World first at Analytica 2000

1000 times more sensitive than SPME:
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New passive air sampler
GERSTEL® TOPAS
Field tested

ICB presents GERSTEL at Achema
Practical knowledge converted to advanced technology

Emission measurement
Comparison of classical and thermal desorption methods for air monitoring
Where has the time gone? All modesty aside, there can only be one answer to that question: it has been spent working on high-quality, technically perfected and unique analytical systems, building a highly skilled and qualified workforce and developing first-class service. In short, the name GERSTEL stands for quality. It is because of this that internationally renowned companies work closely with us to develop innovative solutions to their analysis needs, and why the number of these companies placing their trust in our Global Analytical Solutions technology is constantly growing.

This year, as in the past, we showed pioneering product innovations for gas and liquid gas chromatography at Analytica 2000. Quite outstanding in this regard was the GERSTEL Twister™. Without taking too much away for the article appearing later in this issue of GERSTEL Solutions Worldwide, we will simply say that this simple and ingenious product innovations for gas and liquid gas chromatography. The Twister can be used with matrices as diverse as drinking or wastewater, body fluids, beverages, dairy products, and processed foods. After sample extraction, the Twister can be directly transferred to the GERSTEL TDS 2 thermal desorption system where the extracted compounds are thermally desorbed and determined by gas chromatography. For a more detailed look at Twister, see pages 4 – 8.

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The GERSTEL MPS 3 provides new dimensions

The ultra-versatile LC autosampler

Regardless of whether a sample needs derivatized, have an internal standard edit, or simply diluted – the GERSTEL MPS 3 and the space saving version, the MPS 3 C, set a new standard for automated sampling in liquid chromatography. The sample can accommodate 96-well or 384-well microtiter plate formats, or more traditional 0.7-20 ml. Two HPLC systems can be run simultaneously from one autosampler. A further advantage of the MPS 3/3 C is that samples can be cooled and heated or agitated. This eliminates the need for additional preparation of samples such as tablets since dissolution takes place automatically. All that is needed is to place the sample in the vial and let the sampler do the rest. The versatility of the GERSTEL MPS 3 family of autosamplers makes them ideal for liquid chromatography analysis in the areas of clinical chemistry, pharmaceutical research and pharmaceutical production.

New thermodesorbable passive collector – tested in practice

Faster and more sensitive on a Tenax base

The combining of a badge-shaped passive collector with thermal desorption for transferring atmospheric constituents to GC analysis forms the basis of an innovation developed by GERSTEL in cooperation with the Institute für Chemie- and Biosensorik (ICB) in Münster, Germany. TOPAS is the name of the system, which comprises a badge-shaped, Tenax-based passive collector the size of a large coin (a German five-mark piece) and the GERSTEL thermal desorption system TDS D specially developed for it. This combination enables comparatively simple, fast and extremely sensitive measurements of harmful pollutants as well as the monitoring of limit values in the workplace. The outstanding feature of the TOPAS system is that, in contrast to its active carbon-based counterparts, the harmful substances enriched on the Tenax can be described completely and without any sample preparation through thermal desorption and analysed by gas chromatography. Furthermore, compared with other Tenax-based passive collectors, the new system developed by GERSTEL and the ICB offers the added advantage of being suitable for interior short-time measuring. TOPAS permits sampling cycles of just a few hours even for the lowest of contaminant concentrations.

Editorial

GERSTEL solutions worldwide E 1/2000

GERSTEL technology at Analytica 2000

Pointing the way for decades

We have to admit, that after looking through some old documents recently, we were somewhat surprised when we realized that this year we presented our range of products at the Analytica trade fair in Munich for the tenth time. This means we have been presenting our innovative systems and complete solutions for chromatographic analysis to scientists at Analytica for the last 20 years now.

Where has the time gone? All modesty aside, there can only be one answer to that question: it has been spent working on high-quality, technically perfected and unique analytical systems, building a highly skilled and qualified workforce and developing first-class service. In short, the name GERSTEL stands for quality. It is because of this that internationally renowned companies work closely with us to develop innovative solutions to their analysis needs, and why the number of these companies placing their trust in our Global Analytical Solutions technology is constantly growing.

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The analysis to determine organic compounds in aqueous environmental, biomedical, food and fragrance matrices is normally performed after extraction and enrichment of the solutes from the matrix (drinking water, waste water, body fluids, beverages, ...). Most sample preparation methods are based on liquid-gas equilibrium or extraction (headspace, purge and trap), liquid-liquid extraction or solid phase extraction (SPE).

During the past years, miniaturization has become a dominant trend in analytical chemistry. Typical examples of miniaturization in sample preparation techniques are micro liquid-liquid extraction (in-vial extraction), ambient static headspace and disk cartridge SPE. In combination with state-of-the-art analytical instrumentation, this resulted in faster analysis, higher sample throughput, lower solvent consumption, less manpower in sample preparation, while maintaining or even improving limits.

Some 10 years ago, a new micro-extraction method was developed by Arthur and Pawliszyn (1), namely solid-phase micro-extraction (SPME). Extraction of organic compounds from aqueous samples (or from a gas phase) using a polydimethylsiloxane (PDMS) sorbent as extraction medium was already described by different groups in the mid 80s using open tubular traps coated with thick PDMS films. Extraction using PDMS media is based on sorption instead of adsorption. Sorptive enrichment offers several advantages over adsorption processes, as described by Baltussen et al. (2). These advantages include predictable sorption, absence of displacement effects, inertness and faster and milder desorption. Practical limitations (low sample capacity, low breakthrough volumes, ...), however, limited the applicability of PDMS coated open tubular traps. SPME, on the other hand, is a very simple and fast technique. A relative thin layer of PDMS (7-100 µm) on the outside of a needle device is used as extraction medium. After sorption, the compounds are thermally desorbed in a GC inlet or liquid desorbed in a LC inlet. In contrast to PDMS coated open tubular traps, SPME is by nature an equilibrium technique, based on the partitioning of the solutes between the silicone phase and the aqueous (and/or gas) matrix. Recent studies (3-5) have correlated this equilibrium with octanol/water distribution coefficients ($k_{o/w}$). These studies demonstrated that for solutes with low $k_{o/w}$ ($k_{o/w}<10000$), low recoveries are obtained. This is mainly due to the phase ratio between the aqueous and PDMS phase. The amount of PDMS used in SPME is typically in the order of 0.5 µL or less. For a 10 mL water sample, this corresponds to a phase ratio of 20000. Consequently the enrichment on the PDMS fiber is limited. This is illustrated in Figure 1 showing the recovery of solutes on the SPME fiber in function of the log $k_{o/w}$. A 50 % recovery is only obtained for compounds with a $k_{o/w}$ larger than 20000.

Based on these observations, a new approach using stir bars coated with PDMS was recently developed (2). The technique is called stir bar sorptive extraction (SBSE). In this approach, 50-300 µL PDMS coatings are used. This corresponds to phase ratios of 33-200 for 10 mL samples. Consequently, the sensitivity is increased by a factor of 100 to 1000 in comparison to SPME. This is demonstrated in Figure 1 for a 10 mL water sample and a stir bar coated with 100 µL PDMS. More than 50% recovery is obtained for solutes with $k_{o/w}$ larger than 100 and the SBSE curve reaches 100% recovery at much lower log $k_{o/w}$ values in comparison with SPME. Solutes with $k_{o/w}$ from 10 to 100 can also be analysed using calibration as is done in SPME.

In this paper some applications demonstrate the applicability of stir bar sorptive extraction for the analysis of aqueous matrices.

**Experimental**

PDMS coated stir bars (Twister™) are commercially available from GERSTEL GmbH. Magnetic stirring rods are incorporated in a glass jacket and coated with a 1 mm layer of PDMS (Fig. 2). Two Twisters are available: 10 mm L x 3.2 mm o.d. and 40 mm L x 3.2 mm o.d. PDMS coated stir bars. Typically the 10 mm stir bars are used for 1-50 mL sample volumes and the 40 mm stir bars are used for 100-250 mL sample volumes.
Sample extraction is performed by placing a suitable sample amount (typically 10 mL) in a vial, adding a stir bar and stirring for 30-120 min. After extraction, the stir bar is introduced in a glass thermal desorption tube (4 mm i.d. x 187 mm L), placed in a thermal desorption unit and thermally desorbed. Desorption temperatures are application dependant and are between 150-300°C. Alternatively, liquid desorption can be used.

Two typical applications are shown to illustrate stir bar sorptive extraction. First, an orange juice drink was analysed. A 20 mL sample was placed in a headspace vial and extracted using a 10 mm stir bar for 90 min. The stir bar was then thermally desorbed at 240°C for 10 min in splitless mode using a TDS-2 system (GERSTEL GmbH), installed on a HP 6890 GC – HP 5973 MSD combination. The desorbed solutes were cryofocussed in a CIS 4 PTV inlet at –150°C. After the stir bar desorption, the PTV was programmed to 240°C at 12°C/s and held for 5 min to transfer the trapped solutes in the GC column. Injection was done in split mode (split ratio 1:20). The carrier gas was helium at 1 mL/min constant flow. The compounds were analysed on a 30 m x 0.25 mm i.d. x 0.25 μm Stabilwax (Restek) column. The oven was programmed from 40°C (1 min) to 230°C at 5°C/min. Detection was done using a HP 5973 MSD in scan mode (35-500 amu). Secondly, pesticides were analysed in a wine sample. A 25 mL wine sample (dry white wine) was spiked at the 1 ppb level with a mixture of organochlorine pesticides, placed in a 40 mL vial and extracted with a 10 mm stir bar for 40 min while stirring at 1400 rpm. The stir bar was thermally desorbed at 300°C for 10 min in a TDS-2 system installed on a HP 6890 GC – HP G2350 A Atomic Emission Detector combination. The solutes were cryofocussed in a CIS 4 PTV inlet at –50°C. After the stir bar desorption, the PTV was programmed to 300°C at 10°C/s and held for 5 min to transfer the trapped solutes in the GC column. Thermal desorption of the stir bar and on-line GC-MS analysis gives a very detailed picture of the flavour and fragrance compounds present in the sample. The chromatogram obtained by SBSE-TDS-GC-MS of the orange juice sample is given in Figure 3. The chromatogram shows excellent peak shapes and resolution. Peaks ranging from the very volatile esters (ethyl butanoate) to semivolatile coumarins are identified.

The second application is the analysis of pesticide traces in wine. Classical sample preparation methods involve liquid-liquid extraction or solid-phase extraction, followed by clean-up prior to GC analysis. Figure 4 shows the chlorine trace obtained by SBSE-TDS-GC-AED analysis. All spiked pesticides are easily detected with good peak shapes. The spiked level of 1 ppb is well below the accepted levels for wine (or grapes), so the obtained sensitivity is more than sufficient. Sample preparation time is low and not labor intensive. Several samples can be extracted simultaneously and thermal desorption – GC-AED analysis is fully automated.

Conclusions.

Stir bar sorptive extraction is a powerful technique for the extraction and analysis of organic compounds in aqueous matrices. The system can be used for fast quality control of food and fragrance samples and for trace analysis in environmental, food and biomedical samples.

References.

Analysis of Volatiles in Wet Samples by Direct Thermal Desorption GC

Abstract

The analysis of volatiles in solids is a common analytical problem. Examples include volatile aroma compounds in fresh (e.g., tea, herbs), residual fragrances from soaps and fabric softeners in textiles, and volatiles in foods and beverages. This paper will define conditions necessary to eliminate water from wet samples using the above three strategies. Examples illustrating the high sensitivity of volatiles in wet samples by Thermal Desorption are shown with direct thermal desorption using cryotrapping before the GC column.

A wide variety of sample types can contain significant levels of water. This presents significant challenges when doing direct thermal desorption and cryotrapping for analysis of volatiles, since water can accumulate and freeze at the inlet or at the head of a column. Introduction of significant levels of water into the GC column can degrade chromatographic performance and shorten column lifetime.

There are several strategies that are useful in the introduction of water into a GC when doing thermal desorption. These range from offline thermal extraction with trapping of volatiles on adsorbent beds to incorporating drying steps into the thermal desorption process itself. Estimating the amount of water that can be eliminated with each of these approaches is a challenge.

Volatiles in solid samples containing up to 50% water were analyzed by direct thermal desorption incorporating different drying strategies. Offline thermal extraction of Tenax TA™ adsorbent was the most effective approach for eliminating large amounts of water effectively storing (low boiling) analytes. Small percentages of water (less than 2%) can be eliminated by Soxhlet extraction from samples by using Tenax TA™ packed into tubes narrower than 4 mm. Guidelines for choosing appropriate steps for eliminating different levels of water are outlined.

Experimental

Instrumentation. All analyses were performed on a GC-6890N, Agilent Technologies with Flame Ionization Detection. The GC was equipped with a Thermal Desorption unit with on/at multiples (TDS 2 or TDS 4) and a 4 mm-ID HD-1 column. Offline extraction of wet samples onto Tenax TA™ adsorbent tubes was done using a heated Thermal Extractor unit (Gerstel). Sample Preparation. Fresh Peppers and Herbs. Off-line extraction of volatiles from fresh (100-500 mg) was weighed into large (14 mm ID x 148 mm) glass extraction tubes. Samples were then extracted under 25 mL helium flow for 20 minutes in the TDS 2 or TDS 4 thermal desorption unit. The TDS 2 or TDS 4 thermal desorption unit was then heated to 60°C for 10 minutes to the TDS 2 or TDS 4 thermal desorption unit to eliminate residual water before thermal desorption. Volatiles were cold trapped in the inlet at 40°C without freezing the inlet. (Figure 4). This procedure resulted in analysis times in excess of 1 hour. To try to speed analysis, 400 mg fresh bulk was thermally extracted offline (15 min, 60°C trapping) on Tenax TA™ adsorbent tubes. The Tenax TA™ tube was then heated to 60°C for 10 minutes in the TDS 2 or TDS 4 thermal desorption unit to eliminate residual water before thermal desorption. Volatiles were cold trapped in the inlet at 40°C without freezing the inlet. (Figure 4). This procedure resulted in analysis times in excess of 1 hour.

Results and Discussion

Model Drying Studies

Direct thermal extraction of fresh (30 mg) samples placed into glass Thermal Desorption tubes (18 mm ID x 178 mm) with 10 mg of or 30 mL water. Samples were then directly heated to the analyte high flow of 30°C in the TDS 2 thermal desorption unit. Samples were then directly adsorbed in the TDS 2 or TDS 4 thermal desorption unit to trap volatiles before thermal desorption. The TDS 2 or TDS 4 thermal desorption unit was then heated to 60°C for 10 minutes to the TDS 2 or TDS 4 thermal desorption unit to eliminate residual water before thermal desorption. Volatiles were cold trapped in the inlet at 40°C without freezing the inlet. (Figure 4). This procedure resulted in analysis times in excess of 1 hour.

Online thermal extraction conditions. TDS 2: 40 mL/min helium flow in the TDSA solvent vent mode to eliminate residual water before thermal desorption. Volatiles were cold trapped in the inlet at 40°C without freezing the inlet. (Figure 4). This procedure resulted in analysis times in excess of 1 hour.

Table 1. Percent Water Removed from Terrycloth Towel @30°C under different time and flow conditions.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Water Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°C 60% RH (1 min)</td>
<td>78%</td>
</tr>
<tr>
<td>40°C 60% RH (20 min)</td>
<td>97%</td>
</tr>
<tr>
<td>80°C 60% RH (40 min)</td>
<td>97%</td>
</tr>
</tbody>
</table>

Conclusions

Drying hydrophobic substrates (substrates under a helium flow at 60°C) can effectively remove water from the sample without analysis with boiling points above 200°C. Tenax TA™ adsorbent tubes can be heated offshore to trap and eliminate water from wet samples containing high percentages of water. This approach may be useful in providing more sensitive samples to be analyzed. Drying the sample at 60°C for 20 minutes or more may be necessary to eliminate residual water from wet samples containing high percentages of water. Volatiles in wet samples up to 50% can be analyzed with thermal desorption using Tenax TA™ packed adsorbent tubes. Maintaining inlet temperatures from 20°C above 60°C during thermal desorption can significantly improve retention time.

Acknowledgements

The author thanks Mr. Jack White for his technical work generating the GC data and Mr. Andamas for developing technical support (loaned equipment, conditions, and graphics design).
New calibration method for thermal desorption

- Suitable sampling and measuring methods are required to determine organic compound contamination of interior and exterior air. Enrichment on thermally desorbable sorbents is a widely-used method, offering the advantage over solid-liquid extraction of allowing the entire sample to be injected for GC analysis at once, which results in low detection limits. It also does not require the use of toxic solvents.

The calibration of the measuring process is particularly important. In cooperation with Reinhard Keller, Head of the Department at the Institute of Medical Microbiology and Hygiene at the Medical University of Lübeck, GERSTEL has designed a calibration unit taking six TDS tubes to make this stage faster and simpler.

Using a knitted nut, the TDS tubes can be fixed to the bottom of the unit via a Teflon female, with six septumless sampling heads (SLHs) located on the top for contamination-free injection of the calibration solution. The entire unit is purged with carrier gas and the volumetric rate of flow can be regulated separately for each channel.

The pre-conditioned TDS tubes were clamped into the calibration unit. In his tests, Keller used analytes which are listed in VDI 4300, Sheet 6 for determining the overall concentration of volatile organic compounds and which also span a relatively broad boiling point range (66 – 287°C). Between 10 ng and 2000 ng were selected for the concentrations to be examined so as to take account of all problematic concentrations occurring in interior spaces. The analytes were dissolved in methanol and doped at the rate of 1 µg/mL and doped at the rate of 1 µg/mL and doped at the rate of 1 µg/mL and doped at the rate of 1 µg/mL (66 – 287°C). Between 10 ng and 2000 ng were selected for the concentrations to be examined so as to take account of all problematic concentrations occurring in interior spaces.

The advantages of the process developed by Keller compared with conventional methods are obvious: less instrument equipment and time needed, easy handling and easy to integrate into laboratory practice. This means that an alternative to the established procedures, such as the use of test gases, now exists.

Waste-water analysis made easy

Differing TOC concentrations were found in the waste-water tanks of two plants producing under the same conditions, although the concentrations were virtually identical at the inlet to the tanks. In the troubleshooting process, the GERSTEL Twister proved to be the ideal means of identifying the constituents quickly and economically after thermal desorption, gas chromatography separation and mass-selective detection.

Evaluation

While the chromatograms of the samples from inlet pipes 1 and 2 were virtually identical (Fig. 2), those of the tank samples displayed distinct differences (Fig. 1). The source of the discrepancy therefore had to be in the waste-water tank. As the Twister and the MSD allowed the components to be identified, potential causes of the additional contamination could be determined using available piping plans. This meant that there had to be at least one more inlet pipe to tank 2. This was located, after which a sample was taken and compared with the existing results. When the components found were added to tank 1, the chromatogram showed the same picture as in the analysis of the sample from tank 2 (Fig. 3 and 4). The cause of the additional waste-water contamination could then be established.

Result

With the help of the GERSTEL Twister, it proved possible to implement a process which, compared with conventional sample preparation for GC analysis, enables an organic waste-water contaminant to be detected much more quickly and economically while retaining the same measuring sensitivity. The advantages of using the Twister: the costs were only one third of those normally incurred and the time required for the analysis was, after optimization, reduced to a quarter of that previously needed. Following identification with a mass-selective detector (MSD), the quantifying process can be carried out using a flame ionisation detector (FID). This possibility is currently being tested.
Volatile Organic Compounds from Adhesives and their Contribution to Indoor Air Problems

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Abstract

Carpets for office use are nowadays in most cases applied with water-based adhesives. During the last decade the complaints about odors and emission of volatile organic compounds from these fitted carpets have increased dramatically, causing a major problem for indoor air quality. In a series of investigations it has been established that in many cases the adhesives used were the primary cause of complaints. This is initially surprising, since usually solvent-free water-based dispersion adhesives were used.

This paper describes the analytical approach of analyzing a broad variety of volatile compounds within a wide boiling point range with thermal desorption GC/MS.

Introduction

In the early 90's, due to a German worker safety regulation (TRGS 610), solvent based adhesives for floorcoverings were changed to water-based dispersions. To realize this change in technology, instead of low boiling solvents such as methanol and toluene high boiling components such as Phenoxyl ethanol, miscellaneously glycols and glycolemethers were used. These components still do have the function of a solvent, but due to the solvent definition of the regulation (boiling point < 200°C), the adhesives have been declared solvent free.

These high boiling and polar components have been identified as a major source of problems caused by glued carpets. Due to their low vapor pressure, the high boiling components diffuse only very slowly from the adhesive through the textile floorcovering, but can cause long-term indoor air pollution. Adhesives for textile floorcoverings do not only contain these high boiling components but also other components such as terpenes or other volatile organic compounds as shown in Table I.

For the analysis of volatile organic compounds in indoor air, various sampling techniques and different adsorbing materials are in use (Figure 1). The sampling strategies depend on the boiling point of the components.

As a common adsorbent, activated charcoal tubes are regularly used for the determination of volatile organic compounds. However, this type of adsorbent is not suitable for the detection of high boiling and polar compounds, such as glycols and glycolemethers found in water-based adhesives.

As shown in Figure 2, the use of activated charcoal for the sampling of these components will lead to severely biased analytical results and incomplete information for the interpretation of the indoor air situation.

According to these data, for the determination of volatile organic components from adhesives the adsorption on Tenax TA, in combination with Thermodesorption and GC/MS analysis is nowadays state of the art (Figure 3: GERSTEL Thermo desorption system). Only this technique is suitable for the analysis of a broad variety of volatile compounds with a wide range of boiling points and different polarity.

Experimental

Instrumentation. The analytical system consists of a thermodesorption system with autosampler (TDS A, TDS 2, GERSTEL GmbH & Co.KG, Mülheim an der Ruhr, Germany, Figure 3), a temperature programmable vaporization inlet (CIS 4, GERSTEL), a gas chromatograph (6890, Agilent Technologies, Little Falls, USA) and a mass selective detector (5973, Agilent).

Operation. The air samples are drawn on a Tenax TA tube, which is then introduced into the thermal desorption unit and thermally desorbed to release the trapped organic compounds into the cryogenically precooled PTV for subsequent GC/MS analysis.

Results and Discussion

As shown above, these high boiling and polar compounds...
Long-term emission (TVOC) of a glued carpet in a test chamber

Figure 6

Adhesive after 7 days

Figure 4

Adhesive fitted carpet after 7 days

Figure 5

Figure 7

Test chamber

period of time in a test chamber (Figure 7) to obtain more information concerning the long-term emission behavior of glycols and glycol ethers.

An actual situation similar to the test chamber compounds, has lead to a long lasting emission of volatile components into the indoor air. As shown in Figure 8 in a real room situation these high-boiling components, such as phenox ethanol, do not appear immediately, but instead after a period of time after installation. In this particular case, the office had to be renovated after nine months due to the complaints of the users and according to the emission data.

Another example shows that air analysis alone does not necessarily solve indoor air odor problems. In this case an extremely annoying bad smell was reported in an office room. Indoor air analysis resulted in the detection of bromophenol (Figure 9), but neither the floor covering nor the adhesive contained even traces of this compound. The combination of carpet and adhesive led to the formation of bromophenol and placing a piece of carpet (with the adhesive applied) in the thermal desorption unit and performing thermal extraction could reproduce the bad smell.

Figure 10 shows the mechanism of formation: phenox propanol (from the adhesive) is hydrolyzed to phenol, which itself reacts with inorganic bromide (from the latex back of the textile covering) forming bromophenol.

Conclusions

Volatile organic components from water-based adhesives have a major influence on the indoor air quality. Due to the use of high-boiling and polar compounds, the impact of the problem has been shifted from the installation process to the consumer or inhabitant of the office. The emissions of these compounds are a major problem of indoor air pollution. As shown in this paper, the influence of adhesive components on the long-term emission is substantial and by using the wrong analytical technique the true magnitude of the problem for the indoor air situation can be severely underestimated.

After having learned about the situation, a new testing scheme for the long-term emission of glycols and glycol ethers was developed by the association of adhesive manufacturers and the association of environmentally friendly carpets.
GERSTEL Worldwide

Our American subsidiary: GERSTEL Inc.

Since 1995 our North American subsidiary, GERSTEL Inc., has been successfully developing what is certainly the world’s most important market for analytical instrumentation. Their conveniently located head office in Baltimore, MD acts as the center for sales, service and application support while a network of 23 sales representatives provides local sales support in almost every region of the USA and Canada. Seven full-time employers and the team of sales representatives ensure that our North American customers receive the very best customer service that GERSTEL can provide. Some of our largest customers in the USA include The Coca-Cola Co., DuPont, IBM, IFF, E&J Gallo, Kraft Foods, Procter & Gamble, the US Army.

Our man in Asia: Dr. Fred Schwarzer

The considerable demand for GERSTEL systems in Asia obliged us to quickly step up our activities there and set up a support office in Japan. The office is headed up by Dr. Fred Schwarzer, an experienced chemist who has been a member of the company’s support team since 1998. Dr. Schwarzer has also been providing on-site support to our Japanese sales partner, Yokogawa Analytical Systems Inc., in Tokyo since 1999.

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