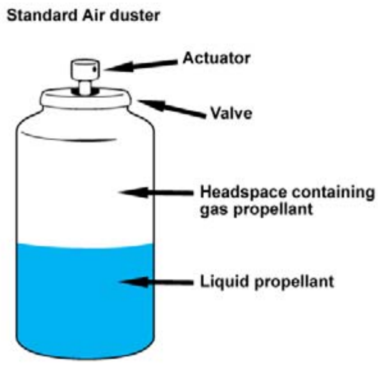
Air-duster / Gas White-Paper
Written by Keith Carruthers

Air-dusters are widely used in the electronics manufacturing industry and are designed to safely remove dust and other types of particulate contamination from very delicate or inaccessible areas of electrical equipment.

The use of air-dusters is a cleaning process that many people use on a daily basis, with little knowledge of how they work, what propellants are used and the environmental implications. This article discusses these points and highlights the differences between the various options available.

How does an air-duster work?

An air-duster is an aerosol can that contains propellant in both the gas and liquid phases. The gas inside the can is compressed which means that the pressure is higher than that of the external atmosphere. When the valve on the aerosol can is opened using the actuator, the high-pressure gas inside the can moves to the area of lower pressure i.e. the external atmosphere. It is this effect that allows dust and debris to be blown away from surfaces.

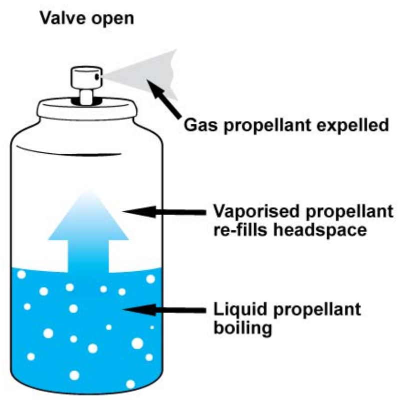


Why does the air-duster contain liquid propellant?

If the air-duster only contained compressed gas, the lifetime of the product would be very short. This is solved by filling the can so that the propellant exists in both the gas and liquid phases.

As an aerosol can is filled with more and more propellant, the pressure will increase to a point where some of the gas will condense into a liquid, producing a liquid and gas equilibrium. This happens because the boiling point of a liquid decreases with increasing pressure. When the valve is opened - causing gas to escape - the pressure inside the can drops, causing some of the liquid propellant to boil and vaporise. This vaporised propellant re-fills the headspace with more gas, returning the can to its original pressure.

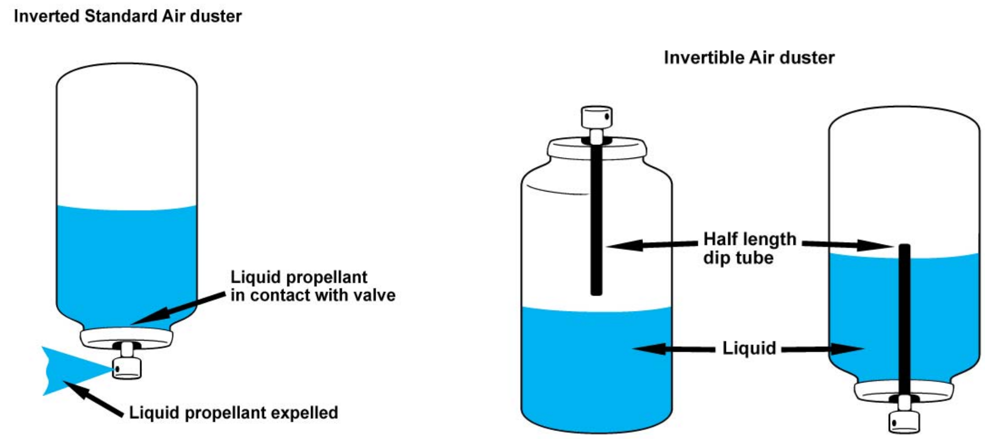
Eventually, the amount of propellant in the can will reduce to a point where the pressure is no longer high enough for liquid to exist, leaving only gas. Shortly after this point, the pressure will drop and equalise to the external atmospheric pressure (approximately 1 bar).



How do invertible air-dusters work?

A standard air-duster has no dip-tube. If the can is inverted, the liquid propellant will be positioned next to the valve. As a result, if the valve is opened during the inversion, liquid propellant will spray out.

An invertible air-duster works by fitting a half length dip-tube to the stem of the valve inside the can. The can also needs to be at least double the volume of the liquid propellant. This means that the end of the dip-tube will always be positioned in the gas phase whether it is upright or inverted, preventing any liquid from spraying out of the nozzle.



What about high-powered air-dusters?

The pressure inside a high-power air-duster is usually the same as a standard air-duster; however, a high power air-duster uses a special valve and actuator that allows more gas to be emitted per second. This valve and actuator can make a high-power air-duster up to three times more powerful than a standard one.

Why does the air-duster get cold during use?

Liquid requires energy to boil i.e. it is an endothermic process. When the valve of the air-duster is opened and the liquid propellant boils, energy is taken from the immediate surroundings around the can. This makes the can feel cold.

What propellants can be used in an air-duster?

In Europe (according Directive 2008/47/EC) an aerosol cannot exceed 12 and 13.2 bars of pressure at 50°C when using a flammable and non-flammable propellant respectively. Therefore, as long as the propellant meets this criteria and is not ozone depleting, it can be potentially used in an aerosol.

The propellants commonly found in air-duster products include the following:

- Hydrocarbon propellants: dimethyl ether; blends of n-butane, isobutane and propane. These are economical propellants, but are extremely flammable.
- Hydrofluorocarbon propellants: These are generally non-flammable, but are costly to manufacture.

The hydrofluorocarbon 1,1-difluoroethane (152a) can also be used, but this propellant is usually classified as being 'extremely flammable'. When 152a is used in an invertible aerosol, however, it can be classified as 'flammable' according to the new Globally Harmonised System (GHS) for substances because it has a heat of combustion <20 kJ/g and it passes the flame extension test.

152a and DME can also be blended with 134a to make a non-flammable blend that is more economical than pure 134a.

Why can't 'air' be used?

'Air' is mostly a mixture of nitrogen and oxygen (99%); Argon, carbon dioxide and other gases make up the remaining 1%[1]. 'Air' cannot condense into a liquid at 20°C unless the pressure is extremely high; about an order of magnitude greater than the maximum pressure that an aerosol can is able to withstand before exploding. Therefore, the amount of 'air' that you can add to an aerosol is very small, and you would have an air-duster that would last for a very short period of time.

For the same reason, pure carbon dioxide and nitrogen are also not suitable for use in air-dusters.

What is GWP (Global Warming Potential)?

GWP is a scale that quantifies the contribution that a greenhouse gas has on global warming over a specified time period. The GWP for a greenhouse takes into account the heat absorption ability of the gas, as well as its atmospheric lifetime. The scale is always adjusted so that carbon dioxide has a GWP equal to one.

For example: 134a has a GWP of 1300 over a time period of 100 years[2], whereas carbon dioxide has a GWP of 1 i.e. 134a has 1300 times the GWP of carbon dioxide.

To put it another way, an air-duster containing 300g of 134a has the equivalent impact on global warming as 390 Kg of carbon dioxide. If you could get the same weight of carbon dioxide into an aerosol, one can containing 134a would have the same GWP as 1300 cans using carbon dioxide as the propellant.

Generally speaking, propellants with a low GWP are extremely flammable and those with a high GWP are non-flammable. However, the gas in Electrolube's EADH is an exception to this rule: it has a low GWP = 6 (over a 100 year time period) and is non-flammable.

Ozone Depletion Potential

As a result of the Montreal Protocol introduced in 1987 there are no longer any aerosols on the market that contain ozone depleting substances like chlorofluorocarbons (CFCs) and hydrochlorfluorocarbons (HCFCs).

Non-flammable aerosols contain hydrofluorocarbons (HFC) that do not cause damage to atmospheric ozone.

Volatile Organic Compounds (VOCs)

An organic compound is a material that is primarily made up of carbon and hydrogen; however, the definition of VOC differs from country to country.

In Europe (according to Directive 2004/42/CE) a "Volatile organic compound (VOC) means any organic compound having an initial boiling point less than or equal to 250°C measured at a standard pressure of 101,3 kPa." All aerosol propellants are classified as VOC in Europe.

In the US the definition is more complicated, but all aerosol propellants are classified as being VOC as well. There is, however, one exception: the gas used in Electrolube's EADH is expected to be classified as being non-VOC is the US.

Photochemical Ozone Creation Potential (POCP) and Minimal Incremental Reactivity (MIR)

The combination of nitrous oxides, VOCs and sunlight (specifically UV light) react to create atmospheric ozone, also known as smog. Photochemical Ozone Creation Potential (POCP) and Minimal Incremental Reactivity (MIR) give an indication of the contribution that a VOC has on the creation of atmospheric ozone. Europe use POCP and the US use MIR.

Standard hydrocarbon propellants have relatively high MIR and POCP; however, hydrofluorocarbons like 134a and 152a have an MIR of zero. Elecrolube EADH has an MIR equal to 0.09 g O_3/g VOC.

As a result, Electrolube's EADH offers the best balance of GWP and POCP/MIR, with the other propellants offering low GWP with higher POCP/MIR or vice-versa.

Spray dusters that Adhere to the New Regulations and Guidelines

With the requirement for environmentally friendly products and 'green awareness' being a major factor when choosing a cleaning process for electrical equipment, Electrolube's - one of the world's leading manufacturers of high performance chemicals - has recently launched the EADH Air Duster.

EADH contains a novel hydrofluorocarbon propellant that is more environmentally friendly than alternative HFCs. The gases used in alternative products are usually HFC-134a or a blend thereof with other HFCs or hydrocarbon propellants. Switching to EADH can reduce the equivalent CO_2 emissions by >99.5%*.

The non-flammable EADH Air Duster is a useful service aid to maintain parts efficiently and quickly, removing dust and other particulate contaminants from fragile or inaccessible areas while being friendlier to the environment.

*Calculated. GWP (vs. CO_2, 100 year ITH): EADH = 6; HFC-134a = 1300. >99.5% is for pure 134a; blends with other propellants may be <99.5%.

www.electrolube.com

References:

[1] Brimblecombe, P. (1996) *Air Composition & Chemistry*. 2nd Edition. Cambridge: Cambridge University Press

[2] Hundy, G, Trott, A, Welch, T. (2008) *Refrigeration and Air-Conditioning*. Fourth Edition. Burlington: Butterworth-Henemann.