

CHEMICAL DETECTION PRODUCTS

by

DET

novel applications of the principles of
Thermionic Surface Ionization
and
Flame Ionization

GC DETECTION

- CERAMIC ION SOURCES (beads) for NPD and other modes of Thermionic Detection (TID)
- RETROFIT DETECTOR EQUIPMENT for Agilent, Thermo, Varian, HP5890, & SRI GCs
- COMPACT GC with NPD or TID selectivity

STAND-ALONE TRANSDUCERS & DETECTION MODULES

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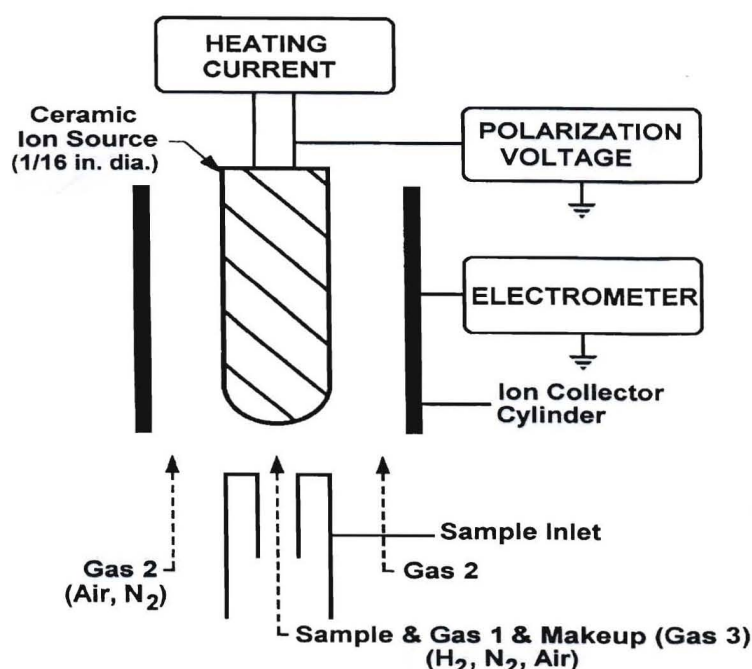
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Thermionic Surface Ionization

(expanding the detection of GC NPD equipment)

THERMIONIC IONIZATION DETECTOR DESIGN
(CONCENTRIC CYLINDER GEOMETRY)



Optimum Geometry

(used on Agilent 6890/7890 NPD and all DET hardware)

cylindrical shaped ion source located on axis of collector cylinder provides streamlined gas flow and optimum electric field for ion collection

Key Sensitivity and Selectivity Parameters:

1. ion source work function (surface composition);
2. ion source temperature (set by heating current);
3. composition of gases around the ion source;
4. polarization between ion source and collector.

Multiple modes of detection are achieved by easy permutations of these 4 parameters.

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TID-1-N₂(O₂): selective for NITRO, OXYGENATED, or HALOGENATED compounds

Equipment:

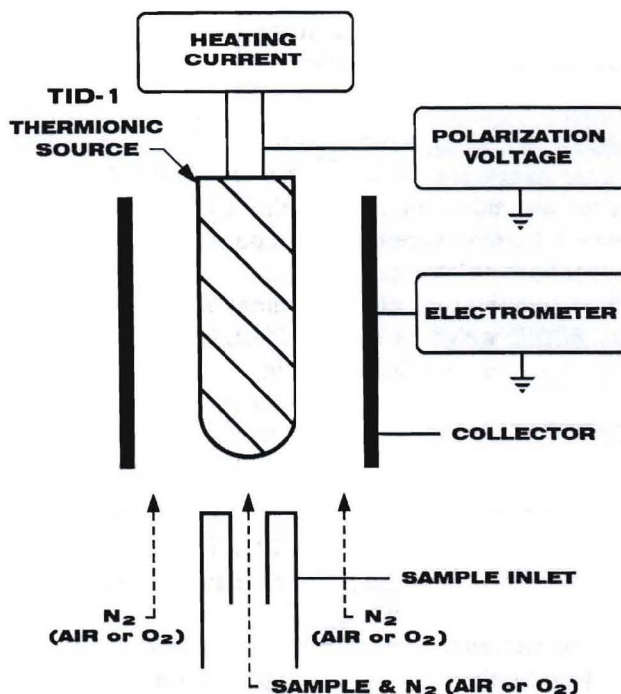
This detection mode uses a TID-1 type thermionic source mounted in either a TID/FID, REMOTE FID, FTID, PTID, or TANDEM TID tower. The detector gas is N₂ flowed through the gas lines which normally provide "H₂" and "air" to an NPD or FID. (Air or O₂ are other possible choices for the detector gases.) The source is heated by a constant current supply and is polarized at -45 Volts relative to the collector. In most applications, the surface temperature of the source is in the range of 400-600 °C which has no visible glow.

Principle:

This mode uses a low work function surface operated in an inert (or oxidizing) gas environment. The surface functions as a reservoir of electrons. Samples impact the surface and are ionized by a process involving the extraction of electrons from the surface. Gas phase negative ions are formed and collected for the detector signal. The process is extremely selective to compounds containing electronegative functional groups such as the NO₂ group, halogen atoms, or oxygenated functionalities. In some cases there occurs a direct electron attachment to the intact sample molecule. In many other cases, there occurs a dissociative electron attachment to an electronegative fragment of the sample molecule. The manner in which electronegative groups are bound in the structure of the sample molecule strongly influences the response.

Response:

This mode is characterized by primary, secondary, and tertiary levels of response. Primary compounds are detectable at femtogram levels and have selectivities of 10⁸ versus hydrocarbons. Examples of primary compounds are 4-nitrophenol, 2,4-dinitrotoluene, TNT, methyl parathion, pentachlorophenol, and heptachlor.



Secondary compounds are detectable at picogram levels and have selectivities of 10⁷ - 10⁵. Examples of secondary responders are atrazine, 2-nitrophenol, 2,4-dichlorophenol, diazepam, chlordane, dieldrin, phenols, carboxylic acids, glycols, vanillin, and methyl salicylate. Tertiary compounds are detectable at 1 - 10 nanogram levels and have selectivities of 10⁴ versus hydrocarbons. Examples of tertiary compounds are alcohols, ketones, aldehydes, phthalates, thiols, and the pyrrole functional group.

The TID-1 source can also be used in oxidizing detector gas environments such as air or O₂. The presence of O₂ in the detector reduces the response of some compounds, and enhances others. Examples of compounds which are enhanced are 2,4-dinitro-phenol, endrin, simazine, furan, and water vapor.

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TID-3-N₂(O₂): selective for VOLATILE HALOGENATES

Equipment:

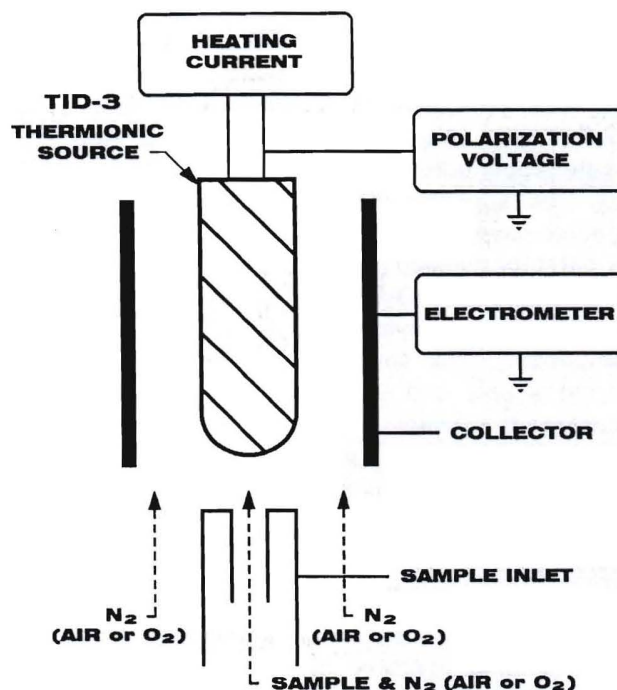
This detection mode is similar to the TID-1-N₂ mode except a TID-3 type source is used. The TID-3 source can be mounted in either a TID/FID, REMOTE FID, FTID, PTID, or TANDEM TID tower. Detector gas is N₂ through the lines which normally provide "H₂" and air to an FID or NPD. (Air or O₂ are other possible choices for the detector gases.) The source is heated by a constant current supply and is polarized at -45 Volts relative to the collector. In most applications, the surface temperature of the source is in the range of 600-800°C which produces a visible orange glow.

Principle:

This mode uses a thermionic surface of moderately high work function operated very hot in an inert (or oxidizing) gas environment. The surface functions as a reservoir of electrons. Samples impact the surface and are ionized by a process involving the extraction of electrons from the surface. Gas phase negative ions are formed and collected for the detector signal. The ionizing principle is essentially the same as the TID-1-N₂ mode except for the higher work function and higher operating temperature of the TID-3 ionizing surface. This mode was developed to eliminate a severe chromatographic peak tailing problem that otherwise occurs in using the TID-1-N₂ mode for volatile halogenated compounds. Assuming thermodynamic equilibrium between the thermionic surface and absorbed electronegative samples, the efficiency of surface ionization is given by the equation:

$$IE = \{1 + (g_o/g_n) \exp[(W - EA)/kT]\}^{-1},$$

where IE is the ionization efficiency, (g_o/g_n) is a ratio of statistical weights of negative ions and neutral species, W is the surface work function, EA is the electron affinity of the sample, k is Boltzmann's constant, and T is the surface temperature. In comparison to the TID-1 surface, the TID-3 surface has a higher work function W, so it must be operated at a higher temperature T in order to provide similar



magnitudes of ionization as the TID-1 surface. Because of the higher operating temperature, the TID-3 surface is less susceptible than the TID-1 surface to surface absorption of samples which can cause significant tailing especially for volatile halogenates.

Response:

The detectivity for volatile halogenates such as methylene chloride, trihalomethanes, etc. is in the range of 1 - 2 pg/sec. The selectivity is greater than 10⁵:1 (bromoform : benzene), and the range of linear response exceeds 10⁴. Oxidizing environments such as air or O₂ are better than N₂ with respect to suppressing interferences from large concentrations of oxygenates such as alcohols.

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REMOTE FID: selective for LEAD, TIN, PHOSPHORUS, or SILICON compounds

Equipment:

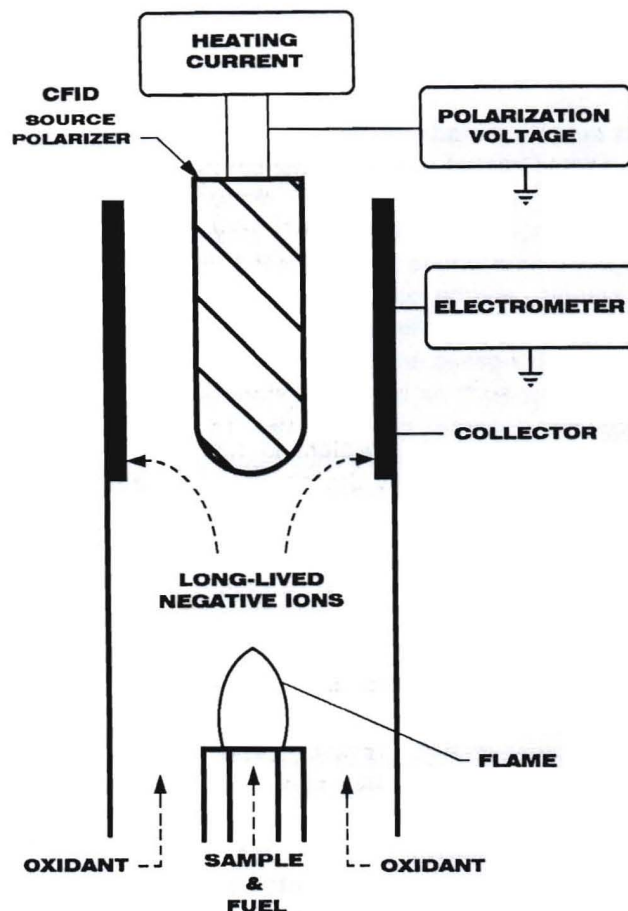
This detection mode uses a CFID type thermionic source mounted in either a REMOTE FID or FTID TOWER. The CFID source is used because it has the highest work function of the available source types, and in this mode the source is used simply as a flame ignitor and a polarizer electrode instead of as a source of surface ionization. The thermionic source polarizer and ion collector are located several centimeters downstream of a flame jet rather than immediately adjacent the jet as is the case in an FID. The detector gases are air and a mixture of H_2 and an organic fuel such as methane. Heating current to the CFID source is increased to ignite a self-sustaining flame which flashes back and burns at the jet structure. After ignition, the heating current is reduced to zero or some low value. The source in this mode is normally polarized at -15 Volts relative to the collector for best sensitivity and dynamic range, or -5 Volts for best selectivity. Negative ion currents arriving at the collector electrode constitute the detection signal.

Principle:

This mode is based on the discovery that some heteroatom compounds form very long-lived negative ion species in flame combustion. These stable ions survive to be measured by the downstream collector, whereas ions from hydrocarbon combustion are dissipated by recombination processes before reaching the collector. The thermionic source serves only as a polarizer, and provides no additional ionization of samples. The detector uses an air-rich flame, and an organic fuel is added to further improve selectivity versus complex hydrocarbon matrices.

Response:

This mode provides selectivity for lead (Pb), tin (Sn), phosphorus (P), and silicon (Si), but it is unresponsive to N, O, S, or Cl. Detectivity for Pb, Sn, or P is 1pg (Pb, Sn, P)/sec, and the selectivity with an organic fuel



is greater than 5×10^5 gC/g(Pb,Sn,P). Applications include detection of lead in gasolines and gasoline contaminated soil and water, organo-tin contaminants in water, phosphorus pesticides, and silicon bleed from gel implant prostheses. Since the ions detected in this mode are produced in the flame combustion process as in an FID, this detection mode is characterized by stable signal magnitudes over long operating times as long as the gas flows are maintained.

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PTID: (Phosphorus Thermionic Ionization) selective detection and very large signals for P with **suppressed N** response.

Equipment:

This detection mode uses a **TID-6** type thermionic source mounted in a **PTID Tower**. The **PTID** tower structure is similar to a Remote FID Tower in positioning the thermionic source several centimeters downstream of the jet. However, the **PTID Tower** contains a reduced internal diameter for high gas velocity to prevent flame front flashback from the hot source to the jet. This allows higher Hydrogen and Air gas flows to be used than are possible with an NPD. In the PTID, typical gas flows are $H_2 = 20 - 30$ mL/min, and Air = 250 - 500 mL/min. The thermionic source is heated by a constant current supply and is polarized at - 15 V with respect to the collector. During operation, the surface temperature of the source is maintained in the range of 600 - 800°C which produces a visible orange glow.

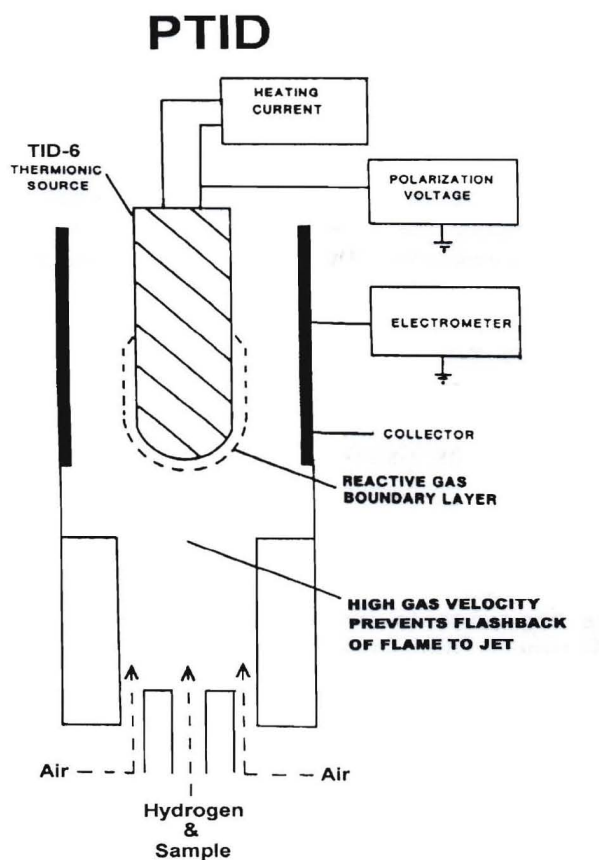
Principle:

This mode uses a thermionic source of high work function operated in an FID-like H_2 /air environment. However, unlike an FID, an internal flow restrictor prevents flame front flashback to form a self sustaining flame at the jet orifice where H_2 and Air are initially mixed together. Instead, an ignited, chemically active gas boundary layer is maintained about the hot source surface similar to an NPD. Because of the higher Hydrogen and Air, this PTID boundary layer has a much higher concentration of chemically active radical species. NPD thermionic sources do not hold up well in this harsher environment, so this mode of detection requires a more durable ceramic source surface. Like an NPD, sample compounds are decomposed in the gaseous boundary layer, and P compounds form

decomposition products which are converted with high efficiency to gas phase negative ions by extracting electrons from the thermionic surface.

Response:

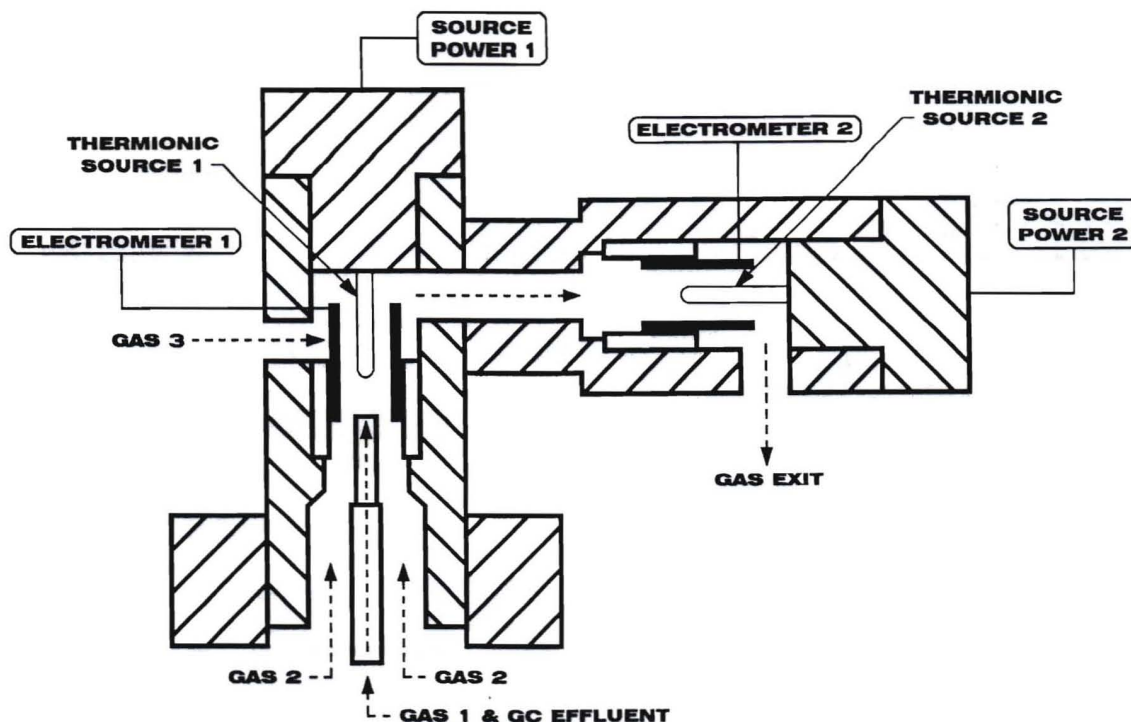
PTID response to P compounds is generally more than 10 times larger than the corresponding response of an NPD. However, the background and noise are also larger, so detectivity is comparable to an NPD (0.07 pg P/sec). The dynamic range of response of a PTID exceeds 5 orders of magnitude, and it has excellent selectivity vs. hydrocarbons, as well as vs. N, O, Cl, Br, S, and Si



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TANDEM TID: 2 SIMULTANEOUS SIGNALS, many signal combinations are possible



Equipment:

In a **TANDEM TID**, two independently controlled thermionic ionization detection stages are combined in a series configuration. The first stage is a **MODIFIED TID/FID** tower (Varian GC models) or a **MODIFIED REMOTE FID** tower (Agilent 6890 and HP 5890 GC models) that mounts onto the existing FID base on the GC. The second stage is a **TID TRANSDUCER** that attaches to the exit port of the first stage. Two different detector gases can be supplied through the lines in the detector base which normally supply "H₂" and "air" to an FID. A third gas inlet in the modified first stage tower provides an additional detector gas flow between the two stages. The two detection stages can be easily decoupled to allow separate operation of each structure. The first detection stage can be purchased separately, and the second stage may be added later as needed.

Each stage requires a thermionic source or FID probe, and their separate heating current and polarization electronics. The simultaneous signals from the two stages require two negative ion electrometers for measurement.

Response:

Many different tandem signal combinations are possible, depending on the type of thermionic sources/FID probe used and the composition of detector gases supplied. Some possibilities are as follows:

- TID-1-N₂/HWCID** - simultaneous detection of oxygenates and hydrocarbons in gasolines;
- TID-1-Air/NPD** - simultaneous detection of organochlorine and nitrogen/phosphorus pesticides;
- FID/FTID-2** - simultaneous detection of hydrocarbons and high concentration halogenates;

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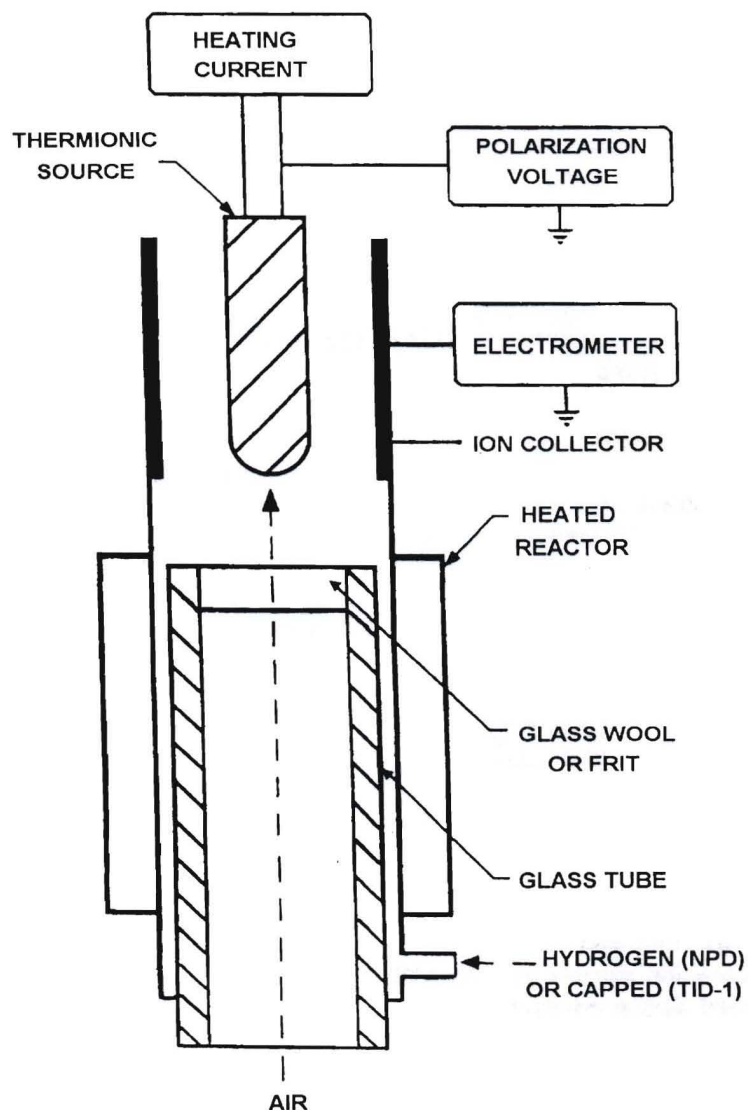
RTIA: REACTOR THERMIONIC IONIZATION ANALYZER

Equipment:

RTIA modules are stand-alone units containing a thermionic ionization transducer preceded by a heated reactor chamber. Each module has a thermally insulated, temperature controlled (50-400°C) transducer and reactor, and supporting gas flow control elements as needed. The transducer response is determined by the type of thermionic source used, and the type of gases supplied. Available modes include **TID-1-Air(N₂)**, **TID-3-Air(N₂)**, or **TID-2-H₂/Air** and **TID-4-H₂/Air** (i.e., NPD). TID-1-Air is an especially simple configuration in which the operating gas may be ambient air drawn in by a sampling pump attached to the module exit port. Ion Source power for the transducer in the RTIA module is provided by a **DET Current Supply**, and signals can be measured with a **Keithley 6485 Picoammeter** or equivalent.

Applications:

The RTIA selectively detects electronegative or NP vapors which thermally evolve from solid or liquid samples. Applications include a direct inject-vaporize procedure for liquid samples; a desorb-detect procedure for solid samples; and a trap-desorb-detect procedure for vapors in ambient air. The TID-1-Air mode detects nitrogen oxides and halogen/halogen oxides evolved in the thermal oxidation of food products, fabricating materials, oil bearing source rocks, and contaminated soil/water samples.



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DET ION SOURCES and AGILENT 6890/7890 NPD EQUIPMENT

Multiple Modes of Selective Detection

- 1. NPD - det. gas H_2 = 2 - 5, Air = 50, N_2 = 10 mL/min
TID-2 (black ceramic) - featuring sharp P peaks
TID-4 (white ceramic) - best N response**
- 2. PTID - det. gas H_2 = 20, Air = 200, N_2 = 100
TID-6 (blue gray ceramic) - P with suppressed N**
- 3. TID-1* (white ceramic) - det. gas N_2 , Air, or O_2
oxygenates, nitro compounds, some halogenates,
 CH_2 functional groups with an oxidizing environment**
- 4. TID-3* (white ceramic) - det. gas N_2 , Air, or O_2
volatile halogenates like Trihalomethanes**
- 5. TID-5* (black ceramic) - det. gas H_2 = 5, Air = 12.5,
 N_2 = 30 mL/min, Br and I with suppressed Cl**
- 6. TID-7* (NEW green ceramic) - det. gas N_2 , Air, or O_2
halogenated pesticides, PCBs, PBDEs**
- 7. POSITIVE IONS - DET Bare Wire Probe & Current
Supply, Agilent NPD Hardware & FID Electrometer
selective detection of triamines with Air det. gas,
universal FID detection with H_2 /Air flame**

*** (Best Sensitivity Achieved With a DET Stand-alone Current Supply)**

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DET NPD/TID/FID EQUIPMENT

retrofit for the

THERMO TRACE GC

- 1. DET Tower structure mounts onto the Thermo FID/NPD base - features a concentric cylinder geometry for streamlined gas flow and efficient ion collection.**
- 2. Tower assembly includes a Thermo jet modified with a ceramic liner and an extended ceramic tip.**
- 3. DET ceramic Ion Sources or Bare Wire FID Probe mount into the top of the DET tower for easy changes in multiple modes of selective or universal detection. (These are the same standard ion sources as used on Agilent 6890/7890 GC models).**
- 4. DET NPD/TID/FID equipment is very compatible with Thermo's versatile NPD electronics which provides Constant Current heating and a wide range of Polarization Voltages for the ion sources. The combination of DET hardware and Thermo's electronics provides unrivaled optimum capability for changing from one mode of detection to another.**

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DET NPD/TID/FID EQUIPMENT

retrofit for

VARIAN GC MODELS

- 1. DET Tower structure mounts onto Varian FID/TSD base - about half the size of Varian's TSD tower - features a concentric cylinder geometry for streamlined gas flow and efficient ion collection.**
- 2. Tower assembly includes a ceramic-tipped jet that seals into Varian base with a non-crushable stainless steel ferrule.**
- 3. DET Ceramic Ion Sources or Bare Wire FID Probe (\$350 ea.) mount into top of DET tower for easy changes of multiple modes of selective or universal detection. (Same standard ion sources as used on Agilent 6890/7890 GC models at a much lower cost than Varian's \$1090 for a TSD bead replacement.)**
- 4. DET NPD/TID equipment compatible with Varian TSD electronics. Varian electronics suffice for NP detection, but big improvement in signal-to-noise for Oxygenate and Halogenate detection is achieved by powering ion sources with a stand-alone DET Current Supply.**

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DET NPD/TID/FID EQUIPMENT

retrofit for

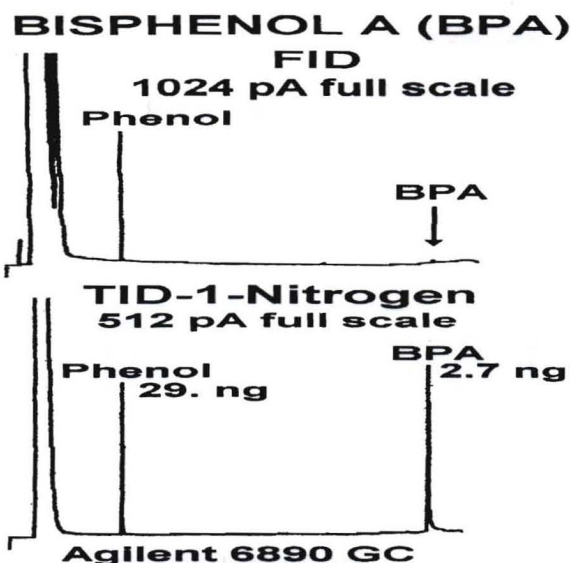
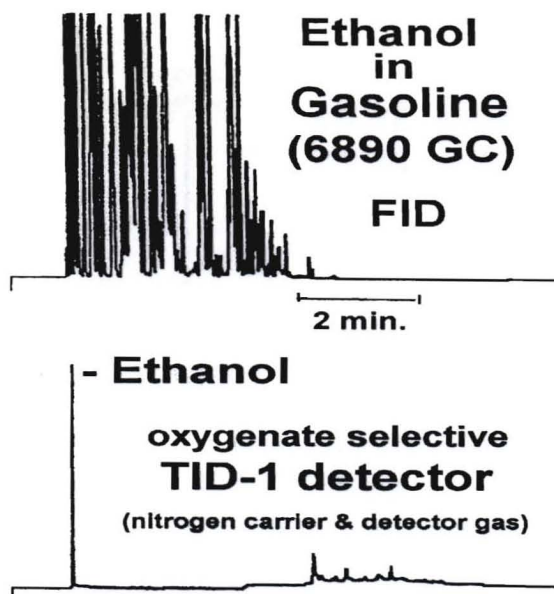
SRI GC MODELS

- 1. DET Tower structure mounts onto SRI FID base - includes a ceramic tipped jet and features a concentric cylinder geometry for streamlined gas flow and efficient ion collection.**
- 2. DET Ceramic Ion Sources or Bare Wire FID Probe mount into end of DET tower for easy changes of multiple modes of selective or universal detection.**
- 3. DET Ion Sources with bare wire terminations can be powered by the SRI NPD power supply with screw driver setting of ion source heating. A stand-alone DET Current Supply provides finer control of heating power and polarization voltages for DET Ion Sources that terminate in a Twinex electrical connector. (These are the same standard ion sources as used on Agilent 6890/7890 GC models.)**
- 4. SRI NPD amplifier suffices for signal measurement.**

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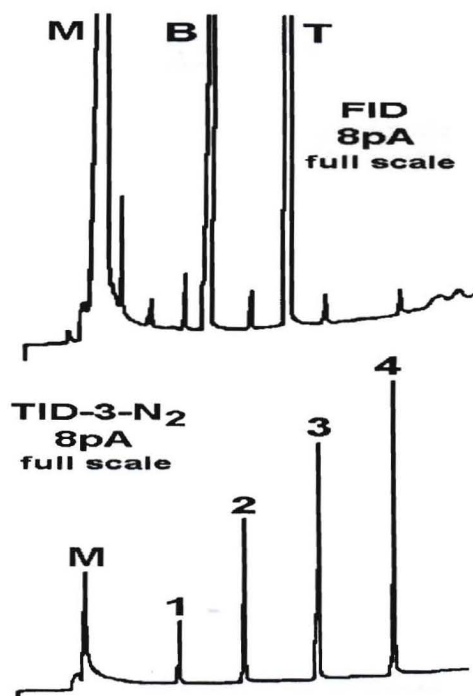
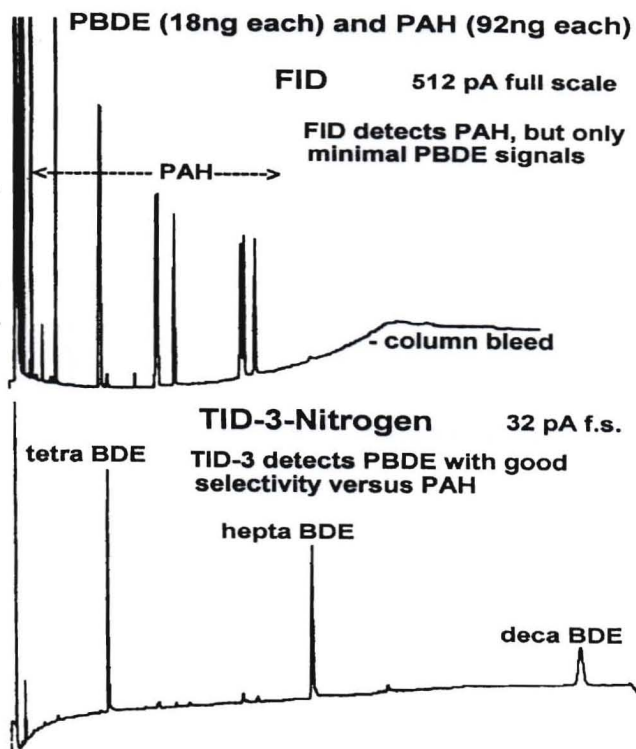
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Oxygenate selective TID-1 ionization provides easy analysis of Ethanol amidst many Hydrocarbons of Gasoline using a single Nitrogen supply for both GC carrier and detector gas.

Oxygenate selective TID-1 provides BPA detectivity which is 50 times better than an FID. TID-1 response to Phenols, Carboxylic Acids, Glycols, Salicylates, and Vanillin is especially large compared to other classes of Oxygenates.



Like TID-1, TID-3 ionization requires only Nitrogen as the detector gas, although TID-3 is designed to operate at a higher temperature to eliminate peak tailing.

Water Solution: M=2500ng Methanol, B=47ng Benzene, T=47ng Toluene;
Trihalomethanes, 0.64ng each
1=CHCl₃, 2=CHCl₂Br, 3=CHClBr₂, 4=CHBr₃

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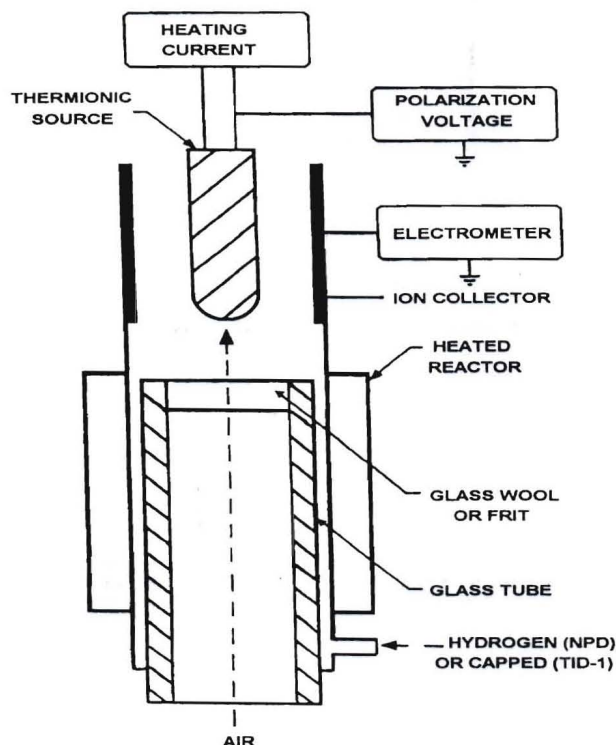
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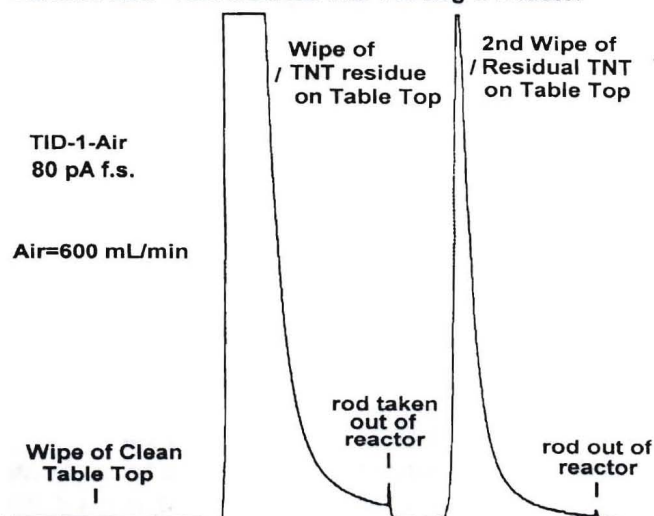
Reactor Thermionic Ionization Analysis (RTIA)

selective TID/NPD transducer screening of vapors evolved from
THERMAL DESORPTION/OXIDATION
of nonvolatile liquid residues or solid sample constituents

Background: Thermal desorption continues to be an increasingly popular means of preparing real world samples for subsequent analysis by gas chromatography. Among the many different types of GC detectors, TID and NPD detectors have the distinctive characteristic that they can provide chemical species selectivity using Air as the primary detector gas. Consequently, these detectors are well suited to non-GC chemical screening applications where the gas environment is simply ambient Air drawn through a TID/NPD transducer by a sampling pump. In an **RTIA** configuration, such a transducer is preceded by a heated reactor chamber into which are inserted solid samples packed into a glass tube or liquid sample residues on a ceramic rod. The TID or NPD transducer provides selective responses to vapors evolved from thermal desorption and/or oxidation of the samples. At low reactor temperatures, thermal desorption usually accounts for most detected signals, while at high temperatures oxidative sample decomposition products often provide large signals. Good examples of the oxidative detection processes are large TID-1 signals from oxidation of sugars and proteins. For TID-1 and TID-3 thermionic detection, only Air is required as the operating gas, while for NPD a small flow of Hydrogen has to also be introduced into the incoming Air.

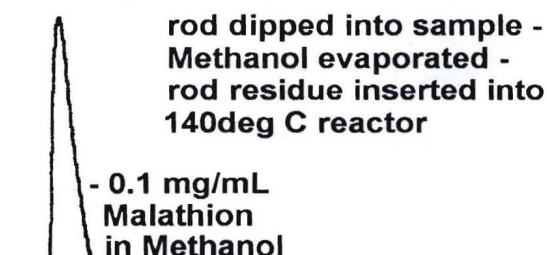


i-Propanol Wipe Transfer of Surface Residue to 1/16 in. Ceramic Rod - Rod inserted into 140 deg C Reactor



Malathion Residue on Quartz Rod

NPD, 160 pA f.s., Hydr.=4.3, Air=200



dried TNT residue on a table top wiped with an iso-propanol rod and transferred to ceramic rod

small quartz rod dipped into a 0.1mg/mL solution of Malathion in Methanol

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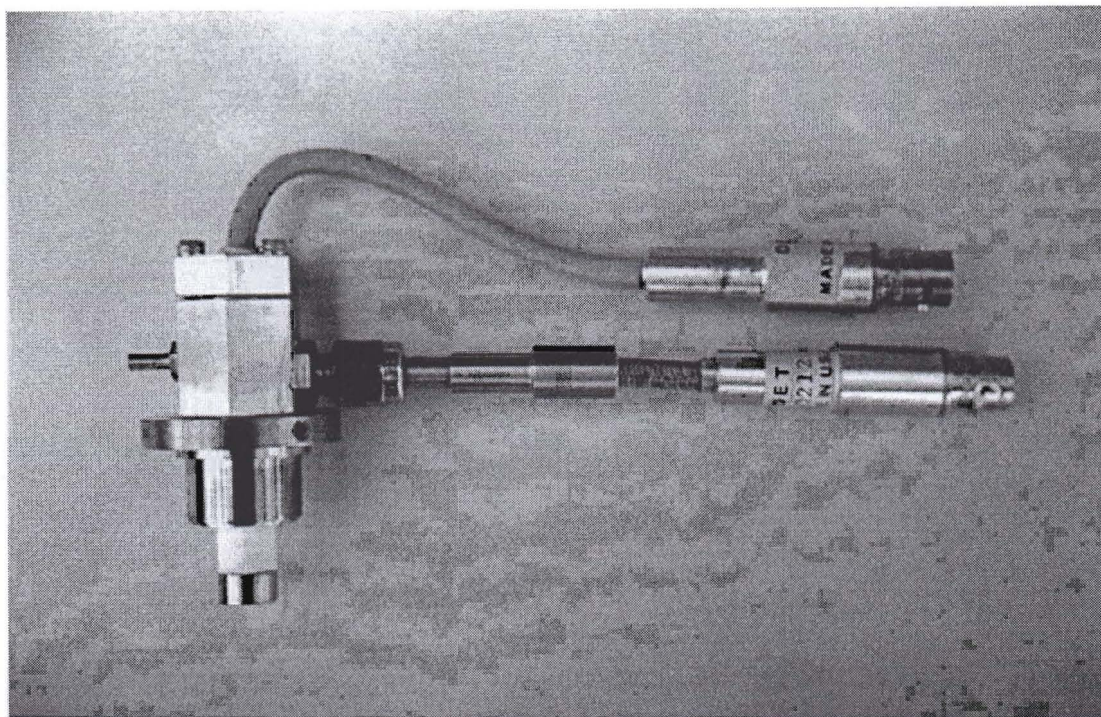
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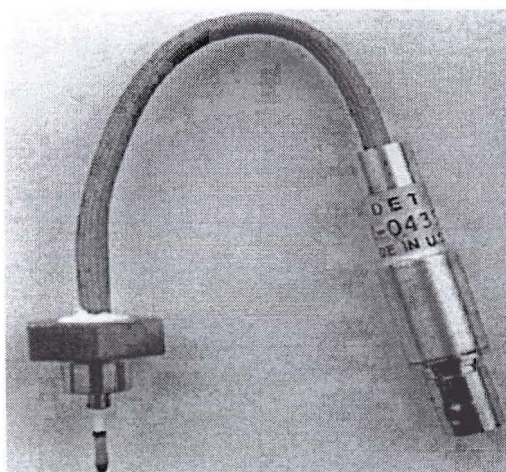
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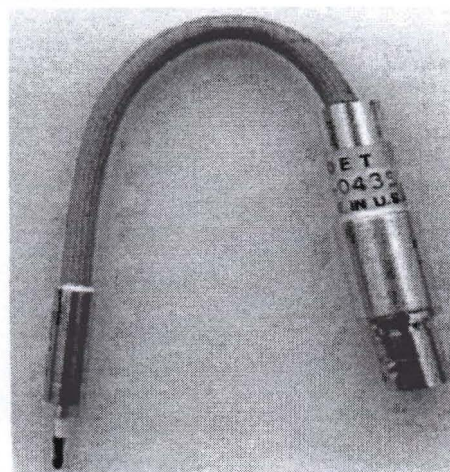


DET NPD/TID/REMOTE FID HARDWARE
MOUNTS ONTO AGILENT 6890 FID BASE OR HP 5890 FID/NPD BASE

THERMIONIC IONIZATION SOURCES **(AVAILABLE WITH OR WITHOUT ELECTRICAL CONNECTOR)**



STANDARD HEXAGONAL FLANGE
MOUNTING FITS ALL DET HARDWARE
AND AGILENT 6890 NPD HARDWARE



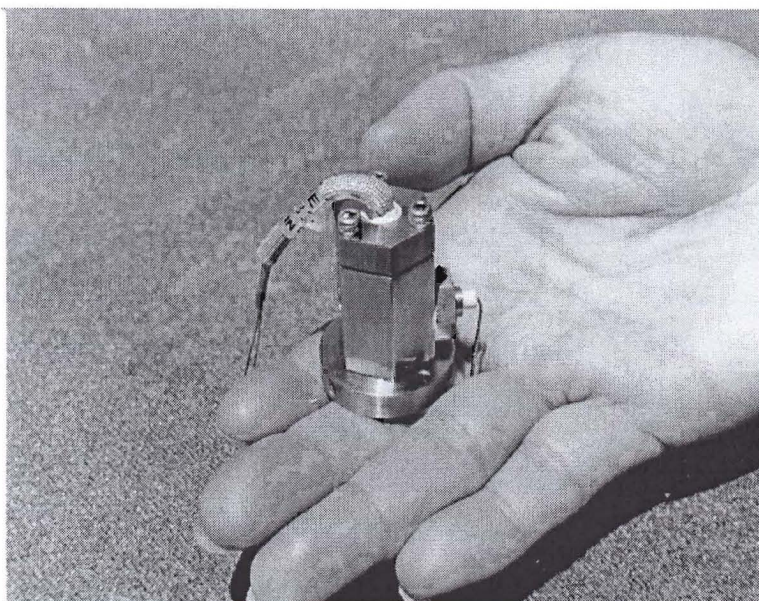
1/4 INCH TUBE MOUNTING FOR
CUSTOM APPLICATIONS. USED
IN THERMO-ELECTRON AND SRI GCs.

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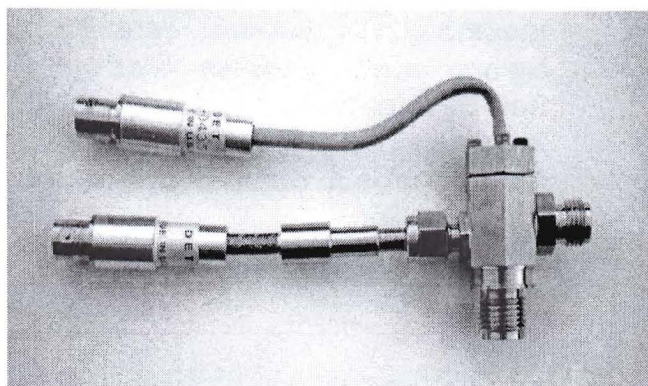
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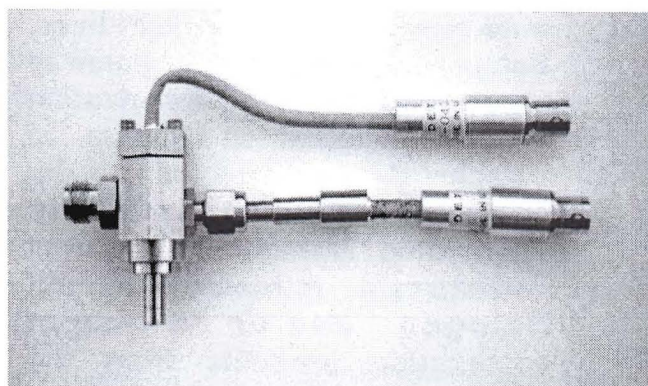
EXAMPLES OF DET HARDWARE STRUCTURES



DET NPD hardware for custom fit onto Bendix Process GC FID base. DET structure is 0.75 inch hexagonal stainless steel stock, approximately 1.50 inches tall. DET structure fits inside Bendix detector housing with ion source power wiring (2 wires) and electrometer signal wiring (1 wire) connecting to terminals in base of Bendix detector housing. Stand-alone DET Current Supply used to power ion sources, and Bendix negative ion electrometer used for signal measurement.



TID Transducer with 0.375 inch Swage inlet and 0.250 inch Swage outlet. Standard hexagonal flanged ion source mounted in top of transducer tower with fiberglass sleeved cabling terminating in a Twinex type connector. Standard signal probe extending from side of tower has a flexible mid section for bending as required and a BNC type connector for cabling to a negative ion electrometer.



TID Transducer with 0.250 inch outer diameter inlet tube and 0.250 inch Swage outlet. Standard ion source and signal connections as described above.

Other size tube/Swage inlet/outlet fittings are also possible.

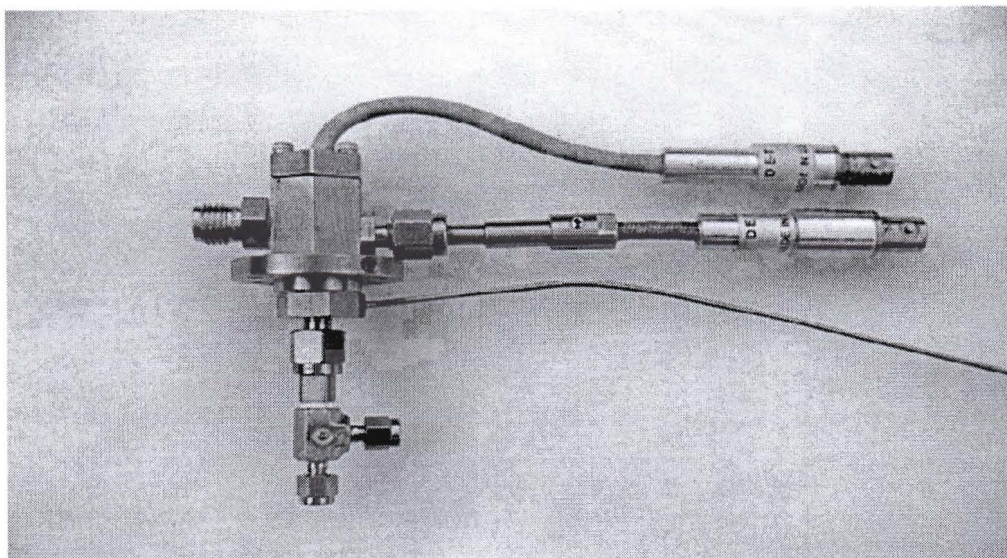
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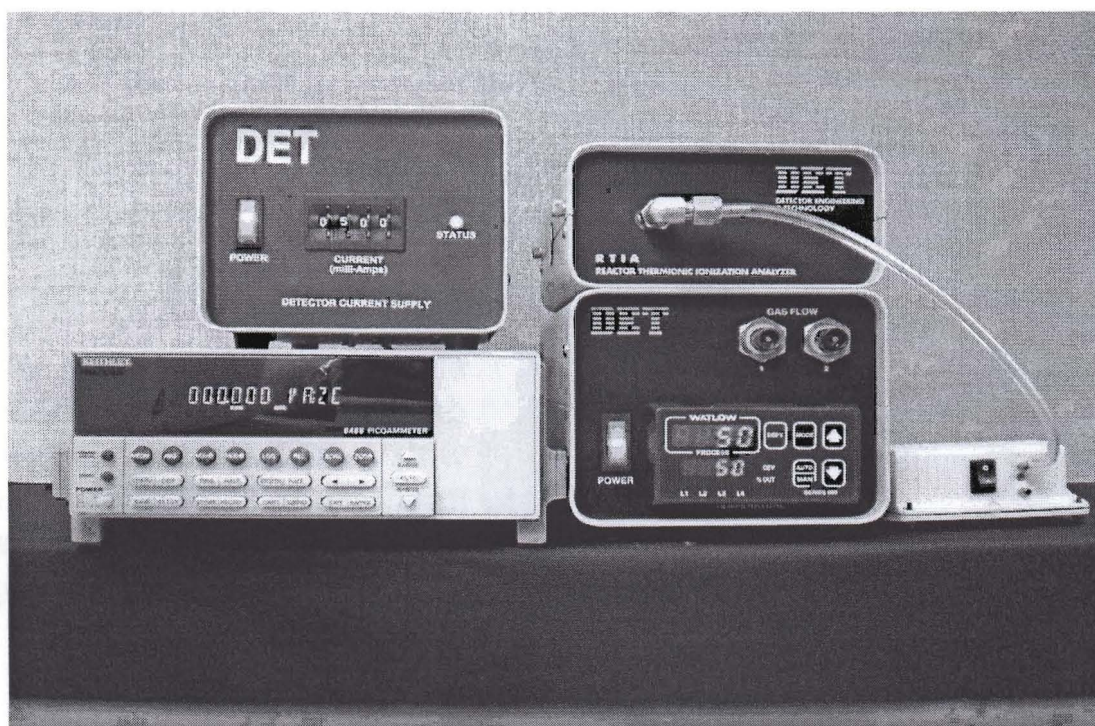
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FID/TID TRANSDUCER - 1/16 SWAGE INLET TEE



**DET CURRENT SUPPLY, KEITHLEY ELECTROMETER,
AND RTIA MODULE WITH AIR SAMPLE PUMP**

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Flame Thermionic Ionization (FTID) – Samples are decomposed in a self-sustained Hydrogen-Air or Hydrogen-Methane-Air flame, and the neutral decomposition products are re-ionized and detected by a thermionic ion source and collector located well downstream of the flame.

Catalytic Combustion Ionization (CCID) – Hydrocarbon and Fatty Acid Methyl Ester (FAME) compounds containing large concentrations of CH₂ functional groups are selectively detected by forming momentary bursts of flame ignition as each compound impacts a hot catalytic ceramic surface in a detector environment containing Oxygen.

Tandem Thermionic or Thermionic/Flame Ionization (Tandem TID, Tandem TID/FID) – Two different detector stages are combined in series, and many different combinations are possible depending on the choices of ionizing elements and detector gases used in each stage. In some cases, the first detection stage is non-destructive, while in other cases, a destructive process in the first stage may be used to generate decomposition products that are then detected in the second stage.

Reactor Thermionic Ionization Analysis (RTIA) - In an non-GC implementation of thermionic detection, a thermionic ionization transducer is preceded by a heated reactor chamber. The transducer detects selective vapors thermally evolved from liquid or solid samples heated in the reactor. When the gas flowing through the reactor and transducer is Air or Oxygen, detected vapors include volatilized sample constituents as well as products of oxidation of the sample constituents.

INTERCHANGEABLE ION SOURCE ELEMENT CHOICES:

TID-2 (Black Ceramic) – selective NPD detection with negligible tailing of P peaks;

TID-4 (White Ceramic) – selective NPD detection with the best possible N response;

TID-1 (Very White Ceramic) – selective detection of Oxygenates, Nitro compounds, some Halogenates, Pyrrole versus Pyridine functional groups, and Methylene groups in linear chain Hydrocarbons and Fatty Acid Methyl Ester (FAME) compounds;

TID-3 (White Ceramic) – selective detection of volatile Halogenates like Trihalomethanes;

TID-5 (Black Ceramic) – selective detection of Br and I compounds with suppressed Cl;

TID-6 (Blue Gray Ceramic) – selective detection of P compounds with suppressed N;

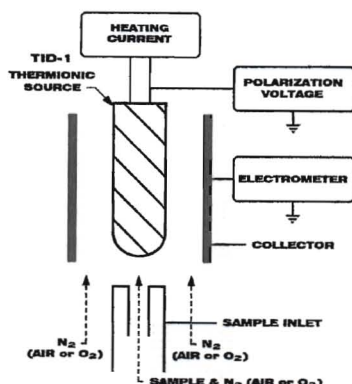
TID-7 (NEW Green Black Ceramic)- selective detection of Halogenates like PCBs;

CFID (Black Ceramic) – used with the Remote FID mode for selective detection of P, Pb, Sn, or Si compounds;

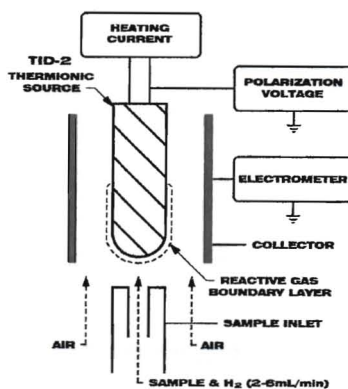
FID Probe (Uncoated Bare Wire) – used as flame ignitor/polarizer for universal FID detection.

GC DETECTOR INNOVATIONS by DET (different implementations of the same basic detector geometry)

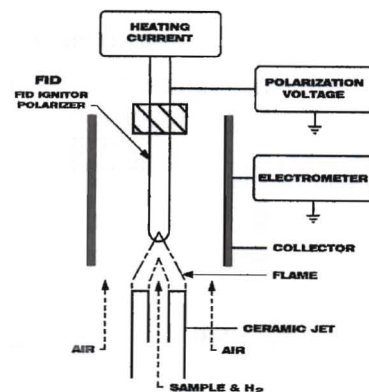
TID



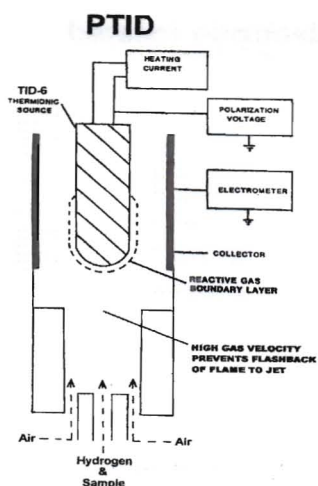
NPD



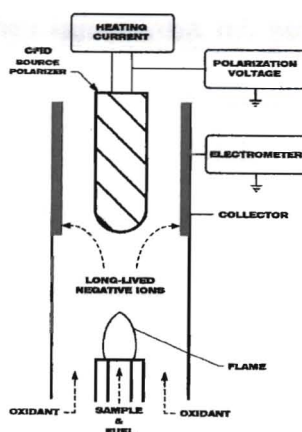
FID



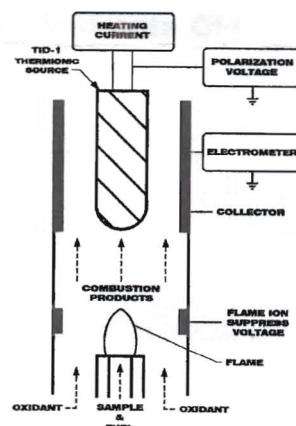
PTID



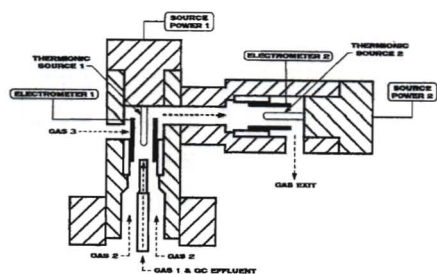
REMOTE FID



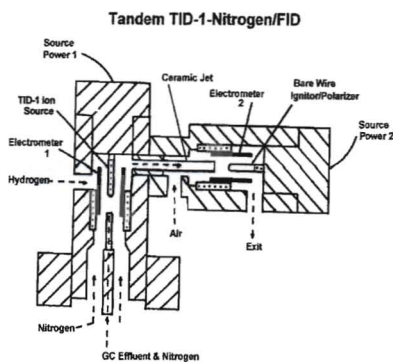
FTID



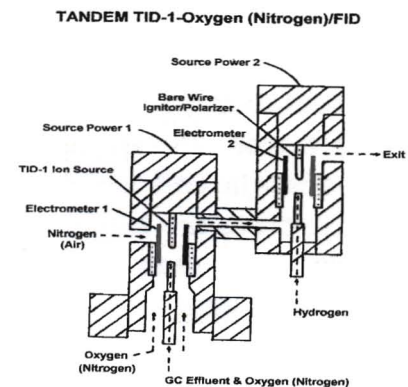
TANDEM TID



TANDEM TID-Nitrogen/FID



TANDEM TID-Oxygen/FID



DET RETROFIT NPD/TID/FID TOWER ASSEMBLY THAT MOUNTS ONTO THE FID/TSD BASE ON VARIAN GC MODELS AND USES VARIAN TSD ELECTRONICS (\$1550):

Accommodates the same ionizing elements as the Thermo retrofit. 10 times improvement in signal to noise achieved for TID modes by substituting the stand-alone DET Current Supply for Varian's TSD power supply.

DET RETROFIT NPD/TID/FID TOWER ASSEMBLY THAT MOUNTS ONTO THE FID/NPD BASE ON SRI INSTRUMENTS GC MODELS (\$2350):

Accommodates the same ionizing elements as the Thermo retrofit. NPD, TID, and FID modes can be powered by SRI NPD electronics, but better user friendly precision control is provided by the stand-alone DET Current Supply.

DET RETROFIT NPD/TID/REMOTE FID TOWER ASSEMBLY THAT MOUNTS ONTO THE FID/NPD BASE ON AN HP 5890 (\$1850):

Accommodates the same ionizing elements as the Thermo retrofit, plus a CFID (Black Ceramic) type source for use in an exclusive Remote FID detection mode which is selective for P, Pb, Sn, or Si compounds. DET hardware IS NOT compatible with 5890 detector electronics, so the stand-alone DET Current Supply (\$1760) and a stand-alone Electrometer (Keithley 6485 picoammeter, \$1800) are also required.

APPLICATION EXAMPLES USING DET RETROFIT EQUIPMENT:

sub-picogram NPD detection of pesticides and drugs of abuse;

femtogram TID-1 sensitivity for Nitro explosives like 2,4-Dinitrotoluene and TNT, as well as Nitro pesticides like Methyl Parathion;

sub-picogram TID-1 detection for some Halogenated pesticides like Heptachlor, Dieldrin, Chlordane, Pentachlorophenol, and Atrazine;

low picogram TID-3 detection of Trihalomethanes in drinking water;

selective TID-1 detection of Ethanol and other Alcohols in petroleum and biofuels;

selective TID-1 detection of Acetic, Formic, and other Carboxylic Acids in wine and other food and flavor analyses;

picogram TID-1 detection of BisPhenol (BPA) and Phthalates in food packaging products;

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ph: 925-937-4203, fx: 925-937-7581; email: detplp@aol.com, www.det-gc.com

VISIT DET at PITTCON 2011, March 13 – 17, Atlanta, Georgia, USA
Booth 4078 Sunday Poster 180-16P

CHEMICAL DETECTION PRODUCTS by DET
featuring novel applications of the principles of
THERMIONIC SURFACE IONIZATION and FLAME IONIZATION

GC detectors and stand-alone transducers manufactured by DET all have an original common design feature consisting of an electrically heated, cylindrically shaped ion source element positioned on the axis of an ion collector cylinder. Ion source elements are fabricated from proprietary ceramic coatings; are mounted on a flange for easy self-aligning installation into detector tower structures; and are available with different ceramic coatings for multiple modes of chemical detection using the same basic equipment.

DETECTION PRINCIPLES USED IN DET PRODUCTS:

Thermionic Surface Ionization (TID & NPD) – Samples form gas phase negative ions by extraction of electrons from a hot, catalytically active solid surface. Key parameters are the surface composition, surface temperature, gas composition around the surface, and polarization of the surface relative to a surrounding ion collector. Multiple detection modes are obtained through systematic changes in these four parameters. Some modes, like the widely used NPD, combine reactive gas phase chemistry to decompose incoming samples, and then ionize the decomposition products by interaction with the surface. In other modes, intact sample molecules are ionized by direct impact with the surface with no intervening gas phase chemistry.

Conventional Flame Ionization (FID) – Samples decompose and form ions in gas phase reactions with radical species like H, O, and OH that are present in self-sustained Hydrogen-Air flames. A polarizer voltage and ion collector located near the flame effectively measure ions formed by combustion of organic compounds.

Remote Flame Ionization (RFID) – Like an FID, samples are decomposed in a self-sustained flame, but the polarizer and collector electrode are located further downstream of the flame. In this detection, hydrocarbon ions dissipate by recombination processes near the flame, and only long lived ion species remain to be selectively measured at the collector. Detectable ion species include decomposition products of compounds containing P, Pb, Sn, or Si atoms, and the selectivity versus Hydrocarbon interferences is greatly improved by using a Hydrogen-Methane-Air fueled flame.

DETECTOR HARDWARE STRUCTURES by DET (visit DET at Pittcon 2011, booth 4078)

GC DETECTOR TOWER CONFIGURATIONS:

NPD/TID/FID Tower Structure – This type of detector structure includes a ceramic tipped jet and a tower assembly that positions an ion source and collector electrode in close proximity to the top of the jet. Selective NPD and TID, and universal FID modes of detection are available depending on the choice of ion source element and the detector gases.

NPD/TID/Remote FID Tower Structure – This type of detector structure includes a wide bore jet, and a tower assembly that positions the ion source and collector electrode several centimeters downstream of the top of the jet. The internal diameter of the jet is sufficient to allow fused silica columns of 0.53 mm diameter or less to be inserted clear through the jet. For NPD and TID modes of detection, the GC column is terminated above the jet in close proximity to the ion source/collector. For the Remote FID mode of detection, the column end terminates right at the top of the jet, a self-sustaining flame is ignited at the jet, and long lived ions formed in the flame are carried downstream to the ion collector.

NPD/TID/Remote FID/FTID Tower Structure – This type of detector structure is similar to the Remote FID structure except it has an additional Ion Suppress electrode located near the top of the flame jet. The purpose of the Ion Suppress is to prevent ions formed in a flame at the jet from moving downstream to the ion collector. Remote FID detection is also achieved by turning Off the Ion Suppress voltage.

NPD/TID/PTID Tower Structure – This type of detector structure is similar to the Remote FID structure except it has a small restricted internal diameter between the jet and ion source that produces a high gas velocity to prevent a flame front formed at the hot ion source from flashing back to a self-sustained flame at the jet.

Tandem TID & Tandem TID/FID Tower Structure – This detector structure consists of 2 detection stages coupled together in a series combination. The first stage is either an NPD/TID/FID tower or Remote FID Tower each modified with an auxiliary gas flow input to sweep any dead volume between the 2 stages. The second detection stage can be either an NPD/TID transducer or an FID transducer. In the case of an FID transducer in the second stage, another auxiliary gas input is provided to achieve the appropriate fuel mixture for a self-sustaining flame.

STAND-ALONE DETECTOR STRUCTURES:

DET tower structures can be configured with various choices and sizes of either Swage or Tube Inlets and Outlets for use as stand-alone transducers. A mounting flange is available to attach to the transducers, as well as Aluminum heater blocks. A transducer attached to a heated inlet reactor is used in DET's Reactor Thermionic Ionization Analyzer (RTIA) module for selective screening applications.

VISIT DET at PITTCON 2011, March 13-17, Atlanta, Georgia, USA
Booth 4078 Sunday Poster 180-16P

GC DETECTION IDEAS FROM DETECTOR ENGINEERING & TECHNOLOGY

RETROFIT THERMIONIC IONIZATION DETECTORS ADD NEW APPLICATIONS AND EXTEND USEFUL LIFE FOR EXISTING AGILENT, THERMO, VARIAN, SRI, AND HP 5890 GC MODELS

DET has developed a family of inexpensive GC detectors that operate according to the principles of Thermionic Surface Ionization and Flame Ionization, and that feature ion source elements made of proprietary ceramic materials. The ion sources are a standard mounting design identical to that used on Agilent 6890/7890 NPD equipment, and are interchangeable in compact detector tower structures designed to custom mount onto existing FID/NPD bases on different model GC instruments.

DET ION SOURCE TYPES FOR USE IN AGILENT 6890/7890 NPD EQUIPMENT (\$350 each):

TID-2 (Black ceramic) – selective NP detection with negligible tailing of P peaks;

TID-4 (White Ceramic) – selective NP detection with best possible N response;

TID-1 (Very White Ceramic) - selective detection of Oxygenates, Nitro compounds, some Halogenates, Pyrrole versus Pyridine functional groups, and Methylene groups in linear chain Hydrocarbons and Fatty Acid Methyl Ester (FAME) compounds;

TID-3 (White Ceramic) - selective detection of volatile Halogenates like Trihalomethanes;

TID-5 (Black Ceramic) - selective detection of Br and I compounds with suppressed Cl;

TID-6 (Blue Gray Ceramic) - selective detection of P compounds with suppressed N;

TID-7 (NEW Green Black Ceramic) - selective detection of Halogenates like PCBs.

STAND-ALONE DET CURRENT SUPPLY FOR IMPROVED NPD AND TID DETECTION ON AGILENT 6890/7890 GC MODELS (\$1760):

Provides optimum Constant Current heating of NPD and TID ion sources, and variable polarization voltages for 10 times signal to noise enhancement for TID detection modes.

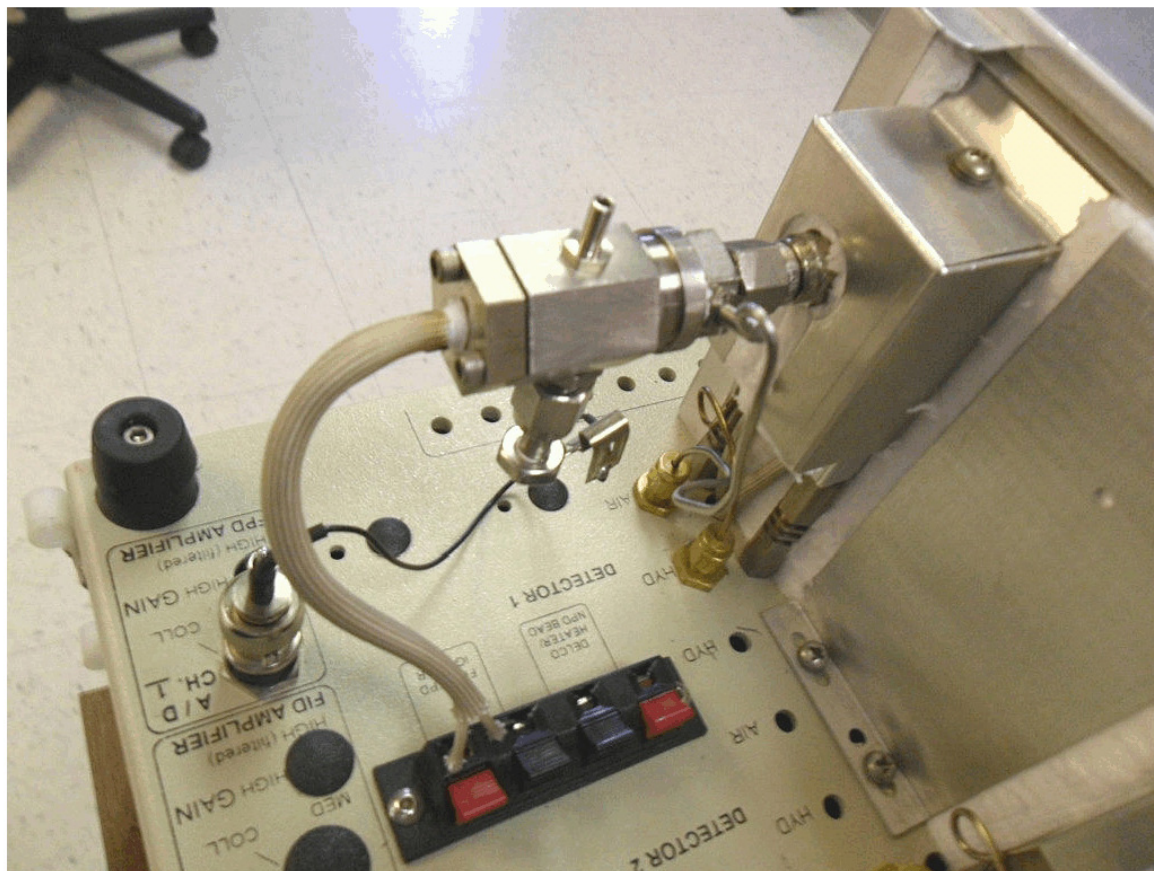
DET RETROFIT NPD/TID/FID TOWER ASSEMBLY THAT MOUNTS ONTO THE NPD BASE ON A THERMO SCIENTIFIC TRACE GC AND USES THERMO NPD ELECTRONICS (\$1800):

Accommodates any of the interchangeable ion source types listed above plus a bare wire probe for universal FID detection. Combination of DET hardware and Thermo NPD electronics provides unmatched performance capability for all modes of detection.

DET

innovations in chemical detection

DET NPD/TID/FID DETECTOR HARDWARE RETROFIT ON SRI GC WITH ION SOURCES POWERED BY SRI ELECTRONICS



DET Retrofit for SRI Instruments GC Models 310 & 8610:

NPD/TID/FID Tower/Jet Assembly, part # 050-864-98, \$1850 USD

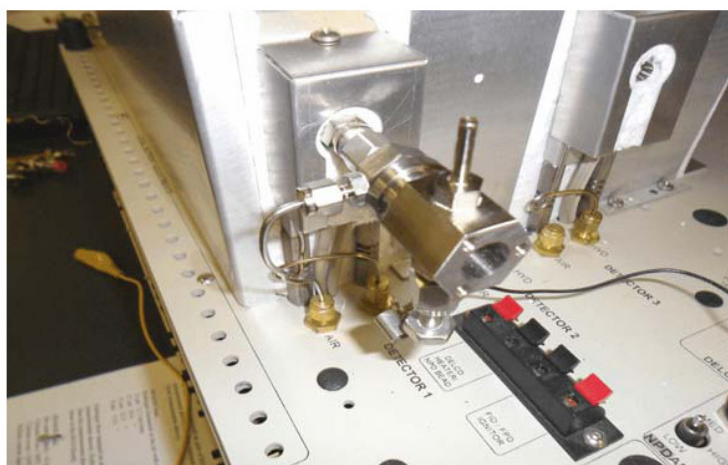
- includes a ceramic tipped jet and tower structure with a concentric cylinder detector geometry that provides a stream-lined gas flow and efficient ion collection comparable to the NPD detector design on Agilent GC models - interchangeable ceramic coated ion source elements (part 010-90X-01, price \$315) mount into the end of the tower and bare lead wires connect to the SRI power terminals - "X" in the part number specifies the type of ion source and its intended selectivity of detection.

Available ceramic coated ion source elements include:

TID-2 & TID-4 ("X" =2 & 4) for NP selectivity; TID-1 ("X"=1) for selectivity to Oxygenates, Nitro compounds, some Halogenates, and certain other functional groups; TID-3 ("X"=3) for selectivity to volatile Halogenates and many Brominated compounds; and a few others.

Also available is a bare wire FID Probe element (\$315 USD) for conversion to a universal FID detection mode (part # 020-902-01 for power with SRI NPD electronics, or part #022-902-01 for power with SRI FID electronics).

DET innovations in chemical detection



DET RETROFIT NPD/TID/FID HARDWARE TO FIT SRI GC MODELS. DET equipment has an optimum concentric cylinder geometry that provides better stream-lined gas flow and efficient ion collection, and it is compatible with the same ion source mountings as used on AGILENT GC models.



COMPACT ANALYZER - portable size SRI GC modified with glass lined flash vaporization injector, 0.32 mm dia. fused silica column, DET detector hardware with ceramic ion sources, and DET Current Supply for precision ion source power.

DETECTOR Engineering & Technology, inc.