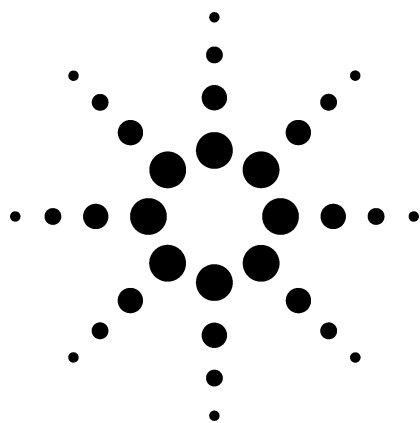


# The 5973N inert MSD: Using Higher Ion Source Temperatures

## Application



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### Abstract

**The new 5973N inert MSD and ChemStation software (G1701DA) offers the capability of operating the ion source at higher temperatures. This feature, combined with the improved inertness of the source, can provide the user with improvements in analysis, if exploited coherently. This application note provides advice and examples of how to explore the utility of ion source temperature.**

### Introduction

The default ion source temperature of 230 °C is commonly applied in electron impact (EI) ionization on the 5973 MSD platforms. The new Inert Source when used with the new revision of the ChemStation software (rev. DA) allows ion source temperature to be set to a maximum of 300 °C. As with all advances, there are advantages and disadvantages in operating at higher source temperatures. This note will address several general aspects in EI operation.

### Tuning

Figures 1 and 2 show the results for autotuning the Inert Source at the standard 230 °C ion source temperature and the 300 °C temperature limit of the new source (quadrupole temperature 200 °C). The higher temperature for the source produces a perfluorotributylamine (PFTBA) spectrum that shows lower abundances of the higher mass fragments, which is not entirely unexpected. The  $m/z$  219 fragment has dropped to an abundance comparable to the  $m/z$  69 ion and the ion at  $m/z$  502 has dropped about 50%. This is to be expected as the internal energy of the calibrating gas has increased. Note, however, that the isotopic ratios are maintained.

The user should also expect to see a higher background in the higher temperature tunes. A portion of the background will be due to ions associated with column bleed. Bleed, which usually condenses in the source, now is volatilized and will appear as an increase in background and baseline.



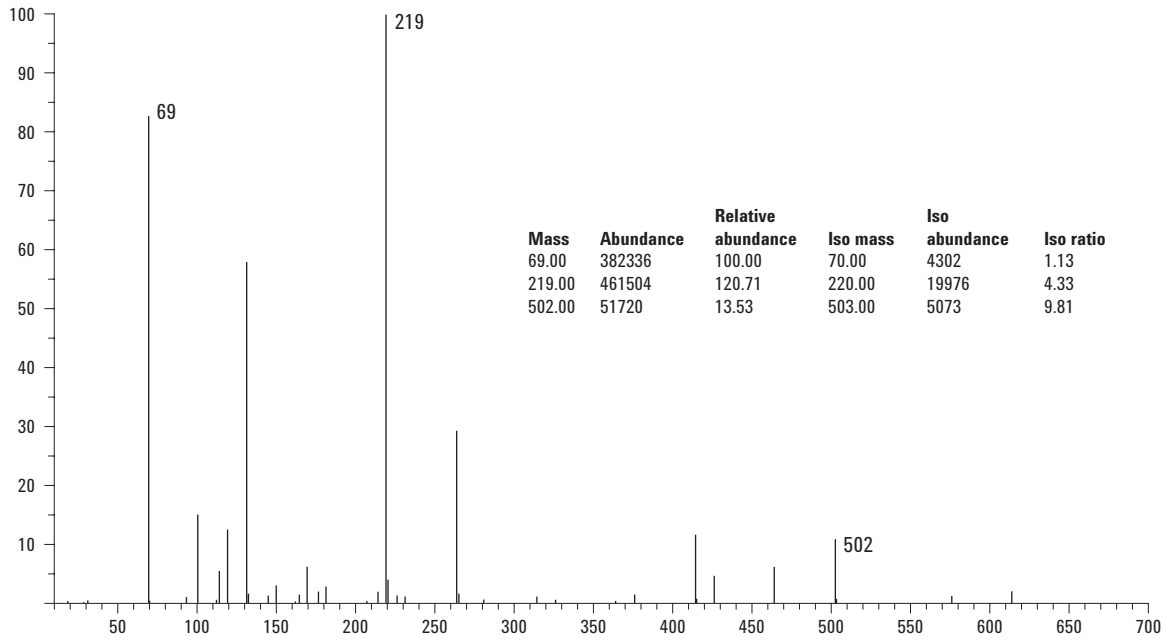


Figure 1. Autotune results for an ion source temperature of 230 °C.

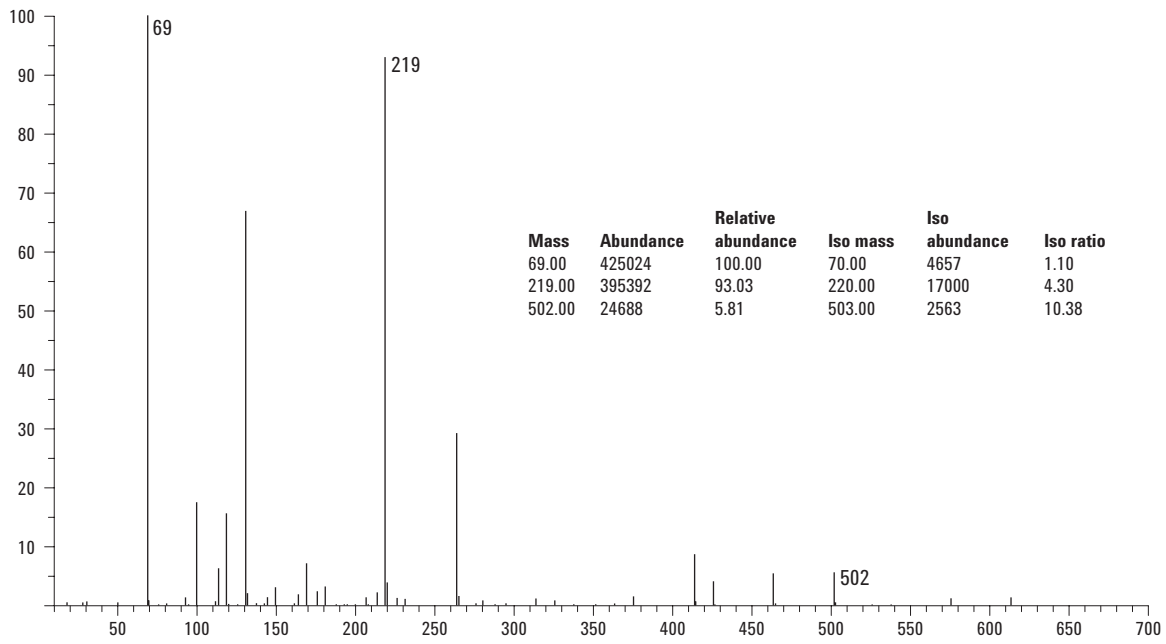


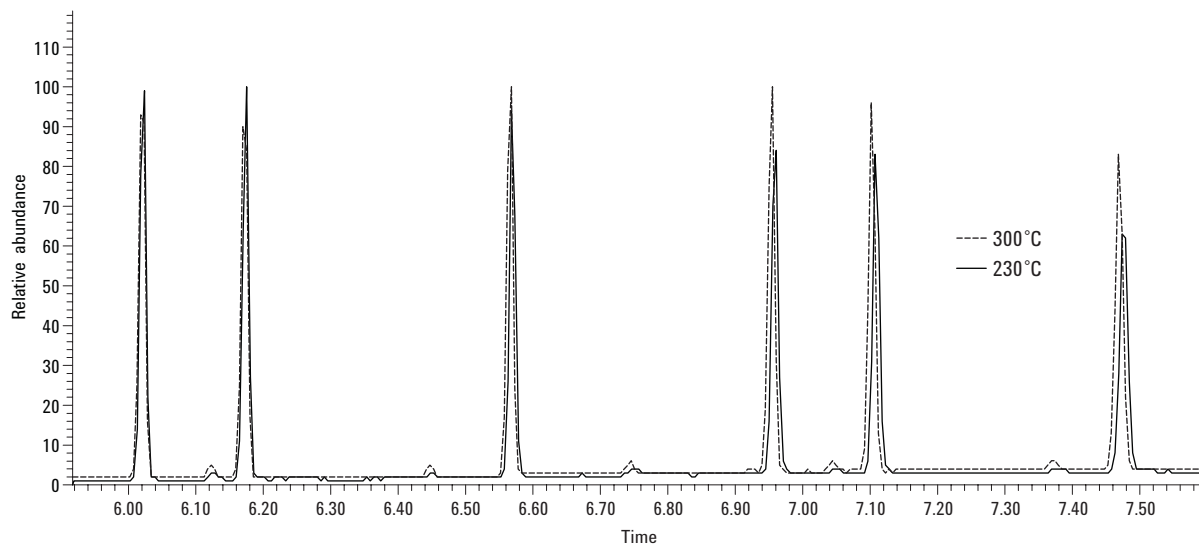
Figure 2. Autotune results for an ion source temperature of 300 °C.

## Implications for Analytical Applications

Although the tuning compound showed a spectral change that favored more fragmentation, and all compounds could be expected to be influenced similarly, there are some advantages that can occur for less fragile compounds, especially those that have higher boiling points and are late eluting in GC. Analysis of the class of compounds known as “persistent organic pollutants” (POPs) is likely to benefit from higher source temperatures.

To illustrate the aspects that need to be examined, consider the six polychlorinated biphenyls (PCBs) acquired in full-scan and presented in Figure 3. The

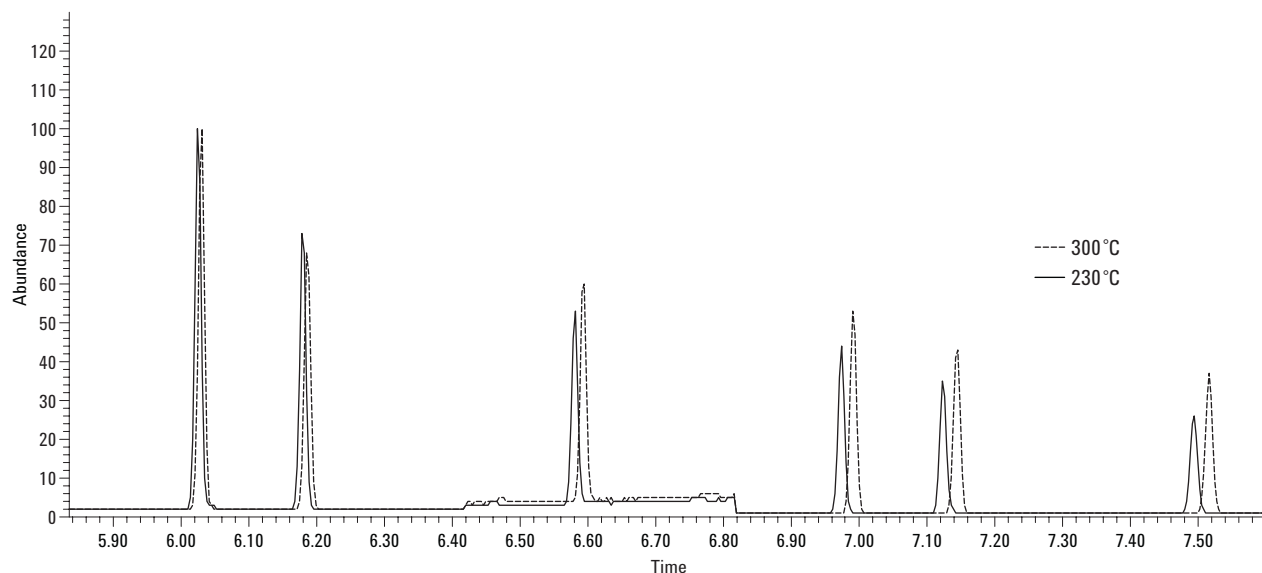
overlaid reconstructed total-ion-current chromatograms (RTICCs) suggest that the higher source temperature increases the total response for the later eluting PCBs but produces little enhancement for the early eluters. This could be due to more fragmentation and may not necessarily be useful if the increase in the RTIC is due to lower mass fragments since these lower mass ions are usually compromised by interferences. A calculation of the signal/noise (S/N) for the RTICCs shows that while there is an increase in signal at the source higher temperature, there is also an increase in the background noise and the result is a lower S/N ratio for the higher source temperature.



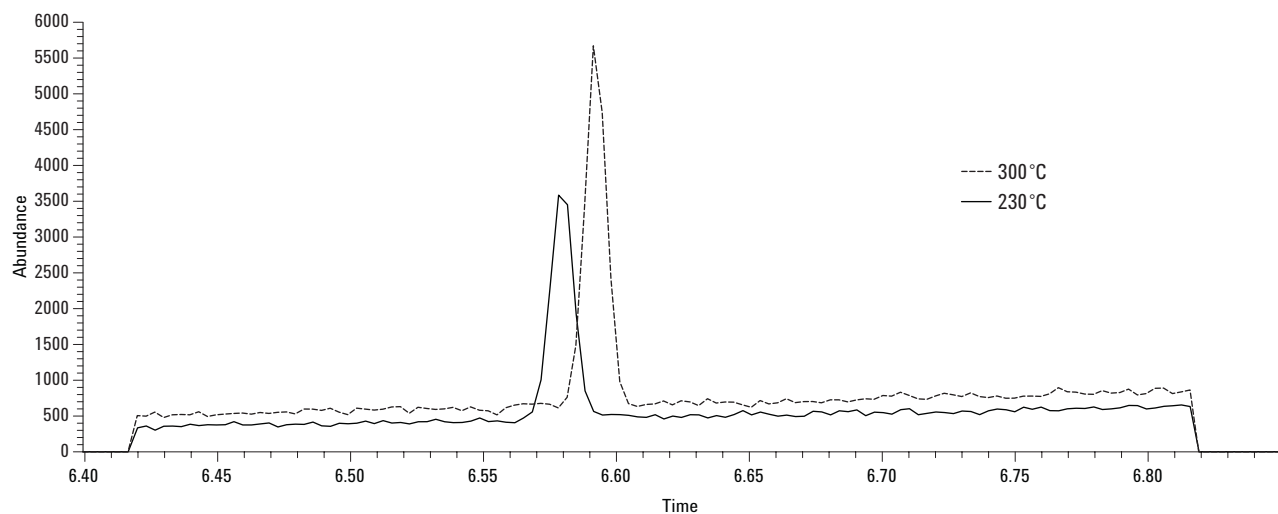
**Figure 3.** Overlaid RTIC of six PCBs acquired in full-scan (50–505 amu) at source temperatures of 230 °C and 300 °C. From left to right, or earlier to later, in the chromatogram, the PCBs consist of a Cl<sub>3</sub>-Biphenyl, Cl<sub>4</sub>-B, Cl<sub>5</sub>-B, Cl<sub>6</sub>-B, another Cl<sub>6</sub>-B and a Cl<sub>7</sub>-B.

Figure 4 shows the same analytes acquired in selected-ion-monitoring mode (SIM) using three ions for each component (M, M+2 or M-2, and M-70). The same trend appears with an enhancement apparent in signal for the later eluting PCBs but little increase for the earlier PCBs. Now, however, the RTIC for the SIM acquisition does show a higher S/N ratio for these later PCBs. As opposed to the full-scan acquisition, the SIM mode acquisition at higher source temperature does increase signal for the ions of interest and, because there was no increase in background, a useful S/N increase was obtained. As always, the guiding principle that an increase in signal is only useful if

it exceeds the concomitant increase in background holds. This is clearly illustrated by the third PCB, the pentachlorobiphenyl ( $\text{Cl}_5\text{-B}$ ). Figure 5 shows the behavior of the signal and background for the two source temperatures for one of the pentachlorobiphenyl confirming ions. The higher source temperature raises the signal and the background for this ion of interest over the lower temperature but fortunately signal increases faster than background. In this case, the background is due to column bleed components and is unavoidable but fortunately not very intense. This may or may not be the case in sample analysis.

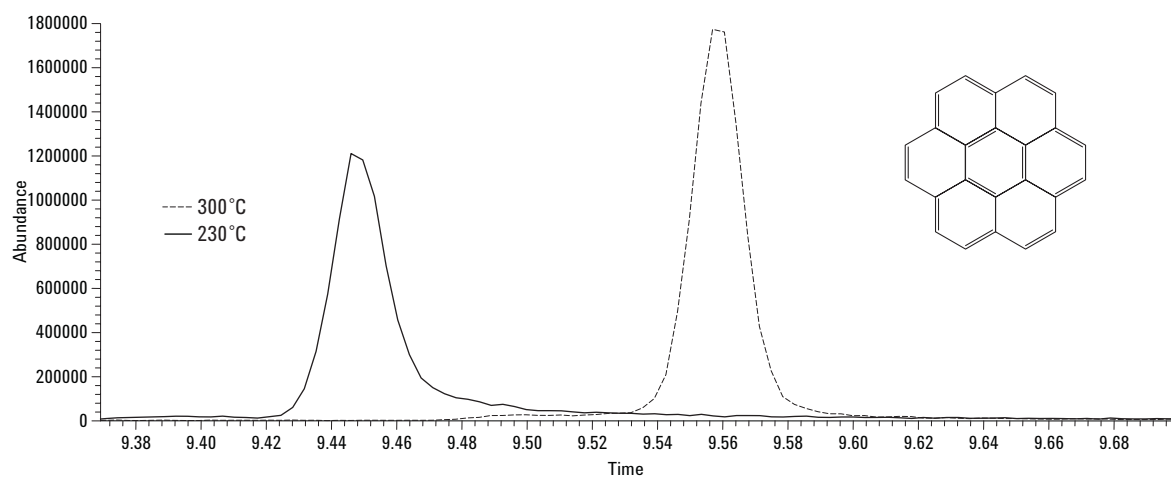


**Figure 4.** Overlaid RTIC of six PCBs acquired in SIM at source temperatures of 230 °C and 300 °C. From left to right, or earlier to later, in the chromatogram the PCBs consist of a  $\text{Cl}_3\text{-Biphenyl}$ ,  $\text{Cl}_4\text{-B}$ ,  $\text{Cl}_5\text{-B}$ ,  $\text{Cl}_6\text{-B}$ , another  $\text{Cl}_6\text{-B}$  and a  $\text{Cl}_7\text{-B}$ .



**Figure 5.** Overlaid extracted ion-current chromatograms of one ion (M-70) for the pentachlorobiphenyl acquired in SIM at source temperatures of 230 °C and 300 °C.

The detection limits for many late eluting, “high-boiling” compounds that will improve by implementing higher source temperatures (for example, PAHs, terphenyls, etc.). As an illustration of the enhancement for very “high-boiling” compounds, consider the 6-ring benzenoid hydrocarbon (PAH), coronene (CAS 191-07-1). This compound is difficult to determine due to low response and poor chromatography, although it is present in many sediment samples. Figure 6 shows overlaid RICCs for acquisitions of coronene at 230 °C and 300 °C. Although the peak area is the same, the enhanced Gaussian peak shape achieved at 300 °C improves detection.



**Figure 6. Overlaid extracted ion-current chromatograms of one ion ( $m/z$  300) for coronene acquired in full scan at source temperatures of 230 °C, and 300 °C.**

## Source "Bakeout"

There may be considerable temptation to use the higher source temperature for source "cleaning" by "baking". In other words, when the user notices a higher background in the source or a reduction in response, the ill-conceived approach of baking the source clean may come to mind. The result will be that "garbage" coating the source will be volatilized further into the analyzer; the other lenses will get dirtier, as will the multiplier, etc. "Baking" is not a substitute for mechanical cleaning of the source. However, baking a source after a cleaning is a good approach and a macro that provides this option is given in Table 1. After a source has been cleaned, and the MS system pumped down and checked to be leak free, this macro can be implemented either

manually or in a sequence. (Note that the temperature limits in the tune file need to be altered to 300 and 200 for source and quadrupole, respectively). Manually the bakeout is called from the command line in TOP by –

```
macro "bake.mac" <enter>
bake 2 <enter>
```

The "2" calls for a 2 hour bakeout, and which can be set to anytime the user requires.

Copy the lines in Table 1 into Notepad and save the file as BAKE.MAC in the MSDCHEM\MSEXEXE directory. The "!" indicates a comment (line) which is not executed. Note that the temperature limits, which reside in the tune file, must be edited to allow the higher settings.

**Table 1. ChemStation Macro for Baking the Source and Quadrupole After Source Maintenance**

```
name Bake
! this macro sets the source and quad temps to their maximum and holds for a set period
parameter hours def 6 ! default setting is 6 hours -this is customizable
msinsctl "mstemp QUAD, , , 200" ! sets the quad temperature to bake at 200C
synchronize
msinsctl "mstemp SOURCE, , , 300" ! sets the source temperature to bake at 300C
synchronize
SLEEP hours*60*60 ! bakes for set period
msinsctl "mstemp QUAD, , , 150" ! sets the quad temperature to operating temp at 150C
synchronize
msinsctl "mstemp SOURCE, , , 230" ! sets the source temperature to operating temp at 230C
synchronize
return
```

Usually a source cleaning is executed at the end of the working day, and the system pumped down overnight for operation the next day. In this case, a “pumpdown sequence” is useful. After the system is confirmed to be leak-tight, this sequence is loaded and executed which bakes the source and quad overnight, then executes an Autotune, and then makes a few injections of a checkout standard to confirm system performance. In this way, the analyst returns the next day to review data about the system prior to beginning new analyses. An example of this is given in Figure 7.

|    | Type    | Vial | Sample          | Method / Keyword | Data File | Comment / KeywordString         | E: |
|----|---------|------|-----------------|------------------|-----------|---------------------------------|----|
| 1  | Keyword |      |                 | Command          |           | Macro "Bake.mac"                |    |
| 2  | Keyword |      |                 | Command          |           | Bake 10                         |    |
| 3  | Keyword |      |                 | Tune             |           | Auto                            |    |
| 4  | Sample  | 1    | Checkout sample | CHECKOUT         | Checkout1 | test of system performance      |    |
| 5  | Sample  | 1    | Checkout sample | CHECKOUT         | Checkout2 | test of system performance -rep |    |
| 6  |         |      |                 |                  |           |                                 |    |
| 7  |         |      |                 |                  |           |                                 |    |
| 8  |         |      |                 |                  |           |                                 |    |
| 9  |         |      |                 |                  |           |                                 |    |
| 10 |         |      |                 |                  |           |                                 |    |
| 11 |         |      |                 |                  |           |                                 |    |
| 12 |         |      |                 |                  |           |                                 |    |

**Figure 7. Pumpdown sequence table using source bakeout.**

Line 1 Loads the Bake macro. Line 2 sets the bake time to 10 hours. After the bake, (Line 3) an auto-tune is executed. Lines 4 and 5 run the system performance method, CHECKOUT.M, on the system checkout standard. Note: after the system has been cleaned and leak-checked, the CHECKOUT.M method should be loaded, THEN this sequence should be run!

## Conclusions

The increased source temperature limit available on the 5973N inert MSD can provide improved detection limits for common, late-eluting, recalcitrant compounds such as the POPs when properly applied. A requirement, that must be explored, is that the higher source temperatures do not increase compound fragmentation or reduce the intensity of the (useful) higher mass ions. These improvements are most likely to be realized in SIM acquisitions where the increased background that must result from higher source temperatures is not as likely to affect the signal.

This application note also describes a programmed bake-out of the source and quadrupole that can be automatically implemented after source cleaning. This bake-out provides a rapid lowering of the air-water background and can be used within the sequence table as part of the instrument performance checkout.

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