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Aroma Associated with the use of Antiseptic Soap

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Equipment: Model 4200

Industry: Environmental

Compounds Discussed: Cocamide dea, Chloroxyleno, Patassium tallate, Sodium lauryl sulfate, Potassium cocoate, Phenoxyethanol, Tetrasodium edta, Sodium chloride

Method: Yes

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Summary

It may be possible to insure hygenic conditions are present in situations such as in hospitals or food preparation facilities where sterile conditions must be maintained. Each soap or lotion was found to contain unique marker compounds and odor signatures which would be used for identification purposes. The zNose® is a real time tool which provides the ability to insure workers adhere to hygenic standards. It is characterized by high speed speed, sensitivity, portability, precision, and accuracy needed for cost-effective quality control measurements. Such measurements, because they are based upon well known chromatographic methods, can easily be validated by independent laboratory testing. A 'good' aroma as determined by measurements can now be quantified in near real time to insure hygienic procedures are followed. The 'good' chemical signature once defined, allows for objective and quantitative quality control testing with other zNose® analyzers integrated into production process.

Introduction

Conventional electronic noses (eNoses) produce a recognizable response pattern using an array of dissimilar but not specific chemical sensors. Electronic noses have interested developers of neural networks and artificial intelligence algorithms for some time, yet physical sensors have limited performance because of overlapping responses and physical instability. eNoses cannot separate or quantify the chemistry of aromas.

A new type of electronic nose, called the zNose®, is based upon ultra-fast gas chromatography, simulates an almost unlimited number of specific virtual chemical sensors, and produces olfactory images based upon aroma chemistry. The zNose® is able to perform analytical measurements of volatile organic vapors and odors in near real time with part-per-trillion sensitivity. Separation and quantification of the individual chemicals within an odor is performed in seconds. Using a patented solid-state mass-sensitive detector, picogram sensitivity, universal non-polar selectivity, and electronically variable sensitivity is achieved. An integrated vapor preconcentrator coupled with the electronically variable detector, allow the instrument to measure vapor concentrations spanning 6+ orders of magnitude.

In this paper a portable zNose®, shown in Figure 1, is shown to be a useful tool for quantifying the concentration of chemicals in aromas produced by the use of antiseptic soaps and cleaners. Test procedures to confirm the use of antiseptic soaps and cleaners by workers are needed in hospitals, food production and food preparation facilities. Such testing could be key in preventing the spread of infectious diseases.

Figure 1- Portable zNose® technology incorporated into a handheld instrument

How the zNose® Quantifies the Chemistry of Aromas

A simplified diagram of the zNose® system shown in Figure 2 consists of two parts. One section uses helium gas, a capillary tube (GC column) and a solid-state detector. The other section consists of a heated inlet and pump, which samples ambient air. Linking the two sections is a “loop” trap, which acts as a preconcentrator when placed in the air section (sample position) and as an injector when placed in the helium section (inject position). Operation is a two step process. Ambient air (aroma) is first sampled and organic vapors collected (preconcentrated) on the trap. After sampling the trap is switched into the helium section where the collected organic compounds are injected into the helium gas. The organic compounds pass through a capillary column with different velocities and thus individual chemicals exit the column at characteristic times. As they exit the column they are detected and quantified by a solid state detector.

An internal high-speed gate array microprocessor controls the taking of sensor data which is transferred to a user interface or computer using an RS-232 or USB connection. Aroma chemistry, shown in Figure 3, can be displayed as a sensor spectrum or a polar olfactory image of odor intensity vs retention time.
Calibration is accomplished using a single n-alkane vapor standard. A library of retention times of known chemicals indexed to the n-alkane response (Kovats indices) allows for machine independent measurement and compound identification.

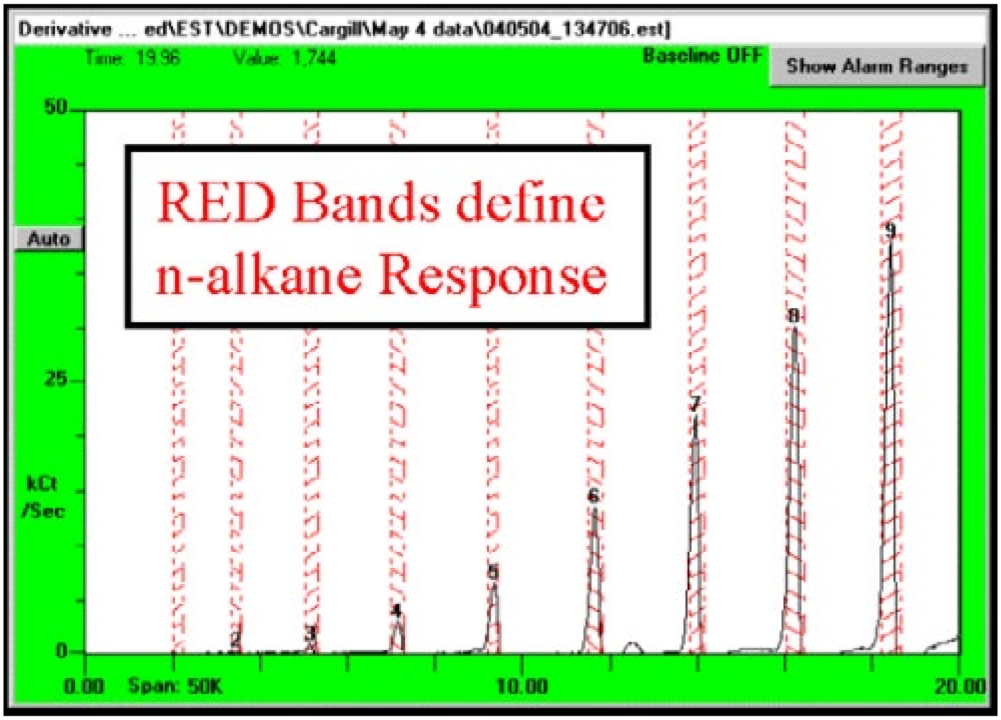

Figure 2- Simplified diagram of the zNose® showing an air section on the right and a helium section on the left. A loop trap preconcentrates organics from ambient air in the sample position and injects them into the helium section when in the inject position

Figure 4 - Chromatogram of n-alkane vapors C6 to C14

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Chemical Analysis (Chromatography)

The time derivative of the sensor spectrum (Figure 3) yields the spectrum of column flux, commonly referred to as a chromatogram. The chromatogram response (Figure 4) of n-alkane vapors (C6 to C14) provides an accurate measure of retention times. Graphically defined regions shown as red bands calibrate the system and provides a reference time base against which subsequent chemical responses are compared or indexed. As an example, a response midway between C10 and C11 would have a retention time index of 1050.

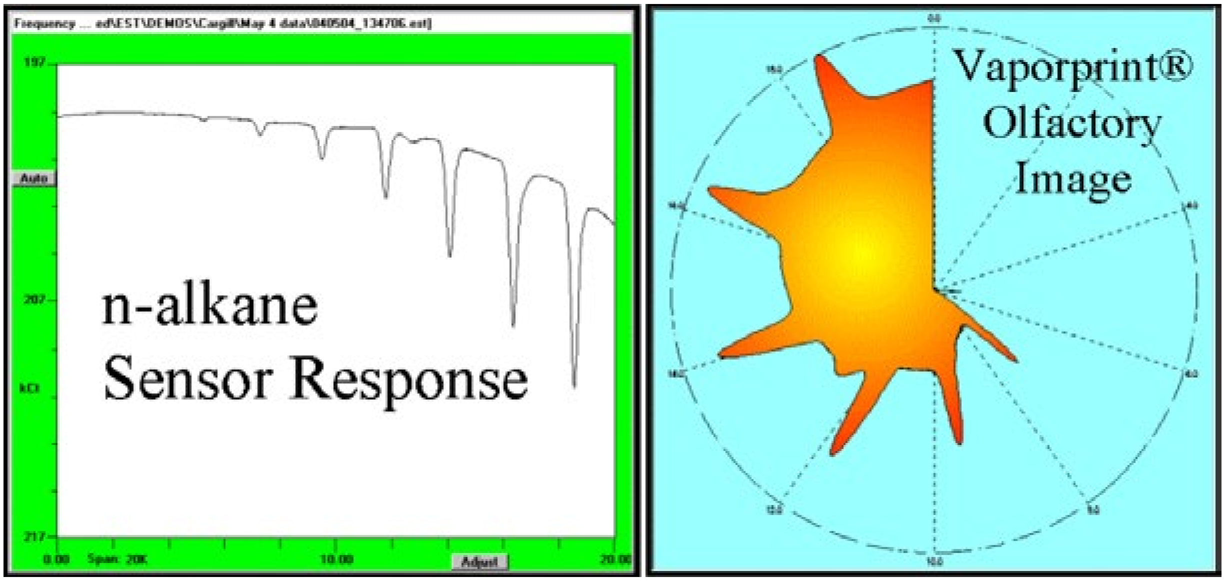

Figure 3- Sensor response to n-alkane vapor standard, here C6-C14, can be displayed as sensor output vs time or its polar equivalent olfactory image

Antiseptic Soap Samples

Samples of antiseptic soap and cleaning lotion was supplied by the Nanozak corporation and manufactured by U.S. Chemical. The antiseptic soap contained the active ingredient chloroxylenol (0.5%) as well as other ingredients such as potassium tallate, sodium lauryl sulfate, potassium cocoate, cocamide dea, phenoxyethanol, tetrasodium edta, sodium chloride and and proprietary fragrance chemicals. The cleaning lotion used the same active ingredient together with potassium tallate, sodium lauryl suflate, potassium cocoate, cocamide dea, styrene acrylates copolymer, tetrasodium edta, phenoxyethanol, and peach fragrance producing chemicals.

Determining Chemical Signatures for Soap and Lotion

The chemistry of headspace vapors from antiseptic soap and lotion was tested by placing approximately 10 grams of each into a septa-sealed 40 mL vials. Headspace vapors were withdrawn and tested by piercing the septa with a needle attached to the inlet of the zNose as shown in Figure 5 Internal temperatures of the zNose® analyzer were set to 165ºC and 200ºC for the inlet. A short 10-second sample time (5 mL vapor sample) was used. The chromatographic analysis was done using a db- 5 column temperature programmed from 40ºC to 180ºC at 10ºC/second. This allowed the headspace vapors to be analyzed in just 10 seconds.

The chemistry of antiseptic soap headspace vapors is shown in Figure 6. In the top right of the figure is shown the olfactory diagram (Vaporprint®). To the left is the chromatogram showing 7 major peaks corresponding to the 7 major chemical components of the headspace vapors. In the right bottom of the figure the retention indices and concentration (in counts) for each of the major components. Placing windows (hatched red bands over each of the peaks is used to define virtual chemical sensors. Each virtual sensor is given a name (e.g. nzk 1057) and the group forms a target array of virtual sensors or olfactory signature.

The olfactory signature and chemistry of the antiseptic cleansing lotion is shown in Figure 7 and was quite different from that of the antiseptic soap. The lotion aroma was dominated by one major peak or compound, which had an index of 1044 and a concentration approximately 20 times higher than that of the soap.

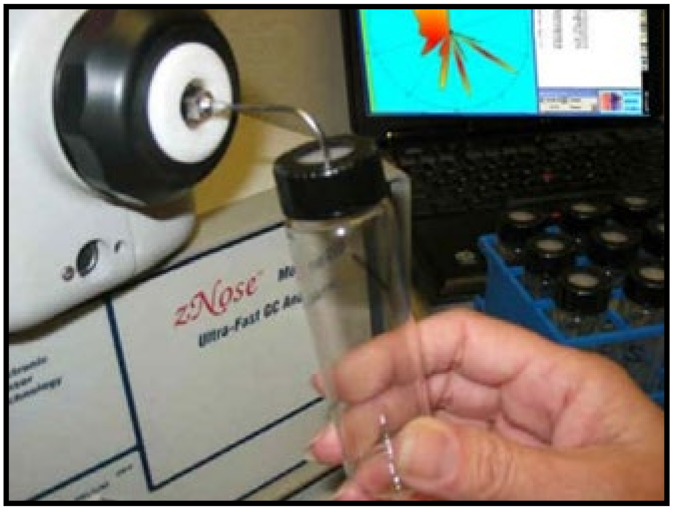

Figure 5- Analyzing the chemical signature of headspace vapors from soap and lotion

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Determining Chemical Signatures for Soap and Lotion

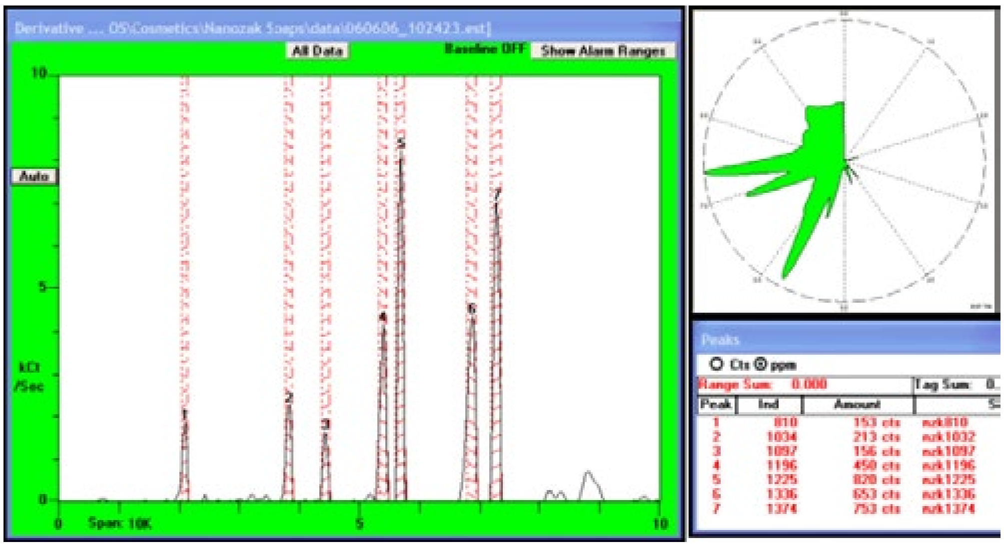

Figure 6- Chemistry of antiseptic soap headspace vapors (10 second sample)

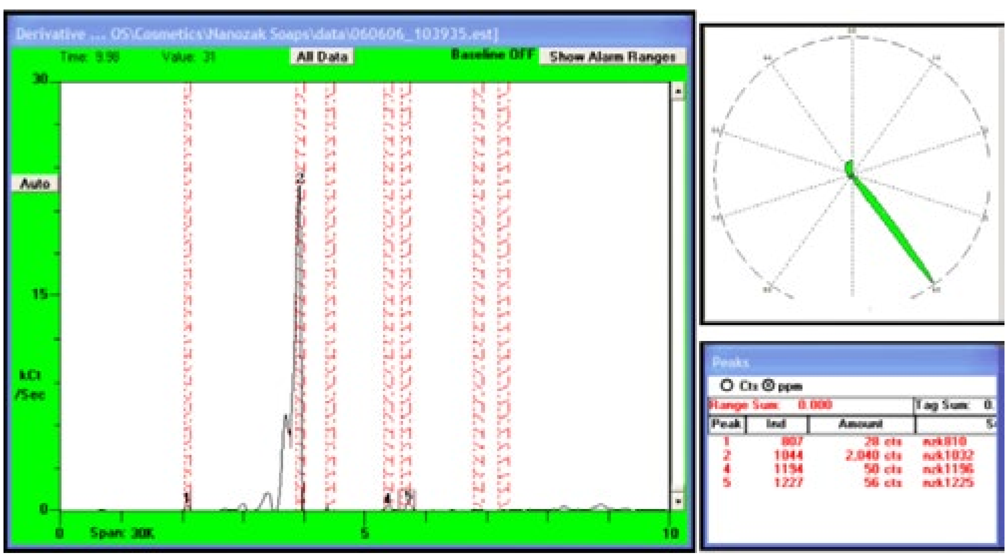

Figure 7- Chemistry of antiseptic cleaning lotion headspace vapors (2 second sample)

To increase resolving power of the chromatograms the column temperature ramping rate was reduced to 5°C/second and the headspace vapors from antiseptic soap and cleaning lotion re-measured. The 20 second chromatogram results are shown in Figures 9 and 10.

As noted previously the lotion chromatogram is dominated by a single compound which had an index of approximately 1032.

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Determining Chemical Signatures for Soap and Lotion

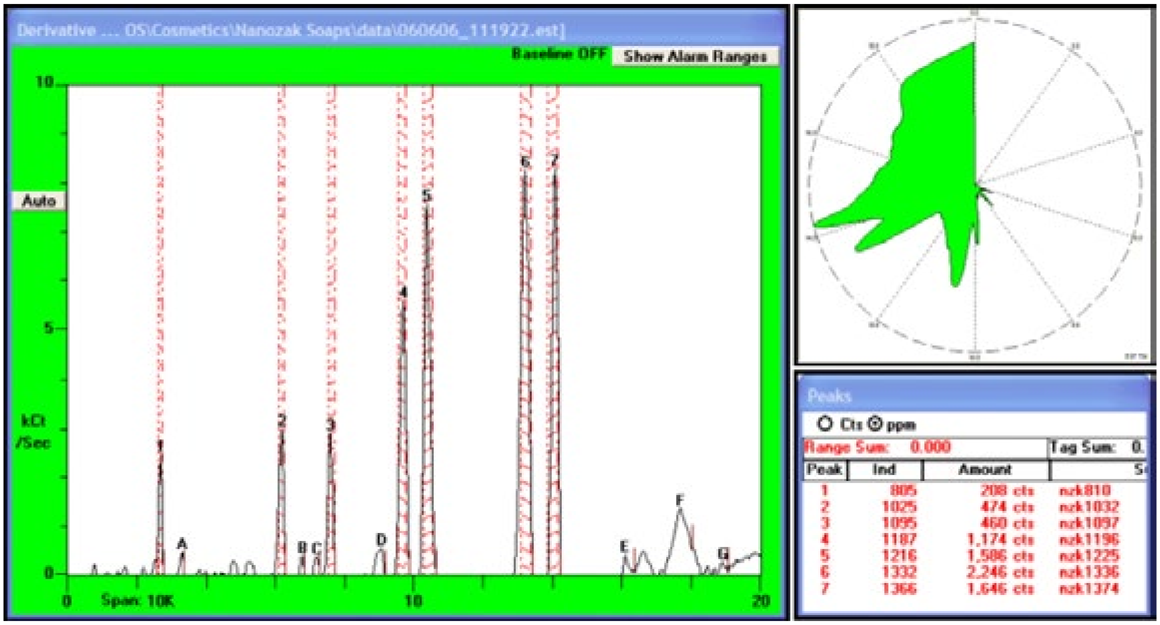

Figure 8- Chemistry of antiseptic soap headspace vapors (10 second sample) and 5°C/second column ramping

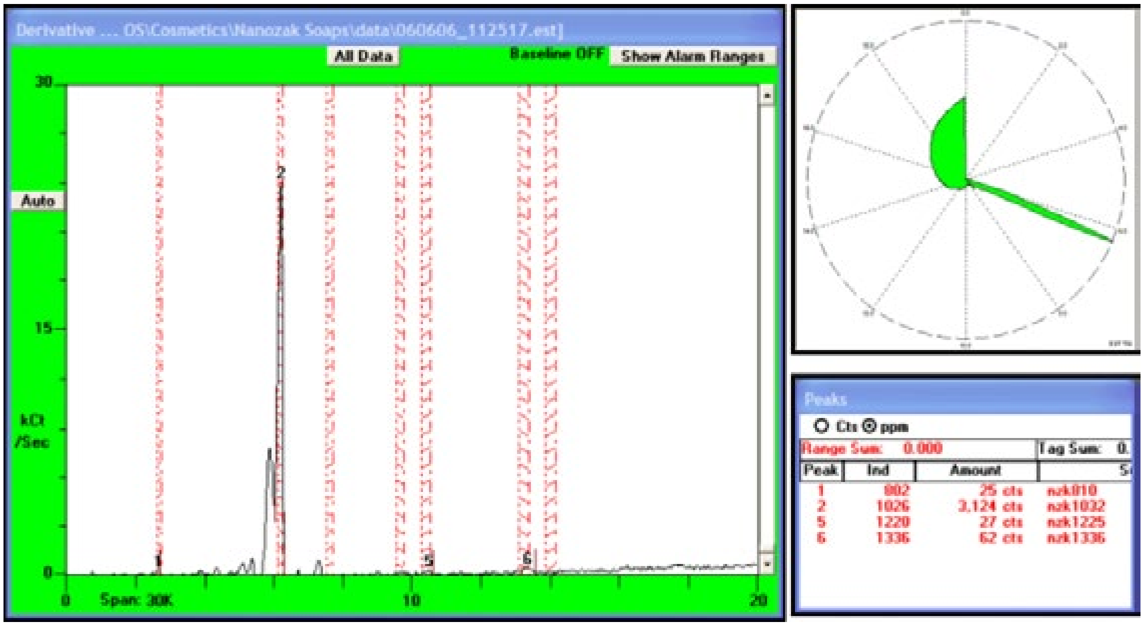

Figure 9- Chemistry of antiseptic cleaning lotion headspace vapors (1 second sample) and 5°C/second column ramping

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Testing Chemical Vapors from Use of Antiseptic Soap

The use of antiseptic soaps and cleansers imparts a distinct aroma or fragrance and an objective of this study was to evaluate this aroma as a means of insuring their use for hygienic purposes. After washing the hands or applying lotion, the aroma imparted was measured using the zNose® to sample the residual vapors as shown in shown in Figure 10.

Shown in Figure 11 are four replicate chromatograms vertically offset for comparison. The top chromatogram was from hands prior to washing and showed no aroma or fragrance. The next three chromatograms were taken sequentially after washing the hands with antiseptic soap. The compounds denoted by red bands (soap headspace vapors) are clearly seen indicating that antiseptic soap had been used.

Figure 10- Using zNose® to test chemical vapors associated with use of antiseptic soaps and lotions

Testing Chemical Vapors from Use of Antiseptic Soap

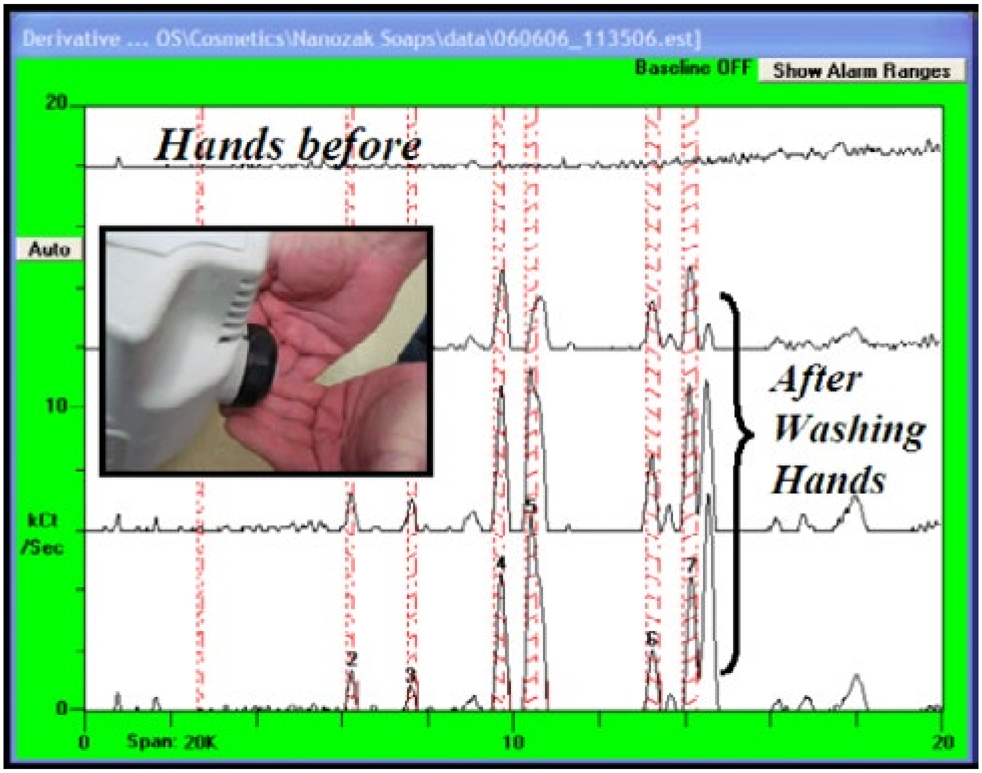


Figure 11-Fragrance from washing hands with antiseptic soap

Testing Chemical Vapors from Use of Antiseptic Lotion

The chemistry of aroma from hands after use of cleansing lotion is shown in Figure 12. Unexpedly the aroma is dominated by a compound with an index of 1215 and not 1032 as had been expected based upon the previous results of lotion headspace vapors. Apparently the more volatile compound quickly dissipates from the hands.

A chromatogram of hand aroma after using lotion and then rinsing with water is shown in Figure 13. Clearly rinsing the hands with water does not remove all of the fragrance from the hands.

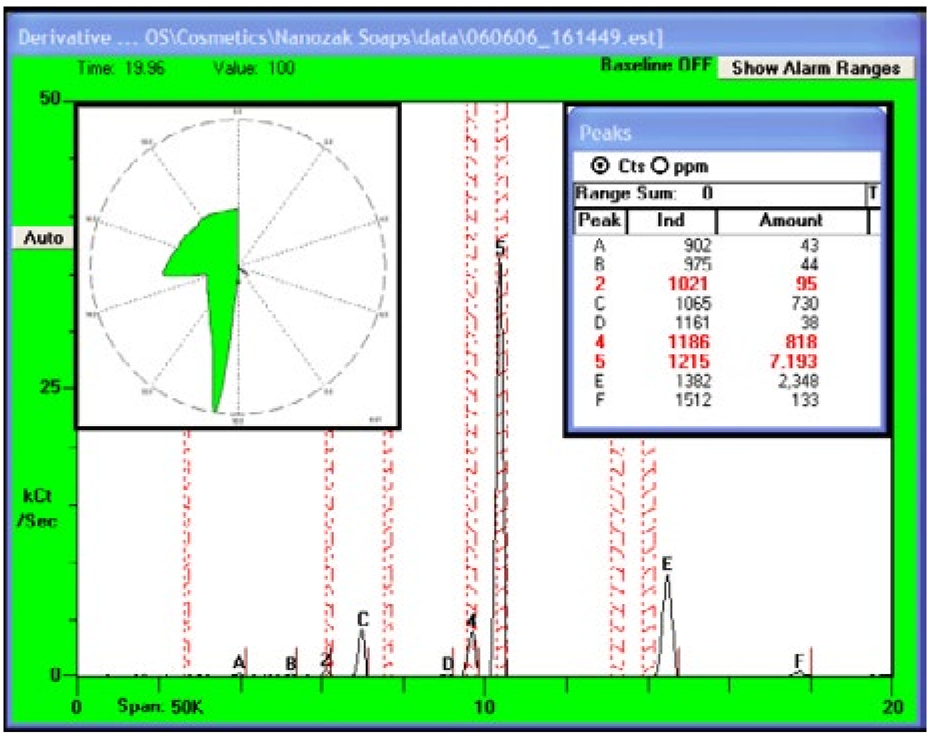
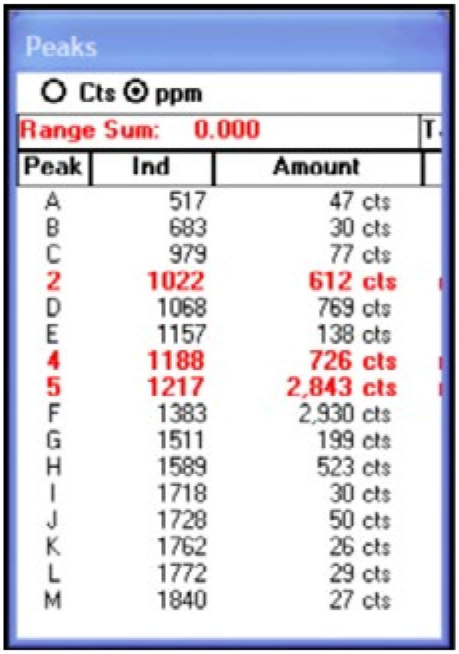


Figure 12- Cleansing lotion on hands

Testing Chemical Vapors from Use of Antiseptic Soap



Peaks

Cts ppm

Range Sum: 0.000

Peak	Ind	Amount
A	517	47 cts
B	683	30 cts
C	979	77 cts
2	1022	612 cts
D	1068	769 cts
E	1157	138 cts
4	1188	726 cts
5	1217	2,843 cts
F	1383	2,930 cts
G	1511	199 cts
H	1589	523 cts
I	1718	30 cts
J	1728	50 cts
K	1762	26 cts
L	1772	29 cts
M	1840	27 cts

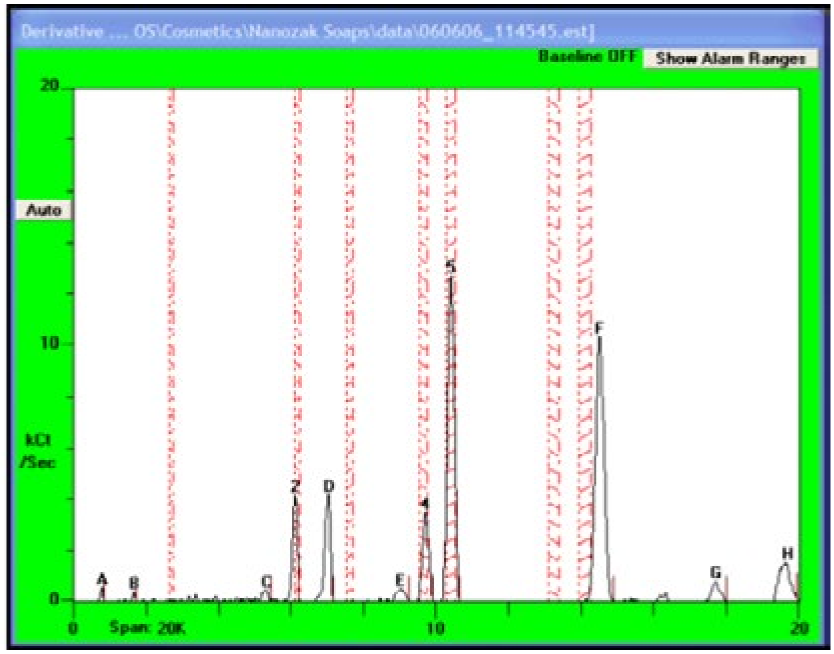
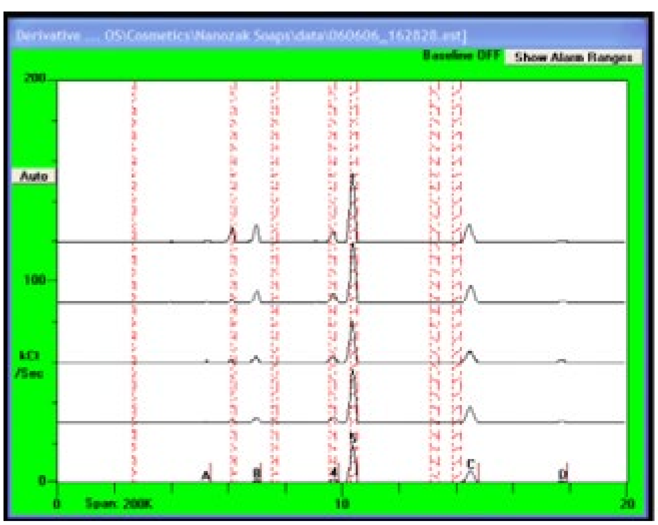


Figure 13- Chemical vapors after cleansing lotion and rinsing with water

The persistence of aroma over time is shown in Figure 14 where replicate chromatograms taken 90 seconds apart are shown. The plot shows that after 8 minutes the aroma is still approximately 50% of its starting concentration.



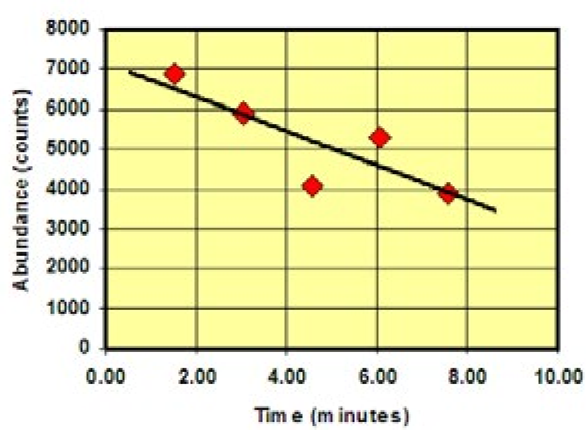


Figure 14- Lotion persistence vs. time

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Summary

Chemical profiling of aroma from antiseptic soap and cleaning lotion was measured using an ultra high speed gas chromatograph called the zNose®. It is possible to quantitively measure these distinctive aromas in a fast and efficient manner. In this way it may be possible to insure hygenic conditions are present in situations such as in hospitals or food preparation facilities where sterile conditions must be maintained.

Indexing of retention times for target compounds using an n-alkane standards provides a convenient method of identification, eleminates the need for multiple chemical standards, and allows for instrument independent chemical analysis. Each soap or lotion was found to contain unique marker compounds and odor signatures which would be used for identification purposes. .

The zNose® is a real time tool which provides the ability to insure workers adhere to hygenic standards. It is characterized by high speed speed, sensitivity, portability, precision, and accuracy needed for cost-effective quality control measurements. Such measurements, because they are based upon well known chromatographic methods, can easily be validated by independent laboratory testing. A 'good' aroma as determined by measurements can now be quantified in near real time to insure hygienic procedures are followed. The 'good' chemical signature once defined, allows for objective and quantitative quality control testing with other zNose® analyzers integrated into production process.

About Electronic Sensor Technology, Inc.

Electronic Sensor Technology, has developed and patented, a breakthrough electronic nose technology, trademarked zNose® , which complements existing security systems, and eliminates the vulnerabilities associated with current trace, and x-ray detection Wsystems.

For more information, please visit our website, www.estcal.com.

In case, you would like to know more, about Electronic Sensor Technology's flagship product, zNose® please send us an email to italib@estcal.com
or call us on 805-214-1873