CHEMICAL ATTACK!

How multiple chemicals can affect gas filter performance

Gas filters are usually tested under ideal laboratory conditions with a single specific gas. But what happens in the mishmash atmosphere of the real working world?

A relatively new research project (March 1990) concerns itself with the service life of respirator cartridges, that is, gas filters, in environments containing more than one chemical.

Normally. filters are tested in a controlled laboratory environment containing a specific concentration of a specific compound.

But such conditions are rare in the actual work situation. It is not unusual for several kinds of vapours to be present simultaneously. with many chemical fumes lingering in the air at fairly high concentrations.

How long a filter will last depends on the concentration of gas. At any concentration there is a breakthrough point. i.e. a point where the activated carbon in the filter becomes saturated and cannot absorb any more gas. The result is that the gas goes straight through the filter and into the lungs. This is why it is important to replace the filter according to a predetermined replacement schedule.

Acetone

The breakthrough time for any one chemical is rather easy to determine in a laboratory setting.

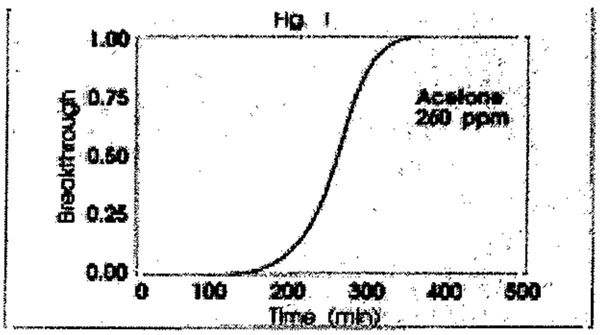
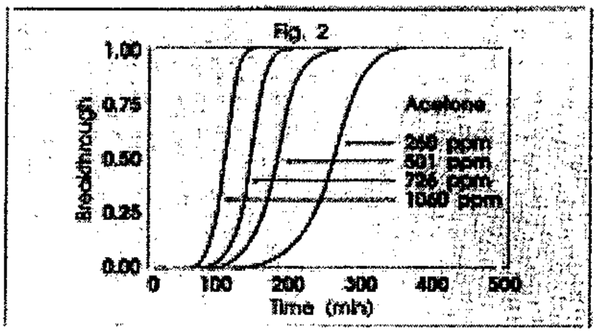


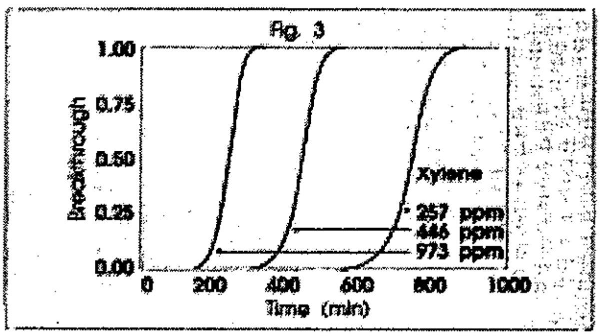
Fig 1 shows the breakthrough pattern for acetone in a cartridge filter. The concentration of acetone was 260 ppm in this particular instance. As we can see, the acetone starts slowly to break through after about 150 minutes (or two and a half hours). After just over 4 hours (260 minutes),50% of the acetone passes through the filter, and after six hours, the filter has lost all its capacity to absorb acetone.

Fig 2 shows the filter breakthrough at about double the concentration, 50] ppm, as well as three even higher concentrations. The curve looks about the same, but the breakthrough happens sooner.



Xylene

Xylene is another common chemical. The curves for xylene are about the same shape as acetone, although the breakthrough occurs later and, consequently, the filter lasts longer (Fig 3).

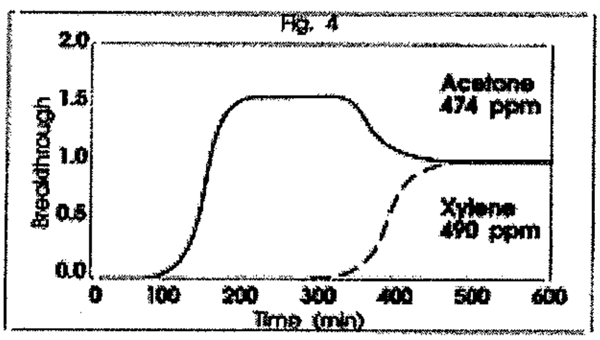


Acetone + Xylene

Let us imagine a workshop where both xylene and acetone are used at the same time in about the same concentrations. The combined concentration is about 1 ,000 ppm. This may not be an unusual case. What is unusual is the breakthrough pattern of the filter (Fig 4):

The xylene curve looks very much like the curve for xylene alone.

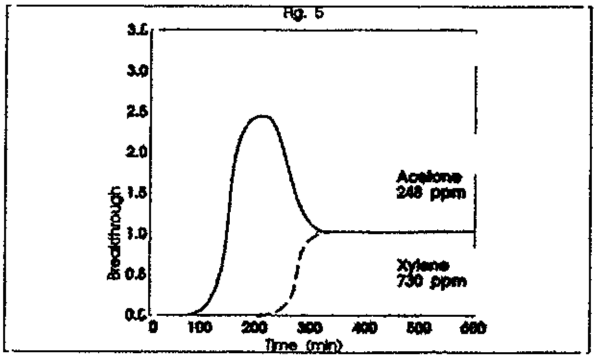
However, something extraordinary is happening with the acetone. It starts off as expected, but the breakthrough concentration soon rises well above the air concentration of acetone and ends up at a level of about one and a half the surrounding concentration of acetone.



This means, that if the worker wears the respirator, more acetone is inhaled than without a mask. Meanwhile, the filter obviously continues to protect quite effectively against xylene.

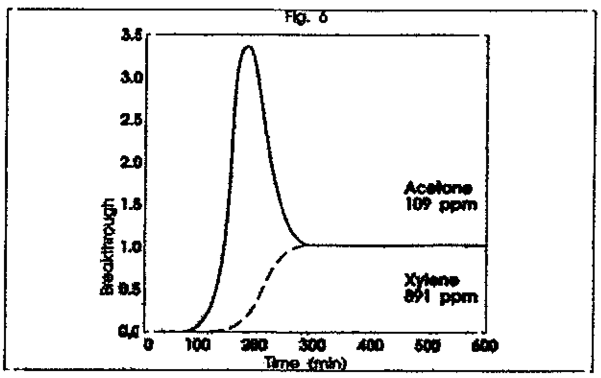
Figs 5 and 6 provide even more impressive illustrations of the phenomenon:

Fig 5 shows the breakthrough pattern in an atmosphere containing approximately three times as much xylene as acetone. The combined concentration is still approximately 1,000 ppm.



The curve for xylene is still relatively normal, but the higher concentration pushes up the maximum concentration of acetone to two and a half times the concentration in the room.

With about 90% xylene and 10% acetone (Fig 6), the acetone is pushed even higher. to over three times the surrounding concentration



What really happens?

What happens is that at a certain stage in the absorption process, the xylene starts to push already absorbed acetone off the absorption surface of the carbon.

These dislodged acetone molecules are drawn into the respirator with every breath. And seeing that the 100% breakthrough has already been reached, the dislodged acetone is added to the concentration that's already in the air. And so we end up with a combined concentration that's much higher than the level in the surrounding air.

In a way, the xylene kicks the acetone out" of the filter, and takes its place.

Think about the implications of this. We'll have to rethink the way we determine the life span of a filter. And they certainly make it impossible to give a blanket recommendation as to how often the filter should be replaced. That, it seems, depends entirely on the chemicals present in the air, their effect on each others, their actual concentrations, and their relative concentrations.

The only sensible conclusion of this is a simple rule of thumb:

when in doubt, use compressed air equipment.

Source: Young Hee Yoon, Ph.D. & James H. Nelson, Ph.D.; *A theoretical interpretation of the service life of respirator cartridges in the binary acetone/m-xylene system;* Submitted to the *American Industrial Hygiene Association Journal;* Datachem Laboratories; Sait Lake city, Utah, USA; 2] March 1990