

What is the chem-ID™

The chem-ID is a precision chemical analysis laboratory in a small box designed to be easily used by someone with no analytical chemical background. It measures a detailed signature of an air sample that can be used to identify the chemicals and determine their concentrations. If a sampled chemical is part of the library (which can include chemical warfare agents, toxic industrial chemicals, and common chemicals), the chem-ID will display the potential identity of the chemical to the operator. The signatures of all chemical samples are maintained in memory and can be analyzed by trained personnel.



The chem-ID is designed to be used in the field in virtually all weather conditions by operators who may be wearing full Hazmat protection. It can be operated by remote control by a PC up to 100 meters via the built-in Bluetooth Class 1 radio. The Bluetooth link can also be used to transmit measured chemical signatures to a nearby PC for quick emailing to any location.

Because the chem-ID is easy to use and performs accurate and consistent measurements, multiple operators in the field can provide near real-time information to a single trained person at a central location.

What the chem-ID does and doesn't do

There should be a clear understanding of what the instrument can do, how it performs the intended mission, and what it cannot do.

- The chem-ID will perform a detailed and accurate analysis of a gas sample, provided the instructions are followed.
- The chem-ID will determine if any of the measured chemical signatures could potentially be a chemical that is present in the chem-ID chemical identification database. If so, the chem-ID will display the potential identification of the chemical(s) recognized.
- The chem-ID will display relative concentrations of the chemicals analyzed.
- The chem-ID will determine the absolute concentration of an analyzed chemical if the unit has been calibrated for that chemical. A trained chemist can measure known concentration levels of the chemical in the lab with the chem-ID to determine the calibrated signal level. Then the chem-ID can be used in the field to provide absolute concentration levels when measuring that chemical.
- The chem-ID will allow the Pre-concentrator tube to be removed and shipped to a laboratory. This allows important or critical identifications to be verified as quickly as possible.
- The chem-ID will not provide an analysis of an incident or situation. It provides a chemical "snapshot" of that specific location at that specific time. Experienced and trained personnel are required to use the "snapshots" provided by the chem-ID to develop an understanding of an incident or situation.

System Description

The chem-ID weighs 15.9 pounds and is the size of a large lunch box. It is battery powered and can be operated by the four buttons on the top of the unit or by remote control from a PC. The chem-ID analyzes and characterizes airborne chemicals either resident in the air or out-gassed from a liquid or solid.

Dual column gas chromatography is used to provide a multi-dimensional characterization of each sampled chemical based on the molecular weight of the chemical and the bond-energies between atoms of the molecule. The chromatographic data is measured by precision thermal conductivity detectors that translate chemical information into electrical signals read by the computer.

By collating the information from these detectors, the chemicals present in an air sample are separated into individual chemical signatures.

A pre-concentrator is utilized to concentrate the chemicals in the air so that even minute quantities of a chemical (parts per billion) can be analyzed. The pre-concentrator can be easily removed from the instrument and sent to a laboratory for further additional testing. The chemical samples are heated and measured across a range of temperatures, from 40°C to 150°C. This allows the chem-ID to quickly analyze an extremely wide range of chemicals. Despite the internal temperatures, the exterior is not hot to the touch.

There are several supplies used in the chem-ID that must occasionally be replaced:

- **Battery:** The lithium ion battery will perform approximately 14 chemical analyses in the field (typically several days). It is easily removable in the field, even with Hazmat gloves. The battery takes about 45 minutes to charge. The remaining battery life is shown in the upper right corner of the display. The chem-ID will alert the operator on the display when the battery needs to be replaced.
- **Helium tank:** The chem-ID contains a canister of ultra-pure helium that is used to separate the chemicals in an air sample and determine their concentrations. A single canister will last about 20 hours of field testing. It is easily replaceable in the field, even with Hazmat gloves.
- **Reference chemical:** The chem-ID dopes every air sample with a small amount of dichlorobenzene. This reference chemical is used to calibrate each sample for temperature and pressure variation.

How the chem-ID Works

The chem-ID uses two-dimensional gas chromatography and thermal conductivity detectors to measure the signature of a chemical sample. Gas chromatography (GC) is a technique to separate a chemical mixture into its individual chemicals. A single mixed cloud of chemicals goes into a GC column, and multiple single-chemical clouds come out, each at a different time.

A GC column is essentially a long coil (15 meters) of very small pipe with a special compound coating the inner wall (called the Stationary Phase). As a cloud of gas passes through the pipe, the molecules in the cloud interact with the wall coating differently, depending on their chemical properties. A chemical that reacts very little with the wall coating will pass through the GC column quickly. A chemical that reacts strongly with the wall coating will pass through the GC column much more slowly.

Two-dimensional gas chromatography means that each chemical is analyzed by two different GC columns that separate chemicals based on different characteristics. Thus each sampled chemical is characterized by two-dimensions of information. The two GC columns used in the standard chem-ID are commonly called DB-1 (using a dimethylpolysiloxane stationary phase) and DB-Wax (polyethylene glycol stationary phase). Both columns are very good at separating a large variety of chemicals. When used together, they provide the capability to determine a unique signature of many chemicals. The chem-ID can be configured with other types of GC columns to increase sensitivity to meet specific customer requirements.

As the individual chemicals exit the GC columns at different times, they are measured by Thermal Conductivity Detectors (TCD's). TCD's are excellent all-purpose detectors, capable of measuring a very large number of different chemicals.

The Chemical Analysis Cycle

The analysis cycle is divided into five phases performed automatically once the operator presses the Analyze button:

Warming up: Each chem-ID analysis begins at the same temperature. This ensures repeatability of results. When the chem-ID is first turned on, different components are heated (or cooled, if necessary) to a baseline temperature. This phase can take a few seconds in warm environments, or several minutes in cold environments.

Air Sampling: When an analysis begins, the chem-ID draws in air through the pre-concentrator. The length of time air collects will be 30 seconds for sampling of high concentration chemicals or 6 minutes for low parts-per-billion concentrations.

Analyzing: Once the collection period is over, the chem-ID stops drawing air, and starts flowing ultra-pure helium through the pre-concentrator. A short pulse of heat into the pre-concentrator rapidly releases a cloud of chemicals it has collected from the outside air. The helium stream moves the chemical cloud into the GCs.

In each GC, the mixed chemical cloud is pulled apart and separated into smaller clouds of individual chemicals. The chemicals that have little reaction with the wall coatings pass through the GCs almost as fast as the helium. The chemicals that react heavily to the wall coatings pass through much more slowly. The GCs start out at the baseline temperature and then heat up to 150°C to encourage the slow chemicals to move through faster (and thereby shorten the analysis time). By the time the sample reaches the end of the GC, each individual chemical has been separated into its own cloud of pure molecules. As these small clouds pass over the Thermal Conductivity Detectors, the detectors measure the time the beginning of the cloud hit the detector, the time the cloud leaves the detector, and the concentration of the cloud.

After the analysis is complete, as the chem-ID beginning the cleaning phase, the raw chemical signature is processed, analyzed, calibrated, and displayed. Both the raw chemical signature and the processed information is immediately saved in memory.

Cleaning: After the analysis is complete, the chem-ID cleans itself of the collected sample. Internal components are heated to high temperatures for several minutes to burn off any trapped chemical residue. The length of the clean cycle depends on the concentration of the sample measured. Large samples will increase the time the chem-ID spends cleaning.

Cooling: After the cleaning cycle, the components of the chem-ID are cooled to the starting temperature before a new sample is taken. This takes several minutes. After cooling, the chem-ID returns to the Ready Screen and is ready to take and analyze more samples.

Remote Operation of the chem-ID

The chem-ID has a built in Class 1 Bluetooth radio that allows communication with a Bluetooth-enabled PC from up to 100 meters away. Across this link, the chem-ID can be operated entirely by remote control, and the results of all chemical analyses can be downloaded to the PC. This link can also be used to update the firmware. The chem-ID kit includes a USB Bluetooth radio kit that will allow any PC with a USB port to link with the chem-ID. Be aware that Bluetooth radios, like any other type of radio, can be interfered with from nearby strong transmitters.

The chem-ID Manager software opens to three windows. The chem-ID **Control Window** allows a user to run the chem-ID by remote control. Operating the chem-ID by remote control is nearly identical to operating it directly. The green buttons and chem-ID display allow the same controls as the controls and display on the unit.



The chem-ID **Datasets Window** displays the chemical analysis files stored on the chem-ID. The PC Files window shows the chemical analysis files stored on the PC located at the file location (path) shown above the **PC Files Window**. To download files from the chem-ID to the PC, just drag the files from the chem-ID window to the PC window. Chemical Analysis files stored on the PC can be examined by selecting the file and pressing the graph button. The files can also be saved as a CSV file.

When a software update becomes available for the chem-ID, the user is notified. The update is emailed directly. The "Utilities" menu is utilized to update to the chem-ID software.

Chem-ID Manager Software (Control Window)

Remotely Control chem-ID

READY

chem-ID

ATK D-tect SYSTEMS

Analyze Clean

Connection Status Battery Status

chem-ID Control

Manage chem-ID datasets on PC

Path: C:\Documents and Settings\ltheiben\My Documents\chem-ID Data Browse

Unit	v Test#	Date	Time	Filename
000213	000001	06/28/07	15:10:06	(213-00001)_2007-06-28_15h10m06s.cid
000205	000004	10/26/07	18:48:30	(205-00004)_2007-10-26_18h48m30s.cid
000205	000006	10/30/07	12:10:28	(205-00006)_2007-10-30_12h10m28s.cid
000205	000007	10/30/07	12:35:30	(205-00007)_2007-10-30_12h35m30s.cid
000205	000008	10/30/07	14:29:59	(205-00008)_2007-10-30_14h29m59s.cid
000205	000008	10/30/07	14:29:59	(205-00008)_2007-10-30_painting out...

Graph Convert Delete PC Files

Manage datasets on chem-ID

Protected	v Test#	Date	Time	Filename
	000004	10/26/07	18:48:30	(205-00004)_2007-10-26_18h48m30s.cid
	000005	10/27/07	11:15:10	(205-00005)_2007-10-27_11h15m10s.cid
	000006	10/30/07	12:10:28	(205-00006)_2007-10-30_12h10m28s.cid
	000007	10/30/07	12:35:30	(205-00007)_2007-10-30_12h35m30s.cid
	000008	10/30/07	14:29:59	(205-00008)_2007-10-30_14h29m59s.cid
	000009	10/31/07	09:33:04	(205-00009)_2007-10-31_09h33m04s.cid

Copy Delete Refresh Protect Unprotect

Ready Connected to chem-ID 0205 NUM

What is a Chemical Signature?

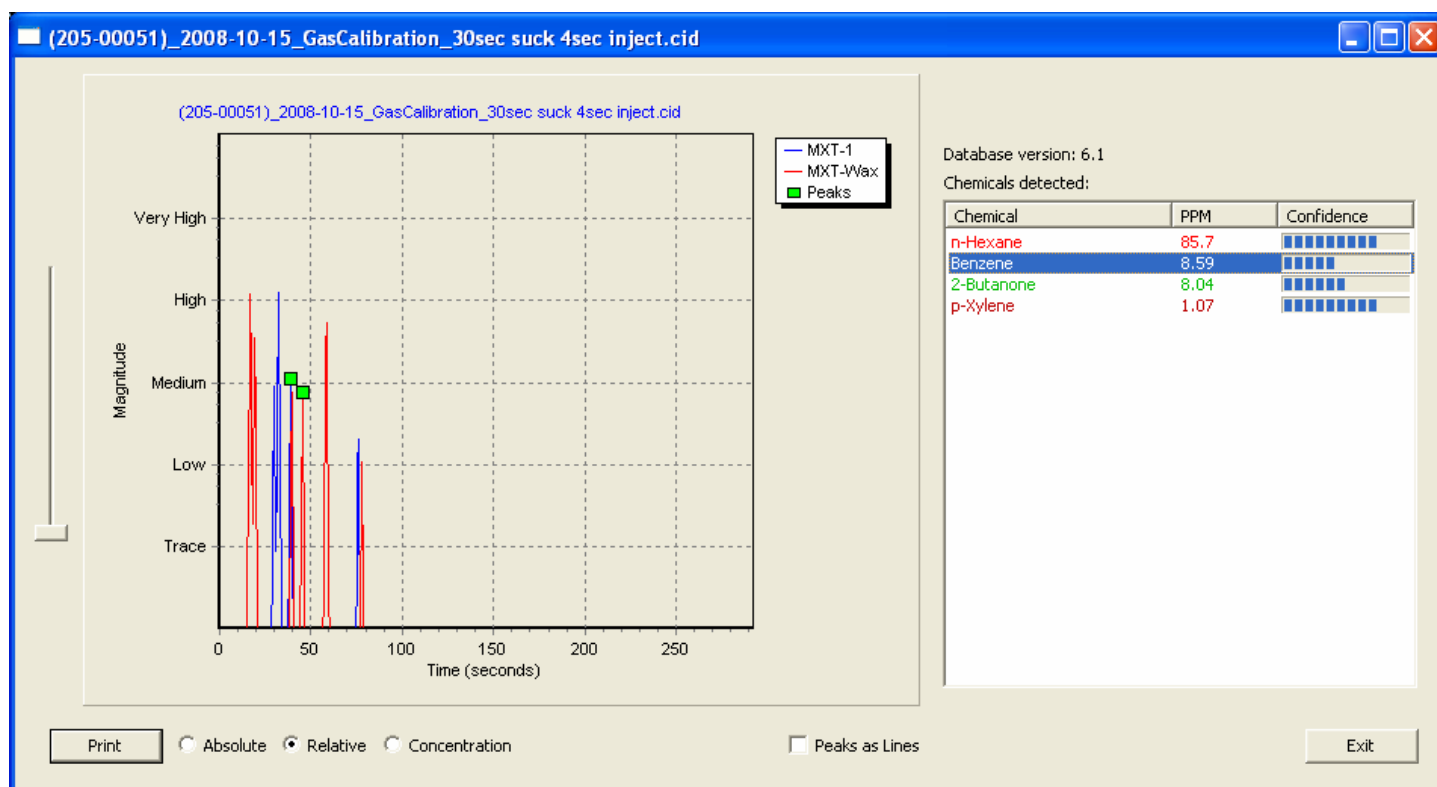
The results of the analysis are known as a chromatograph. The horizontal axis on the bottom of the graph shows time, going from 0 seconds on the left (the start of the analysis), to 300 seconds. Each vertical line represents a cloud of a pure chemical moving across the detector. The color of the peaks indicates which GC separated the chemical: the DB-1 column is red and the DB-Wax column is blue. The height of the peaks shows the concentration of each chemical.

Air samples will contain a common set of atmospheric elements in addition to the chemicals the operator is trying to identify. Common chemicals include the gases of the air (nitrogen, oxygen, CO₂), water, and the chem-ID reference chemical injected into the sample. The chem-ID automatically identifies the signature data from these common chemicals.

Interpreting a chromatograph requires training and experience. A majority of chemicals measured by the chem-ID will have a clear signal (a peak) in each GC column. These peaks represent a signature that is relatively unique.

The chem-ID will compare the chemicals measured to the chemicals in its identification database, and will display any potential identifications. Whether a match is found or not, the chromatograph provides a trained chemist with a great deal of information about the type of chemicals measured, the relative concentrations of the chemicals, the volatility, the boiling point, and much more. If specific chemicals are suspected of being present in the sample, a quick test by a chemist with a chem-ID and a known sample of chemical can verify its presence.

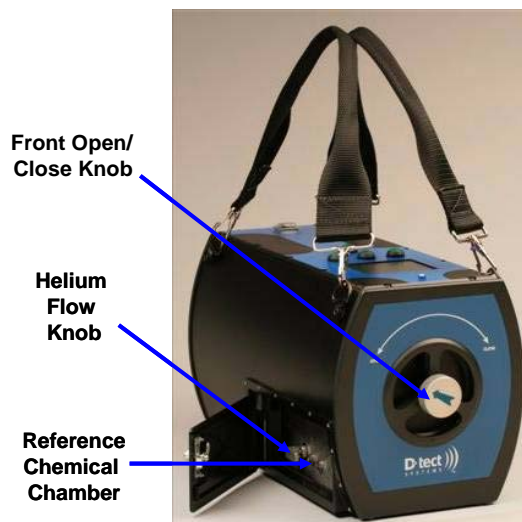
Chem-ID Manager Software (Chromatograph)



Features and Controls of the chem-ID



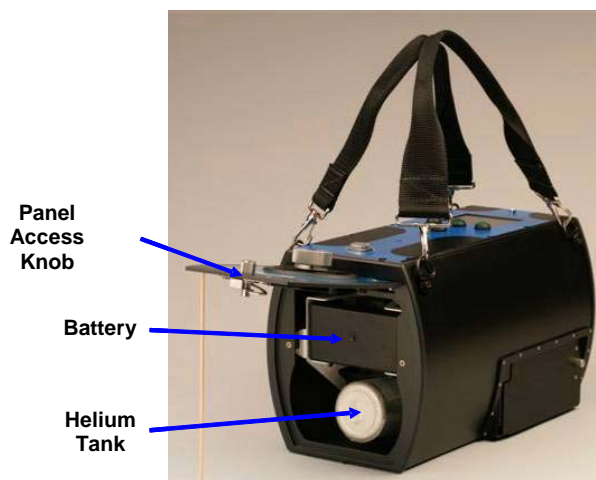
The Top of the chem.-ID



Front View – Right Side



Front View – Left Side



Rear View – Panel Open

