



## CONTAINER MONITORING

TOXIC GAS THREAT FROM SHIPPING CONTAINERS

### INTRODUCTION

Research has shown that around 20% of shipping containers contain dangerous levels of toxic gases and represent a major threat to port and transport workers, customs officials, warehousemen, store employees and consumers. It is therefore essential that containers are tested before entry is permitted, but there is growing concern that insufficient numbers of containers are being tested properly.

A wide variety of test instruments are used for testing containers and it is vitally important that any limitations in the monitoring technique are understood. For example, if a container is tested for just one gas, there may be risks from other chemicals. As a result, there is

a growing move to monitoring technologies that are able to measure large numbers of gases simultaneously; the most popular of which is FTIR.

The Finnish manufacturer of FTIR gas analyzers, Gasmet, has supplied portable FTIR analyzers to ports around the world for a number of years. Their Nenne Nordström says: “With long-standing experience in the inspection of containers, we have developed a comprehensive library of gases that our analyzers can be ‘programmed’ to measure. Consequently, the risk of exposure to harmful gases is dramatically reduced where containers are tested with a Gasmet FTIR analyzer.



## SOURCES OF TOXIC CHEMICALS

There are two potential sources of hazardous chemicals inside cargo containers: (1) Fumigants and (2) Chemicals that arise from the goods or packing materials. Fumigants are applied to goods to control pests, mold and micro-organisms in containers with foodstuffs, leather goods, handicrafts, textiles, timber or

cane furniture, luxury vehicles, timber cases or timber pallets from Asia.

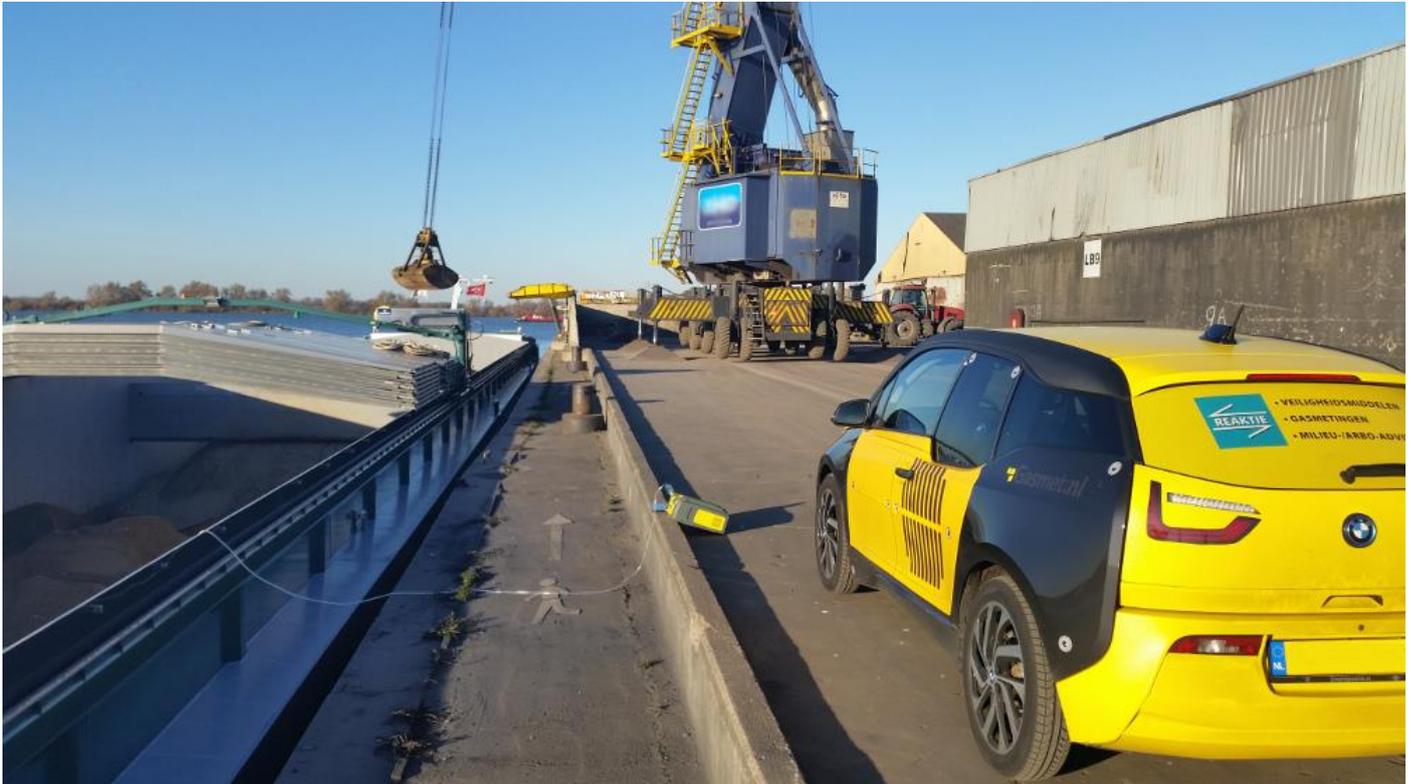
Containers often travel for extended periods and experience a wide range of temperatures, and this can cause the release of chemicals from cargo such as shown in Table 1:

**TABLE 1. CHEMICALS TYPICALLY RELEASED FROM CARGO.**

Compounds	Found in
Solvents from glues	Clothing, accessories and shoes
1,2-dichloroethane	Plastic products, PVC, blister packaging
Formaldehyde	Furniture (Plywood, MDF etc.), and in used pallets and lashing materials
Solvents and formaldehyde	Poly-resin products
Carbon monoxide	Charcoal and natural products
Carbon dioxide	Natural products
Ethylene oxide	Sterilized medical equipment
Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	Decoration and fresh painted products
Volatile Organic Compounds (VOCs)	Fire lighters
Flammable gases	Disposable lighters
Ammonia	Household equipment, cleaners and foam products
Pentanes and hexanes	Consumer electronics
Phosphine/arsine	Natural minerals such as ferrosilicon
Many gases from IMDG Code hazardous materials	

Peter Broersma from Reaktie in the Netherlands supplies gas monitoring equipment to ports, transport companies and test organizations. He says: “Most of the gases that are detected and measured by FTIR analyzers are cargo related. Off-gassing during shipment is the greatest problem, producing VOCs such as Toluene,

Xylenes, MEK, 1,2-dichloroethane and blowing agents such as isopentane and butanes from the packing materials. Formaldehyde from plywood is common in addition to the fumigant Phosphine. Occasionally Sulfuryl difluoride is detected and Methyl bromide is still found even though it is banned.”



## INTERNATIONAL REGULATIONS

Major ports have strict regulations in place to protect against potential hazards in cargo containers. In general terms, every incoming stream of products has to be checked for dangerous gases and if one of more dangerous gases are detected during the preliminary investigation, all of the containers from this specific producer must be checked. If no gases are detected, it may be possible to only conduct random tests a few times per year. If it is necessary for Customs staff to enter a container, all containers must first be tested and if necessary de-gassed.

According to the IMO's international regulations, 'Recommendations on the safe use of pesticides in ships', fumigated containers and ship cargoes must be labelled with information on the dates of fumigation and the fumigation gas used.

Appropriate certificates are necessary and records must be forwarded to the Port Health Authorities without their explicitly asking for them. Importantly, the absence of marking cannot be taken to mean fumigants are not present, because containers marked ventilated after fumigation may also contain fumigant that was

absorbed by the cargo and released during transit. There is also concern that fumigants may be retained in the goods and subsequently present a hazard to logistics providers, retail staff and consumers.

## INSTRUMENTATION

Chemical stain tubes provide a colorimetric assessment of an individual gas, typically with a low level of accuracy (+/- 15%). Different tubes are available for many gases and results can be obtained between 5 seconds and 15 minutes depending on the test. Once a result has been obtained, the tube itself is hazardous waste and must be disposed of in an appropriate manner. In the past, stain tubes were popular because the cost per test was low. However, the number of tubes that have to be employed in order to demonstrate that a container is safe can be prohibitively expensive and time-consuming to employ. Detector tubes also suffer from cross-sensitivity with other gases, which can make monitoring extremely difficult in containers with a wide range of unknown gasses. False positives can significantly increase costs and cause serious accidents.

Instrumental gas analyzers such as electrochemical sensors, which measure either a single gas or a small number of gases, represent a similar level of risk to stain tubes because of the possibility of missing or failing to measure a harmful gas. The use of multiple instruments also presents practical problems because each will require maintenance and re-calibration in addition to a power source or re-charging. Electrochemical sensors also suffer from cross-sensitivity with other gases, which can lead to false positive results. In addition, they have a relatively short lifespan and can be susceptible to

Since there are many gases that may be present in a cargo container, the traditional approach to monitoring has been either to employ a wide range of instruments or to use chemical stain tubes for the most common gases, or a combination of both. This approach can result in excessive costs and greater risks for staff.

interferences. They can also be 'poisoned' by high concentrations in a sample gas. In contrast, high concentrations do not harm FTIR; the instrument simply recommences analysis after a few minutes of backflushing.



Generally, preliminary assessment is conducted with a combination of a PID detector for total VOCs; a combustible gas sensor (LEL) and a handheld electrochemical device. However, it is very important to be aware of the limitations of these instruments. For example, whilst a PID gas detector measures total VOCs, it does not provide an individual value for, say, benzene, which is a known carcinogen.

Advantages of test and inspection regime based on Gasmeter FTIR:

- Speed (see below)
- No sample preparation
- No hazardous waste
- Ability to cope with complex gas matrix and interfering compounds
- Ability to re-analyze the spectra when:
  - the container gas composition is unclear
  - accident investigation is necessary
  - spectra analysis by an expert is necessary to resolve disputes or where difficult or complex gas matrices exist

Speed is vitally important in a busy port because container inspection could become a bottle-neck in the logistic chain, which would increase costs and incur delays. The ability to conduct inspections quickly and effectively with Gasmeter's portable FTIR analyzers is therefore a major advantage. Gasmeter has developed a configuration for its portable FTIR analyzer, the DX4040, so that it is able to measure the 50 compounds of greatest

concern in around 3 minutes. This dramatically lowers the time taken for container inspection and greatly increases the number of containers that can be examined every day. Consequently, the Gasmeter DX4040 is able to act both as a screening tool and an analytical tool without adding further costs or the delays that would be incurred by laboratory analysis.



If further analysis is required, to identify unknowns or to measure even greater numbers of compounds, Gasmeter's Calcmet professional software can analyze more than 350 additional gases. The utilization of NIST reference spectra enables the analysis of over 5,000 compounds.

A further major advantage of the DX4040 is the minimal amount of calibration and maintenance that is necessary. A new instrument can be delivered pre-configured and factory calibrated and then the only calibration required is a quick zero-check with nitrogen once per day. As a result, it is not necessary to transport a large number of expensive, bulky calibration bottles or target gases.

## SUMMARY

Millions of containers arrive in ports every year and represent a significant hazard to staff. Employers therefore have a duty of care to protect their staff and court cases have found in favor of workers that have suffered ill-health from container gases. In the Netherlands Peter Broersma says: “Gasmet FTIR is used by more than 75% of the main professional gas measuring companies - most of the time they are surprised by how many different components there can be in a container.”



In addition to port authorities, Gasmet’s analyzers are also used by freight companies, logistics centers and organizations responsible for fumigation and degassing cargo containers.

Gasmet’s portable FTIR gas analyzers substantially reduce the amount of equipment required to test a container, but more importantly, the technology enables the simultaneous analysis of a large number of target compounds, which improves the effectiveness and speed of the assessment, and thereby reduces risk to staff.



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GASMET TECHNOLOGIES IS LEADING THE WAY IN BRINGING ADVANCED FTIR MEASUREMENT TECHNOLOGY TO ON-LINE AND ON-SITE APPLICATIONS. GASMET IS COMMITTED TO THE PROVISION OF THE BEST POSSIBLE SUPPORT THROUGH OUR GLOBAL NETWORK OF HIGHLY TRAINED REPRESENTATIVES COVERING ALL CONTINENTS AND LOCATED IN MORE THAN 70 COUNTRIES. OUR MISSION IS TO PROVIDE CLIENTS WORLDWIDE WITH INNOVATIVE, CUSTOMER-DRIVEN AND RELIABLE SOLUTIONS IN THE FIELD OF GAS ANALYSIS. EACH OF OUR PRODUCTS IS FINE-TUNED TO MEET THE CUSTOMER’S NEEDS AND APPLICATION REQUIREMENTS.