

Technical Paper (ref 2.2)

Probe home page

Relationships between odour detection thresholds and numbers of molecules

Even though many ODT values **appear** to be very small (eg methyl mercaptan [CH_3SH] – ODT = 0.0000003 mg/m^3), the actual number of molecules involved is very large as can be seen in the following data.

Methyl mercaptan = 48 ODT = 0.0000003 mg/m^3

At the ODT there are = 3.75×10^9 molecules/L

This approximates to about **4 billion** molecules of **CH₃SH** per litre.

Ammonia = 17 ODT = 0.03 mg/m^3

At the ODT there are 1.06×10^{15} molecules/L

There are more than **1million billion** molecules of **NH₃** per litre

Skatole (3-methyl indole) = 131 ODT = 0.00035 mg/m^3

At the ODR there are 1.6×10^{12} molecules per litre

This represents more than **1.5 thousand billion** molecules of **skatole** per litre

Hydrogen sulphide = 34 ODT = 0.0001 mg/m^3

At the ODT there are 1.76×10^{12} molecules per litre

This is more than **1.5 thousand billion** molecules of **H₂S** per litre

Butyric acid – ($\text{C}_4\text{H}_8\text{O}_2$) = 72 ODT = 0.004 mg/m^3

This is a concentration of about 3.3×10^{13} molecules per litre

More than **30 thousand billion** molecules of **butyric acid** per litre

Diallyl sulphide – $\text{C}_6\text{H}_6\text{S}$ = 110 ODT = 0.001 mg/m^3

This represents about 5.4×10^{12} molecules per litre

Almost **5.5 thousand billion** molecules of **diallyl** sulphide per litre



Implications of these calculations for PROBE INDUSTRIES

The low ODT values for those molecules which result in malodour listed above, are rather misleading. On a molecular scale these ODT values represent many billions of molecules, even at the lowest detection level. In practice, at the locations where we operate our Rotary Atomisers, these incredibly vast numbers of molecules have to be reduced to a level where the odour is no longer recognisable by humans and that is below the ODT level. This asks a great deal of any chemical system but we are very confident that our Rotary Atomiser/microdroplet combinations do indeed reduce odour to an acceptable level.

The human sensory system is not particularly good at detecting odours, unlike some of our animal relatives who can still detect odours at extremely low levels. As evolution has taken place, the human race seems to have lost the ability to detect odours at low levels. This is shown by the fact that for **methyl mercaptan**, (which has the lowest odour detection threshold yet recorded), at the ODT, there is a concentration of about 4 billion molecules present per litre. Another compound with a bad odour is **ammonia**. Most adults are familiar with its extremely pungent smell, and the ODT for NH_3 (0.03 mg/m^3) is much higher than that of methyl mercaptan. At this detection level there are approximately 1 million billion molecules of ammonia present per litre. **Skatole (3-methyl indole)** has a particularly unpleasant faecal odour and there needs to be about 10 billion molecules of skatole present per litre in the air before we can detect its smell. The problems of eliminating or reducing odours at the molecular level are consequently very daunting.

One Rotary Atomiser operating, under normal circumstances, produces about 15 billion microdroplets per litre of AiroNaut/water mixture consumed, so we can estimate the time required to operate a Rotary Atomiser in order to reduce malodour to an acceptable level. If we assume that 1 microdroplet is capable of absorbing 1 molecule, (in practice every microdroplet has the potential to absorb thousands of molecules). For methyl mercaptan, 1 hour of operation will reduce the number of molecules present in air to such a level, that humans cannot detect its presence. Skatole ($\text{ODT}-0.00035 \text{ mg/m}^3$) and hydrogen sulphide ($\text{ODT}-0.001 \text{ mg/m}^3$) have about the same numbers of molecules present at the ODT, about 1.5 thousand billion molecules. If every microdroplet absorbed only one molecule of these compounds, then a Rotary Atomiser would have to operate for more than 100 hours (about 4 days) in order to reduce the level of these substances present to such an extent that they were no longer detectable. Our experience tells us that this is not the case and after a few hours of operation a Rotary Atomiser reduces the levels of these unpleasant compounds to such an extent that they are no longer detectable.

Other malodorous molecules such as ammonia, butyric acid and diallyl sulphide are more difficult to remove because there are **thousands of billions** of these molecules present at the ODT. Again, our experience with Rotary Atomisers over the years, has shown that even the very large numbers of these molecules present in the air can be reduced to such a level that they are no longer be detectable by smell. In this situation **every microdroplet** is interacting with, encapsulating and changing the chemical structure of many thousands of molecules every hour.

