Could excessive use of aerosols in a confined space result in exposure to lethal levels of butane?

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Revised September 2009, with thanks to Nigel Jackson

INTRODUCTION

Death from the deliberate inhalation of butane to achieve a change in mental state (Volatile Substance Abuse, VSA) is well known. Almost 50 deaths occur every year in the UK[1] from VSA - many of them are teenagers.
In the absence of clear evidence of deliberate inhalation, pathologists and toxicologists have attributed deaths to cardiac arrhythmia resulting from the accidental inhalation of butane from the incautious use of aerosols in confined spaces. We explore the likelihood of this occurring.

Figure 1. Domestic products containing volatile substances that have been abused. *TICTAC Communications Ltd*

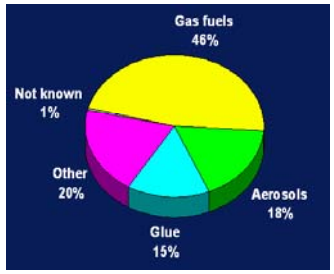

Figure 2. Products causing death from Volatile Substance Abuse in UK 1984-2006. *TICTAC Communications Ltd*

(a) (b)

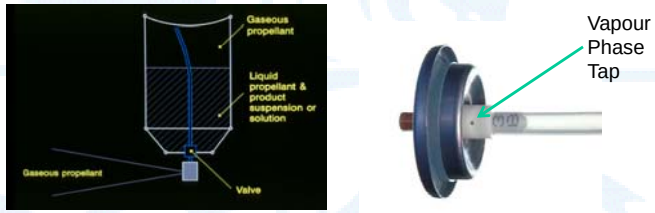

Figure 3. Aerosol (a) old products were inverted when abused - aerosol delivers only propellant (butane) (b) newer valve with vapour phase tap still delivers product and propellant even when inverted. *(TICTAC Communications Ltd)*

The most common aerosol propellants are n-butane, propane and isobutane, often used in a mixture. It is the propellant that is abused not the product. Previously when an aerosol was inverted the dip tube, that normally delivers the product, was in the headspace and so delivered only the propellant. Most modern products have valves with a vapour phase tap (small hole) that still deliver product and propellant even when the can is inverted. Almost any propellant rich aerosol may be abused – typically deodorants, antiperspirants, air fresheners and even fly spray. The propellant is usually discharged through cloth e.g. a towel or socks to remove the product.

EXPERIMENTAL

The investigation was in four parts:

1. A review of the published hazard data relating to the inhalation of butane in high concentrations.
2. The calculation of the maximum amount of butane which could be released at any time in a worst case scenario.
3. The measurement of simulated inhalation of propellant in a worst case scenario.
4. Physical tests to measure and model the potential for pockets or layers of gas to be created.

Part 1. The lethal dose of n-butane, expressed as the LC 50 (4 hour) inhalation dose in rats and mice is 270,000 to 286,000 ppm.

Part 2. Assuming a room size of 15.6m^3, a propellant content of 95% (worst case) and that the contents of three cans are completely and instantly expelled. A maximum concentration of 6,656 ppm is achieved, well below levels at which any adverse effects would be expected. Emptying a single170 ml can of antiperspirant took 3 minutes, was physically difficult to do and the butane concentration reached a maximum of 3,500 ppm.

Part 3. A trial to model accidental misuse using a mannequin was carried out on aerosols containing propellant only. A Miran® infrared spectrometer was used to measure the concentration of propellant continuously. Four runs, sprayed directly into the face of the mannequin with the spectrometer sampling by the 'nose', showed the maximum concentration achieved to be 6,855 ppm, well below the 280,000 ppm level.

Part 4. A can was discharged into a small room using a portable vapour analyser to take readings. This experiment was to help determine whether the propellant gas might pool near the floor Fig 4.

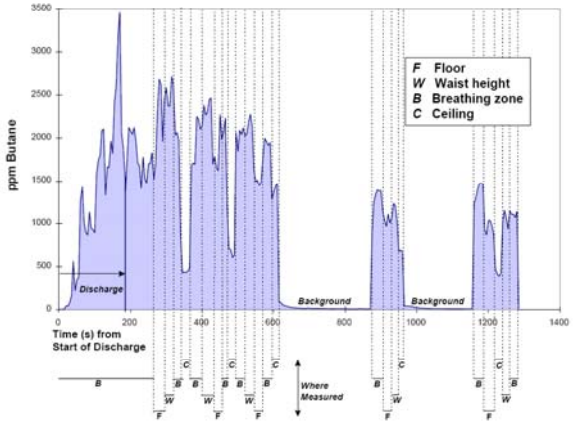

Figure 4. Vapour analyser reading (butane) for a 170 ml anti-perspirant deodorant fully discharged in a small room.

RESULTS

- Measurement of gas concentrations after the compete discharge of three aerosol deodorants simultaneously (a physical impossibility for one person) showed that 11.4% (32,000ppm) of the lethal dose (280,000ppm) of butane was reached. This implies that to achieve the lethal concentration in the atmosphere of the room, 28 full cans of product would have to be emptied at once.
- There is no evidence that pockets or layering of the gas propellant can cause sufficient concentrations to deliver a lethal dose of propellant.
- Concentrations of propellant sufficient to cause death cannot be achieved by normal or excessive use nor accidental misuse.
- Propellant gases disperse within 15 minutes even in a small poorly ventilated room.

CONCLUSION

We have explored the possibility that death might result from butane toxicity following the excessive use of aerosol products in confined spaces. Despite extensive research, calculation and practical testing, we were not able to reproduce conditions which could lead to harmful or fatal effects from excessive spraying of aerosol products in a confined space. However there is no information available regarding the possibility of specific individual hypersensitivity to high concentrations of butane.
There may be a significant risk of fire or even explosion if high concentrations of butane are allowed to accumulate. It is wise to always read and follow the manufacturers instructions printed on the product.

References:

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