually insulators. In connectors carrying AC signals (especially higher radio frequencies) it is necessary to have the latter parts dimensioned so that the electrical impedance of the connector is the same as that of the cable - otherwise there will be a discontinuity and a reflection will occur in the transmission system.

Where the AC electrical impedance is not a consideration we have to deal with losses in or on the electrical insulation. Excessive leakage across the insulation will result in heating in high-power applications, insulation breakdown in high-voltage applications, or signal leakage in multiple pin control circuits. None of these are acceptable, and the consequences could be destruction of the connector and a fire hazard to consequential damages due to failure of a process-control, alarm, or communications system.

Where AC electrical impedance is a factor, insulation leakage can cause loss of signal strength and or unacceptable modification of the signal caused by line reflections. A good example of the latter is ghosts images or detail blurring in cable TV.

Failure of what patent attorneys like to call the "connector means" can range from a simple erratic connection (intermittent) to terminal failure of the contact pair.

The introduction of corrosion products into the gap between the connecting pair can also result in problems ranging from rectification effects (many corrosion products can create crude semiconductor junctions with metal surfaces) which can produce strange modulation distortion of the signals or even introduce spurious signals derived from the rectification of whatever RF (conventional RF of even fast rise time) signals may be present in the environment. Generally, this is characterized as excessive sensitivity to "electronic smog".

As before, the corrosion products can completely break the contact means or through its increased bulk, lock-up the connector so that it cannot be properly disconnected.

How can I achieve electrical contact improvement?

If a mated contact were potted in a clear material, sawn along at right-angles to, the connection plane polished, and examined under a microscope, it would be seen that what we think of as smooth contact surfaces are really almost mountainous, and that as a consequence, the contact area is far from continuous. One of the benefits of gold plating in the days when gold was much less expensive, derived from the fact that gold is soft and malleable. Under the action of making the connection, the gold deformed, producing a much larger total contact area. The plating, being thicker, was much less likely to be porous, and so corrosion was also prevented. In addition, the closely mated surface prevented the intrusion of oxygen and other contaminants.

As the price of gold has generally risen with time, many newer applications use a thin "flash" – applying as little as possible consistent with porosity constraints. Even then special processes are used to try to minimize porosity as will be evident upon reading almost any connector manufacturer's brochures.

Where gold is not used on both surfaces, the question becomes one of the compatibilities of the connecting surfaces both with one another and with environmental intrusions. Often when less inert metals than gold are used in a contact pair and combined with sufficiently high contact pressure, they perform with greater reliability than gold at lower pressure. The key here is to have enough pressure to exclude oxygen and other contaminants.

Stabilant 22 (or its isopropanol diluted form, Stabilant 22A) when used on a contact need only be present in a film thick enough to fill the interstices (or gaps) between the contact surfaces. Because of its switching ability, it will become conductive there without becoming conductive between adjacent pains or causing leakage across insulating surfaces.

Note that the conductivity of a new connector will not be substantially improved by the Stabilant when there is already sufficient contact so that any added contact area aided by a material which has a higher volume resistance than the contacting metal will be of minor consequence.

However the Stabilant's presence will help to exclude oxygen and corrosive materials from the contacts, and its surfactant action will keep existing contaminants in suspension.

The action of Stabilant on an aging or older contact is somewhat different. Here the contact will not be as good. Thus, the conductivity of the Stabilant-treated surface will appreciably lower overall contact resistance.

On high current applications, the lowered resistance well may be enough to stop thermal runaway of the contact means. a situation where the heating of a joint causes expansion which by stretching the clamping means beyond their elastic limit results in a reduced contact pressure, increasing the resistance of the contact area, and further increasing the heating. In extreme cases this can literally cause a high current connector to explode.

Because of the “switching threshold” effect, Stabilant will not become conductive between adjacent contacts and its bulk resistivity is high enough to prevent signal leakage.

In an environment where it is impossible to guarantee the exclusion of contaminants, silicone grease can be used on the insulation to keep its surface resistance as high as possible. The problem them becomes one of preventing the contamination of the Stabilant by the silicone, and vice versa.

On low frequency connector applications, it is sometimes possible to take a thin sheet of soft silicone rubber (with a Durometer of about 30 to 40, per ASTM D2240 type A) and make a washer which is perforated with holes for the male contacts, and which will fit inside the connector shell. The material should be thick enough such that when the connector is screwed or clamped together, the silicone will deform and form a water and gas tight seal between the adjacent contacts.

This solution will work only where the connector design allows the silicone washer to be compressed.

Another potential problem in connectors is the area where the wire and or cable is connected to the contact means.

Frequently the wire may be of solder or tin plated copper, while the rear of the contact body could be anything from gold-plate, through silver or tin plate to an as-machined alloy. The introduction of solder itself on a bare copper wire can provide a potential problem of galvanic corrosion while some of the fluxes themselves can cause problems if they wick up into stranded wires. Then too there is the possibility that breakdown products from the cable jacket can cause corrosion of the copper.

Multiple point crimps, made with properly designed tools such that there is sufficient pressure on the conductors are often much more reliable than soldered joints besides having greater consistency. The Stabilants can be used to enhance the operation of such joints.

What procedures can be followed on assembled connectors?

Once a connector is assembled, it may be necessary to protect it against the environment by somewhat less orthodox (in the eyes of the manufacturer) means. One of the simplest of these is the use of a heat shrinkable tubing.

This is a special tubing that shrinks in diameter (but not much in length) when a hot air gun or other heat source is used. This typically is a layered polyolefin material with an internal low-molecular weight layer that melts while the outer layer shrinks. This provides a much more intimate seal when a length is used that stretches from the wire jacket over the connector (and on to the wire jacket on the other side for an in-line connector). A problem with this material is that it loses its elasticity and gets stiff at low temperatures - any leaks will likely occur when its cold. We have seen this material used with rubber splicing compound (as used on high voltage connections) where a single layer of stretched splicing compound is used over the wire-connector-wire area before the heat shrink tubing is used. The elasticity of the splicing compound under compression is certainly better than that of any of the heat shrinkable materials and the resultant "booted joint" is much less messy to open up.

Another treatment is to use a thick long fiber equivalent silicone dielectric grease such as vacuum grease applied in a layer over the connector and wire. This can be used inside heat shrink tubing. Enough should be applied so that the shrinking of the tubing extrudes the excess from the ends of the tubing. A possible problem here is that the grease may also be forced into the connector with degradation of the metal to metal contact. In an attempt to resolve this latter problem, I have seen the same treatment used with an external wrapping of kitchen cling-wrap being used to cover the silicone. Ordinary vinyl tape can be used over this providing the silicone has not got on the surface of the plastic.

Yet another technique is to use one of the low-melting tool protection coating material such as the butyrates. These are an oil bearing plastic material normally used in the tool room to protect sharpened milling cutters against damage. The material melts easily and connectors can be dipped into the liquified butyrate. It is not easy to apply in the field, but it can be readily cut and is easy to strip away from the connector.

All of these solutions are, of course, designed to exclude the salt and moisture from the connector and a choice of which treatment to use will be based on the location of the connectors, the ease of application of the treatment, and the life of the materials used. Consideration must also be given to possible degradation of heat shrink materials themselves by ultraviolet, ozone, or chemical contaminants.

In what forms is Stabilant available?

Stabilant 22 is the name of the concentrated product. Stabilant 22A is the formula in which the concentrate is diluted with isopropyl alcohol (25% Stabilant, 75% isopropanol by volume). This is popular, as it is much easier to apply due to its lower viscosity. When used at normal room temperatures or higher, the isopropanol will evaporate after the application, leaving a thin film of the concentrate in place. In some applications such as socketed IC's it is not even necessary to unplug the IC to treat the connection. The dilute form should be used for treating existing crimp type joints between multiple stranded wire and the contact. The concentrate is available in 5mL, 15mL, 50mL, 100mL, 250mL, 500mL and 1L sizes. Stabilant 22A is usually sold in the 15mL Service Kit, which also includes several microbrush applicators and instructions, all in a capped tube that is ideal for the tool box or bench.

What are some products that are used to exclude water?

Silicone greases have been manufactured for several decades by several companies including Dow Corning and General Electric Silicones Division. Besides the usual silicone dielectric greases, which are available from many manufacturers there is a much stiffer silicone grease called High-Vacuum grease which is somewhat easier to handle as an external moisture barrier due to its higher viscosity.

For applications disqualifying silicones from use we have been told that Apiezon™ Grease type T and the more rubbery Apiezon™ type N grease (both generally used in laboratory glassware applications) have had some success.

Heat Shrinkable tubing is manufactured by such companies as Alpha. One surface irradiated type with the soft inner core is their FIT-300 product line. Their standard shrinkable polyolefin (XLPO) tubing is the FIT-221 line. Many others have been added by these manufacturers and others since the first publication of this note.

NATO CAGE/Supplier Code 38948

5mL Stabilant 22 (Concentrate), NATO Stock Number 5999-20-002-1112

15mL Stabilant 22 (Concentrate), NATO Stock Number 5999-21-909-9981

15mL Stabilant 22A (Isopropanol Diluted), NATO Stock Number 5999-21-900-6937

15mL Stabilant 22E (Ethanol Diluted), NATO Stock Number 5999-21-909-9984

Stabilant products are patented. Because the patents cover contacts treated with the material a Point-of-Sale license is granted with each sale of the material.

SAFETY DATA SHEETS ARE AVAILABLE ON REQUEST

NOTICE