Technical Note

Thermal Conductivity Detector (TCD) Guide

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What is a TCD?

A Thermal Conductivity Detector (TCD) is a universal and non-destructive detector which can be used to analyze a wide range of compounds. The SCION TCD can be seen in Figure 1 below.

Figure 1: SCION Thermal Conductivity Detector (TCD)

TCD and thermal conductivity?

A TCD utilizes the differences in thermal conductivity. Thermal conductivity is the measure of how effectively a material transfers heat. Materials with a low thermal conductivity will act as an insulator by resisting heat flow whereas a material with a high thermal conductivity will act as a conductor, rapidly transferring heat. Gases have differing thermal conductivity value. To achieve maximum sensitivity from your TCD, choose a carrier gas which has the greatest thermal conductivity difference to what you are analyzing i.e. if analyzing carbon dioxide in a sample then choose helium as a carrier gas rather than nitrogen.

TCD Assembly

The TCD consists of an oven "block" and a measurement cell. The TCD cell holds four electrically heated wires known as filaments. The configuration of the filaments is called a Wheatstone bridge as shown in Figure 2. The TCD is very temperature sensitive so the TCD cell is encased in the oven block and then the oven block is wrapped with insulation. The TCD oven block temperature is set to a temperature which will avoid any drop out of the injected sample which is typically 20 °C above the final GC column oven ramp temperature. The filament temperature is then set at least 20 °C above that of the TCD block temperature. This is important because if this is not set correctly then the block will be heating the filaments which can lead to a loss of sensitivity. The larger the difference between the block and the filaments, the greater the sensitivity.

There are different SCION TCD configurations available: a single TCD, a dual TCD which consists of two TCD cells contained in a

single TCD oven block, TCD with Nickel filaments and a hydrogen carrier gas optimised TCD.

Nickel filaments in a TCD can be useful in for applications where corrosive gases, for example the halogens (F_2, Cl_2, Br_2 and I_2) and acid gases (HF, HCl, HBr and HI) are being measured. TCD settings must be adjusted when using Nickel filaments compared with the standard filaments.

How does a TCD work?

The basis of the TCD is that it measures the change in thermal conductivity between the sample gas stream and an independent reference gas stream. The compounds being analyzed will come off the GC column and cause a thermal change in the sample filaments compared to the reference filaments. The voltage measured across the filaments from the change in gas conductivity corresponds to the concentration of the compounds being analyzed which creates the peaks in the chromatogram as see on the Chromatography Data System i.e. CompassCDS.

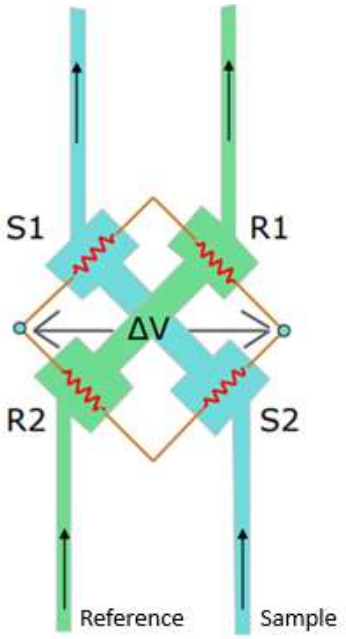

Figure 2: Wheatstone Bridge

TCD Operational Tips

When turning the TCD on, it will take many hours to warm up and stabilize. Never turn on the TCD detector electronics until the TCD has reached its set point temperature. The detector is very sensitive to air leaks which can damage the detector.

The lower the filament temperature is, the longer the lifespan but there is a balance to be found between sensitivity and filament life. Typically gas flows for a TCD are in the 20-30 mL/min range with makeup gas required when using capillary columns.

What are the advantage and disadvantages of a TCD?

Some of the advantages of a TCD include; it is a universal detector and non-destructive. This means that a sample can pass to another detector such as the Flame Ionization Detector (FID). A TCD is not as sensitive as the FID but the TCD is a great choice for gas analysis and major components in chemical mixtures. Another benefit of a TCD is that it does not require a flame or hydrogen so this could be seen as a safety benefit.

TCD Maintenance

The TCD does not require the user to change any parts of the detector as part of a maintenance schedule. The TCD can be conditioned by setting the detector temperature to 350 °C for 4 h or overnight. It is crucial the electronics must be turned off and there must be gas flow when conditioning the TCD so not to damage the TCD filaments.