PRE-WETTED WIPERS OPTIMIZED FOR APPLICATION-SPECIFIC CLEANING

This technical note describes the three optimum isopropyl alcohol (IPA) concentrations found in pre-wetted wipers and explains why each concentration is ideal for its particular cleaning application. Additionally, the note explains why pre-wetted wipers incorporate different wetting levels to optimize cleaning.

INTRODUCTION:
Pre-wetted wipers are well-accepted for contamination control activities in the cleanroom. Because they combine cleanroom wipers pre-wetted with the proper amount of cleaning liquid into one convenient delivery system, pre-wetted wipers are frequently used to wipe down environmental surfaces – those surfaces not involved in product contact (think of bench tops, counters, carts, trays, etc.). Different pre-wetted wiper products can be used to wipe down process equipment – surfaces that do have product contact – and to clean the manufactured product itself.

CLEANING LIQUID
One common cleaning liquid used in pre-wetted wipers is isopropyl alcohol (IPA). IPA is commercially available in high purity, is reasonably inexpensive, has good soil removal capability (i.e., good cleaning power), and most importantly, evaporates completely without leaving a surface residue. Consequently, IPA is generally considered to be the universal wetting liquid for pre-wetted wiper products. As with any consumable, the quality of the IPA used to wet the wipers should be verified through product specifications and testing. For the electronic industry, this means extremely low ion profiles; for the health care industry, this means the absence of viable or non-viable organisms. This latter requirement can be achieved through sub-micron filtration of the IPA prior to wetting of the wipers. Filtration will not remove dissolved ions. Ideally, electronic grade IPA (rated 99.5% pure or better) should be used because it offers the lowest level of all contaminants.

WHAT IS THE OPTIMUM IPA CONCENTRATION?
A question that arises frequently from cleanroom operators relates to the optimum IPA concentration for pre-wetted wipers. There are an infinite number of IPA concentrations that could be considered, but thankfully, we only need to consider three concentrations – 6% IPA, 70% IPA, and 100% IPA – to cover virtually all cleanroom cleaning requirements. Determining which of the three concentrations to use depends on the nature of the manufactured products and the nature of the surface to be cleaned.

HEALTH CARE INDUSTRY
It’s easiest to deal first with the health care industry, which includes pharmaceutical and biotechnology products and services, medical devices, pharmaceutical compounding laboratories, and animal care products. These industries share a common requirement: their manufacturing and support areas must be kept as free as possible from contamination from the cells of living or dead microorganisms – bacteria, viruses, and fungi. The IPA concentration that is most effective in sanitizing surfaces in the health care industry is 70% IPA. This solution contains 30% deionized water (DIW). This water content enables the cleaning liquid to penetrate the cell nucleus to kill the organism. (Interestingly, spores are not killed by 70% IPA solutions, but other treatment methods are available to deal with them). A further advantage offered by the 70% IPA wetting solution is that there is a good measure of surface tension reduction compared to pure water, which enables soils and residues to be dissolved or easily removed from surfaces. The downside of pre-wetted wipers incorporating 70% IPA is that they are classified as flammable and must be handled, transported, stored, used, and disposed of as such. Please refer to the flammability chart below:

<table>
<thead>
<tr>
<th>% IPA CONCENTRATION</th>
<th>FLAMMABLE</th>
</tr>
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<tbody>
<tr>
<td>&lt; 10%</td>
<td>NO</td>
</tr>
<tr>
<td>70%</td>
<td>YES</td>
</tr>
<tr>
<td>100%</td>
<td>YES</td>
</tr>
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</table>
Non-Health Care Industries (Everything Else)

The cleaning requirements for all other cleanrooms (i.e., those not involved in health care) – microelectronics, aerospace, flat panel displays, hard drives, etc., - allow wipers to get by with either 6% IPA or 100% IPA solutions.

Low IPA Concentration

Wipers pre-wetted with 6% IPA solutions are used primarily for environmental surface wipedowns (see examples above). These surfaces are expected to be cleaned on a daily or shift basis, so it is unlikely that the surfaces have built up significant levels of contamination since the last cleaning. Therefore, wipers pre-wetted with 6% IPA will suffice for removing surface particulate matter and enable it to be captured into the wiper. The 6% IPA concentration ensures that the liquid acts as a bacteriostat, inhibiting the growth of mold in the product. It also is well below the 10% IPA concentration, which would require the pre-wetted product to be classified as flammable. A 6% IPA concentration allows the product to be classified as combustible, permitting easier, less costly storage and disposal methods. The 6% IPA solution provides some measure of surface tension reduction to the wetting liquid, but the primary mechanism for surface particle removal is the wiping action itself. One additional benefit of using 6% IPA solutions is that they minimize Volatile Organic Compounds (VOCs) in the cleaning product. This feature can be important to the environmental control department of an organization.

High IPA Concentration

Non-health care industries have more than just environmental surfaces to clean. These can be product surfaces (wipedown of the product itself) or production surfaces that come into contact with the product. In these latter cases, soils or residues must be removed at regular intervals to avoid contamination of the end product. A pre-wetted wiper containing 100% IPA is ideal for these applications since it offers the maximum amount of surface tension reduction (think cleaning power). One further advantage is that the 100% IPA wetting liquid incorporates no water and acts as a drying agent if any water is present on the surface to be cleaned. This feature is critical in the semiconductor industry, where certain vacuum process equipment must be kept free of water (and water vapor) at all costs.

If soiled surfaces must be cleaned and water can be tolerated, then of course one can employ a pre-wetted wiper with 70% IPA.

Why Nothing in Between?

Why are intermediate concentrations of IPA, say 9% IPA, 40% IPA, or 85% IPA, not routinely employed as wetting solutions? The answer is that you are trying to balance a number of factors at the same time:

- Cleaning capability
- Flammability rating (see chart above)
- Volatile Organic Compounds (VOCs)

A word or three about VOCs: IPA stands for isopropanol, a substance containing carbon (along with hydrogen and oxygen). Because IPA evaporates so readily, it is termed volatile, and because it contains organic carbon, it is classified by the EPA as a Volatile Organic Carbon, or VOC. The EPA requires that all users disclose the quantity of VOCs from IPA (as well as from other volatile solvents) they use and discharge into the environment. The concern is that once discharged into the environment, the VOCs become precursors for smog. The greater the amount of IPA, the greater the amount of VOCs, as shown in the graph below. Obviously, minimizing IPA concentration and usage will reduce overall VOC levels.
At the low end, there’s not much improvement in cleaning capability between 6% IPA and 9% IPA to warrant the 50% increase in VOCs. Certainly, you want to keep below 10% IPA to preserve the combustible rating. The 6% IPA product is the one that is (should be) used to the greatest extent to clean the appropriate cleanroom surfaces.

Once you move above 10% IPA, you enter the flammability range; so you may as well maximize the cleaning capability by moving directly to 70% IPA if you can tolerate water or 100% IPA if you can’t. True, doing so increases the VOCs significantly. If this is an important factor, there may be a case for using an intermediate concentration.

As stated previously, if you’re trying to remove or kill microorganisms, 70% IPA is the accepted standard. There’s no benefit in going from 70% IPA to 100% IPA or anything in between for these applications. In fact, there is a possible reduction in killing power.

100% IPA is used when the maximum cleaning capability is needed and/or water must be kept from the wiped surfaces.

Typically, wetting levels of 45-50% of saturation have been found to work best for particle removal. This provides enough liquid to wet the surface to aid in particle removal, but not so much liquid as to fill all the interstices of the fabric and prevent the particles (or other soils) from occupying those empty fabric spaces. The small amount of liquid left behind on the wiped surface evaporates quickly due to the high airflow found in most cleanrooms.

Higher wetting levels, say 60% of capacity (or higher), may be required if the wiper is used as an applicator of IPA cleaning liquid to a surface or in cases where you want to deliberately leave behind an amount of IPA on the surface to maximize the destruction of microorganisms on the surface. Additionally, some soils may require greater amounts of cleaning liquid to be removed from certain surfaces.

**CONCLUSION:**
Understanding the three concentrations of IPA and the wetting levels used in pre-wetted wiper products will facilitate optimum cleaning of environmental and production surfaces.