TECHNICALLY SPEAKING

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Chlorinated Solvents vs. Alcohols vs….;
Let's Clarify Our Terms

I recently had a comment from the field that some misinformation exists regarding our use of hydrocarbon solvents in our cleaning products and our claim that some of these same products are plastic safe. Some people claim that trans-1,2-dichloroethylene (trans), acetone and MEK are hydrocarbons and caution the user that hydrocarbons are not safe for use on plastics. This is misleading because "trans", acetone and MEK are "**substituted**" hydrocarbons, and have different chemical properties from the un-substituted hydrocarbons which contain only carbon and hydrogen atoms in their chemical structure. Substituted hydrocarbons may contain chlorine, fluorine, oxygen, nitrogen or other atoms in their chemical structure. These atoms give the molecule the properties required to be good solvents for oil, grease, flux residues and other PCB contaminants but are also the cause for their effect on plastics...

To clear up the confusion as to which solvents are true hydrocarbons and which are substituted hydrocarbons, I'll give a brief description of some the common types of solvents used in electronics cleaners today. This will allow you to predict which cleaners will do the best job in a particular application in terms of cleaning, evaporation rate and plastic safety.

Hydrocarbons

This is the general classification given to all chemicals that have **only** carbon and hydrogen atoms in their chemical structure. In terms of Chemtronics cleaning products and most other electronics cleaners on the market, we are primarily concerned with solvents like isohexane and naphtha.

Hydrocarbon solvents are non-polar, which make them good solvents for non-polar soils. As the number of carbon atoms in the hydrocarbon molecule increases, these species change their physical form and properties. If there are less than four carbon atoms in the molecule the hydrocarbon is a gas at room temperature (i.e. methane, ethane, propane and butane). If there are more than four carbon atoms the hydrocarbon is a liquid at room temperature (i.e pentane, hexane, heptane, octane.). Very long chain hydrocarbons with twenty or more carbon atoms are solids. Hydrocarbons generally have boiling points between –167 $^{\circ}$C (methane, a one-carbon molecule) and +174 $^{\circ}$C (decane, a 10 carbon molecule); flash points range between –306 $^{\circ}$F (highly flammable methane) and +111 $^{\circ}$F (combustible decane).

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Hydrocarbon solvents generally have little or no effect on plastics, because the atoms that make up these substances are not chemically aggressive. They can't "grab" onto another molecule or atom, like the surface of a plastic. Therefore, straight hydrocarbon solvents (containing only hydrogen and carbon) have little or no effect on most plastics. **Aggressiveness towards plastics usually comes from substituting one or more of the hydrogen atoms in the molecule with a more active atom, as described below. Substituted hydrocarbons are usually stronger solvents for dissolving heavy oil, grease and flux residues, as well as polar soils like salt residues. However, the trade-off is the effect that they may have on plastics.**

Substituted Hydrocarbons

In a substituted hydrocarbon, one or more of the hydrogen atoms in the original hydrocarbon molecule have been substituted with a more active halogen atom or replaced with oxygen, as in alcohols or ketones.

In halogenated hydrocarbons one or more hydrogen atoms in the hydrocarbon molecule have been replaced with a more active halogen atom such as chlorine, bromine or fluorine. The halogenated hydrocarbons have different physical and chemical properties from those of the simple hydrocarbons. The halogenated compounds are denser (heavier) than the simpler hydrocarbon solvents. Halogenated solvents are usually non-flammable rather than flammable. The chlorinated and brominated solvents are usually very aggressive toward plastics and rubber and must therefore be tested for compatibility with these materials. Fluorinated solvents like perfluorocarbons and hydrofluoroethers are much less reactive with plastics and elastomers.

Chlorinated solvents like methylene chloride, 1,1,1-trichloroethane and perchloroethylene are no longer widely used as many of these chemicals are toxic or have been found to cause harm to the atmospheric ozone layer, and are therefore restricted for use by the Federal Clean Air Act. Fluorine-containing chemicals like the tetrafluoroethane used in Ultrajet® dusters, and the perfluorocarbons and hydrofluoroethers have relatively low toxicity, do not harm the ozone layer and are therefore used today as replacements for the chlorine-containing solvents.

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Alcohols are hydrocarbons that contain active oxygen. Water-soluble isopropyl alcohol and n-propyl alcohol are hydrocarbons in which one hydrogen atom has been replaced with an oxygen-containing “hydroxyl” (OH) group. Alcohols are the primary constituents in many flammable flux removers. Most of the simple alcohols (3 carbons or less) are generally plastic safe, though even methyl alcohol (1 carbon) will effect soft plastics like polycarbonate and polystyrene. Alcohols are flammable, but usually have flashpoints above those of hydrocarbons. Alcohols also have higher boiling points than hydrocarbons and evaporate more slowly.

Ketones have generally higher solvency than alcohols, making them stronger cleaners. The active oxygen in ketones makes them especially aggressive on plastics. The most common ketone solvent used in cleaners is acetone. Ketones are extremely flammable and have very fast evaporation rates.

The effect on plastic and rubber that a particular substituted hydrocarbon may have can be moderated by how the solvent is used and how it is formulated in the cleaning product. By controlling the amount of the substituted hydrocarbon used and balancing the properties of the formulation with the other co-solvents with which it is blended, Chemtronics is able to enhance the cleaning power of its solvent products without sacrificing the product’s plastic safety.

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