



Understanding Intellidilution for Use with the Torch High Temperature Combustion Analyzer
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Application Note

Introduction

The Torch is a High Temperature Combustion (HTC) Analyzer that utilizes a patent pending Static Pressure Concentration (SPC) technology for the analysis of carbon and nitrogen. The Torch Analyzer contains a built in autosampler with three vial rack options and PC driven controls. Automated calibration and Intellidilution, which automatically dilutes over-range samples to within the working calibration range, facilitate user free operation from start to finish of sample schedules. Maintenance is simplified by design, allowing easy access to all areas of the unit.

Features

- Intellidilution automatically detects over-range samples and dilutes them to within a specified calibration range
- Ability to program and store furnace temperatures to accommodate various methods
- Static Pressure Concentration technology (patent pending)
- Built-in Benchmark diagnostic checks - including Leak Check
- Multiple pre-set application ranges for analytical requirements
- Auto-calibration eliminates the need for manual standard preparation
- Detection Levels:
 - Carbon 50ppb to 30,000ppm
 - Nitrogen 50ppb to 2,000ppm
 - Simultaneous analysis for carbon and nitrogen
 - Easy access for maintenance of combustion tube
 - Improved catalyst
 - Built-in autosampler
 - Increased throughput with ASM Sparge Auto-blanking Mass Flow Controller
 - Optional vial mixing capabilities
 - Optional TN Module
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Intellidilution

Below are some helpful definitions that will be used within this application note:

ABS – Units of measure that the detector output data uses and is an abbreviation for absorbance.

AutoRinse – The sample pathway rinse performed after detection of an over-range sample

Saturation Range – The maximum value of the detector output data defined above 1000 ABS.

Calibrated Range – The range of values in ABS found in the calibration file.

Calibration Target Range – The dilution range determined by Intellidilution to fit samples into the calibrated range.

Sample – The detector output value in ABS of a sample run.

Minimum Sample Volume – This is the smallest sample volume that can be used due to the physical limitations of the syringe size.



Figure 1: The analysis of a 3-point calibration curve is shown with the real-time display in the center.

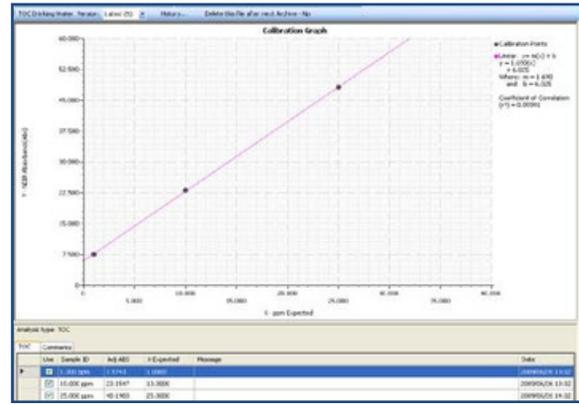


Figure 2: Graphical display of Torch calibration indicating excellent linearity with $R^2 = 0.99991$.

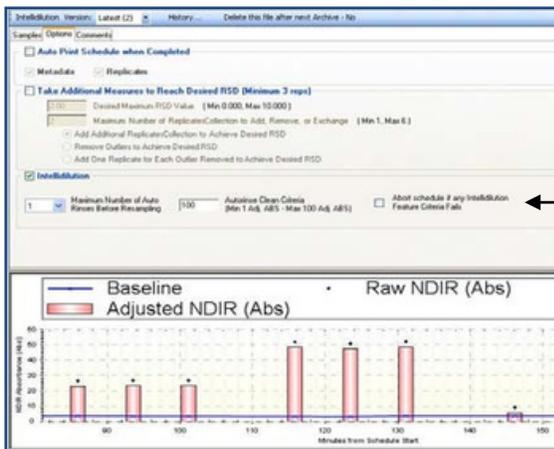


Figure 3: To activate the **Intellidilution** feature, located on the Options tab of the analysis schedule screen, check the **Intellidilution** box.



Figure 3A: Once selected, three options become available.

- **Maximum Number of Auto Rinses Before Resampling** – This feature allows for up to 5 sample path rinses [cleans] to be performed before continuing on with the schedule
- **AutoRinse Clean Criteria** – This sets minimum absorbance values that “cleans” must be below before continuing on with the schedule.
- **Abort schedule if any Intellidilution Feature Criteria Fails** – This will stop the sample schedule completely if the “cleans” do not meet the absorbance criteria.

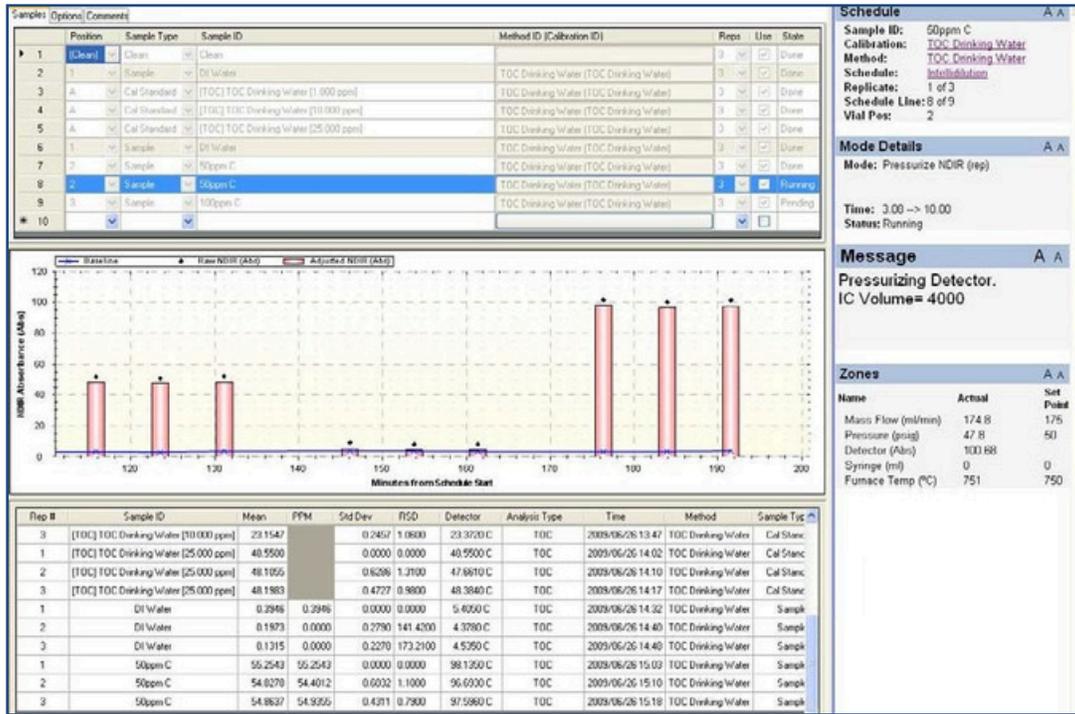


Figure 4: Analysis of a 50ppm C sample that is analyzed in triplicate not using *Intellidilution*. The sample absorbance values were applied directly to the calibration curve without dilution. Although the analysis falls outside of the Calibrated Range, the result is within 10% accuracy and has less than 1% Relative Standard Deviation (RSD).

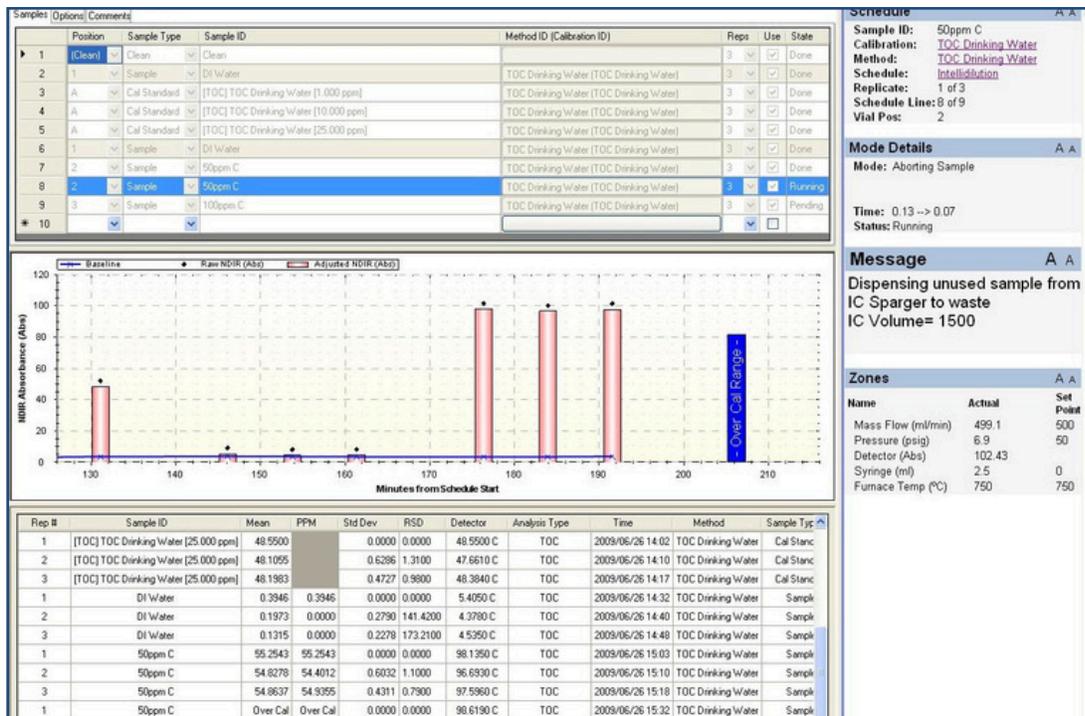


Figure 5: The sample run screen depicts the analysis of the first replicate of the 50ppm C using *Intellidilution*. In Figures 5 – 7 and Figure 3A, the process of analyzing over-ranged samples using *Intellidilution* is shown and occurs in the following manner.

1. The software analyzes the first replicate and determines that its absorbance is out of the Calibrated Range by comparing the sample ABS to that of the highest point in the calibration curve.
2. The replicate ABS is flagged as *Over Cal* and the graphical display is in blue [Figure 5].

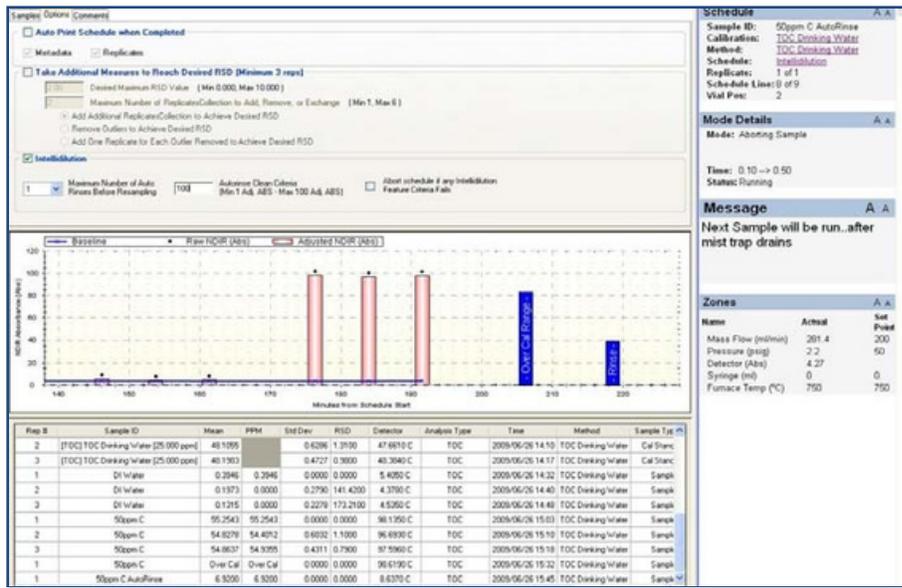


Figure 6: AutoRinse is performed before the analysis continues and is shown in blue along with the original sample ABS.

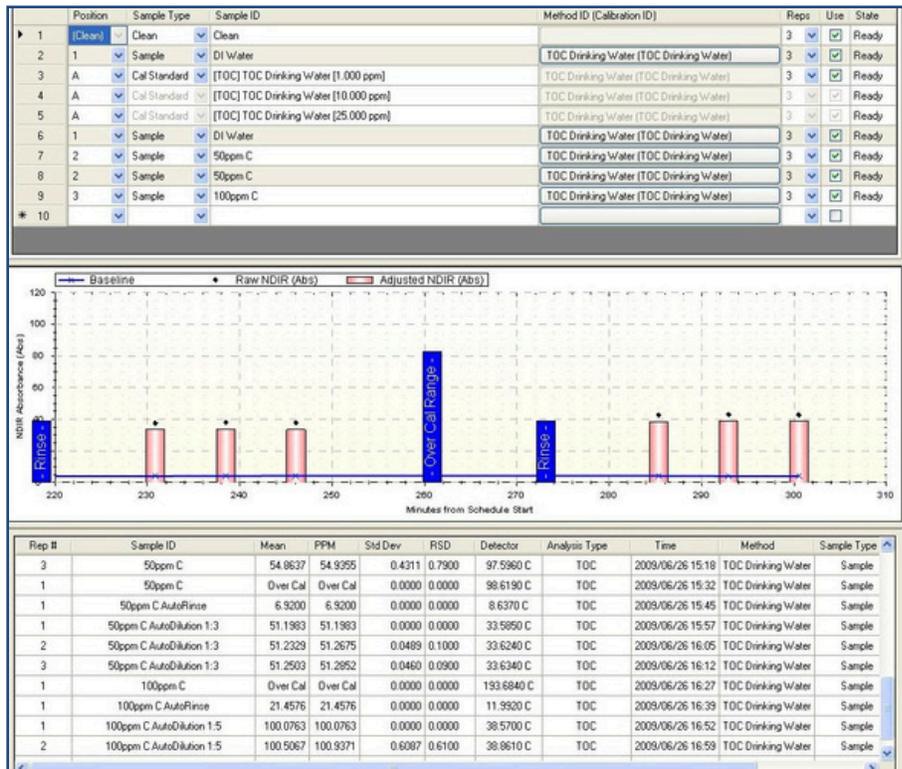


Figure 7: AutoRinse performed after a 50ppm C sample is shown at far left in blue. Following the AutoRinse, three 50ppm C replicates using **Intellidilution** are analyzed along with the analysis of a 100ppm C sample using **Intellidilution**.

3. The AutoRinse function then cleans the sample pathway based upon the user requirements chosen in the Options Tab [Figure 3A]. If the AutoRinse ABS meets the requirements then the sample schedule continues. If the AutoRinse ABS does not meet requirements then the schedule will either halt or continue with the next sample based upon user input in the Options Tab.
4. The 6.92 ABS for the AutoRinse was below the 100 absorbance limit. Therefore, the analysis of the sample using Intellidilution continues [Figure 7].
5. A dilution of the sample will be made based upon its ABS. TekLink estimates a dilution factor so that the sample ABS will fall within the Calibrated Range. Intellidilution first attempts to calculate a dilution factor based on 90% – 70% of the Calibrated Range. If not successful, it will broaden its parameters to 90% – 50% of the Calibrated Range. The final attempt will be based on 90% – 20% of the Calibrated Range. Intellidilution will use the first dilution factor that fits the criteria.

Calibration Target Range attempts within the Calibrated Range:

1st: 90% – 70%

2nd: 90% – 50%

3rd: 90% – 20%

6. For the calibration curve of 1 – 25ppm C, the 25ppm calibration standard returned an ABS of 48.1983. The dilution calculations are as follows:

$$1\text{st: } [48.1983 * 0.90] = \underline{43.3785\text{ppm C}} // [48.1983 * 0.70] = \underline{33.7388\text{ppm C}}$$

$$2\text{nd: } [48.1983 * 0.90] = \underline{43.3785\text{ppm C}} // [48.1983 * 0.50] = \underline{24.0992\text{ppm C}}$$

$$3\text{rd: } [48.1983 * 0.90] = \underline{43.3785\text{ppm C}} // [48.1983 * 0.20] = \underline{9.6397\text{ppm C}}$$

7. The first replicate of the 50ppm C sample returned an over- range absorbance of 98.6190 [Figure 7]. Since a 1:3 dilution is acceptable within the 90% to 50% range, TekLink continues with the analysis and uses this dilution factor. The final result has better accuracy and precision than the original undiluted sample.

Summary

Often during schedules, unknown samples fall outside of the upper range of the calibration curve. The Intellidilution feature of the Torch TekLink™ software automatically detects the sample as being outside of the upper calibration limit. Intellidilution accomplishes this by selecting the ABS of the highest point on the calibration curve as its high limit. Results over the established high limit are regarded as exceeding the calibrated range and Intellidilution then performs a number of cleaning procedures. How many is open to user input. The cleanliness of the sample pathway is verified by averaging the last three ABS values of the final clean. This is compared to the memorized ABS of the baseline prior to the analysis of the over-ranged sample. Only after Intellidilution determines that the baseline is within an acceptable limit of the memorized baseline, will the dilution of the over-ranged sample begin. Once the sample is successfully diluted and analyzed, the sample report flags the sample as having been over-ranged and analyzed with Intellidilution. Intellidilution is simple to activate, saves time, reduces the need for manual dilutions, and provides user input as well and has pre-set parameters for multiple applications.