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Application

Released: July 2014

Application Note 109

Improving productivity and reducing costs by off-line sorbent tube conditioning

Summary

Rigorous conditioning of sorbent tubes is an essential part of any sampling and analysis protocol. This Application Note will explore the cost savings and productivity enhancements that can be made by off-line conditioning with Markes' TC-20 multi-tube conditioner, rather than on-line with the thermal desorber itself. In particular, we will focus on the revenue resulting from running more analytical samples, the cost-effectiveness of increasing sample capacity by this approach, and the benefits that stem from using nitrogen rather than helium.

Introduction – The need for sorbent tube conditioning

In any sampling campaign employing thermal desorption tubes, it is vital that the sorbent bed is free from contaminants before sampling commences, to avoid complications during analysis and minimise the potential for false-positive results.

There are a number of potential causes of such contamination (covered in more detail in Application Note 006), but in the vast majority of cases tube cleanliness can be assured by rigorous conditioning whenever they are:

- Freshly packed with sorbent.
- Stored without being properly capped.
- Heavily contaminated during a sampling procedure.
- Required for trace-level monitoring.

Tubes should be conditioned for at least as long as their standard desorption time, using clean carrier gas (*e.g.* grade 5.0 oxygen-free nitrogen or helium, and ideally with a hydrocarbon filter in the gas line). Temperatures and gas flow rates should be higher than those used in the analytical method – conditions recommended for specific sorbents are detailed in Application Note 005 and are provided with shipments of pre-packed tubes from Markes.

Many commercial thermal desorbers, such as UNITY™ and TD-100™, offer a dedicated tube conditioning mode. Whilst this is a useful feature, it can take up valuable analytical instrument capacity – especially because only one tube can be conditioned at a time. This Application Note will explore the cost savings and increased productivity that can result by instead employing a dedicated TC-20 multi-tube conditioner.

Background to the TC-20

The TC-20™ is a stand-alone unit that can clean (or dry-purge) up to 20 industry-standard sorbent tubes simultaneously. The only requirements are power and a clean, high-purity gas supply (typically nitrogen rather than the more expensive helium).

The TC-20 operates by passing a uniform flow of gas through each attached tube, at a rate that is independent of tube impedance. The temperature and time required are selected using the controls on the front of the instrument, and the flow rate is set by adjusting the pressure of gas supplied.

Increased revenue through running more analytical samples

Using the TC-20 is an excellent way to free up analytical instrument time to run more samples, and thus increase revenue. To illustrate this, imagine conditioning 20 tubes using a typical 1-hour method[1] – a process that would take more than 20 hours on a thermal desorber. Conditioning these tubes on a TC-20 instead would free up 20 hours to run more samples.[†]

More generally, whatever proportion of time your analytical instrument(s) are used for conditioning, this is the time that will be released to run analytical samples. Imagine using those extra 20 hours of instrument time to run samples using a 40-minute GC run. Up to 30 additional runs could be completed in this time, resulting in $3000 additional revenue, at $100 per sample.

[†] It is also worth noting that the speeding-up of the conditioning process, as well as improving turn-around times on re-conditioning, would mean that laboratories with large inventories of tubes may be able to reduce the number of tubes in service.

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Even if a laboratory were to recondition just 20 such tubes per week on the TC-20 rather than on their analytical system, this would result in (52 × $3000) = ***$156 000 per year additional revenue from the extra analytical instrument time released***. This is a striking amount, and even if the laboratory is only running at maximum capacity for a fraction of the time (as is quite probable), the financial advantage of purchasing a TC-20 will still be considerable.

The following formula can be used to estimate the revenue that you might be able to generate through running more analytical samples in your laboratory:

$$\text{Additional revenue per sample conditioned} = \frac{\text{Charge per sample} \times \text{Time stipulated in conditioning method (min)}}{\text{Time needed for GC run (min)}}$$

Cost-effectiveness of increasing capacity with the TC-20

Purchasing a dedicated tube conditioner is also a much more cost-effective way of increasing capacity than buying a whole new analytical system.

To illustrate this, consider the cost per sample of a new TD–GC–MS analytical system, with or without a TC-20, over the lifetime of the instrument. Inserting approximate figures into the formulae below (including an estimate for maintenance costs of 10%) suggests that ***the cost of system hardware and maintenance per sample with a TC-20 would be about half the cost for an analytical system on its own***.

With conditioning on the analytical system:

$$\text{Instrumentation cost per sample} = \frac{\text{Cost of analytical system} + \left(\text{Annual maintenance costs} \times \text{System lifetime (years)}\right)}{\text{Current sample run capacity per week} \times 52 \times \text{System lifetime (years)}}$$

With conditioning on the TC-20:

$$\text{Instrumentation cost per sample} = \frac{\text{Cost of analytical system and TC-20} + \left(\text{Annual maintenance costs} \times \text{System lifetime (years)}\right)}{\text{New sample run capacity per week} \times 52 \times \text{System lifetime (years)}}$$

The simple calculations above assume sufficient business for the laboratory to run at capacity, but even when this isn't the case, it is far cheaper to have the TC-20 idle than the analytical instrument idle.

For information on TC-20 pricing, please contact your Markes representative.

Reducing ecological footprint and lowering costs by using helium rather than nitrogen

When tubes are conditioned on the TD analytical instrument, it is necessary to use the instrument's carrier gas – which is nearly always expensive grade 5.0 helium. This is unnecessary for tube conditioning, which can be carried out on the TC-20 just as effectively with cheaper oxygen-free nitrogen. As well as reducing use of helium, which is an increasingly scarce and expensive global resource, this results in an additional cost saving. This is assessed below for conditioning using the 1-hour method, with a gas flow of 100 mL/min per tube, and 2014 gas prices in Markes' laboratory in Cincinnati, Ohio, USA.

Gas usage for 20 tubes:
20 × 60 min × 100 mL/min = 120 000 mL

Using grade 5.0 helium on the analytical instrument:

Gas unit cost: $159.00 for 582 ft^3 = $0.00000965 per mL

Overall gas cost: 120 000 mL × $0.00000965
= ***$1.16 for 20 tubes***

Using grade 5.0 nitrogen on the TC-20:

Gas unit cost: $73.00 for 912 ft^3 = $0.00000283 per mL

Overall gas cost: 120 000 mL × $0.00000283
= ***$0.34 for 20 tubes***

Although the cost saving seems on the face of it quite modest, the overall saving over the course of a year might be quite significant, especially in the context of laboratory budgets for consumables as opposed to instrumentation. It is also more ecologically responsible to use nitrogen rather than helium, especially given growing demand for organisations to be 'greener' and less resource-intensive.

Conclusions

The above-described calculations have shown that the TC-20 is a cost-effective investment for the majority of laboratories running TD–GC methods, particularly in terms of analytical instrument time released, but also with regard to reducing the use of helium carrier gas.

Whatever your situation, Markes' experts can help to assess your specific needs and indicate appropriate conditioning methods for your application. Please visit our website to download the TC-20 brochure, or contact us directly to discuss your specific circumstances.

Notes

1. The calculation described assumed that a 1-hour conditioning method was used, such as is applicable to previously-used tubes packed with graphitised carbon black or carbonised molecular sieve sorbents (15 min at 100°C, followed by 15 min at 200°C, followed by 15 min at 300°C, followed by 15 min at 380°C).

   The recommended conditioning method depends on sorbent type, and is more rigorous if the tubes have been freshly packed or heavily contaminated during sampling. Further details on conditioning parameters are available in Application Note 005, and are also supplied with shipments of pre-packed tubes from Markes.

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