



Bundesamt
für Bevölkerungsschutz
und Katastrophenhilfe

Detection and Identification



Gas detection devices

- single or multiple gases
- different mechanisms:
 - semi-conductor cell
 - electrochemical cell
- many substances as:
HCl, H₂S
- specific, but: cross-reactivity possible!

PID

- Pump produces ambient air flow through a measuring chamber
- Ultraviolet light of UV-lamp gets into the measuring chamber
- UV-light converts hazardous substances to electrically charged particles = ionisation
- Ions are discharged on electrodes
- Discharge leads to a current flow of electricity
- The current flow is displayed as intensity and concentration of the hazardous substances respectively

PID

Information provided by a PID :

1. **Yes-no statement:** within the context of what it can detect, something is present or not.
2. Intensity (concentration) of substances is changing.
3. **Sum of the signals** of all the detectable substances present in the air is monitored.
4. Quick overview about the situation (continuous measurement)

A PID is nonspecific!

PID

What substances are detected?

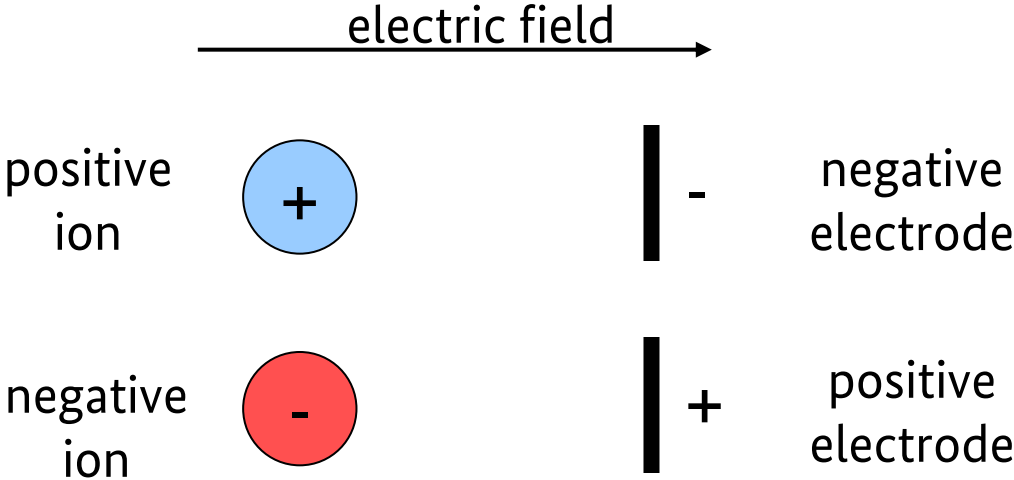
- Many organic but also inorganic substances:
- Aliphatic hydrocarbons (except methane, ethane, propane, butane : the longer the C chain the better is the detection)
- Benzene, toluene, xylene
- Acetone
- Ammonia
- Nitrogen monoxide, nitrogen dioxide
- Many other organic substances

IMS

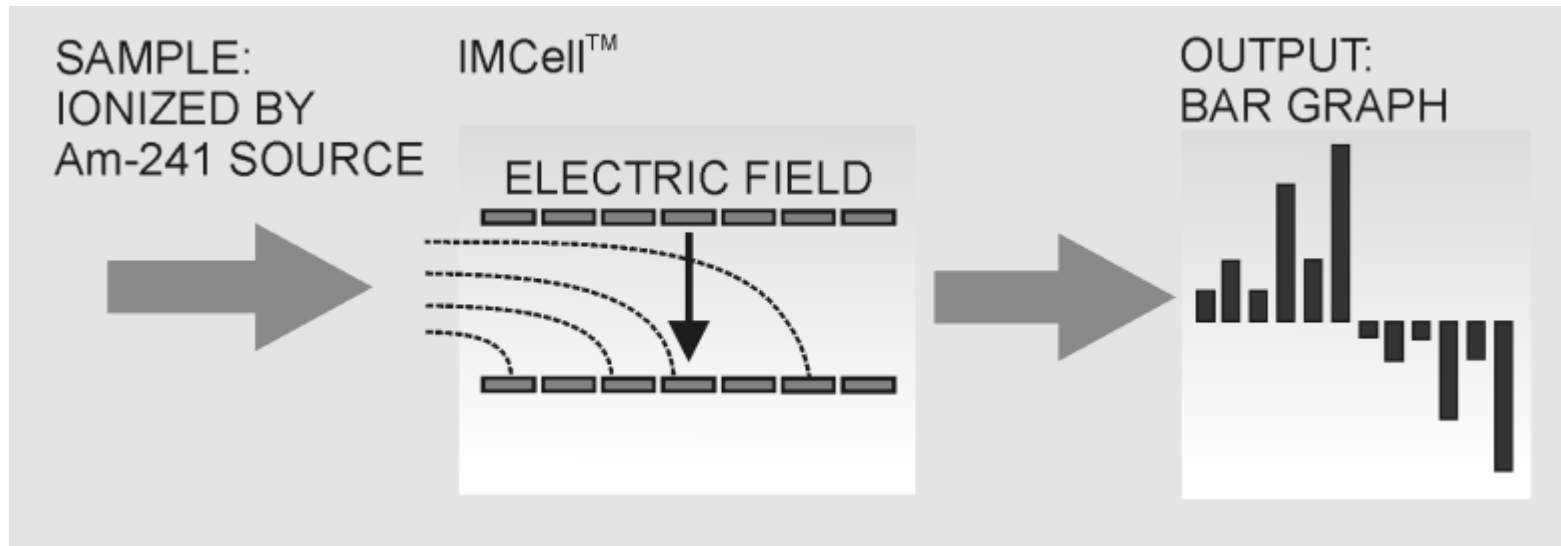
- Measuring principle in use, commonly military, for more than 20 years.
- Very low detection limit, capable of detecting nerve agents in non lethal concentrations
- Identification of certain substances, depending on concentration and chemical structure

“mobility”:

- ions move in an electric field at different speed
- speed depends on their mass



Forming and detecting of ions



- high mobility: ions drop to the first electrodes.
- low mobility: need longer time; ions drop to the latter electrodes.

Result: a signal pattern used to identify the type of ions by comparing the pattern with those in the libraries

IMS

Library RAID1

Chemical Warfare agents – CWA:

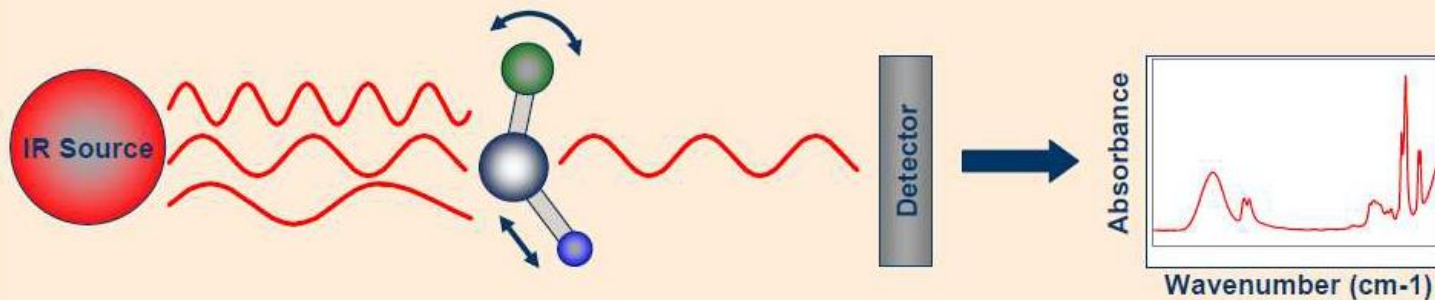
- VX
- Soman (GD)
- Sarin (GB)
- Tabun (GA)
- Sulphur yperite (HD)
- Nitrogen yperite (HN)
- Lewisite (L)
- Simulation substance (SIM)

Industrial chemicals – ITOX:

- Ammonia (NH₃)
- Chlorine (Cl)
- Chlorinated hydrocarbons (RCl)
- Toluenediisocyanate (TDI)
- Acetic acid (HAC)
- Hydrocyanic acid (HCN)
- Sulphur dioxide (SO₂)
- Simulation substance (SIM)

IR-Spectroscopy

- Infrared (IR) radiation emitted from the HazMatID 360 source travels through the diamond sensor and passes into the sample
- This enhances natural molecular vibrations within covalent bonds of the sample
- This interaction produces a graph of how much radiation is absorbed at each IR frequency
- The graph is called a spectrum and is characteristic of the sample



IR-Spectroscopy

Identification	not possible
solids, liquids	gases, vapours
substances with covalent chemical bonds	pure elements
inorganic materials: water, oxy salts (nitrates, chlorates etc.), oxy acids	simple binary salts (NaCl etc.)
organic materials: hydrocarbons and ist derivatives	biological materials
	mixture components with less than 10% concentration

Raman-Spectroscopy

- uses „fingerprint“ of chemical substances
- inelastic scattering of laser at atomic level

Solids, Liquids, Gels, Pastes
Can be Covalently or Some Ionically Bonded Compounds

Examples:

- Organic compounds
 - Petroleum products, Pesticides, Fertilizers, Plastics, Plant materials
 - Drugs (Legal or illicit)
 - Chemical Weapons
 - “White Powders”
- Inorganic Compounds
 - Mineral acids (sulfuric, nitric, *etc.*)
 - Inorganic oxides (rust, titanium dioxide, *etc.*)
 - Some ionic compounds (*e.g.*, sulfates, phosphates, perchlorates, carbonates)
 - Crystalline semi-metals (*e.g.*, silicon)
- Substances in water (aqueous solutions)

Comparison: Detection and identification methods

	test tubes	multiple gas detector	PID	IMS	IR	Raman	GC-MS
phase	g	g	g (l)	g (l)	(g) s, l	(g) s, l	g (l)
specific to substance?	(yes)	(yes)	no	(yes)	%	%	%
detection?	yes	yes	yes	yes	%	%	%
identification?	yes	no	no	(yes)	yes	yes	yes
CWA?	yes	no	no	yes	yes	yes	(yes)
aqueous sol.?	no	no	no	no	no	yes	no
B?	no	no	no	no	(hint)	no	no
metals, solid anorganic compounds, salts	no	no	no	no	(if IR active)	(if Raman-active)	no

Additional: What do you see / smell / feel / observe ?