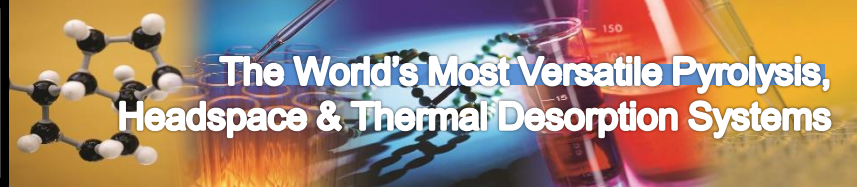
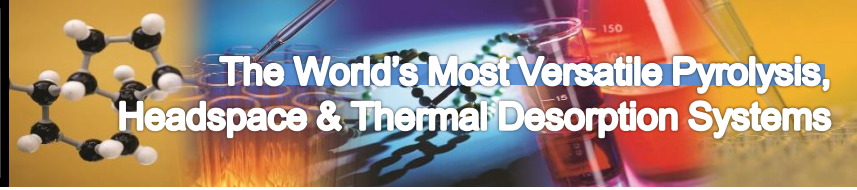
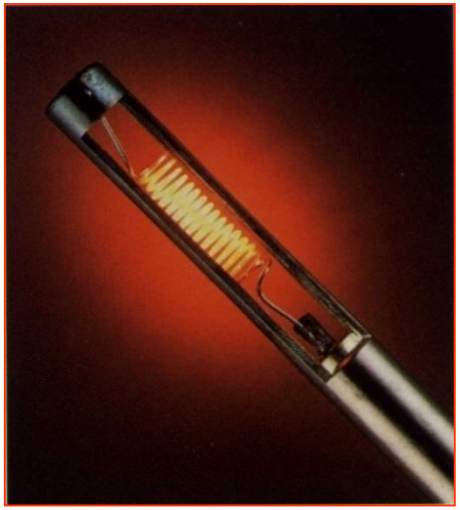


NEW PYROPROBE 6000

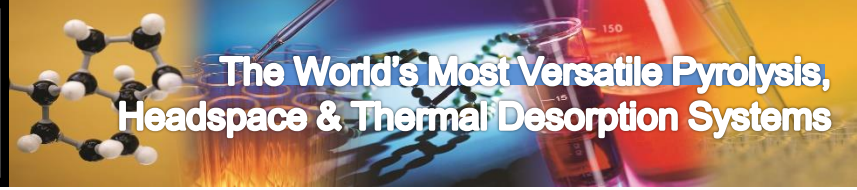


CDS RESISTIVELY HEATED FILAMENTS

Benefits of Resistively Heated Systems

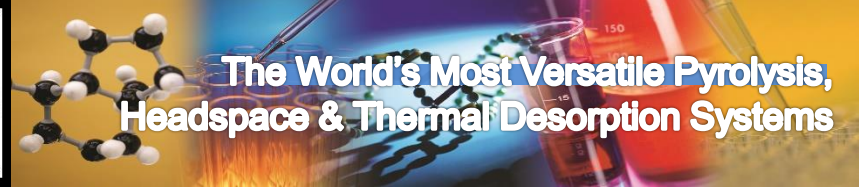


- Highest pyrolysis temperature of 1400C
- Adjustable heating rates and pyrolysis times
  .01C/minute to 20C/millisecond
- Multi- step methods possible (up to 10)
  Allows auto purge solvent to vent
  Analyze for additives before the polymer
- CDS systems can perform TD studies and desorb large sample sizes
- Variety of probes allow fastest heating rates (ribbon), convenience (DISC) and larger sizes (350 mg)
- Heating elements can be changed by customer



6000 SERIES PYROPROBES

- 5000 series was introduced in 2004
  - Instrument manufacturers like to push a 7 year trade-in cycle but….true trade-in cycles are closer to every 10 years+.
- Has served us well but electronic components are becoming obsolete
- 5000 series will be supported for another 10 years
- Target price is 10-15% above 5000 series



6000 SERIES PYROPROBE

Pyrolysis Temp: 0-1400°C (1300C for AS)

Heating Rate: 0.01°C/min. to 20°C/millisec

Modular Design with individual models 6150, 6200 (trapping) and 6250 (Autosampler) and 6250T (AS w/ trap)

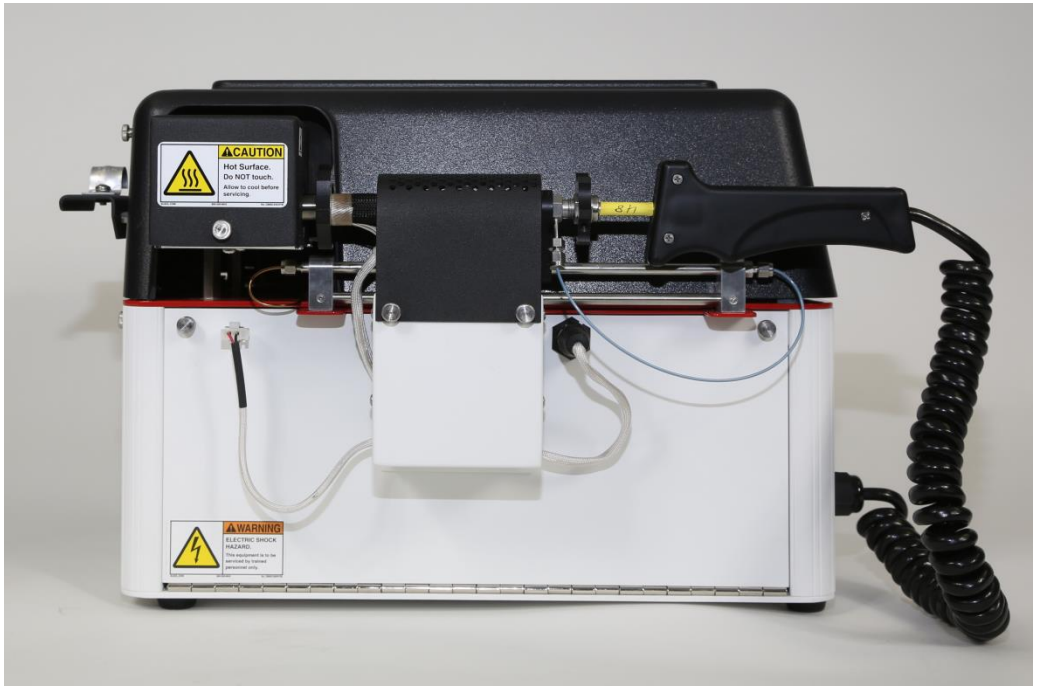
Incorporates a textured molded “Kydex T” top cover and new color scheme

Foot print slightly larger then 5000 series…several cm in depth

PC Software for programming but has LCD display for local control and readout

10 step programming vs 8

6000 SERIES PYROPROBE



Option for new DISC probe
"*Drop-In-Sample-Chamber*"
User can change between probes & DISC

Increased temp's in heated zones:

400C- Interface
375C - Heated Line

More consistent temp in heated valve box- *Allows heavier compounds to column- less long term carryover*

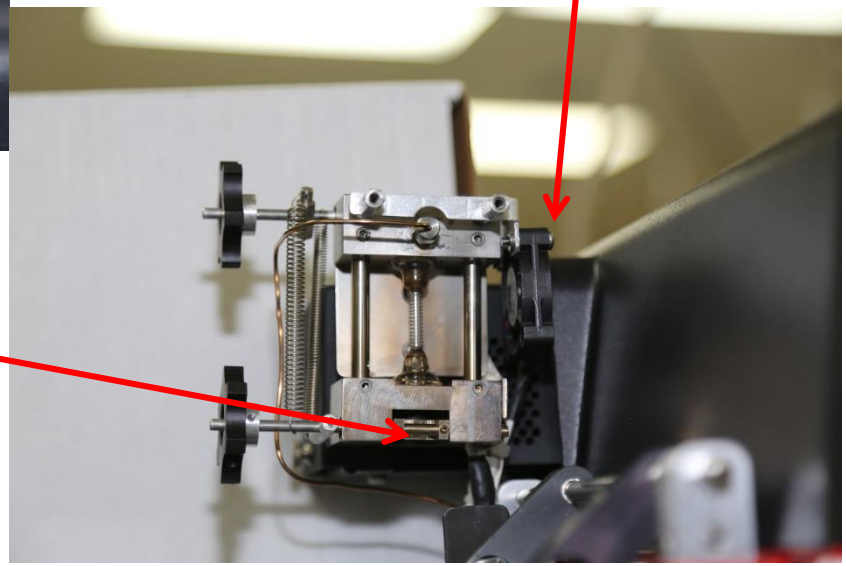
Uses same filament and coil probes

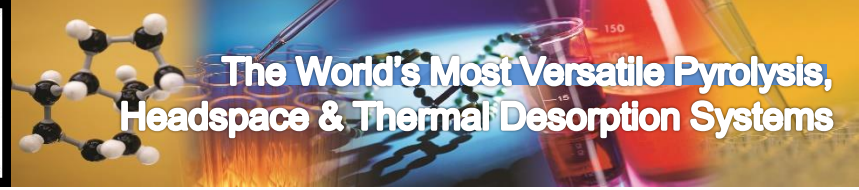
Silcosteel interface and lines

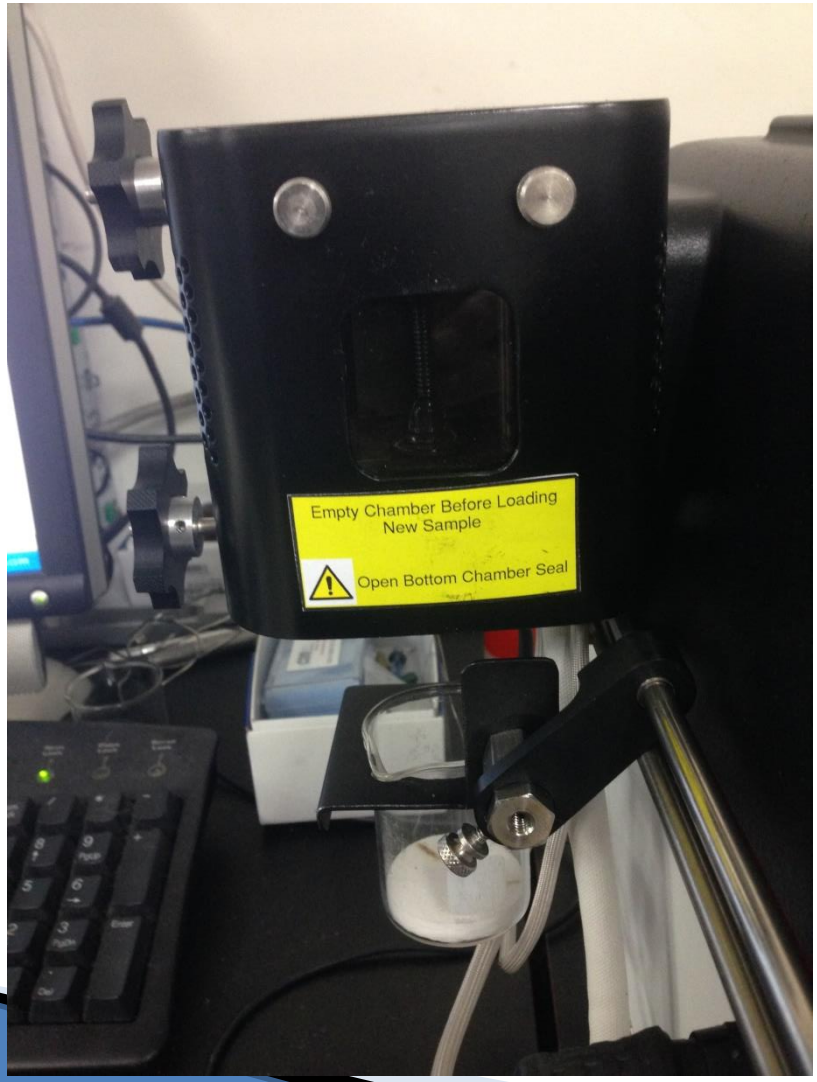
DISC PROBE

- **Designed as optional add on to all manual systems.**
- **Uses AS chamber**
- **User can switch between standard probes and DISC**
- **DISC uses longer AS quartz tubes**
- **Multi-step capabilities are not lost**

DISC PROBE

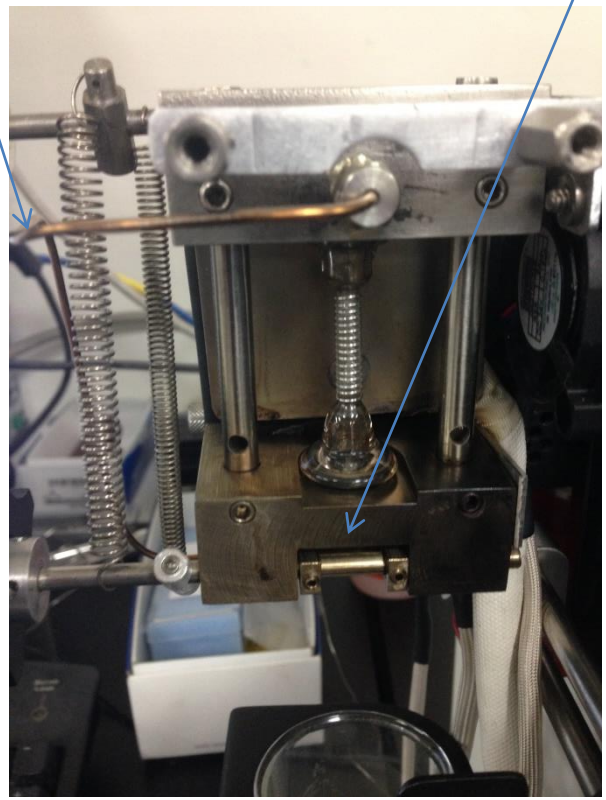


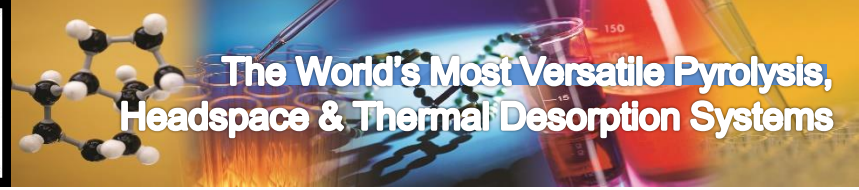




Carrier gas comes into top of chamber here.

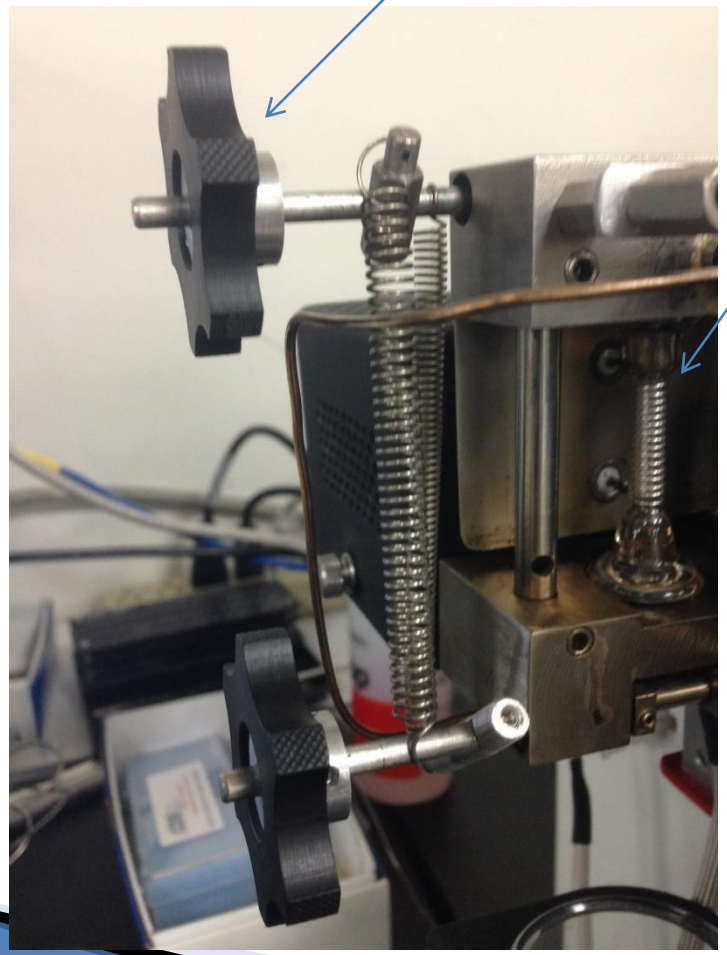
Pyrolyzed gas flows Through the heated block to GC.

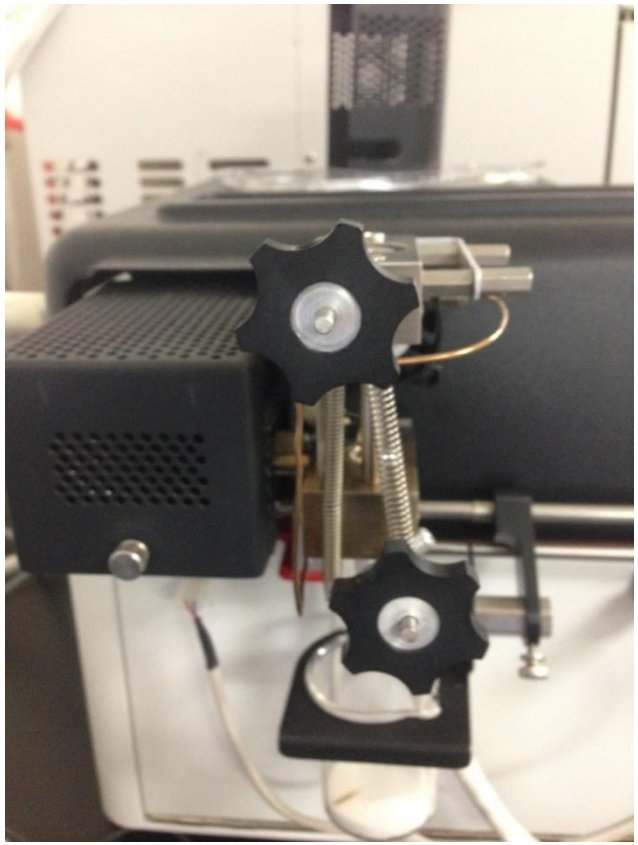




Turn this know to open py chamber

Sample drops into this py chamber

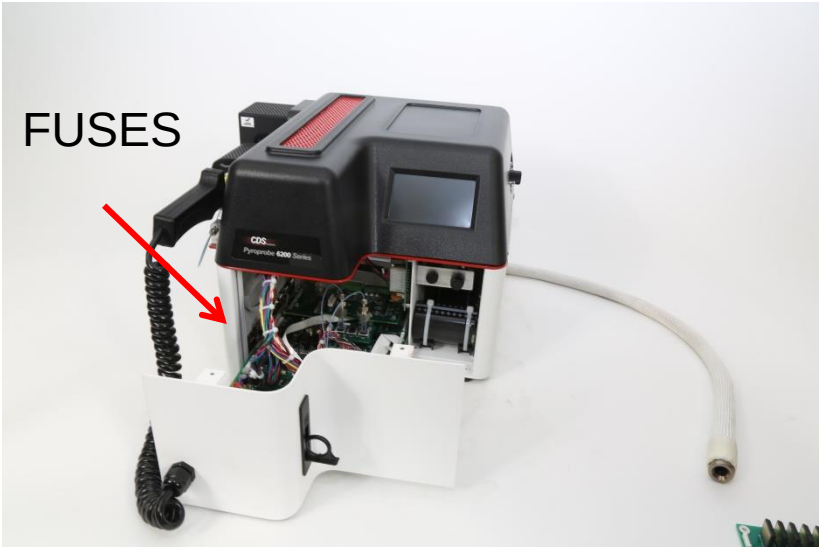




6000 SERIES PYROPROBE

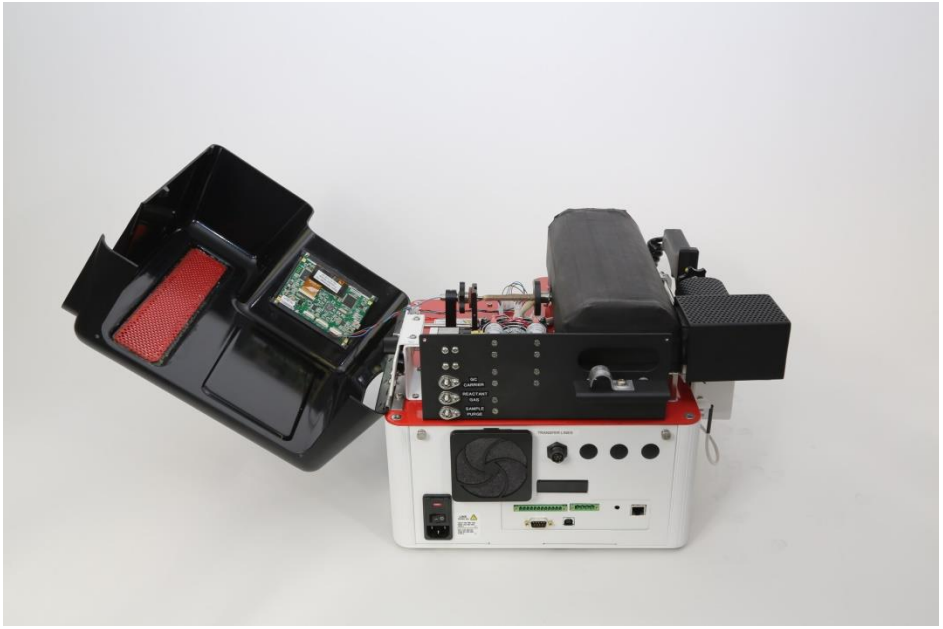
Electronics and fuses easily accessible from pull-out drawer

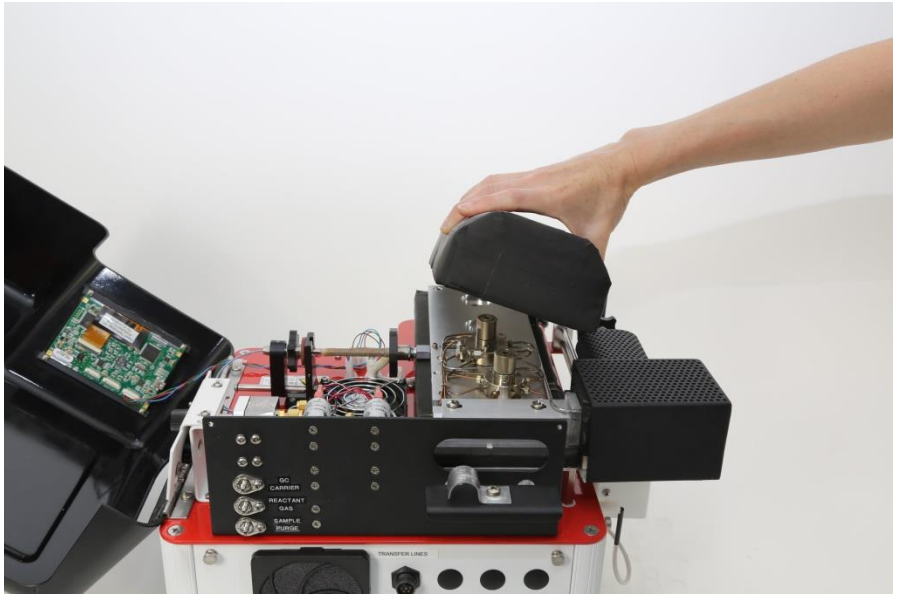
Build out for HPR version will slide under system- true modular design



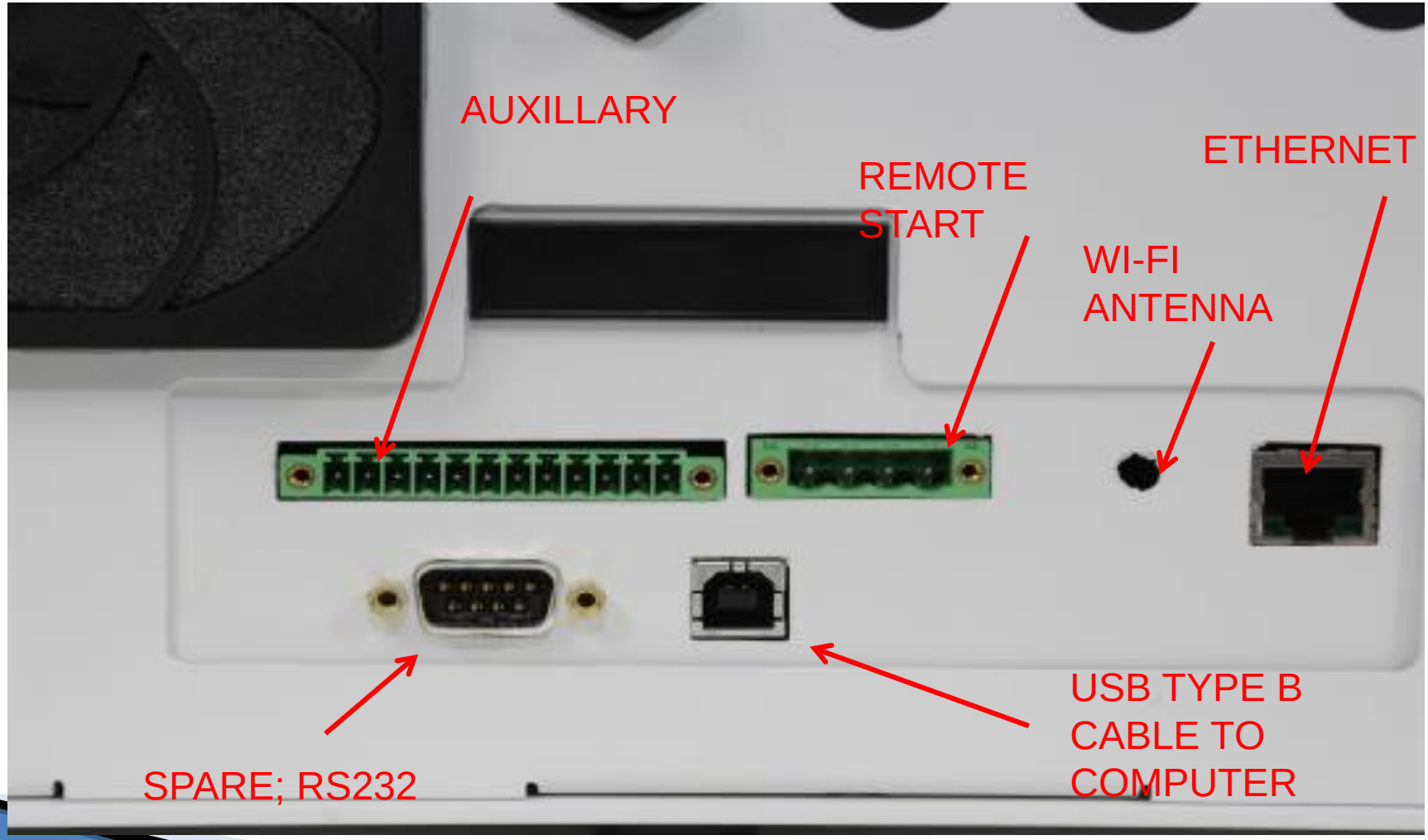
6000 SERIES PYROPROBE

All pneumatics accessible from the top

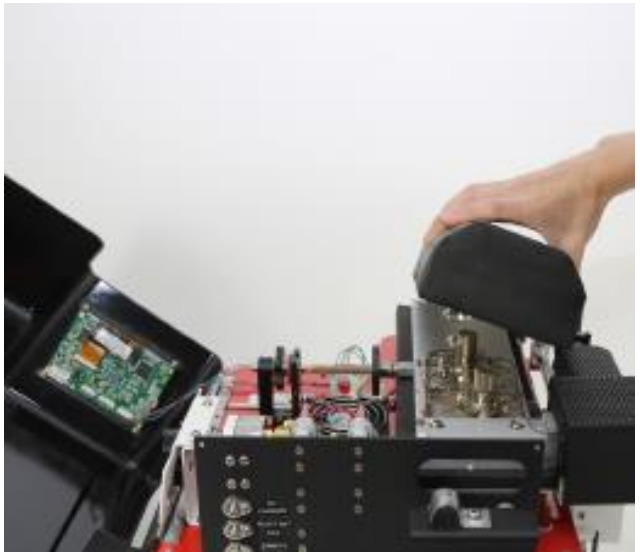


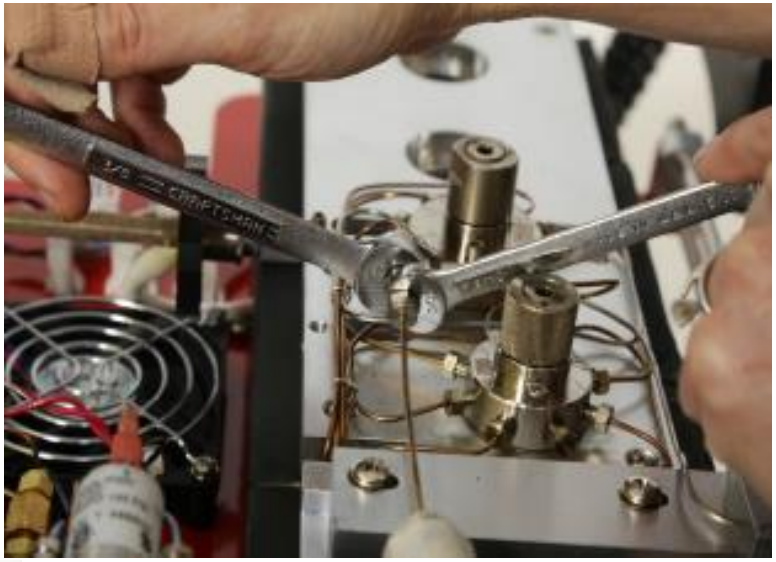


ELECTRICAL CONNECTIONS



TRANSFERLINE CONNECTION



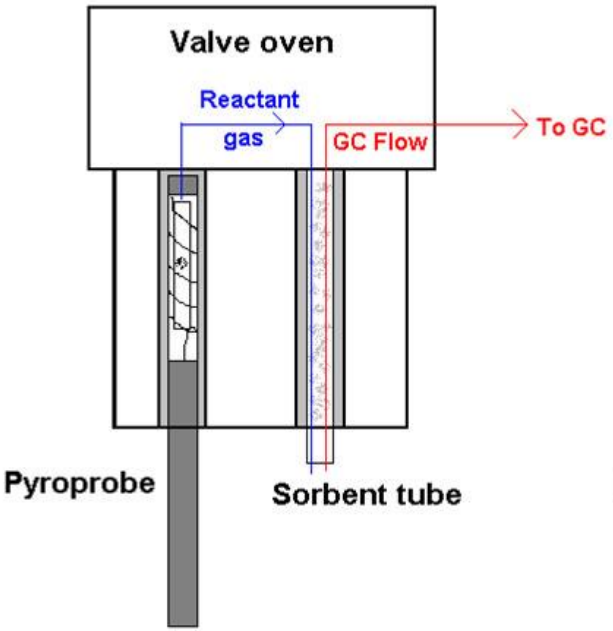


Pyroprobe 6200

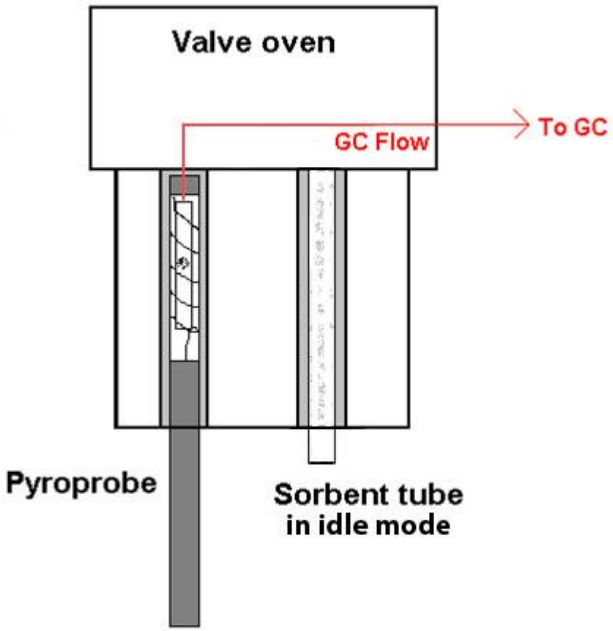
- All features of 6150
- Has built in "sorbent" trap and Thermal Desorber
  - Allows pyrolysis in air analysis
  - Thermal desorption chamber- analyze sorbent tubes or thermal extraction of large sized samples
  - Slow rate pyrolysis with trapping
- Can interface to GC or to trap
- Trap Specifications-
  - Heating up to 400C
  - Heating rate > 900C/min
  - Supplied with 3 Bed-Trap
  - Other packing materials available

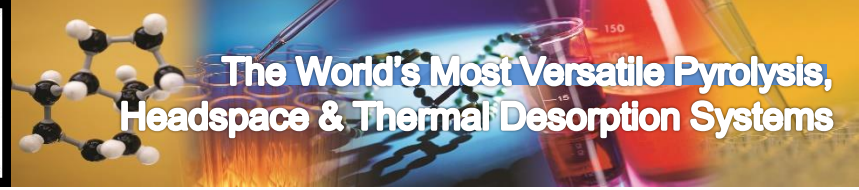
Pyroprobe 6200

Configuration 1.
Flow goes from the probe to the trap then from the trap to the GC.

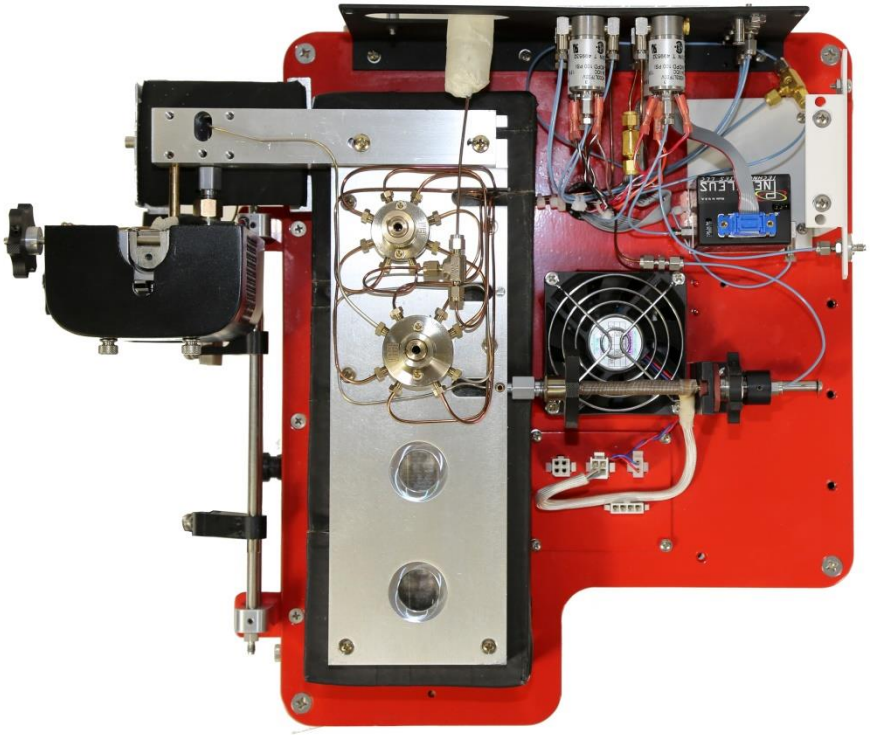


Configuration 2.
Flow goes from the probe directly to the GC.





PYROPROBE 6200



New Pre-Heat feature is added onto the trapping version, 6200.

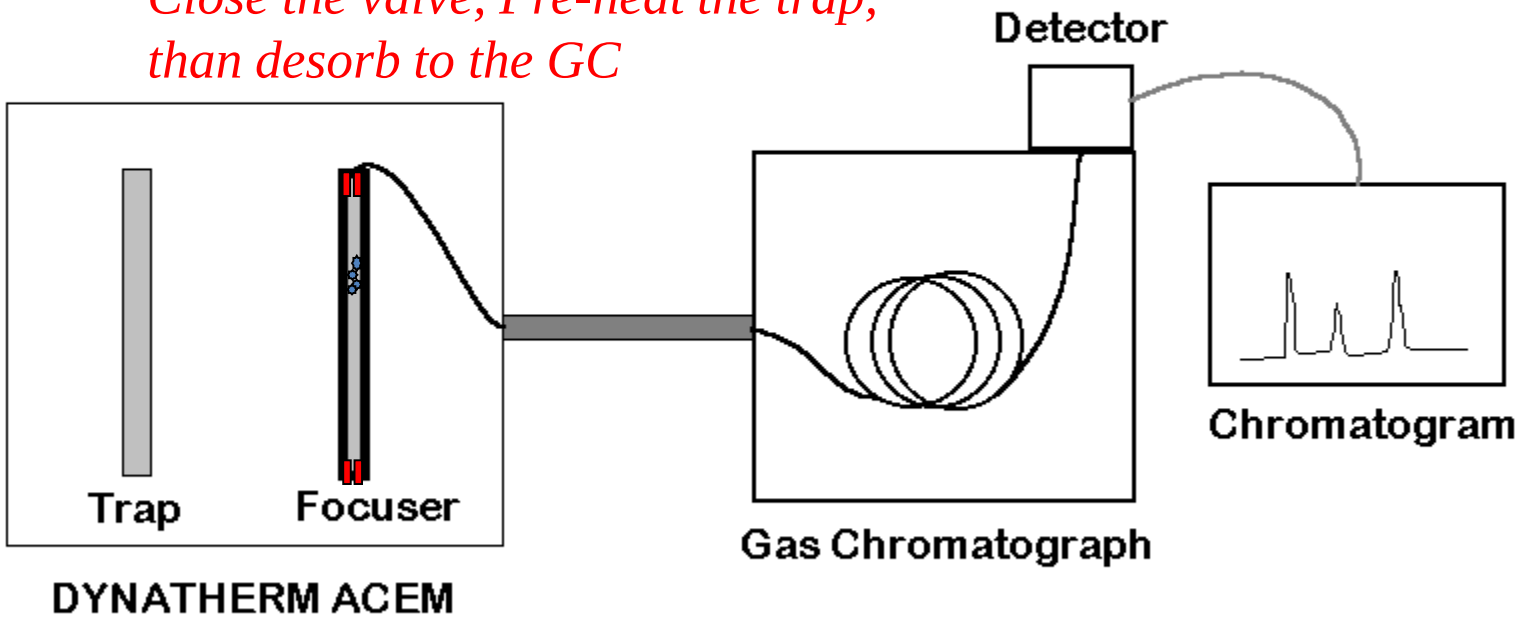
This feature has long been used in our Dynatherm product line and helps sharpen up the early eluting peaks.

Cryo is no longer needed on the 6200, however it is available if your customer still desires it.

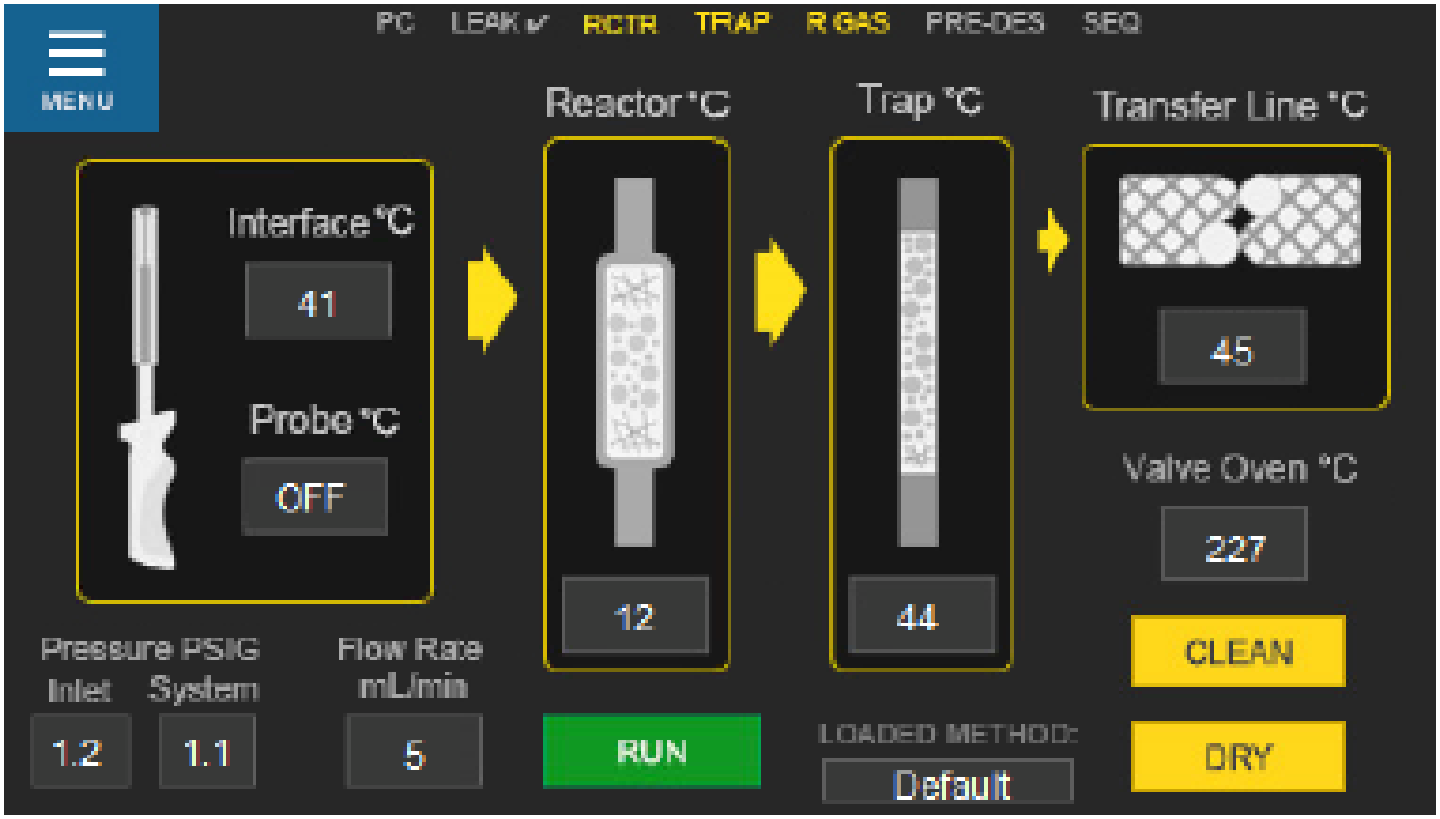
Only “click” software needed to change from py-trap to py-direct mode

Transfer from the focuser to the GC for chromatogram

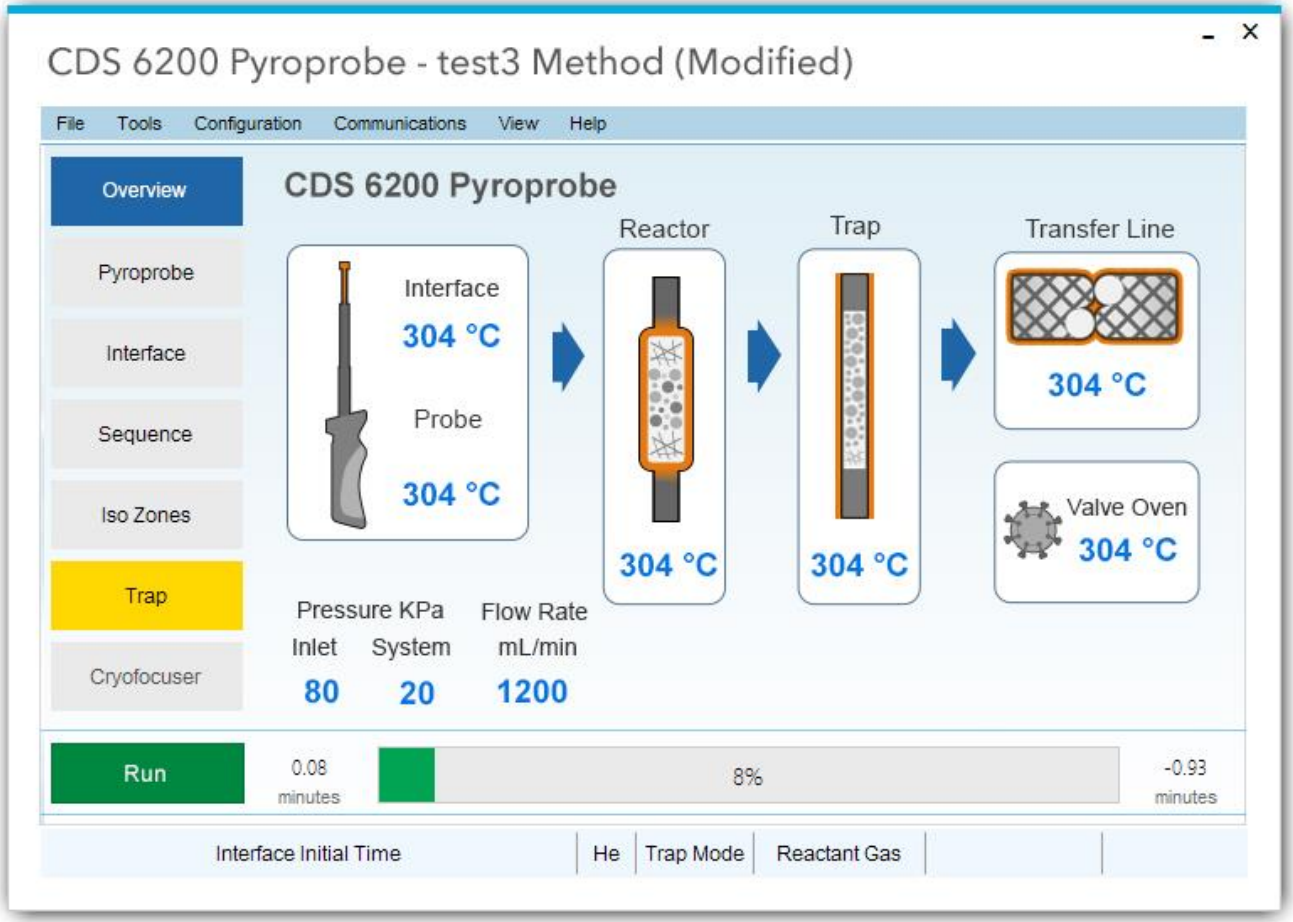
Close the valve, Pre-heat the trap, than desorb to the GC

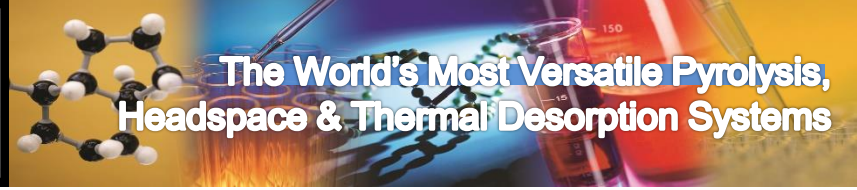


LCD TOUCH SCREEN



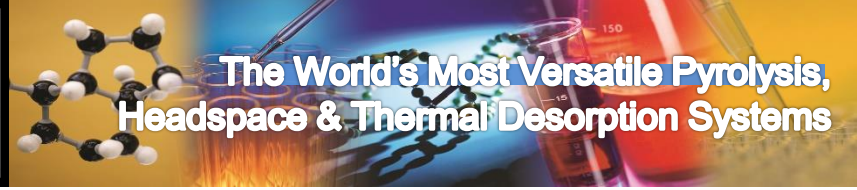
OPERATING SOFTWARE



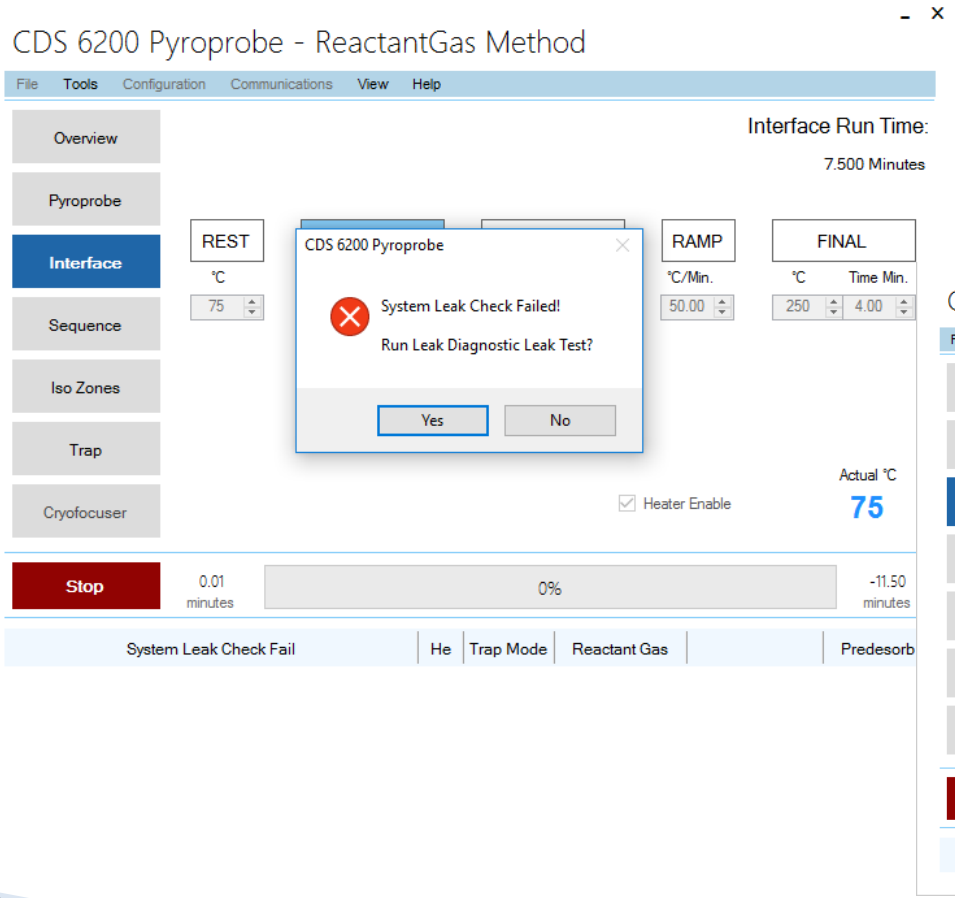


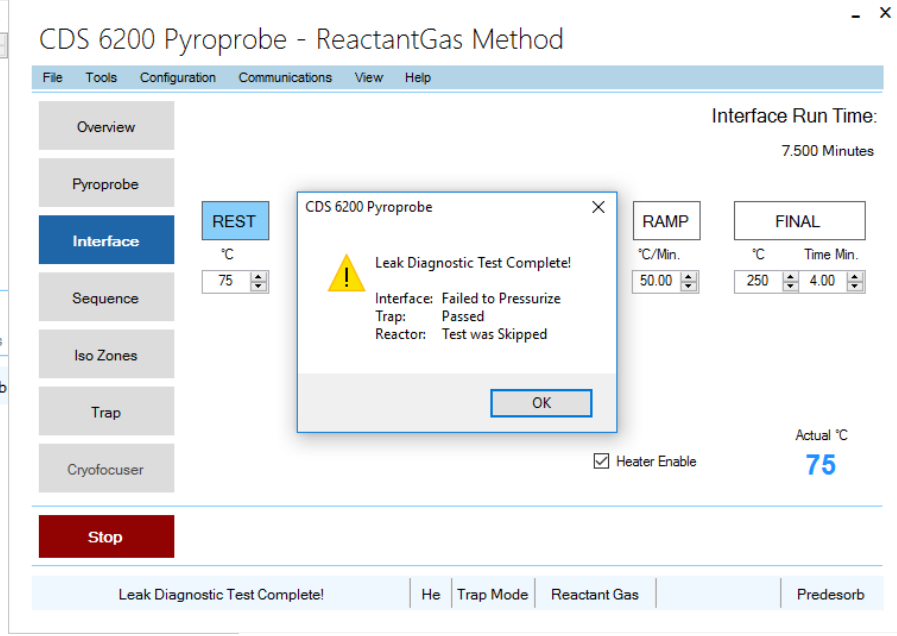
NEW LEAK CHECK FEATURE

- System pressure checks as a pre-run test (if selected) or with the press of a button for PM test.
- If it fails, you will be pointed to the failed device including the interface, trap, reactor or system.
- User adjustable pressure setting and leak decay time…



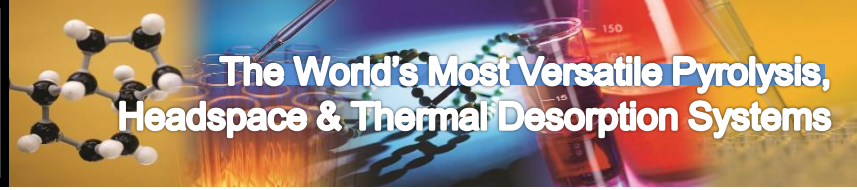
LEAK CHECK TEST/ERROR





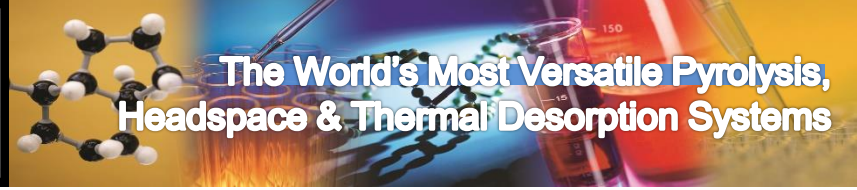
OTHER NEW FEATURES

- Incorporates a USB and Ethernet (coming soon) communication port.
- New graphics plot out the temp vs time profile for your programmed run
- Includes a pyrolysis and thermal desorption library of 50 preprogrammed methods.
  - Saves user time and prevents miss-programming
  - Not offered by competitors

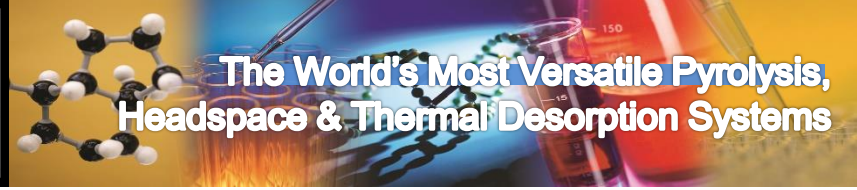


Pyrolysis Method Libraries

FILE NAME	METHOD	APPLICATION/DESCRIPTION
	SINGLE STEP METHODS	
SS-01	Heats sample to 200C	looks for volatiles from sample. Polymers not being analyzed
SS-02	Heats sample to 300C	looks for volatiles & semi-volatiles. Polymers not being analyzed
SS-03	Heats sample to 400C	looks for all volatiles & semi-volatiles.
SS-04	Fast Pyrolysis at 500C	
SS-05	Fast Pyrolysis at 600C	General polymer defomulation- best for natural polymers, cellulose etc
SS-06	Fast Pyrolysis at 700C	General industrial polymer defomulation
SS-07	Fast Pyrolysis at 750C	General industrial polymer defomulation
SS-08	Fast Pyrolysis at 900C	Generally used for coal analysis
SS-09	Fast Pyrolysis at 1000C	Typically used for the 1/2 inch probe and soil analysis
	SINGLE STEP METHODS WITH INITIAL PURGE TO VENT	These methods purge volatiles to vent BEFORE pyrolyzing the sample
SSPV-01	sample purged to vent at 150C then pyrolyzed at 700C	purges unwanted water & residual solvents from sample
SSPV-02	sample purged to vent at 250C then pyrolyzed at 700C	purges all volatiles before pyrolyzing polymer
SSPV-03	sample purged to vent at 300C then pyrolyzed at 700C	purges all volatiles & most semi-volatiles before pyrolyzing polymer
	TWO STEP SEQUENCE METHODS	Allows you to run the same sample twice to better determine additives
		from polymer fragments. Auto starts GC on each run
2S-01	Sample heated to 200C then 700C	sends volatile additives to GC for analysis before pyrolyzing sample
2S-02	Sample heated to 300C then 700C	sends most additives to GC for analysis before pyrolyzing sample
2S-03	Sample heated to 700C then 900C	First run analyzes complete sample. Second run verifies that sample is
		completely pyrolyzed
2S-04	Sample purged at 150C then heated to 300C & 700C	Purges unwanted water/solvents before starting 2 step method
2S-05	Sample heated to 350C then 700C	send all volatiles & semi-vol to GC for analysis before paralyzing sample



	MULTI STEP SEQUENCE METHODS	Sample will be run with 3 or more methods and a GC run on each
MS-01	Sample heated to 150C, 300C then 700C	Allows analysis of volatiles , semi-V and polymers w/ individual GC run
MS-02	Sample heated to 200C, 350C then 700C	Allows analysis of volatiles , semi-V and polymers w/ individual GC run
MS-03	Sample heated to 100C, 200C, 300C, 400C	4 step method showing thermal cutting of non-polymeric compounds
MS-04	Heated to 100C, 200C, 300C, 400C, 500C, 600C, 700C, 800C	8 step method showing thermal separation at 100C intervals
MS-05	Sample purged at 150C then heated to 250C, 350C & 700C	Purges unwanted water/solvents before starting 3 step method
	TRAPPING METHODS	Will demonstrate what compounds are evoled and formed with a slow
		temperature ramp
TM-01	Sample pyrolyzed at 50C/minute up to 700C	Allows for evolved gas studies
TM-02	Sample pyrolyzed at 100C/minute up to 700C	Allows for evolved gas studies
TM-03	Sample pyrolyzed at 500C/minute up to 700C	Allows for evolved gas studies
TM-04	Sample pyrolyzed at 100C/min up to 300C then to 700C	2 step method with a temp rise of 100C/min for each step
	REACTIVE GAS-TRAPPING METHODS	Sample is pyrolyzed in a reactant gas and then captured on to trap.
		Used for reactive studies of sample and background gas
RG-01	Sample pyrolyzed at 700C with ramp of 10C/second	allows maximum reaction time between py sample and reactant gas
RG-02	Sample pyrolyzed at 700C with ramp of 100C/second	allows less reaction time between py sample and reactant gas
RG-03	Sample pyrolyzed at 700C with ramp of 1000C/second	allows least reaction time between py sample and reactant gas
RG-04	same as RG-01 EXCEPT Trap rest temperature is at 100C	light volatiles will be purged and not analyzed
RG-05	same as RG-02 EXCEPT Trap rest temperature is at 100C	light volatiles will be purged and not analyzed
RG-06	same as RG-03 EXCEPT Trap rest temperature is at 100C	light volatiles will be purged and not analyzed

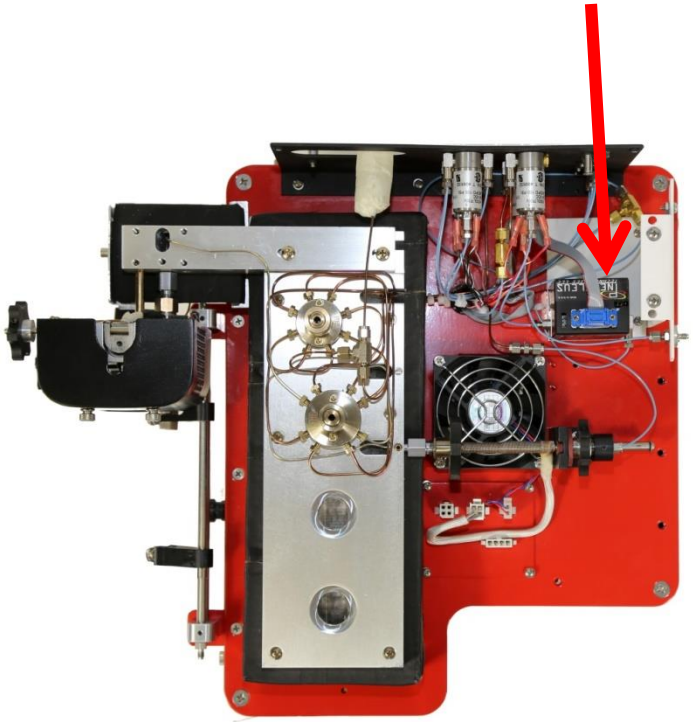


	SLOW TEMPERATURE RAMP METHODS -EGA	Normally used to send sample direct to MS for analysis. GC can be
		configured with empty fused-silica column to transport sample
		through GC oven into MS
ST-01	Sample heated to 700C at 50C/minute	For Evolved Gas Analysis
ST-02	Sample heated to 700C at 100C/minute	For Evolved Gas Analysis
ST-03	Sample heated to 800C at 100C/minute	For Evolved Gas Analysis
ST-04	Sample heated to 800C at 500C/minute	For Evolved Gas Analysis
	THERMAL DESORPTION PROBE METHODS	Uses the CDS thermal desorption probe in place of the pyrolysis
		probe.
TDP-01	Sample heated to 200C for 1 minute	Allows thermal desorption of volatiles to trap
TDP-02	Sample heated to 300C for 1 minute	Allows thermal desorption of most volatiles & semi Vol's to trap
TDP-03	Sample heated to 350C for 1 minute	Allows thermal desorption of all volatiles & semi Vol's to trap
	TOBACCO METHODS	Several methods have been published that try to best simulate the
		temperture of burning tobacco and to set an average heat increase
		while the cigarette is being smoked. These methods use a 9% O2 in
		N2 as the reactant gas and an average heat rate or 30C/sec.
TOB-01	300C for 5 sec then to 900C for 5 sec. Heat rate 30C/sec	Shows all compounds formed from the inside of the hot zone to the
		outside of hot zone
TOB-02	600C for 5 sec then to 900C for 5 sec. Heat rate 30C/sec	Shows compounds formed in burning "unpuffed cigaretter (600C)
		up to "puffed" cigarette temprature of 900C

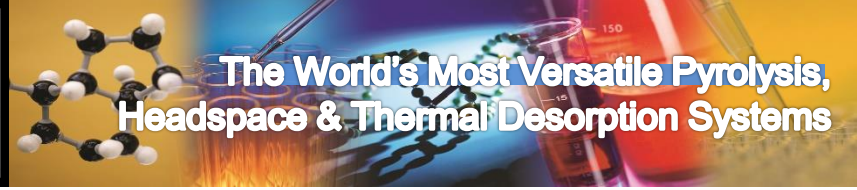
Notes: Unless otherwise stated, all sample lines and valve box temperatures are programmed isothermally at 325C

If using any of the trapping methods, please confirm that the software has been set for trap mode. You can find this under the "configurat

Mass Flow Control Option



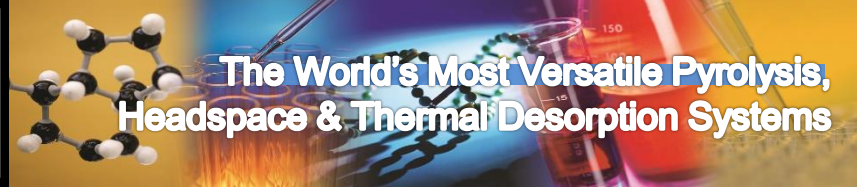
- Program and read actual flow rates (purge & reactant gas) from software, providing the mass flow control option was purchased.
  - Will also allow programming of gas flow into reactor
  - Important for optimizing reactant gas flows for reaction studies



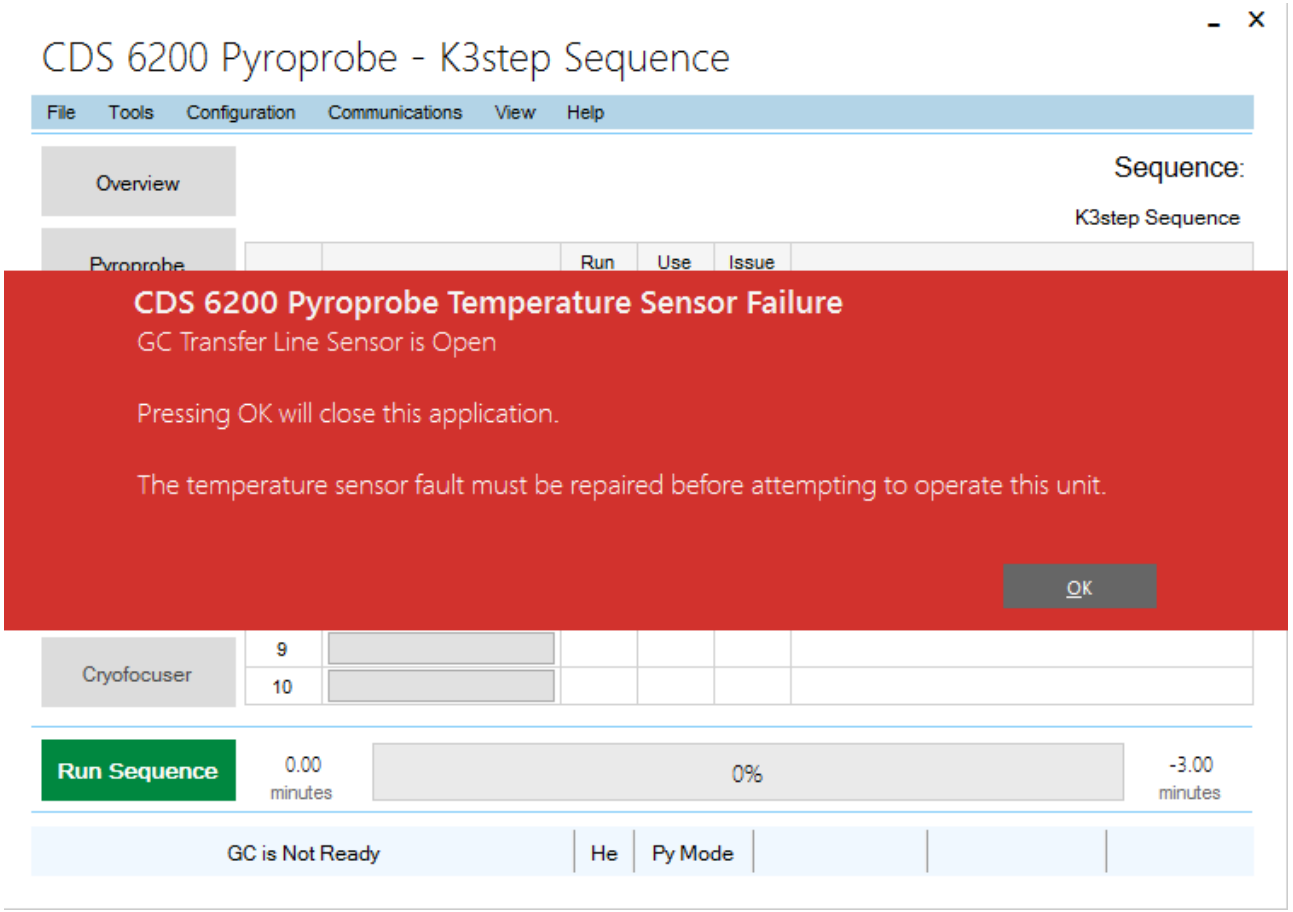
OTHER NEW FEATURES

- Monitor system with your smart phone or tablet
  - Alerts when finished or system error
  - Release date in 2017..free upgrades for earlier units sold.
- Easy to read diagnostic errors displayed in the software screen

- Easier upgrade path to Autosamplers



SYSTEM DIAGNOSTICS



Pyroprobe Open Sensor
Pyroprobe Over-Temperature

Interface Open Sensor
Interface Shorted Sensor
Interface Over-Temperature

Trap Open Sensor
Trap Shorted Sensor
Trap Over-Temperature

Valve Oven Open Sensor
Valve Oven Shorted Sensor
Valve Oven Over-Temperature

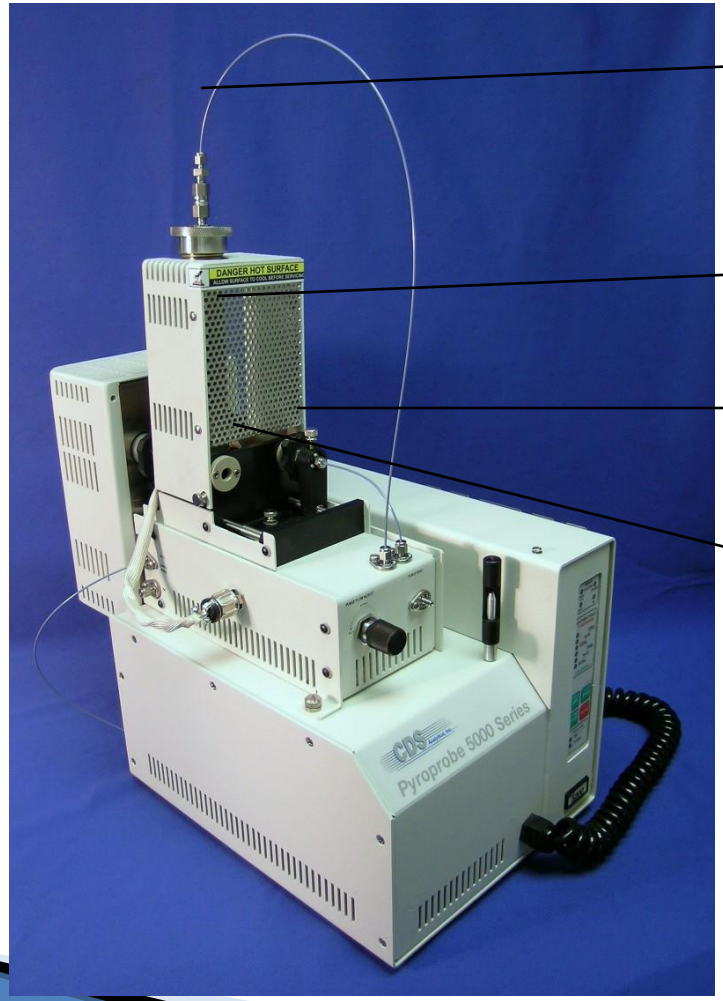
GC Transfer Line Open Sensor
GC Transfer Shorted Sensor
GC Transfer Over-Temperature

Reactor Open Sensor
Reactor Shorted Sensor
Reactor Over-Temperature

Reactor Oven Open Sensor
Reactor Oven Shorted Sensor
Reactor Oven Over-Temperature

Focuser Open Sensor/short/over temp

5200 & Test Tube Desorber



Purge Gas Through Top

Test Tube Head Space Vessel

Sorbent Trap

Chamber for pyroprobe or thermal desorption tube

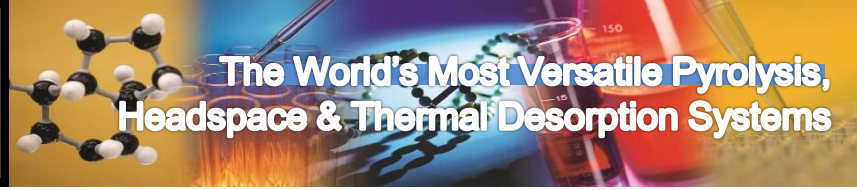
OPTIONAL DHS VESSEL

Optional Dynamic Headspace vessels will be capable of direct desorption to the trap in 6200

Sizes: 25 ml test tube desorber, 150 ml horizontal chamber and 800 ml chamber

5200 had ability only for test tube desorber

Thermally extract large machined parts, food, packaging etc..



AUTOSAMPLERS

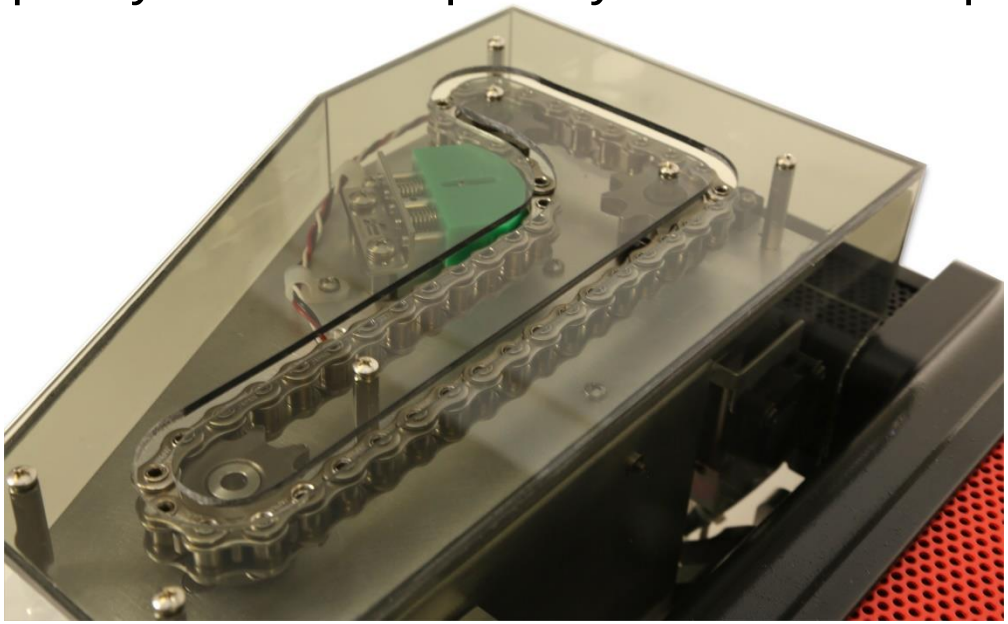
- CDS was first company to market a pyrolyzer autosampler (1999), model 2500
- Market turned out to be bigger than imagined- now 30% of py sales
- Autosampler offers great upgrade opportunities on manual systems
- Will still offer 5250 upgrades for several years, maybe longer
- Autosamplers do not have the life of a manual system. Should be on a 7-10 year trade-in cycle

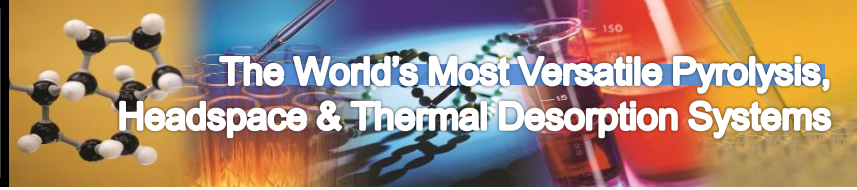
6250 AUTOSAMPLER

- Easy upgrade from any 6150 or 6200
- Manual and AS system can be interchanged by user
- Same operating specs as 5250:
  - 1300 C max temp
  - .01C/min- 20,000/sec heating rate
- 47 samples can be originally loaded, but samples can be added continuously to empty slots after analysis (Sequential analysis only)
- Tray temperature stays at (or near) Ambient

6250 AUTOSAMPLER

- No valves, No rotors
  - Increases reliability
- Easily exchangeable pyrolysis chamber
- Py chamber cools quickly so multi-step analysis can still be performed



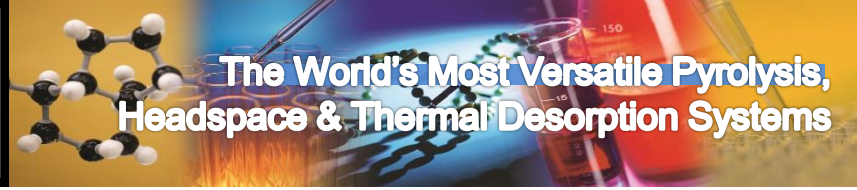


OTHER ANALYTICAL CAPABILITIES FROM A "STATE OF THE ART" PYROLYZER

A REVIEW

- Pyrotomy; Fast pulsed pyrolysis for layered samples
- Simulated TGA (Evolved Gas Analysis)
- VOC's in Air by desorbing thermal desorption tubes (with optional trapping pyrolyzers)
- Thermally desorb large sample sizes for volatiles
- Combustion studies- pyrolysis in air
- Special programming features

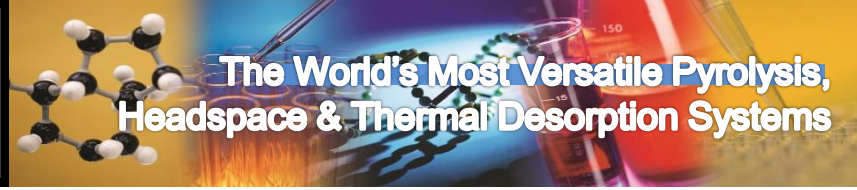
ONLY FILAMENT TECHNOLOGY CAN DO ONES IN RED

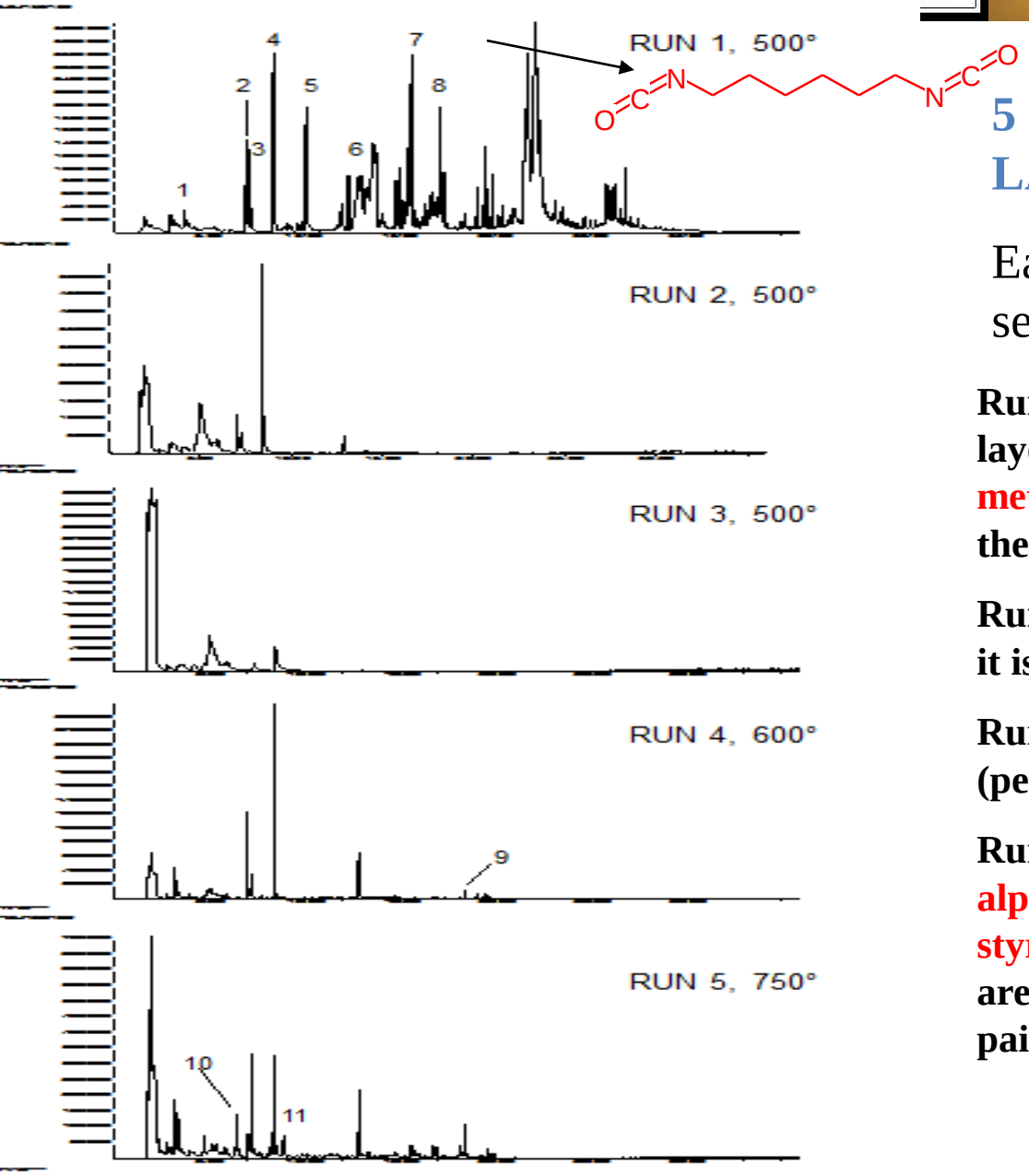


PYROTOMY TECHNIQUE

A pyrolysis method that applies many short high-temperature runs on the same sample

- Technique used for analyzing composition of different polymer layers in a sample
- Works best on multi-layered paints; but also films, coated paper and laminated compounds
- Can also be applied to surface contamination
- Each pyrolysis run is typically programmed for 1 second or less. This allows analysis of only 1 layer at a time
- Use the CDS ribbon probe for best results





5 STEP ANALYSIS OF A LAYERED PAINT SAMPLE

Each pyrolysis step was for 1 second and then sent to GC

Run 1 shows monomers from the outside layer including styrene, methyl methacrylate and butyl acrylate. Also there is (peak 7) hexane diisocyanate

Run 2 & 3 produces most of the same so it is still the first layer

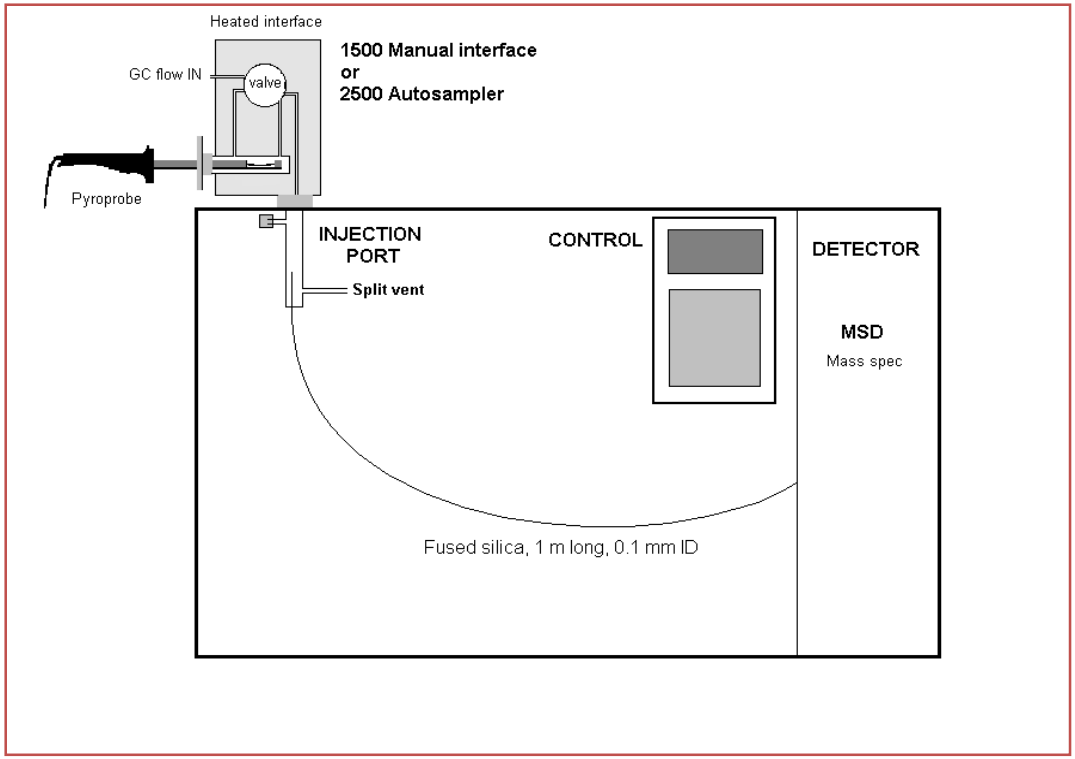
Run 4 produces another polyurethane (peak 9)

Run 5 produces aromatics including alpha-methyl styrene in addition to styrene and acrylics. These compounds are formed from the bottom base layer of paint

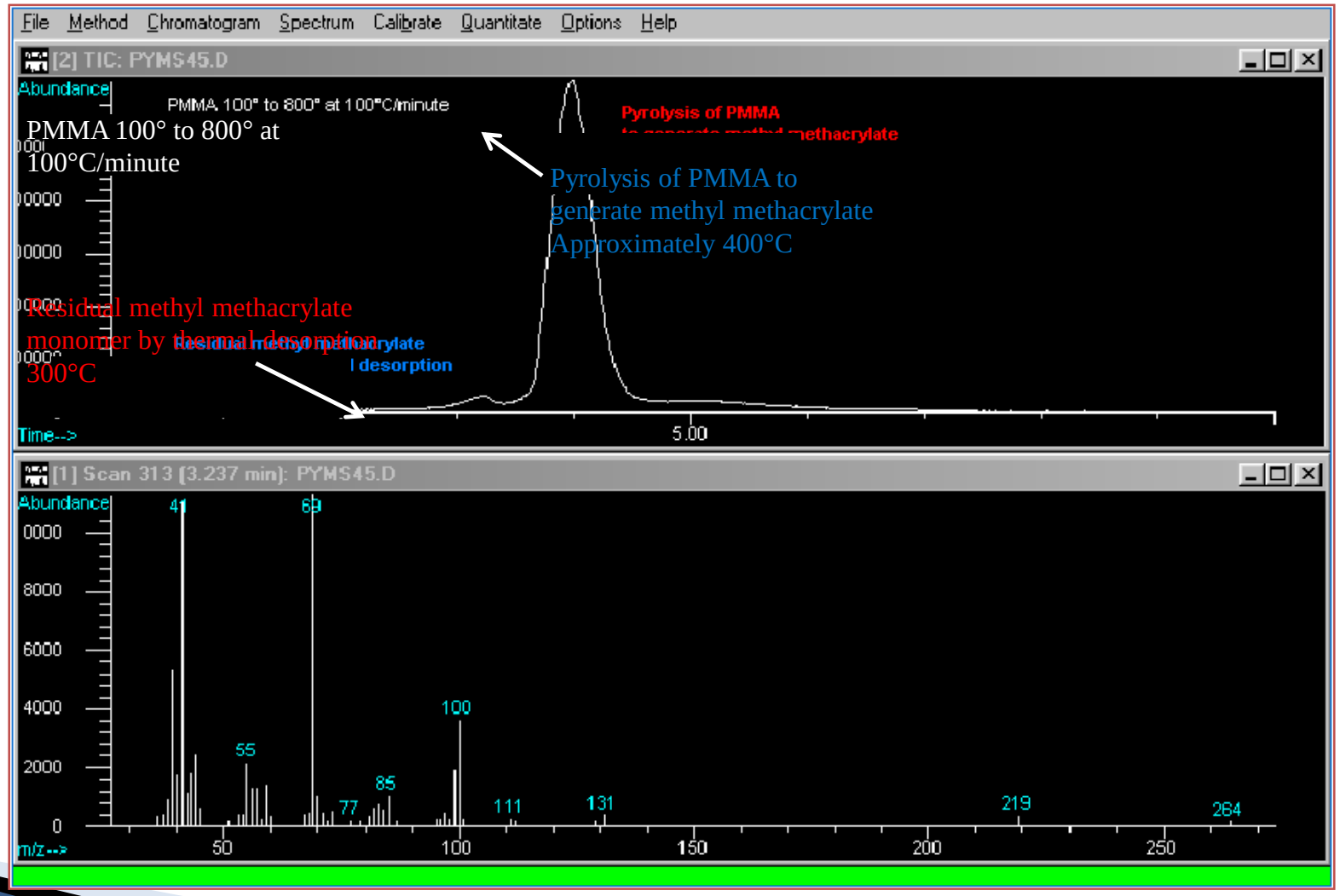
EGA SAMPLING DIRECTLY TO MSD

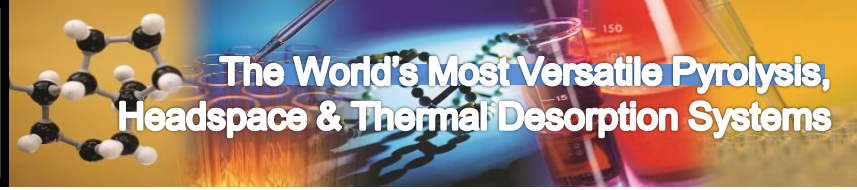
Because the CDS prolyzers can be programmed to heat slowly in degrees per minute, it may be used to introduce samples at controlled thermal rates for analysis by FT-IR and direct-MS, like a TGA system

The pyrolyzer is connected to an MSD using a 1 meter piece of fused silica instead of a GC column.



THERMAL SAMPLING OF PMMA AT 100°C/MINUTE, DIRECTLY TO MSD.

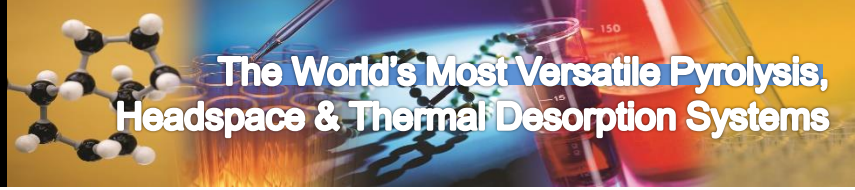




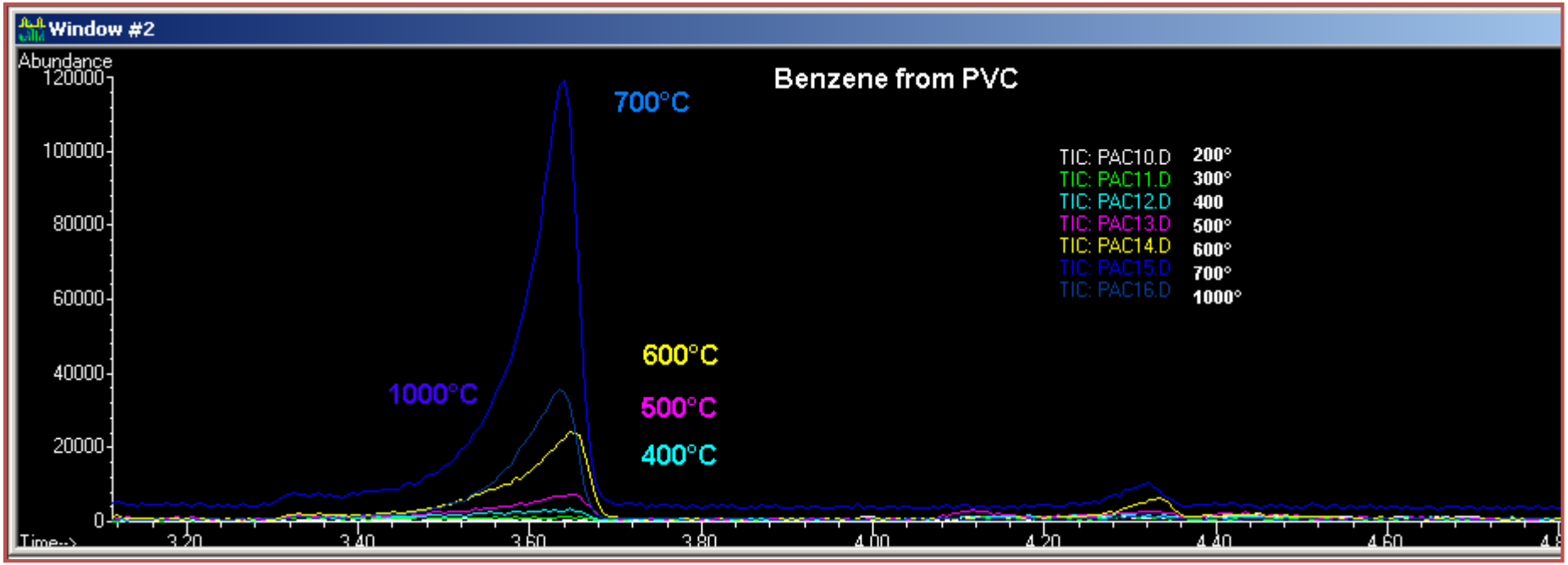
EIGHT RUNS WITH CDS

Many times, two runs are not enough to characterize a material or process. In this example, the production of benzene by heating poly vinyl chloride is studied by sequentially analyzing the same piece of polymer at seven temperatures, each with its own GC run. The 5000 can perform 8 steps per sample just by adding methods to sample tube number in the software.

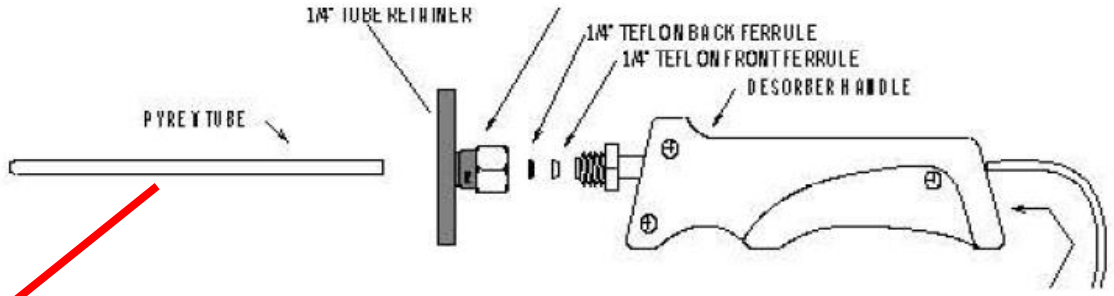
Only CDS pyrolyzers allow up to 8 steps per sample with a GC start on each step.



PRODUCTION OF BENZENE FROM THE SAME PIECE OF PVC AT INCREASING TEMPERATURES



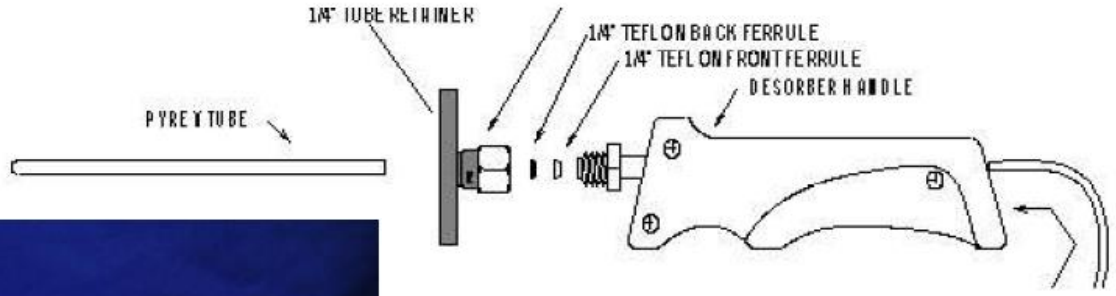
OPTIONAL THERMAL DESORPTION PROBE

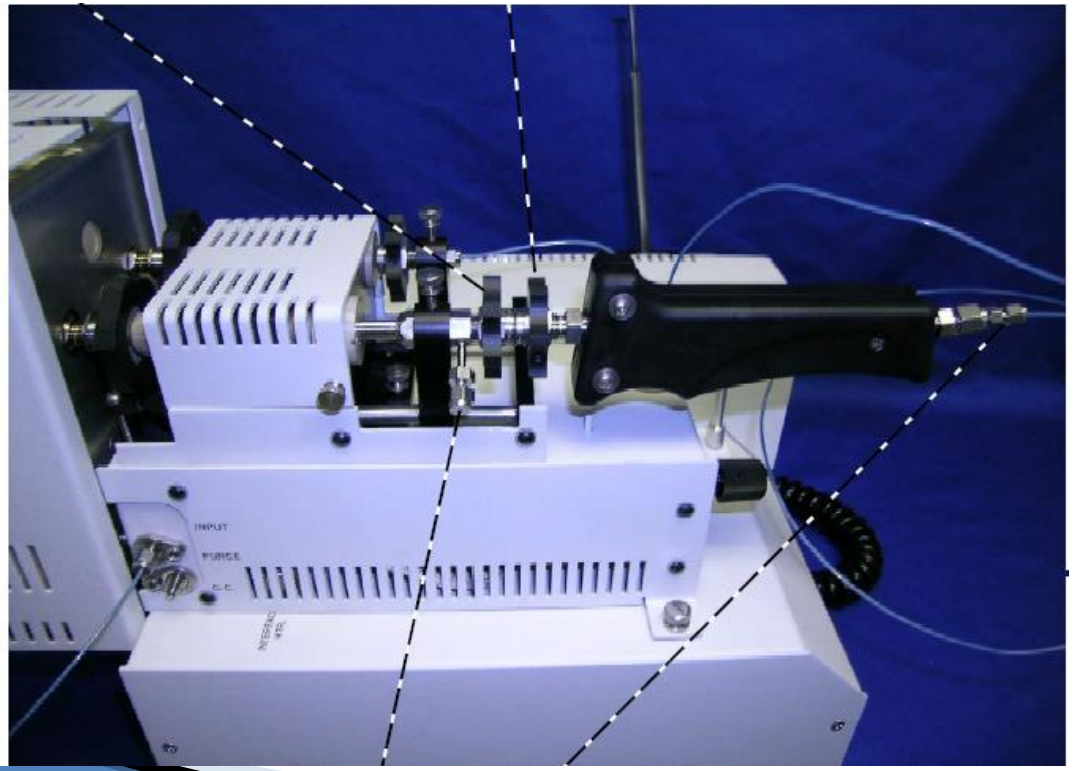


Can be used to thermally desorb "gram" sized solids

Or, used to desorb TD tubes for VOC's in air

OPTIONAL THERMAL DESORPTION PROBE

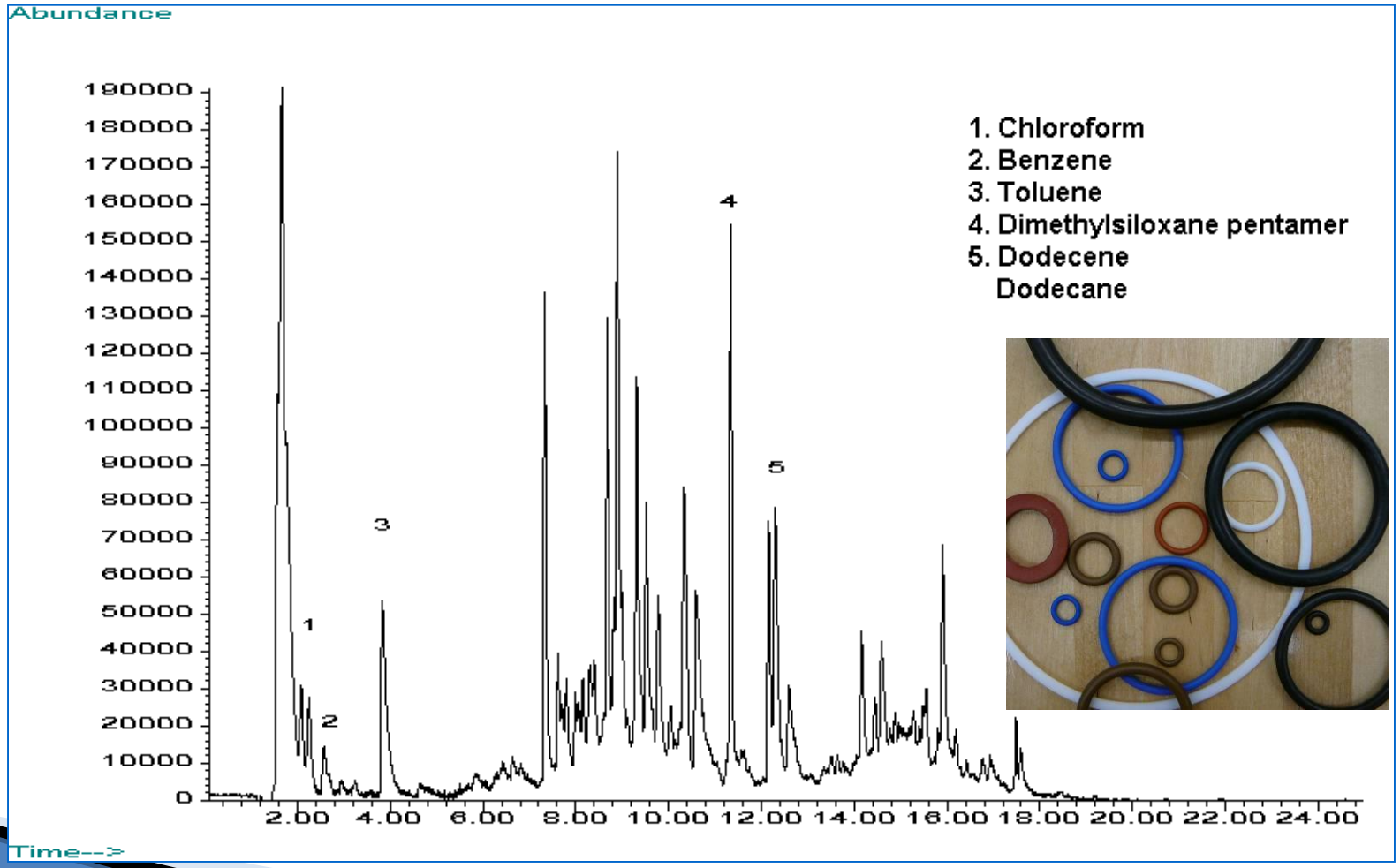




Can be used to thermally desorb "gram" sized solids

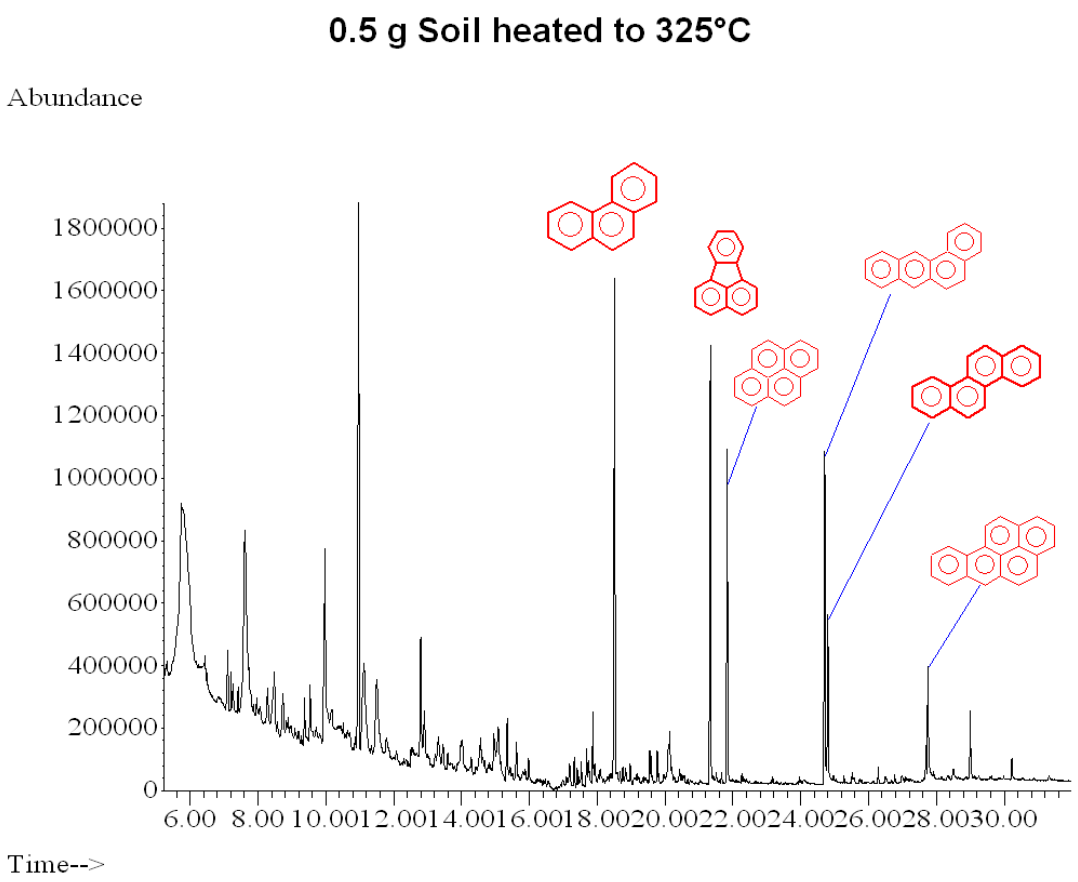
Or, used to desorb TD tubes for VOC's in air

POLYMER ANALYSIS
Residuals in Rubber Gasket - 60°C for 15 minutes



THERMAL EXTRACTION OF PAH's FROM SOIL

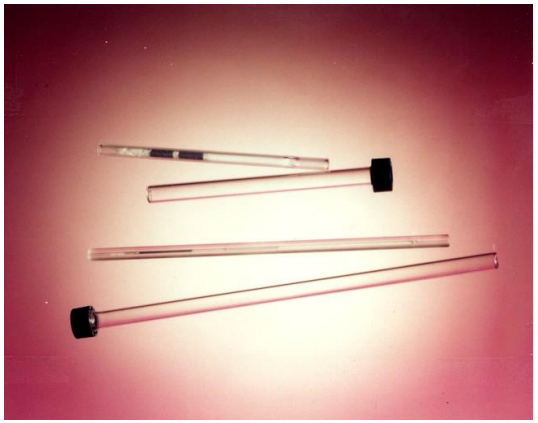
10 PPM each looks like this



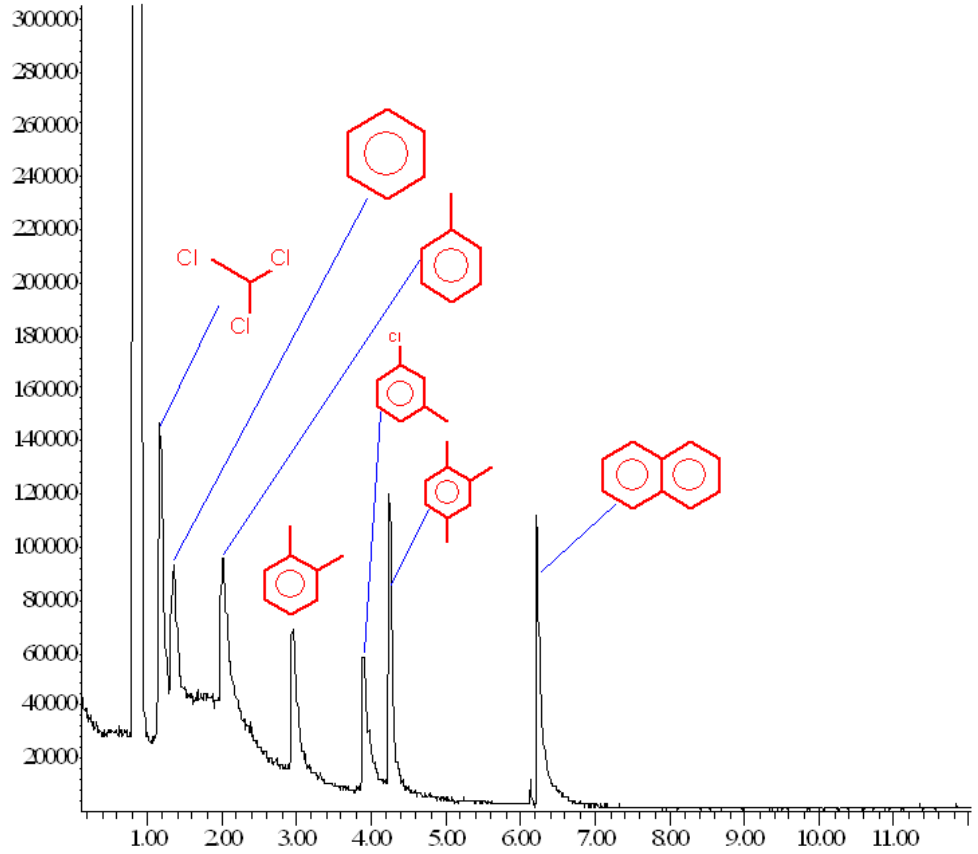
PY Filament was replaced with TD probe

500 mg of soil with PAHs tested.

Soil was heated directly to the GC column

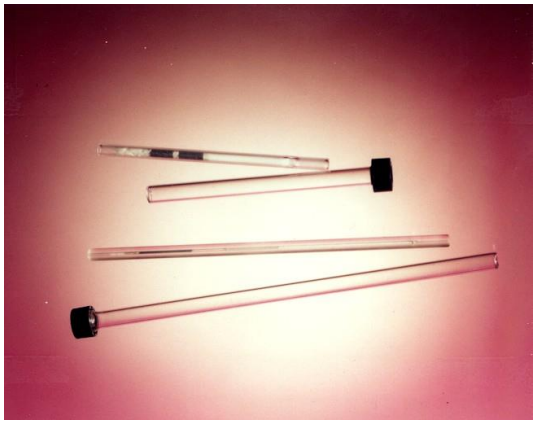


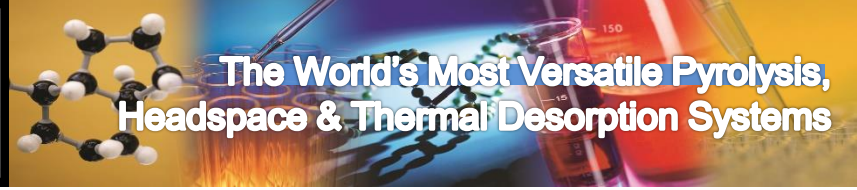
AIR SAMPLE ANALYSIS



Air sample collected on a tenax tube

Desorbed by pyrolyzer from the interface at 325C direct to the column.

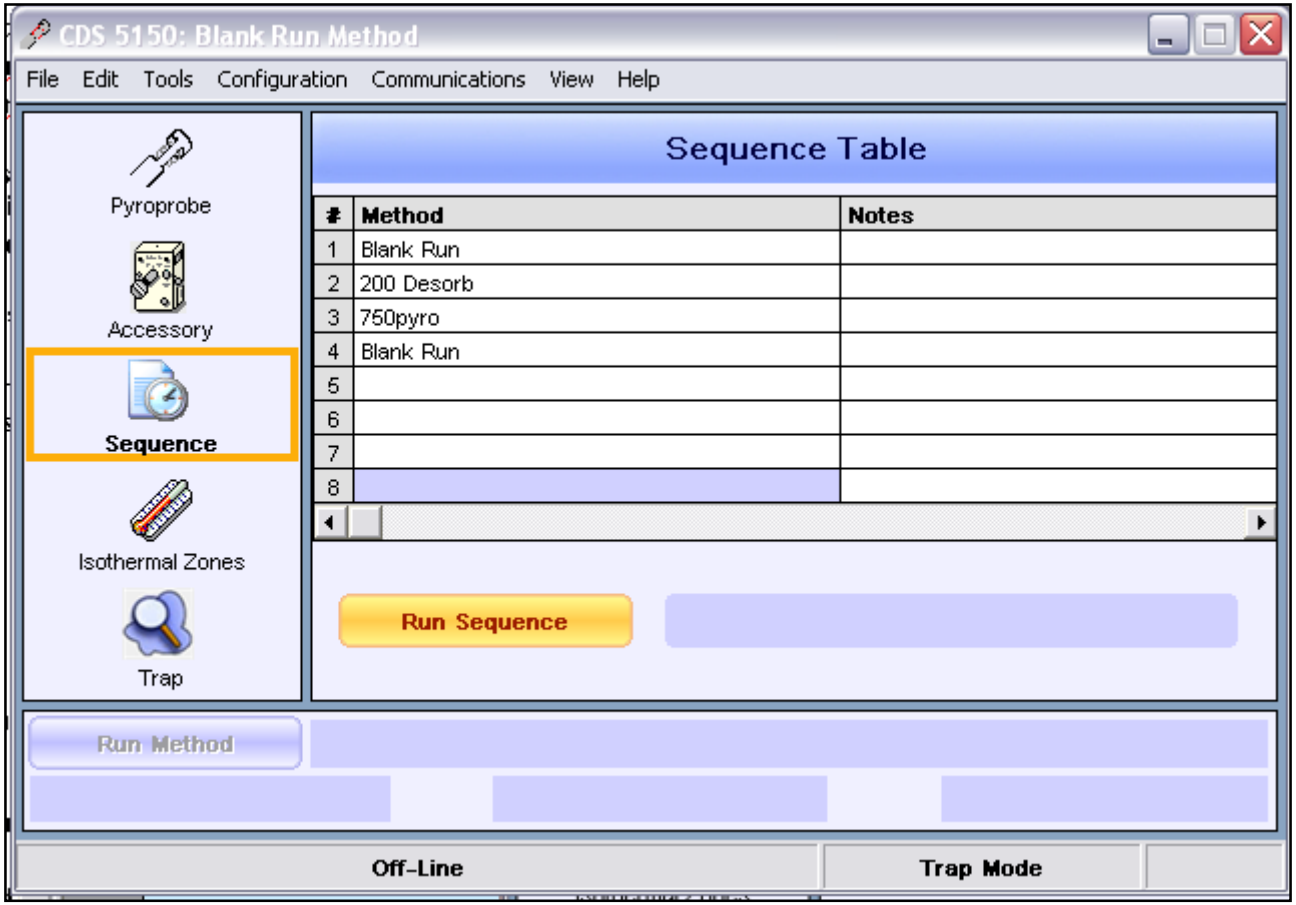


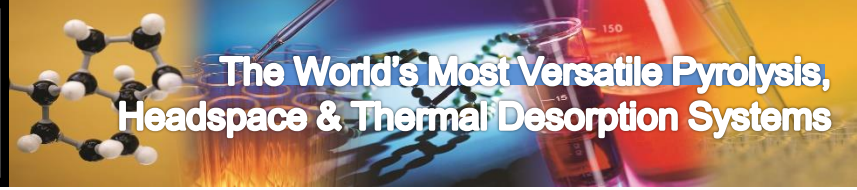


Programmable Sampling Features

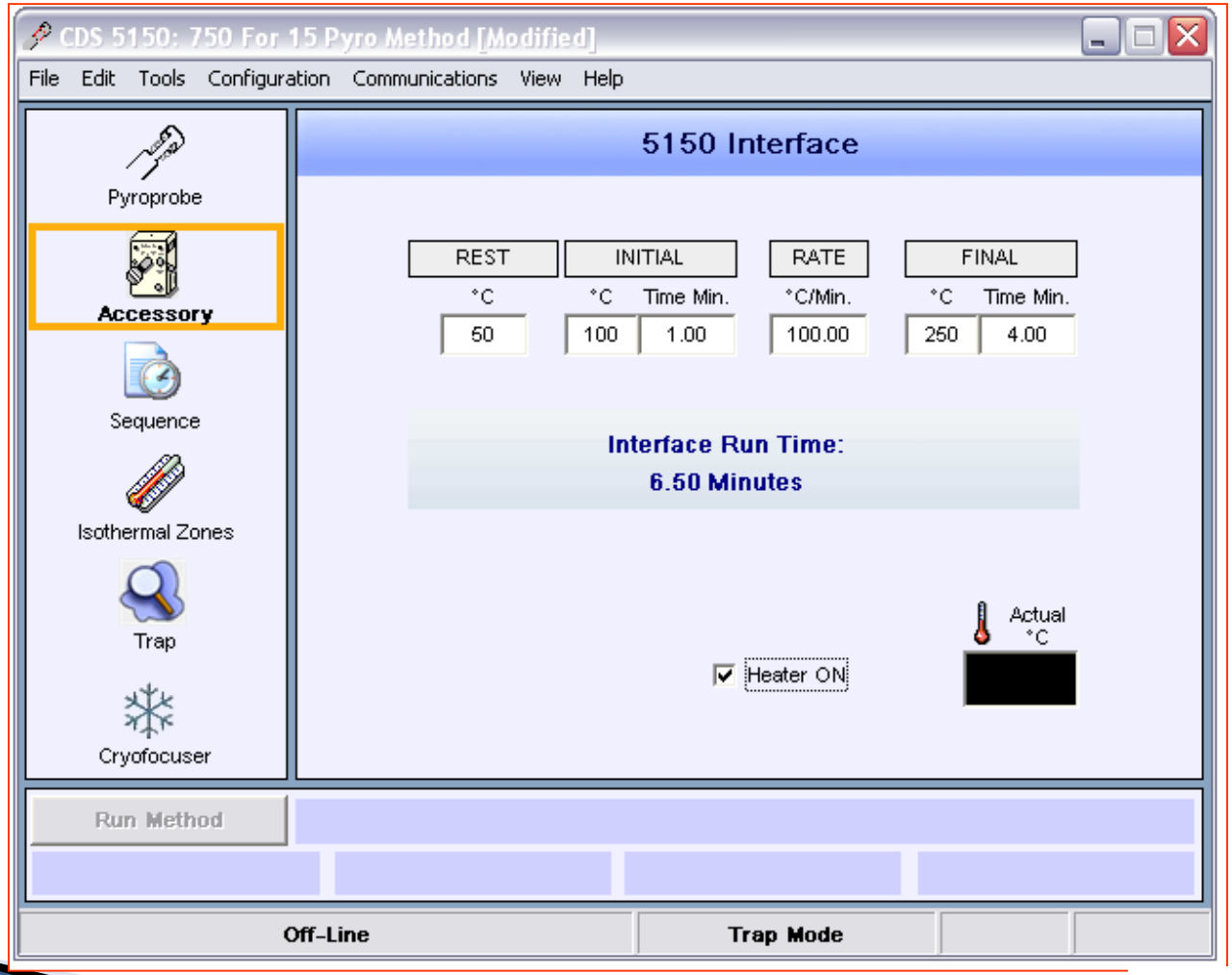
- Automatic blanks
  - Add steps in sequence table
  - Blanks before and after runs
  - Can program to run overnight to save time
- Multiple temperatures per sample
- Purge solvents to vent before running sample

Automatic Blanks

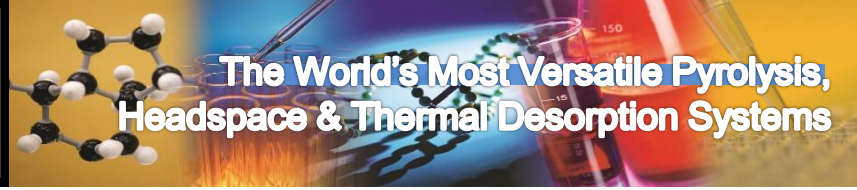




Programmed Interface Temperature

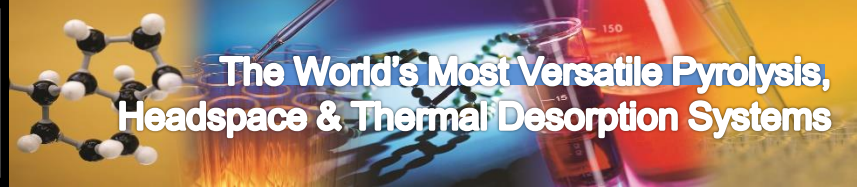


This method is purging the sample to vent at 100C before pyrolyzing the sample



CDS LIBRARY OPTIONS

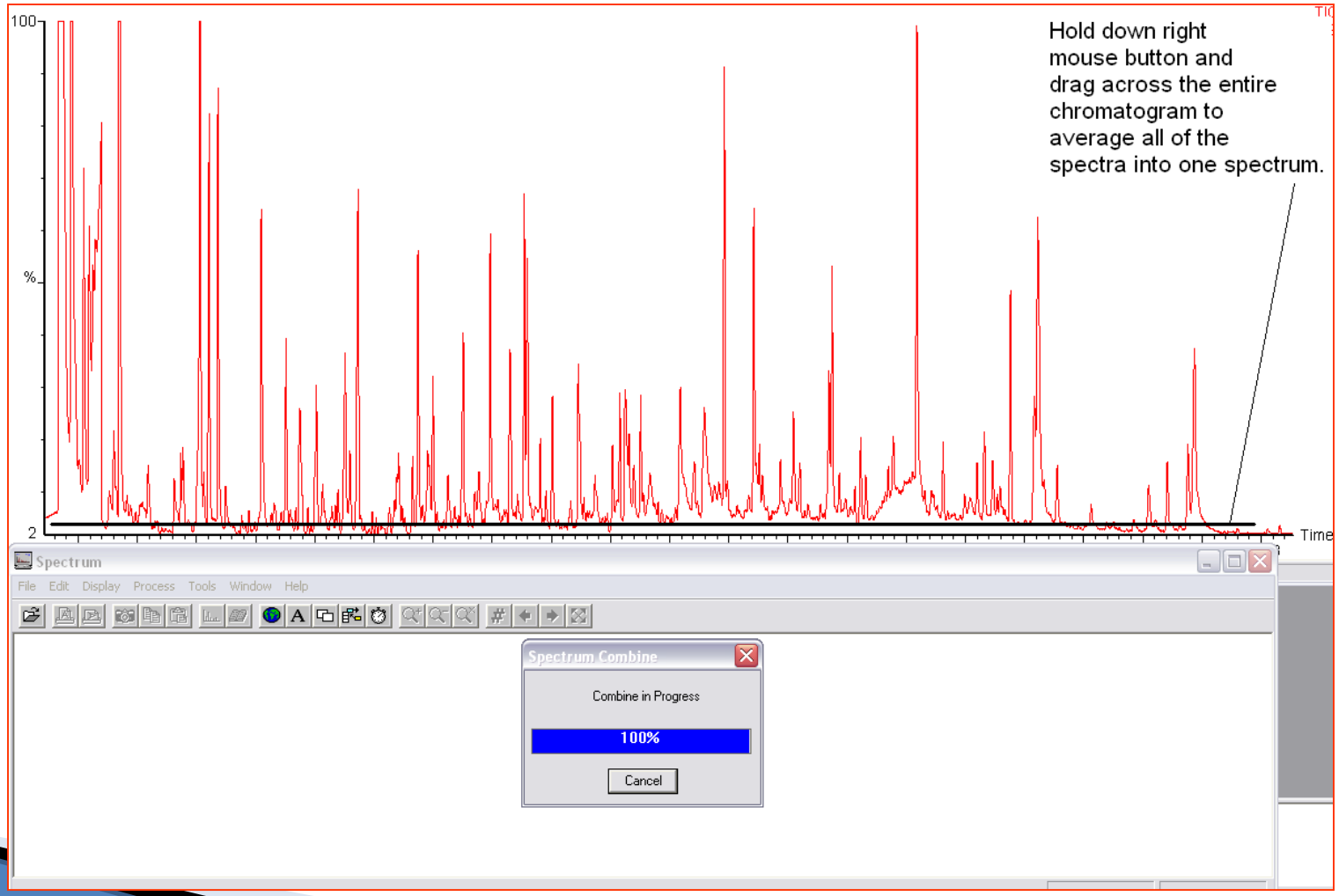
- Polymer library
  - Inexpensive library designed by CDS to help user identify polymers
- Polymer additive library & search software
  - Powerful search tool using deconvolution software and CDS additive library



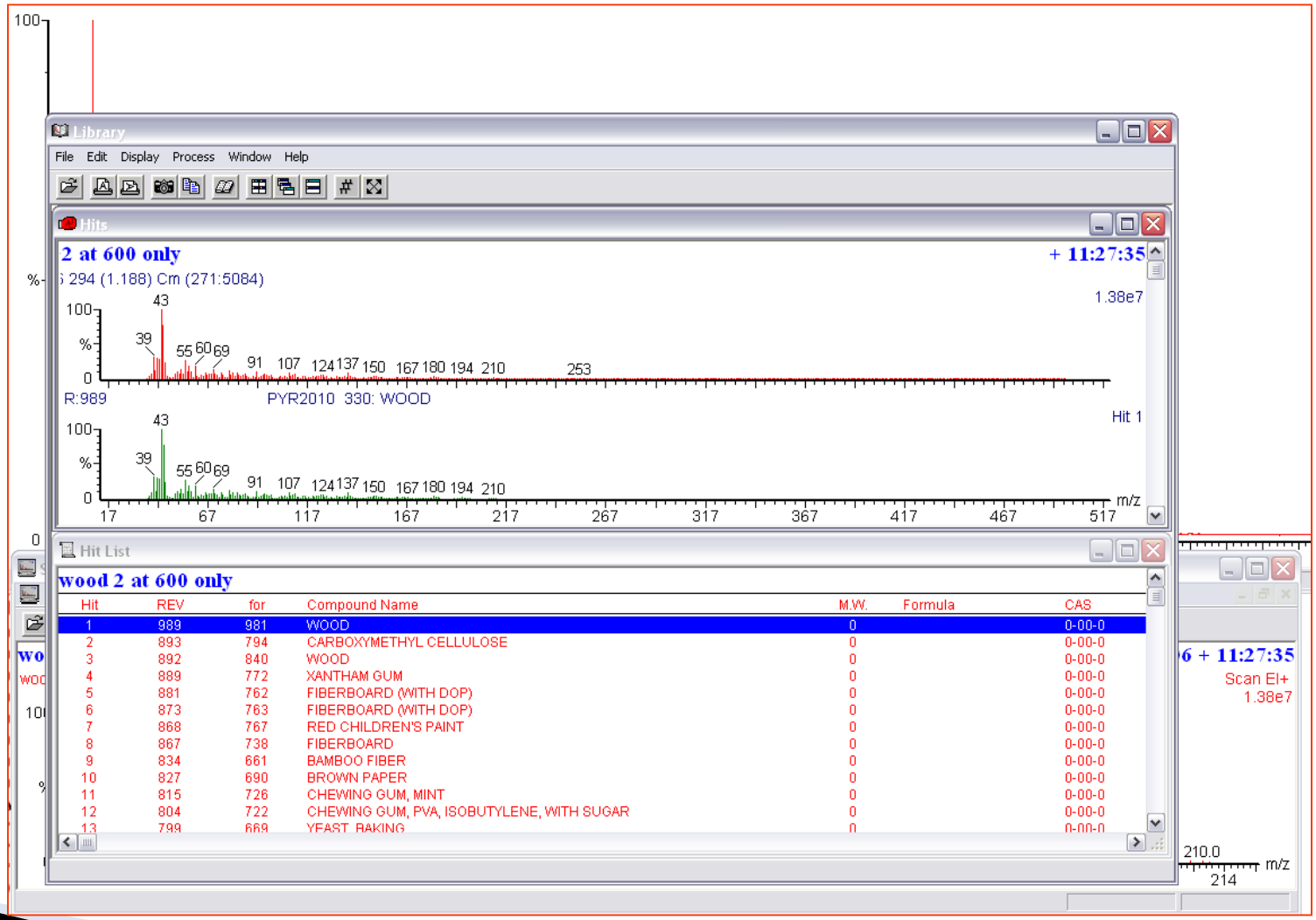
Polymer Library

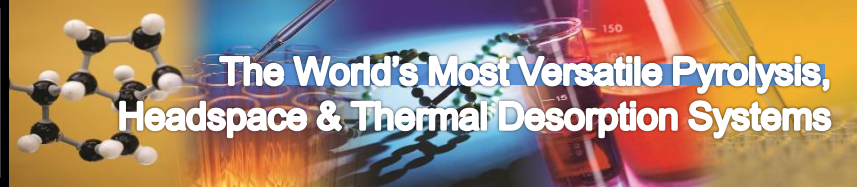
- Currently contains 500+ polymers
- Designed to be used with any MS
- Library has averaged spectra from known polymer samples and compares with samples run for a match
- Customer can add additional compounds
- Can be added to any CDS pyrolyzer
- List price is $1,750

Search for Polymer Match by Averaging



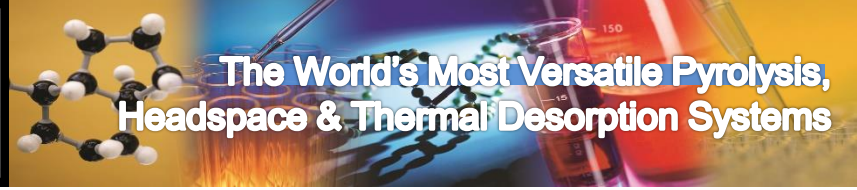
Search in CDS Pyrolysis library





Polymer Additive Library

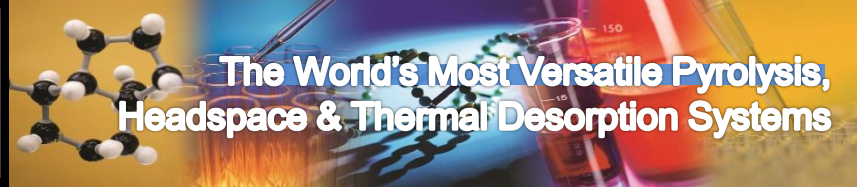
- Customer need- Pyrolysis is being used more to identify unknown additives in polymers.
  - Many of these compounds are not in the Wiley or NIST libraries
  - Additives can be in trace levels, so hard to search for manually
  - User may not know the names of specific additives by category
- Currently contains 250+ additives & 250 + Biofuel Compounds
- Designed to be used with any MS
- You can use Agilent Chemstation or the free AMDIS program from NIST
- Customer can add additional compounds
- Can be added to any CDS pyrolyzer; but must have an MS
- Free upgrades for life!



Polymer Additive Library

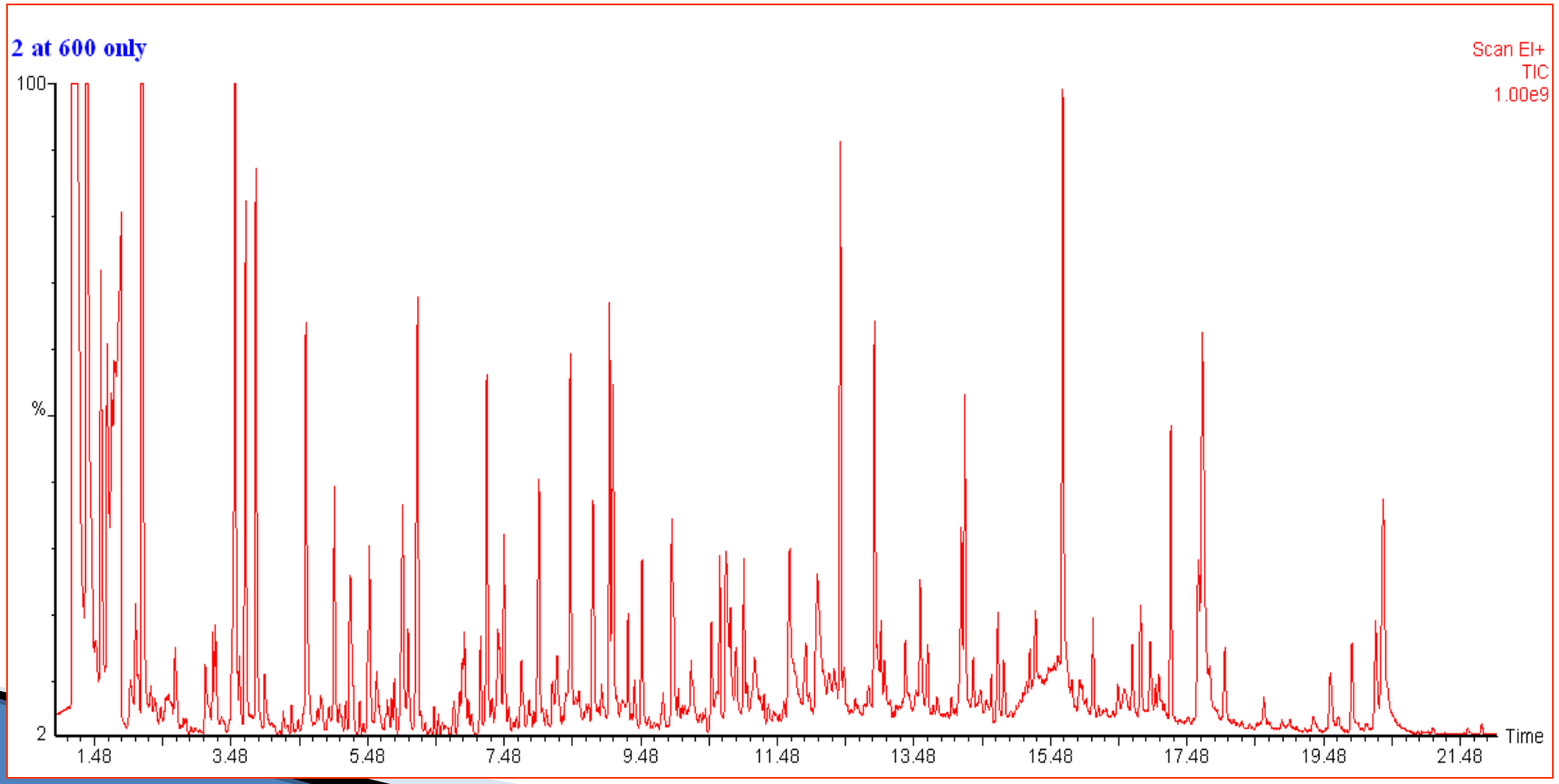
LIBRARY CATEGORIES

- ***Plasticizers***
- ***Light Stabilizers***
- ***Antioxidants***
- ***Corrosion Inhibitors***
- ***Lubricants***
- ***Fragrances***
- ***Flame Retardants***
- ***Antistatic Agents***
- ***Solvents***

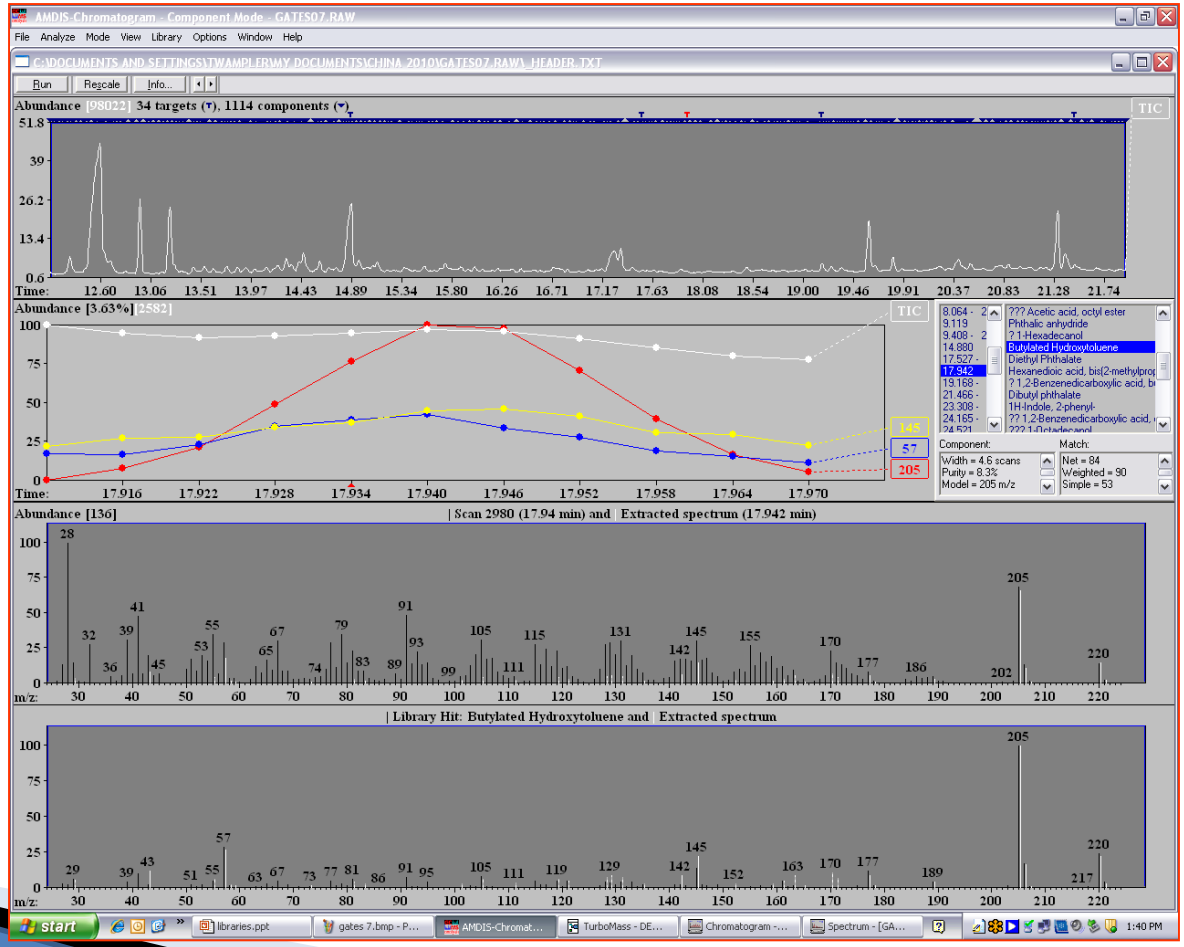


Pyrolysis of Complex Sample

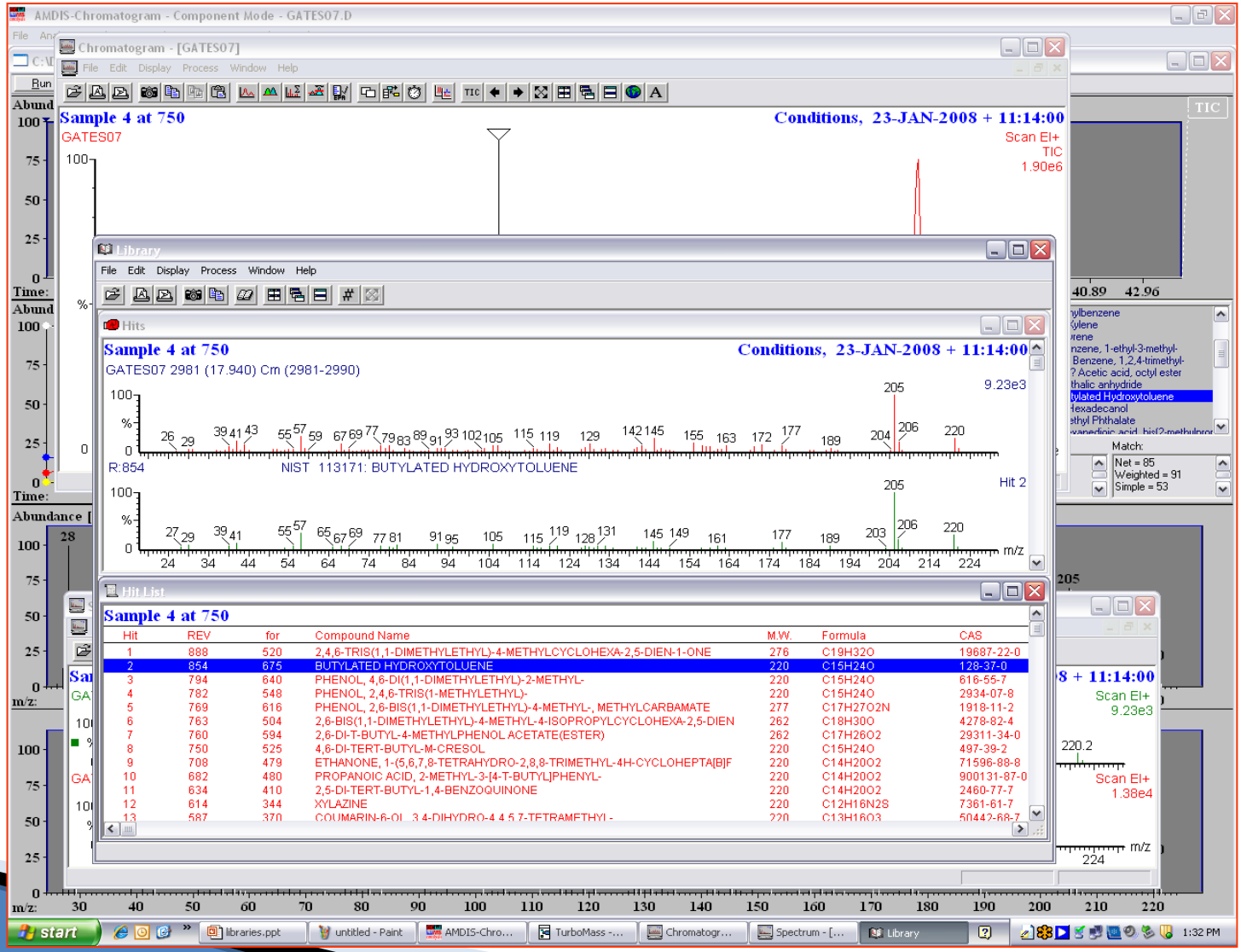
Can you find the antioxidant?



AMDIS searching the sample for any antioxidant matches from CDS Library



Confirming BHT as the Anitioxidant



Could you find BHT without the library??