MARKES international

TDTS

Thermal Desorption Technical Support

Note 82: TubeTAG™ - Enhanced tracking of sample- and tube-related information for thermal desorption

Keywords:

Air sampling, sorbent tubes, sample identification, RFID, TubeTAG

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 bar code 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.

A new RFID-tag based technology*, TubeTAG™, has recently been introduced for TD tubes which overcomes these limitations and offers a real step forward in sample tracking and analytical quality control for TD-GC(MS) users.

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

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

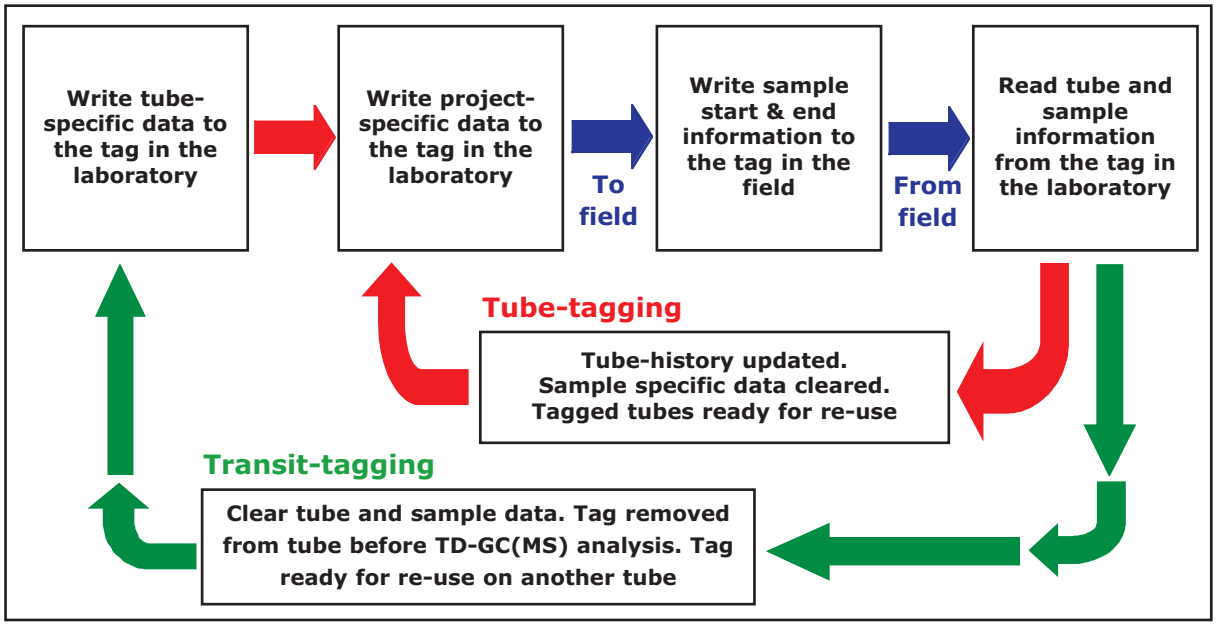

Figure 1: Using RFID tube tags for transit tagging and tube tagging

**** Patent number: US 6,446,515 B2***

The two modes of operation are illustrated in figure 1.

Background

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, high particulate levels, *etc.* and still allow a tube to be capped for long-term storage.

Developed by Markes, the new RFID TubeTAG has overcome these difficulties and provides a robust, permanent and programmable tube labelling solution. Tags attach to the non-sampling ends of ordinary ¼-inch (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 a protective, high temperature, low-emission polymer to reduce the effect of temperature and protect it from environmental factors (Figure 2). The clips are designed such that tube tags can't be attached to or removed from a TD tube without using a special tool.

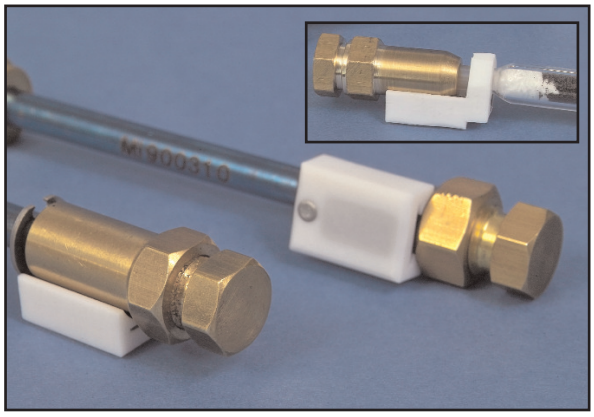

Figure 2: Close up of TubeTAG assemblies fitted to both metal and (inset) glass sorbent tubes

TubeTAG in operation

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 sample collection details such as monitoring location, sampling method, sampling start- and end-times, *etc.* can be entered onto each tag. When the tubes are received back into the laboratory after monitoring, all of the stored information can be readily downloaded from the tags and entered in the laboratory's information management system. The tags are then removed from the sampled tubes, using the special tool, as they are 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 *e.g.* monitoring location, sampling method and sample start & end times, simply allow multiple opportunities for users to confirm 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.

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

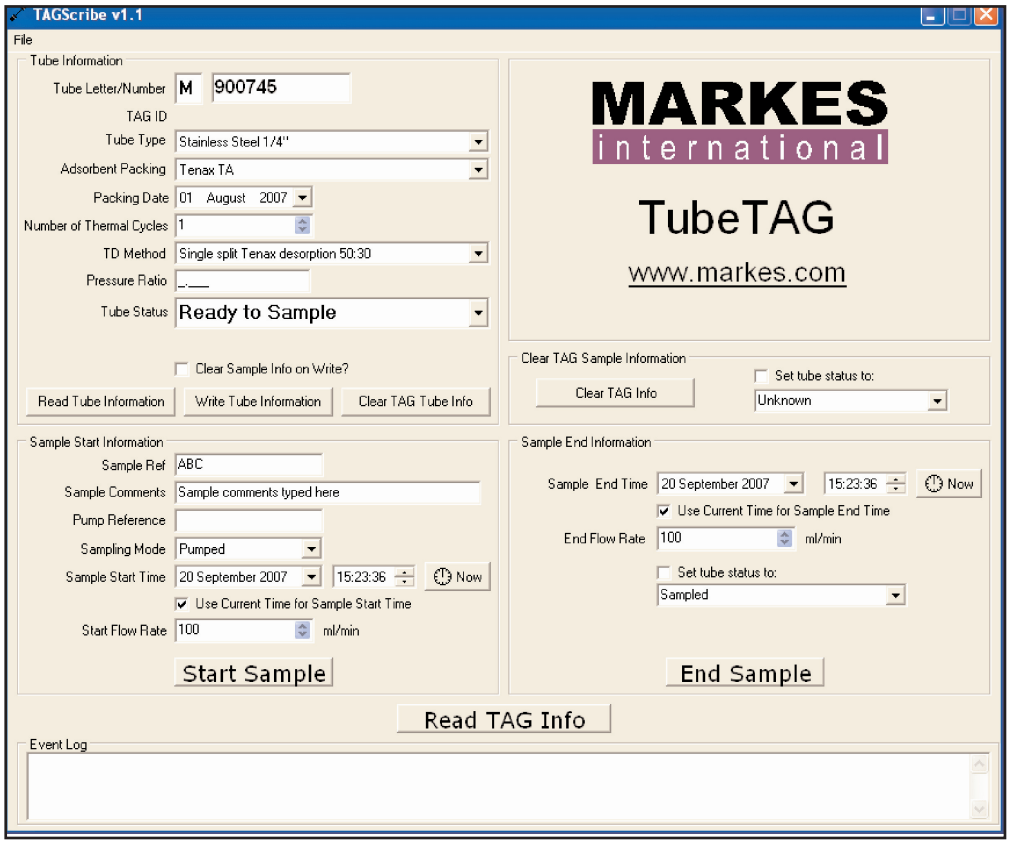

Figure 3: Typical tube- and sample-parameters recorded on tube tags

Figure 4: The TAG^{SCRIBE} field-portable device, used with PC for programming tags in the field or laboratory

be entered onto the tag in the lab before dispatch. As described above, sampling information (pumped or diffusive, flow rate/ duration of exposure, start time, *etc.*) can then be entered onto the tag in the field.

An example of the type of tube and sample data that can be recorded is shown in figure 3 and the TAG^{SCRIBE} typical field-portable tag read/write system is shown in figure 4.

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 received back into the laboratory they are placed into the automated TD system (Figure 5). If the series 2 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 *i.e.*

permanently attached to the same tube, also last indefinitely. Tests have shown them to be compatible with over a thousand thermal cycles, even under extreme desorption conditions *e.g.* 400ºC for 30 minutes. As above, this means that tagging costs are minimal - less than 25 cents per thermal cycle.

Tube conditioning in tube tag 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 specific 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(MS) 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 that a blank profile can be obtained automatically as part of the conditioning process. However, if ever/whenever 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 post-conditioning. The number of thermal cycles can be manually incremented as each tag is re-attached to its specific conditioned tube.

Figure 5: The Series 2 UltrA-UNITY TD system

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 or read to or from a tube tag either using the field portable TAG^{SCRIBE} device or *via* 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 as and when required. Subsequent interrogation of that database could then be used to determine when that tube or batch of tubes needs repacking or whether one or more tubes have a history of leak test failures, *etc.*

Summary

Markes International TubeTAG technology has the potential to greatly enhance the analytical quality assurance of air monitoring studies and TD-GC(MS) applications generally.

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(MS) data processing systems. Going forward this should allow key analytical factors such as background levels or key artifacts to be linked with specific tubes and tracked over the lifetime of the tube.

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