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(54) **COMPOSITION DE FLUX A FAIBLES RESIDUS POUR LE
SOUDAGE, A BASE D'ACIDES ORGANIQUES ET NE
NECESSITANT AUCUN NETTOYAGE DES PIECES**

(54) **ORGANIC ACIDS ACTIVATED LOW RESIDUE NO CLEAN
SOLDER FLUX COMPOSITION**

(57) A blend mixture of non-toxic, non-corrosive liquid soldering flux consists essentially of a mixture of short-chain carboxylic acid derivatives of a short to medium-chain hydrocarbon, such as: adipic acid and formic acid in an organic solvent system consists of iso-propanol and ethyl acetate. Neither precleaning nor postcleaning of the pieces being joined is necessary. The flux evaporates completely upon heating, leaving no corrosive residue or other product on the surface of the piece. The composition comprises about, a) 60-95% by weight iso-propanol, b) 0-30% by weight ethyl acetate, c) 1-10% by weight formic acid, c) 0.5-8% by weight adipic acid, and d) 0-10% by weight acetic acid.

Abstract**“Organic Acids Activated Low Residue No Clean Solder Flux”**

A blend mixture of non-toxic, non-corrosive liquid soldering flux consists essentially of a mixture of short-chain carboxylic acid derivatives of a short to medium-chain hydrocarbon, such as : adipic acid and formic acid in an organic solvent system consists of iso-propanol and ethyl acetate. Neither precleaning nor postcleaning of the pieces being joined is necessary. The flux evaporates completely upon heating, leaving no corrosive residue or other product on the surface of the piece. The composition comprises about, a) 60-95% by weight iso-propanol, b) 0-30% by weight ethyl acetate, c) 1-10% by weight formic acid, c) 0.5-8% by weight adipic acid, and d) 0-10% by weight acetic acid.

16 Claims, No Drawings

“Organic Acids Activated Low Residue No Clean Solder Flux Composition”

Background of the Invention

1. Field of the Invention

5 The present invention is directed to a liquid solder flux, and, more particularly, to an organic acid activated liquid solder flux specifically formulated for cleaning electronic circuit assemblies, such as printed circuit boards, during the fabrication thereof. Adipic acid, acetic acid, and formic acid in a solvent, such as isopropanol and ethyl acetate, are used to remove solder flux, oils, waxes and greasy substances, as well as adhesive and other residues from various
10 substrates.

2. Description of the Prior Art

 Soldering with a soft solder, such as tin-lead based alloy melting at between 200°C to 260°C, is widely employed in the electrical and electronics industries. In order to produce a
15 satisfactory soldered joint, it is necessary to use a flux with the soft solder in order to remove any residual surface oxide films and hence provide a clean surface and in order to reduce the surface tension of the molten solder and hence promote good wetting of the surface by the solder. It is important that the molten solder fully wet the surfaces to be joined during the tinning step, as unwet portions result in voids at the surfaces after soldering is complete, and the voids can cause
20 later failure of the bond.

 Therefore, the surface to be fluxed must be cleaned of a portion of the oxide and contaminant coating prior to fluxing. Equally important, the soldered array must be carefully

cleaned after soldering is complete, in a postcleaning process, to remove any unreacted flux and reaction products of the flux treatment. Any remaining flux or reaction products can continue reacting with the bonded pieces and corrode them during service. Such corrosion caused by fluxes is a major concern for many types of solder bonding, as the bonded pieces are sometimes
5 used in environments having conditions such as high humidity and high temperature that accelerate corrosion reactions that might otherwise proceed slowly. Tiny amounts of unreacted flux or reaction products that remain on the surface following soldering and postcleaning can therefore have disastrous consequences. Because of the consequences of solder failures and the significance of solder joints, the soldering process has been studied extensively.

10 Fluxes now in use include mixtures of inorganic acids in inorganic vehicles or solvents such as water, inorganic acids in petrolatum pastes, salts in water, petrolatum paste or organic solvent, organic acids in water, organic halogens in water, amines and amides in water, and natural or modified rosins. All of these fluxes require postcleaning of the soldered joint. Fluxing can also be carried out in a reducing environment, as by accomplishing the soldering process in a
15 hydrogen gas atmosphere. Postcleaning is not required, but maintenance and use of a pure hydrogen atmosphere in large scale production operations is difficult, and can lead to related hydrogen embrittlement. In sum, there is known no effective, generally applicable approach to fluxing which avoids the need for postcleaning of the soldered parts.

There exists a need for an improved approach to soldering, and particularly to the fluxing
20 operation, which increases the reliability of the joining process by promoting effective wetting of the solder to the piece during the tinning step, and also reduces the incidence of post-soldering failures due to corrosion or related causes. Work continues in an effort to develop suitable fluxes

that permit making a solder joint faster and better, in a manner that is both environmentally acceptable and also does not require special precautions to protect the health and productivity of production line workers.

5 **Summary of the Invention**

The present invention provides a solder flux, and related method for fluxing a surface and for joining two pieces together using the flux. The flux promotes even, smooth, regular wetting of the surface of the piece by solder, with a virtual absence of unwetted portions. Use of the flux does not require cleaning of the surface prior to fluxing or postcleaning of the bonded portions of the pieces after soldering is complete. The ingredients of an organic acids activated solder flux increase the reaction to metal oxides and make wetting by the solder easier and faster. Any residue of the activated agent boils off with the heat of soldering. The flux evaporates entirely during the fluxing process, leaving no residue or reaction products to interfere with the use of the bonded components, or cause corrosion or other harmful post-bonding effects. At ambient temperature, the flux is a liquid having a viscosity comparable with that of water, and can be readily provided in open containers at the point of use. The vapors from many embodiments of the flux are not odorous and offensive to persons who use the flux, and contact of the flux to the body does not cause injury. The flux can therefore be used in assembly operations involving hand labor without special precautions such as required with some other fluxes.

20 In accordance with the invention, organic acids activated liquid solder flux comprising a flux base and the organic acids dissolved in sufficient solvent to form a liquid solder flux is provided. The organic acids consist essentially of carboxylic acid derivatives of a short to

medium-chain hydrocarbons. The amount of the organic acid derivatives range from an amount effective to provide improved fluxing action to an amount sufficient to form a saturated solution.

The flux of the invention is applied to the surface to be fluxed by briefly immersing the surface into the flux, spraying the flux onto the surface, or by other convenient means. The surface is then tinned by dipping the surface into liquid solder, brushing the liquid solder onto the surface, or other convenient means.

When the flux of the invention is used, the surface to be fluxed and bonded need not be specially cleaned prior to application of the flux. The surface should not have grease, thick dirt, or other impenetrable barrier that prevents contact of the liquid flux to the surface. In the other aspect of the invention, the organic acids are mixed with an evaporative organic solvent to form a flux. The organic acids must be present in an effective amount, which is typically in the range of from about 1 part of acid mixture to 99 parts of solvent. Full fluxing effectiveness is normally reached with about 1 part of the acid mixture for 95 parts of the solvent. Acceptable evaporative organic solvent would be isopropanol and ethyl acetate. Acceptable organic acids are those that sublime fully at the fluxing temperature when mixed with the solvent. Adipic acid is especially preferred in this embodiment. Significant amount of evaporative organic acid, such as formic acid and acetic acid, would improve the surfaces to be joined during the tinning step.

A wide variety of types of pieces can be fluxed and joined by the processes of the invention. Conventional electronic components such as resistors, diodes, capacitors, transistors, integrated circuits, and the like are included. Subassemblies can be formed or joined. Wires, connectors, printed wiring boards, and the like can be joined together or with active components. The processes are also operable in conjunction with non-electronic soldering operations, such as

general metal joining, fabrication, and the like. There are no known limitations on such uses of the flux.

It will be appreciated that the present invention presents an important advance in the art of soldering and fluxes. The flux of the invention is highly effective in promoting wetting of the portions of components to be joined by solder, producing an evenly tinned surface. The flux and its reaction products evaporate completely by the conclusion of the fluxing operation, so that postcleaning is not required. The flux is easy to use in fluxing the surfaces and in bonding components. It is not dangerous to contact to the skin, and does not have an objectionable odor, so that the flux can be used in mass production soldering operations.

Further, the purpose of the foregoing Abstract is to enable the Canadian Intellectual Property Office (CIPO) and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms of phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. Accordingly, the Abstract is neither intended to define the invention or the application, which only is measured by the claims, nor is it intended to be limiting as to the scope of the invention in any way.

It is therefore an object of the present invention to provide a new and improved composition for cleaning the surface of various soldered articles and which has all of the advantages of the prior art and none of the disadvantages.

It is another object of the present invention to provide a new and improved composition for cleaning the surface of various soldered articles which may be efficiently manufactured and marketed.

An even further object of the present invention is to provide a new and improved composition for cleaning the surface of various soldered articles which is susceptible of a low cost of manufacture with regard to both materials and labor, and which accordingly is then susceptible of low prices of sale to the consuming public, thereby making such composition available to the
5 buying public.

Still yet a further object of the present invention is to provide a new and improved composition for cleaning the surface of various soldered articles and which is adapted to be topically applied to such articles in a colourless thin liquid, easily sprayable form.

These together with still other objects of the invention, along with the various features of
10 novelty which characterize the invention, are pointed out with particularity in the claims forming a part of this disclosure. For a better understanding of the invention, its operating advantages and the specific objects attained by its uses, reference should be made to the following detailed description of the preferred embodiments of the invention.

15 **Description of the preferred Embodiment**

The present invention is embodied in a flux used in conjunction with soldering. The flux preferably is a mixture of adipic acid, acetic acid, formic acid and the evaporative organic solvent system including isopropanol and ethyl acetate, with the ratio of acid and solvent being from about 2 part of acid mixture for each 50 parts of evaporative organic solvent system. While
20 greater proportions of acid are operable, completely effective results are obtained with less than about 1.5 parts of acid mixture. Preferably, the solvent system is isopropanol and ethyl acetate.

Both the acid mixture and solvent system should be without impurities that would not evaporate during fluxing.

A flux having reagent grade adipic acid, reagent grade acetic acid, reagent grade formic acid, reagent grade isopropanol and ethyl acetate, mixed in the ratio of 1 part by volume of adipic acid to 2 parts by volume of acetic acid to 2 parts by volume of formic acid to 85 parts by volume of isopropanol to 10 parts by volume of ethyl acetate, is the presently most preferred embodiment of the invention. This flux mixture is prepared by adding the required volume of adipic acid, acetic acid, formic acid slowly to the isopropanol and ethyl acetate, taking care not to splatter the acid or overheat the solution. Consequently, the preparation of the flux mixture should be accomplished by a person skilled in making acid mixtures, using good ventilation and appropriate safety equipment including at least goggles, a rubber apron, and rubber gloves.

The flux mixture can be contacted to the skin without burns or injury, although it is recommended that any flux touching the skin be washed away as soon as possible. Nevertheless, the flux mixture is much safer than many other commercial liquid fluxes, which quickly burn the skin. The dominant odor of the flux is that of the solvent, in the preferred case the isopropanol and ethyl acetate. While prolonged exposure to this odor is not recommended, exposure to a weak odor or for brief periods is not immediately harmful. Thus, the flux is safe to handle in ordinary conditions of good ventilation and a reasonably safe working environment. It is seen that the flux and approach of the present invention yield important advantages in soldering. Good tinning and soldering are achieved, without the need for cleaning and postcleaning. The flux is nontoxic, and can be used in production operations where hand wiring is done.

While the present invention has been fully described above with particularity and detail in connection with what is of ordinary skill in the art that many modifications thereof may be made without departing from the principles and concepts set forth herein. Hence, the proper scope of the present invention should be determined only by the broadest interpretation of the appended
5 claims so as to encompass all such modifications.

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The Embodiments of the Invention in which an exclusive property or privilege is claimed are defined as follows:

1. A soldering flux, consisting essentially of a mixture of an evaporative organic solvent and the acids selected from the group consisting of carboxylic acid derivatives of short to medium-chain hydrocarbon and an evaporative organic acid, the acid being present in an effective amount less than the solubility limit in the evaporative organic solvent.
2. The composition of claim 1 comprising, by weight of the total composition of:
 - i). 60 to 95% of organic solvent selected from the class consisting short-chain alcohol,
 - ii). 0 to 30% of organic solvent selected from the class consisting ethyl acetate,
 - iii). 1 to 10% of evaporative organic acid containing formic acid,
 - iv). 0.5 to 8% of organic acid containing adipic acid,
 - v). 0 to 10% of organic acid containing acetic acid.
3. The flux of claim 1, wherein the acid is adipic acid, and the ratio of adipic acid to evaporative organic solvent is from about 1 part of adipic acid, to about 95 parts of evaporative organic solvent.
4. The flux of claim 1, wherein the acid is adipic acid, and the ratio of adipic acid to evaporative organic solvent is about 2 parts of adipic acid to about 95 parts of evaporative organic solvent.

5. The flux of claim 1, wherein the acid is acetic acid, and the ratio of acetic acid to evaporative organic solvent is from about 1 part of acetic acid, to about 90 parts of evaporative organic solvent.
6. The flux of claim 1, wherein the acid is acetic acid, and the ratio of acetic acid to evaporative organic solvent is from about 2 parts of acetic acid, to about 90 parts of evaporative organic solvent.
7. The flux of claim 1, wherein the evaporative organic solvent is selected from the group consisting of isopropanol and ethyl acetate.
8. The flux of claim 1, further including an evaporative organic acid.
9. The flux of claim 1, wherein the flux is a mixture of about 2 parts of adipic acid in about 80 parts of isopropanol and ethyl acetate.
10. A method for fluxing the surface of a portion on a piece, comprising the steps of:
 - Furnishing a piece to be fluxed;
 - Contacting the portion to be fluxed to a solution consisting essentially of a mixture of an evaporative organic solvent and organic acid selected from the group consisting of adipic acid, and evaporative organic acids, the acids being present in an effective amount less than the solubility limit in the evaporative organic solvent;

- Heating the contacted portion to a temperature at which the organic acids mixture reacts with the oxides on the surface, and the solution evaporates.
11. The flux of claim 8, wherein the acid is the evaporative organic acids, formic acid and acetic acid.
12. A method for joining portions of two pieces, comprising the steps of:
- i). Furnishing the two pieces to be joined;
 - ii). Contacting the portions to be joined to a solution consisting essentially of a mixture of an evaporative organic solvent and the organic acids mixture selected from the group consisting of citric acid, adipic acid and an evaporative organic acid, the acid being present in an effective amount less than the solubility limit in the evaporative organic solvent;
 - iii). Applying a metallic solder to at least one of the portions to be joined to tin the portion at a temperature above the melting temperature of the solder;
 - iv). Contacting the two portions to be joined at a temperature above the melting point of the metallic solder and then cooling the contacted portions to a temperature below the melting point of the metallic solder, thereby joining the contacted portions together, said method being accomplished without any postcleaning of the joined components.
13. In claim 12, wherein at least one of the pieces is an electronic component.

14. In claim 12, wherein the acid is adipic acid, and the ratio of mixture of adipic acid to evaporative organic solvent is about 1 part of organic acid mixture, to about 95 parts of evaporative organic solvent.

15. In claim 12, wherein the organic acid is adipic acid and the evaporative organic solvent is an isopropanol.

16. In claim 12, wherein the organic acid is adipic acid, the evaporative organic solvent is isopropanol and ethyl acetate and the evaporative organic acids are formic acid and acetic acid.