GOW-MAC® INSTRUMENT CO.

Hotwire©

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In This Issue

GOW-MAC Instrument Co.
World Headquarters, Bethlehem, PA U.S.A.

From the Editor's Basket

In this issue of the "*Hotwire*", I'll be discussing the thermal conductivity detector (TCD). The TCD is one of the more widely used detectors for gas chromatography and gas analysis because it is simple in construction, rugged, versatile, sensitive, relatively linear over a wide range, nondestructive to the sample, and inexpensive. It is because of these qualities that it continues to be widely used even though more sensitive and specialized detectors have been developed.

GOW-MAC has been manufacturing TCDs for well over 60 years now. We make more, and have made more, thermal conductivity detectors than anyone else in the world. Chances are we supplied the one that's in your GC or gas analyzer (or at least the filaments) at this very moment, regardless if it's a GOW-MAC instrument or not.

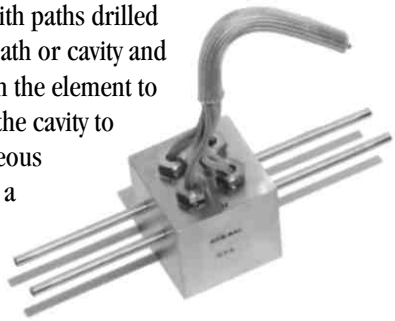
Contact us to get the answers regarding thermal conductivity detectors. Whether you need to replace one in an existing instrument or need to select one for a special application, we'll make sure it's right for you.

We hope you enjoy this latest issue of the "*Hotwire*". Your comments and suggestions are always welcome.

The Thermal Conductivity Detector (TCD)

The Thermal Conductivity Detector (TCD) can contain two types of transducers 1) hot-wire filaments or 2) thermistors. The vast majority of TCD's in use today are of the hot-wire type. Historically they were used in the thermal conductivity cell in the 1840's when the effect of hydrogen was observed on a glowing wire and noted in the proceedings of the Royal Irish Academy. Thermistors were developed at Bell Telephone Laboratories in the mid 1940's.

The TCD also called katharometer, is a metal block with paths drilled for gas flow. The detector element is located in this path or cavity and is heated by an electric current. The loss of heat from the element to the cell wall is determined by the ability of the gas in the cavity to conduct heat, i.e., the thermal conductivity of the gaseous medium in the cavity. The elements are connected in a Wheatstone bridge circuit, one exposed to a reference gas, the other to a sample gas. Other designs have developed which include four elements, eight elements, novel flow patterns, heat sinks and completion resistors.



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Announcements

New Year 2000 Analytical Training Schedule is here.

Exhibitions

ACS Fall National
August 21 - 23
Washington, DC
Booth: 136

ISA
August 21 - 24
New Orleans, LA
Booth: 1958

Gulf Coast Conference
September 26 - 28
Galveston, TX
Booth: 232-234

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GOW-MAC® Instrument Co.
277 Brodhead Road
Bethlehem, PA 18017 U.S.A.
Phone: (610) 954-9000
Fax: (610) 954-0599
E-mail: sales@gow-mac.com
Home Page: www.gow-mac.com

Editor . . . . . Robert J. Mathieu
Associate Editors . . . . Jeffrey B. Lawson
. . . . . Ken Fincke
. . . . . Gail Smith
. . . . . Marcus Creaven
Production . . . . . Gail Smith

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Thermal conductivity of a gas or vapor is based on three properties: diffusion, viscosity, and transfer of kinetic energy. The operation of the TCD is dependent on a rate of heat loss, q, and is described by the equation

$$q = \frac{I^2R}{J} = \lambda S \frac{dt}{dx}$$

where I is the bridge current, R, is the bridge resistance, J is the Joules equivalent (4.19 w/cal), λ is the TC of the gas in the cell, S is the area of interface, and dx/dt is the temperature differential.

Maximum sensitivity is dependent on three basic factors whether thermistors or metal filaments are used:

1. A geometric factor, relating to the ratio of the size of the element to the size of the cavity.
2. An electrical factor which is a function of the resistance-temperature characteristics of the detector element, the differential temperature of the elements, and the power available.
3. A thermal conductivity term which incorporates the relative difference in thermal conductivity between the sample and reference gases.

Metal Filaments

Filaments used in commercial TC cells consist of tungsten (W), rhenium-tungsten (WX), gold-sheathed tungsten (AuW), nickle (Ni), or other corrosion resistant material. The resistance temperature characteristics of the typical metal filament are a straight line over the range of 0˚C to 700˚C. Metals exhibit positive temperature coefficient of resistance. The temperature of the wire is determined by three factors:

1. The current.
2. The gaseous medium surrounding the wires.
3. The temperature of the cell block.

9225 Mount 333 Mount
Filaments
a.k.a. Hotwires or Elements

Thermistors

Thermistors are sensitive resistors having a high negative temperature coefficient of resistance. As the temperature increases the resistance decreases as a log function. This is opposite to that found in metallic resistors which have a positive temperature coefficient of resistance. Thermistors are semiconductors of ceramic materials formed into beads, wires are inserted and they are sintered to make electrical connection to the wires. The beads are coated with glass to protect from oxidation. If a bead with cracked glass is operated in a reducing atmosphere such as hydrogen, a change in resistance is caused by a change in the oxygen content in the ceramic material. This shows up as drift.

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OEM TCD Supplier

GOW-MAC makes more thermal conductivity detectors than anyone in the world. Our Engineering Department will work on a proprietary basis with you to design a detector for your specific needs. Our detectors have gone into space as well as have been incorporated into CAT Scan machines.

A TCD is a rugged, small, fast response sensor that is inexpensive to purchase and operate. The TCD is concentration dependent and universal. If you think your application or instrument requires a TCD, call us at (610) 954-9000 and discuss you idea in confidence.

TCD TROUBLE SHOOTING GUIDE - Part 1

TROUBLE	PROBABLE CAUSE	CHECKS AND/OR REMEDY
1. No signal	a) Detector or power switch off.	Make sure carrier is flowing and turned on. Set bridge current to desired setting.
	b) Recording device improperly connected.	Check connections.
	c) Detector filaments burned out.	Replace elements.
	d) Open circuit on detector cell.	Check for broken lead wires, loose terminal screws and broken filament(s).
2. Low cell current capacity.	a) Power Supply voltage inadequate (likely to occur with change from lower resistance element to higher resistance element).	Increase power supply.
3. Recorder can't be zeroed.	a) Excessive bridge current.	Reduce bridge current.
	b) Detector contaminated.	Clean cell cavities and elements. Replace elements if required.

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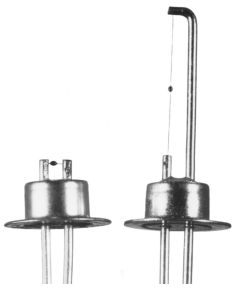
Thermistors (cont.)

Under certain conditions thermistor elements can provide higher sensitivity than metal filaments, but the conditions are so restrictive that thermistors cannot effectively perform as wide-range, general purpose detectors. Hotwire elements provide higher overall sensitivity, superior stability, longer operating life, fewer anomalies of operation and lower cost replacement.



9225AA Mount 9225A Mount

GOW-MAC Makes Replacement Thermal Conductivity Detectors

GOW-MAC has been supplying TCD's and filaments to Gas Chromatography manufacturers for over 40 years. Manufacturer's cells we repair or replace include:

Agilent (Hewlett Packard, F & M)
Beckman
Bendix
Burrell
Carlo Erba
Chrompak (Packard)
Finnigan (Tremetrics, Tracor)
Fisher Scientific (Victoreen)
Intersmat
Nuclear Chicago (Barber Coleman)
Perkin Elmer
Philips Electronic
Siemens
Toyo
Varian

If the manufacturer of your TCD is not listed, contact us with the manufacturer and model number and we'll determine if replacement filaments or a replacement TCD is available.

U.S.A. / Int'l Headquarters & Plant
GOW-MAC Instrument Co.
277 Brodhead Road
Bethlehem, PA 18017-8600 U.S.A.
Tel: (610) 954-9000
Fax: (610) 954-0599
E-mail: repairs@gow-mac.com

European Office & Plant
GOW-MAC Instrument Co., Ltd.
Bay K, 14a Industrial Estate
Shannon, Cty. Clare, Ireland
Tel: +353-61-471632
Fax: +353-61-471042
E-mail: sales@gow-mac.ie

TROUBLE	PROBABLE CAUSE	CHECKS AND/OR REMEDY
3. Recorder can't be zeroed (cont.)	c) Loose or corroded electrical connections.	Check connections.
	d) Detector elements oxidized bridge out of balance.	Replace all elements.
4. Drift.	a) Change in flow sample and/or reference gas pressure.	Check flow gauges. Creeping regulator or reducing valve.
	b) Warm-up period too short.	Allow sufficient time for purge and temperature equilibration.
	c) Changes in ambient temperature.	Protect instrument from drafts, direct sunlight, or nearby sources of hot or cool air.
	d) Carrier gas flow leaks.	Tighten all fittings so they are leak free.
	e) Detector contaminated.	Clean detector cell.
	f) Contamination in column; Column bleed.	Recondition column.
	g) Filament aging.	Replace filaments.
	h) Decompression chill by the reference gas.	Install heater or buffer volume.