Flux: A General Overview

Our thanks to American Beauty for allowing us to reprint the following article.

Flux is a key contributor to most soldering applications. It is a compound that is used to lift tarnish films from a metals surface, keep the surface clean during the soldering process, and aid in the wetting and spreading action of the solder. There are many different types and brands of flux available on the market; check with the manufacturer or reseller of your flux to ensure that it is appropriate for your application, taking into consideration both the solder being used and the two metals involved in the process. Although there are many types of flux available, each will include two basic parts, chemicals and solvents.

The chemical part includes the active portion, while the solvent is the carrying agent. The flux does not become a part of the soldered joint, but retains the captured oxides and lies inert on the joints finished surface until properly removed. It is usually the solvent that determines the cleaning method required to remove the remaining residue after the soldering is completed. It should be noted that while flux is used to remove the tarnish film from a metals surface, it will not (*and should not be expected to*) remove paint, grease, varnish, dirt or other types of inert matter. A thorough cleaning of the metals surface is necessary to remove these types of contaminates. This will greatly improve the fluxing efficiency and also aid in the soldering methods and techniques being used.

Detailed Examination

All common untreated metals and metal alloys (including solders) are subject to an environmental attack in which their bare surfaces become covered with a non-metallic film, commonly referred to as tarnish. This tarnish layer consists of oxides, sulfides, carbonates, or other corrosion products and is an effective insulating barrier that will prevent any direct contact with the clean metal surface which lies beneath. When metal parts are joined together by soldering, a metallic continuity is established as a result of the interface between the solder and the surfaces of the two metals. As long as the tarnish layer remains, the solder and metal interface cannot take place, because without being able to make direct contact it is impossible to effectively wet the metals surface with solder.

The surface tarnishes that form on metal are generally not soluble in (and cannot be removed by) most conventional cleaning solvents. They must, therefore be reacted upon chemically in order to be removed. This required chemical reaction is most often accomplished by the use of soldering fluxes. These soldering fluxes will displace the atmospheric gas layer on the metals surface and upon heating will chemically react to remove the tarnish layer from the fluxed metals and maintain the clean metal surface throughout the soldering process.

The chemical reaction that is required will usually be one of two basic types. It can be a reaction where the tarnish and flux combine forming a third compound that is soluble in either the flux or its carrier. An example of this type of reaction takes place between water-white rosin and copper oxides. Water-white rosin, when used as a flux is usually in an isopropyl alcohol carrier and consists mainly of abietic acid and other isomeric diterpene acids that are soluble in several organic solvents. When applied to an oxidized copper surface and heated, the copper oxides will combine with the abietic acid forming a copper abiet (which mixes easily with the unreacted rosin) leaving a clean metallic surface for solder wetting. The hot molten solder displaces the rosin flux and the copper abiet, which can then be removed by conventional cleaning methods.

Another type of reaction is one that causes the tarnish film, or oxidized layer to return to its original metallic state restoring the metals clean surface. An example of this type of reaction takes place when soldering under a blanket of heated hydrogen. At elevated temperatures (the temperature that is required for the intended reaction to take place is unique to each type of base metal) the hydrogen removes the oxides from the surface, forming water and restoring the metallic surface, which the solder will then wet. There are several other variations and combinations that are based on these two types of reactions.

Once the desired chemical reaction has taken place (lifting or dissolving the tarnish layer) the fluxing agent must provide a protective coating on the cleaned metal surface until it is displaced by the molten solder. This is due to the elevated temperatures required for soldering causing the increased likelihood that the metal's surface may rapidly re-oxidize if not properly coated. Any compound that can be used to create one of the required types of chemical reactions, under the operating conditions necessary for soldering, might be considered for use as a fluxing material. However, most organic and inorganic compounds will not hold up under the high temperature conditions that are required for proper soldering. That is why one of the more important considerations is a compounds thermal stability, or its ability to withstand the high temperatures that are required for soldering without burning, breaking down, or evaporating.

When evaluating all of the requirements necessary for a compound to be considered as a fluxing agent, it is important to consider the various soldering methods, techniques and processes available and the wide range of materials and temperatures they may require. A certain flux may perform well on a specific surface using one method of soldering and yet not be at all suitable for that same surface using a different soldering method. When in doubt it never hurts to check with the flux, or solder manufacturer for recommendations.

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