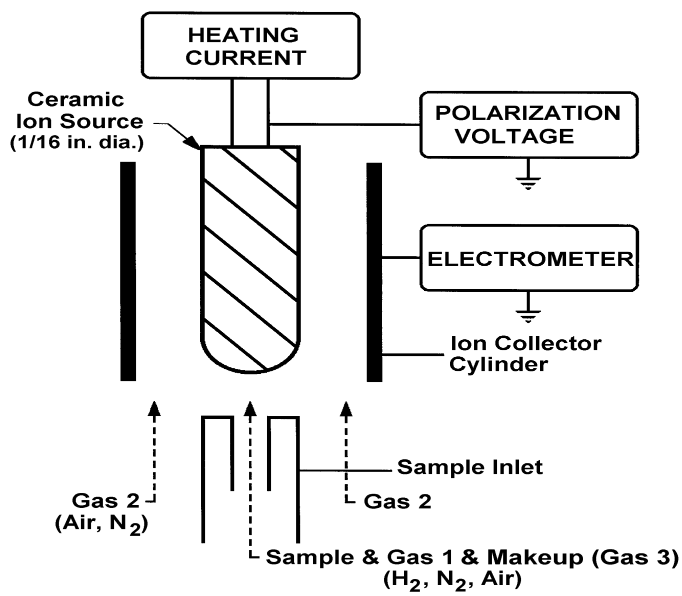
Thermionic Surface Ionization & Catalytic Combustion Ionization

Unique GC detection technologies convert selected chemical compounds into negative ion currents using electrically-heated ionizing surfaces made of catalytically-active ceramic materials.

OPTIMUM DETECTOR HARDWARE - concentric cylinder geometry used on the Agilent 6890/7890 NPD, Thermo Trace 1300 NPD, and all DET hardware features an ion source positioned on the axis of an ion collector, with top access for easy ion source changes.

OPTIMUM DETECTOR ELECTRONICS - Constant Current electrical heating of ion sources plus choice of ion source polarization ranging from - 5 Volts to at least - 45 Volts relative to the ion collector as available with Thermo NPD electronics or a stand-alone DET Current Supply . (existing Agilent, Varian/Bruker, SRI NPD electronics also work, but not most optimum)

THERMIONIC IONIZATION DETECTOR DESIGN
(CONCENTRIC CYLINDER GEOMETRY)



PARAMETERS THAT DETERMINE COMPOUND SELECTIVITY & SENSITIVITY:

1. catalytic ionizing activity of the ion source as determined by the composition of its ceramic coating (an unlimited number of ceramic formulations are possible);

2. temperature of the ion source (typically in the range 300 - 900°C);

3. composition of the gases flowing past the ion source (e.g., N_2, Air, O_2, N_2O, H_2, and combinations thereof);

4. the magnitude of the polarizing voltage between the ion source and collector.

Multiple modes of detection are achieved using the same basic equipment, a choice of different ion source ceramics, and various permutations of the 4 operating parameters - selectivity choices include compounds containing O, N, P, Cl, Br, I, Pb, Sn, or Si atoms, or NO_2, Pyrrole, CH_2, and certain other functional groups - new compound selectivities continue to be identified. Tandem configurations of different detection modes provide the ultimate versatility for simultaneous selective detection combinations.

Detection equipment is inexpensive, uncomplicated in design, easy to use, does not require ultrapure or exotic gases, and provides detection capabilities unmatched by any other type of GC detector technology.

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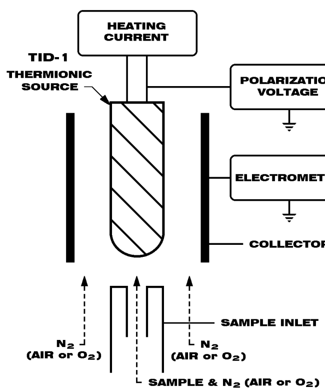
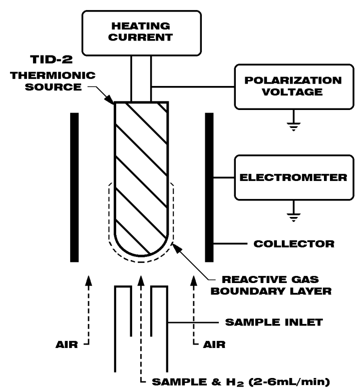
GC DETECTOR INNOVATIONS by DET

(different implementations of the same basic detector geometry)

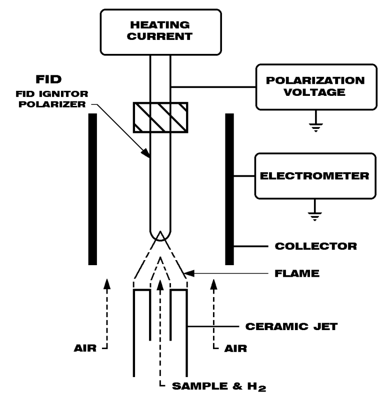
TID/CCID (O, Cl, Br, NO_2, CH_2, etc.)



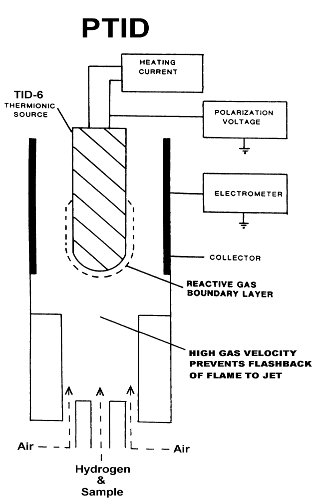
NPD (N, P)



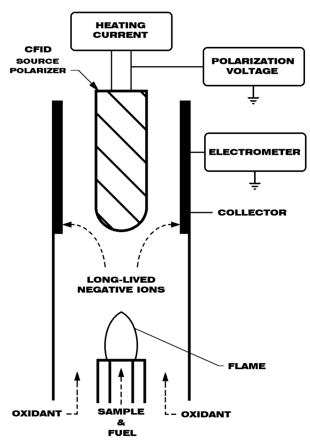
FID (universal)



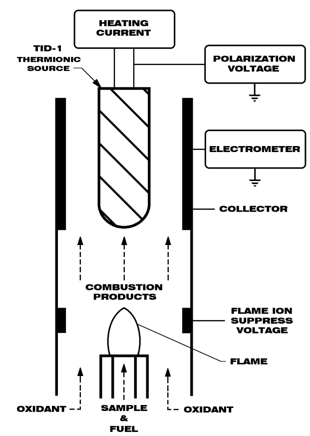
PTID (P)



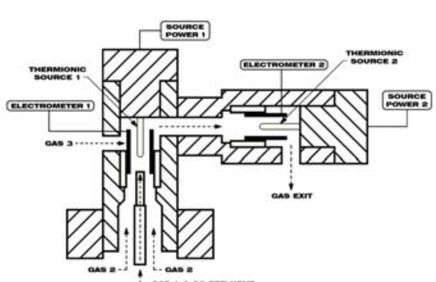
REMOTE FID (P, Pb, Sn, Si)



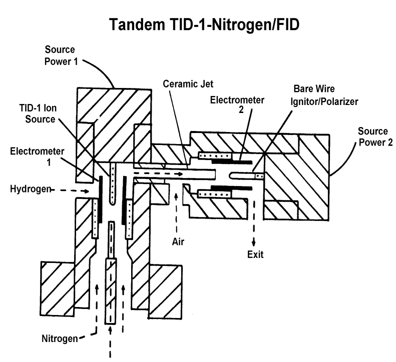
FTID (N, Cl, Br)



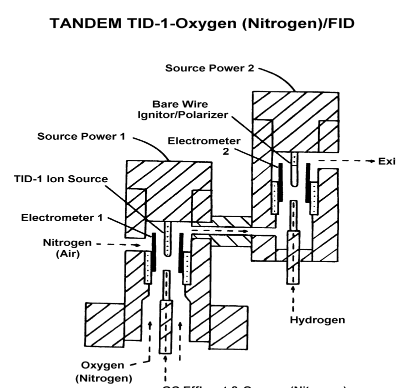
TANDEM TID-Oxygen/FID



TANDEM TID



TANDEM TID-Nitrogen/FID



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DET Chemical Detection Products based on Scientific Principles of THERMIONIC SURFACE IONIZATION and FLAME IONIZATION featuring Electrically Heated Ion Sources made of Proprietary Ceramics

multiple modes of selective detection using common detector components

COMMON COMPONENTS - inexpensive detection equipment features a concentric cylinder geometry in which interchangeable ion source elements are positioned on the axis of a collector electrode, with the ion sources heated by an electrical current and polarized at a negative voltage with respect to the collector - ion sources are small cylindrical rods formed from multiple layers of ceramic coatings molded over a wire core and mounted on a stainless steel flange.

THERMIONIC IONIZATION DETECTION (TID) - sample compounds directly impact the ion source and form gas phase ions by extracting negative charge from the ceramic surface - selectivity and sensitivity of detection depends on the catalytic ionizing activity of the ceramic, and on whether the detector gas environment is inert (e.g., Nitrogen) or oxidizing (e.g., Air or Oxygen) - available types of ceramic ion sources are as follows:

TID-10 - selective for some Nitro and Halogenated compounds at Femtogram and Picogram levels; many Oxygenates at Picogram and Nanogram levels with especially large responses for Phenols, Carboxylic Acids, Glycols, Glycerol, Vanillin, and Methyl Salicylate; Pyrrole vs. Pyridine functional groups; Water vapor at ppm levels with Air detector gas; also used in the Catalytic Combustion Ionization mode for selectivity to Methylene (CH_2) functional groups.

TID-3 - selective for volatile Halogenates such as Trihalomethanes.

TID-5 - selective for Br and I compounds with suppressed Cl response.

TID-7 - selective for Halogenates such as PCBs

NITROGEN PHOSPHORUS DETECTION (NPD) - NP selectivity turns on when the ion source is heated sufficiently (i.e., 600 - 800°C) to ignite a dilute mix of Hydrogen in Air to form a chemically reactive gaseous boundary layer around the hot ion source surface - samples are decomposed in the ignited boundary layer, and electronegative N and P decomposition products extract negative charge from the hot ion source to form detectable gas phase ions - DET has developed 2 types of ceramic ion sources for NP detection as follows:

TID-2 (Black Ceramic) - NP detection with negligible tailing of P peaks - 70fg P/sec detectivity;

TID-4 (White Ceramic) - NP detection with the largest possible N response - 70fg N/sec detectivity;

PHOSPHORUS THERMIONIC IONIZATION DETECTION (PTID) - a TID-6 ion source is located downstream of a small diameter flow restrictor such that when the ion source is heated sufficiently to ignite a pre-mixed stream of high concentration Hydrogen in Air, the high total gas flow prevents flame flash back from the source to the original mixing point of the Hydrogen and Air - like an NPD, the ignited chemistry remains as a boundary layer about the hot source - this mode provides selective detection for P compounds with very large signals and suppressed N response.

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REMOTE FID DETECTION (RFID) - a CFID ion source & collector electrode are located several centimeters downstream of a self-sustained Hydrogen/Methane/Air flame - ions produced by Hydrocarbon combustion dissipate rapidly downstream of the flame, but combustion of Lead (Pb), Tin (Sn), Phosphorus (P), or Silicon (Si) compounds produces long-lived ions that persist to be selectively detected at the downstream collector - an organic fueled flame improves selectivity.

FLAME THERMIONIC IONIZATION DETECTION (FTID) - an electrically heated TID-1 or TID-2 ion source located several centimeters downstream of a self-sustained Hydrogen/Methane/Air flame re-ionizes the electronegative neutral products of the flame combustion of samples - a TID-2 source provides selectivity for Halogenates, while a TID-1 source provides selectivity for Halogenates and Nitrogen compounds.

FLAME IONIZATION DETECTION (FID) - an FID Probe consisting of an uncoated bare wire loop, and a collector electrode are located adjacent a self-sustained Hydrogen/Air flame burning at an unpolarized ceramic tipped jet - the FID Probe serves as flame ignitor and polarizer, and the flame ionization provides Universal detection of organic compounds.

HOT WIRE COMBUSTION IONIZATION DETECTION (HWCID) - similar to a PTID configuration except a heated bare wire FID Probe is used to maintain an ignited Hydrogen/Air boundary layer - Universal detection like an FID, but sensitivity about 100 times less than an FID - does not require a jet structure - provides about a factor of 2 enhancement for Aromatics vs. Alkane Hydrocarbons.

CATALYTIC FLAME IONIZATION DETECTION (CFID) - uses a self-sustained flame similar to an FID except includes an electrically heated ceramic CFID ion source to augment the gaseous flame ionization with surface ionization from the hot catalytic ion source - Universal detection with similar response factors for Halogenates and Hydrocarbons.

CATALYTIC COMBUSTION IONIZATION DETECTION (CCID) - uses a catalytic TID-10 ion source heated to 300 - 400°C in an oxidizing detector gas environment to ignite a momentary burst of flame ionization as individual peaks of high concentration sample compounds elute from the GC column and impact the ion source - provides selective ionization of Methylene (CH_2) functional groups in linear chain Alkane, FAME, and Triglyceride compounds with discrimination vs. compounds with unsaturated Carbon double bonds.

TANDEM DETECTION (TID/NPD, NPD/TID, FID/FTID, TID/FID, etc.) - 2 simultaneous detector signals with many different possible combinations of ion sources and detector gas environments.

REACTOR THERMIONIC IONIZATION ANALYSIS (RTIA) - stand-alone TID or NPD transducer attached to a heated inlet reactor with a sample pump pulling ambient Air through both transducer and reactor - provides selective screening of vapors generated by Thermal Desorption and Thermal Oxidation of non-volatile constituents of liquid or solid samples - TID-1 or TID-10, TID-3, TID-7, and NPD (TID-2 or TID-4) ion sources can be used in the transducer for different selectivities.

STAND-ALONE TID, NPD, OR FID TRANSDUCERS - transducer exit connected to a sampling pump provides real time monitoring of selective or universal organic vapors in incoming ambient Air stream - selectivity determined by type of ion source element installed.