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Overview

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Application Note 082

TubeTAG – Enhanced tracking of sample- and tube-related information for thermal desorption

Summary

This Application Note describes TubeTAG™, Markes' radio-frequency ID technology for thermal desorption tubes. The technology allows information about sample type and analytical conditions to be associated with the sample for the lifetime of the tube, so aiding sample tracking and analytical quality control.

Introduction

Historically, associating information with thermal desorption (TD) tubes has relied on manually reading and recording tube serial numbers. Barcode technology has proved difficult to apply to TD tubes because the high temperatures required limit the lifetime of barcode labels. Barcodes etched onto curved tube surfaces also get increasingly difficult to read electronically – especially after extensive handling. Another limitation of barcodes is that they can't be programmed to record sample or tube-specific information.

TubeTAG™, a system based on radio-frequency identification (RFID) tags,[1] was introduced by Markes to overcome these limitations and offer a real step forward in sample tracking and analytical quality control for TD–GC users.

The tags are re-usable, read/write-programmable devices that can be attached to standard sorbent tubes (metal or glass) and may be used in two ways (Figure 1):

- **Transit tagging** – Tracking samples within a lab and in transit between lab and field during air monitoring projects. Available to all TD users.
- **Tube tagging** – Tracking samples as above, and to monitor the history of each sample tube throughout its life. Requires 'tag-compatible' instrumentation.

The development of TubeTAG

There are significant challenges in developing re-usable RFID tag technology for TD tubes, not least the high temperatures required for analysis. RFID tags are destroyed at temperatures above 140 °C and the associated read/write devices do not work through the metal walls of most tubes. Tags must also be unobtrusive, resistant to environmental factors such as humidity and high particulate levels, and still allow a tube to be capped for long-term storage.

Developed by Markes, the TubeTAG has overcome these difficulties and provides a robust, permanent and programmable tube labelling solution. Tags attach to the non-

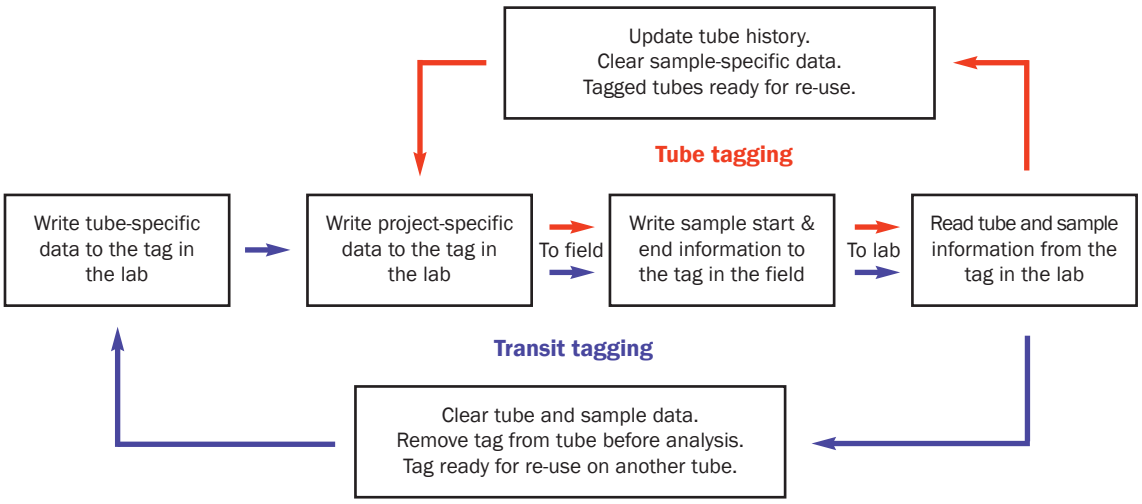

Figure 1: Using TubeTAG for tube tagging and transit tagging.

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sampling ends of ordinary ¼″ (6.4 mm) or 6 mm o.d. TD tubes, and comprise a compact RFID-chip assembly mounted on a special tube clip. The RFID chip itself is embedded in low-emission polymer that is resistant to high temperatures, to reduce the effect of temperature and protect it from environmental factors. The clips are designed so that the tags can only be attached or removed using a special tool.

TubeTAG in operation

Transit tagging

When used for transit tagging, individual tags are attached to every tube in a batch and programmed with relevant information – tube ID number, sorbent type, project code, *etc.* – prior to dispatch. Once that batch of tagged tubes reaches the field, additional details such as monitoring location, sampling method, and sampling start & end times, can be entered.

When the tubes return to the laboratory after monitoring, the information can be downloaded from the tags into the laboratory's information management system. The tags are then removed, and the tubes placed into the automated thermal desorber for analysis.

From the moment a tube is tagged and programmed prior to dispatch, in the relative calm of the lab environment, no manual re-entry of tube ID number, sorbent packing or project number is required. Write-access to primary fields like these can be disabled by the system administrator if required. Subsequent reading and entering of other information onto the tags in the field then allows users to validate the tube ID number programmed into the tag before dispatch.

Tags that have been removed from a batch of tubes just before analysis can be cleared of information relating to the last monitoring exercise and re-applied to the next batch of tubes going out for field sampling. Relevant new tube ID numbers, sorbent details and project information can be entered onto the tags by the system administrator and the whole cycle repeated. In this way, one RFID tag can be shared between several sampling tubes, and costs can be kept down to around 25 cents per tube per monitoring cycle.

Figure 2: The TAG*SCRIBE* field-portable tag read/write system.

Tube tagging

When used for tube tagging, a given tag is linked to a specific sorbent tube throughout its life, or at least until that tube is re-packed (typically 200 or more sampling–analysis cycles.) This allows the history of that tube to be recorded and tracked. In this case, a tag is assigned to a tube as soon as it has been packed and conditioned, and the tube ID number, date of packing and combination of sorbents are entered only once.

Each time a permanently-tagged tube is about to be sent to the field, project information can be entered onto the tag in the lab before dispatch. As described above, sampling information can then be entered onto the tag in the field using a TAG*SCRIBE* system (Figure 2). An example of the type of tube and sample data that can be recorded is shown in Figure 3.

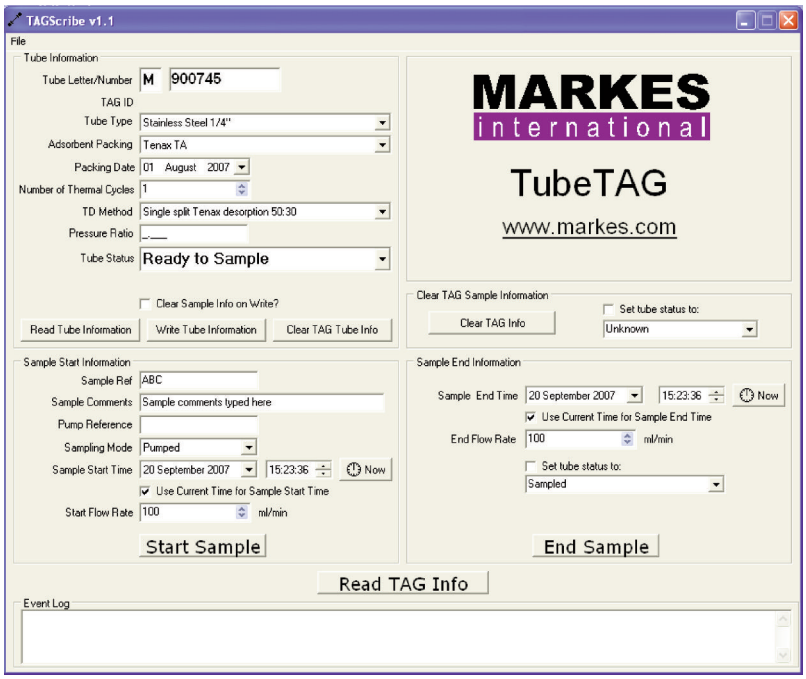

Figure 3: Typical tube and sample parameters recorded using the TubeTAG system.

Operation in tube-tagging mode requires the use of tag-compatible TD instrumentation such as the Series 2 ULTRA™-UNITY™ TD system.

Once the tagged tubes are returned to the laboratory, they are placed into the automated TD system. If the ULTRA-UNITY is equipped with an onboard tag read/write accessory, this automatically reads the information recorded on each tag and enters the relevant details into the automation sequence. Post-run, the desorber can also write to the tags; incrementing the number of thermal cycles, changing tube status (*e.g.* from sampled to desorbed) and clearing the sample collection information. Analytical anomalies such as leak test failures or unusually high back-pressure can also be recorded on the tag if required.

Tags used in tube-tagging mode also last indefinitely. Tests have shown them to be compatible with over 1000 thermal cycles, even under extreme desorption conditions, *e.g.* 400°C for 30 minutes. As above, this means that tagging costs are minimal – less than 25 cents per thermal cycle.

Tube conditioning in tube tagging mode

The process of desorbing TD tubes is usually sufficient to condition them. In other words, no additional cleaning is necessary in most cases, and analysed tubes can be re-used straight away. However, there are instances where additional, post-analysis conditioning is recommended, *e.g.* if tubes have been stored for extended periods (>30 days) or if the monitoring protocol requires the confirmation of tube blank levels before they can be used for field sampling.

If additional tube cleaning is required, it can be carried out either using the TD–GC system or by using separate off-line multi-tube conditioning rigs. The advantages of using the tag-ready ULTRA-UNITY for tube conditioning is that the number of thermal cycles can be automatically incremented and a blank profile can be obtained automatically as part of the conditioning process. However, if multi-tube off-line equipment is preferred for cost-effective conditioning of an entire batch of tubes, tags can be readily removed from the tubes using the special tool and re-attached to the same tubes after conditioning. The number of thermal cycles can be manually incremented as each tag is re-attached to its specific conditioned tube.

Data output and information storage

Users of tag-ready TD instrumentation record the status of every tagged tube whenever that tube is desorbed, allowing the information to be recorded as part of the sequence report. Moreover, a comma-separated variable (.csv) file is created every time data is written to (or read from) a tag, either using the field-portable TAG^{SCRIBE} device or the thermal desorber. This allows all tube- and sample-related data relevant to that tube to be simply and easily entered into a database and accessed when required. Subsequent interrogation of that database could then be used to determine when that tube (or batch of tubes) needs repacking, or whether any of the tubes tubes have a history of leak test failures, *etc.*

Conclusions

Markes' TubeTAG technology can greatly enhance the analytical quality assurance of air monitoring studies and TD–GC applications.

This is only the start. Future developments should allow TubeTAGs to be linked to TD methods, allowing the analytical system to generate its own automatic sequence for tubes loaded randomly into it. TubeTAGs also offer the potential for intelligent interaction with GC data-processing systems. Going forward, this should allow key analytical factors such as background levels or key artefacts to be linked with specific tubes and tracked over the lifetime of the tube.

References

1. US Patent 6,446,515 B2.

Trademarks

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