Technical Note: 51306

Performance of the Smart Thermostatted Rotary 7-Cell Changer Using Semi-Micro Cells

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Key Words

- Cell Changer
- Evolution
- Kinetics
- Semi-Micro Cells
- Smart Accessories
- Spectro-photometer
- UV-Visible

Throughput Advantages of Multicell Changers

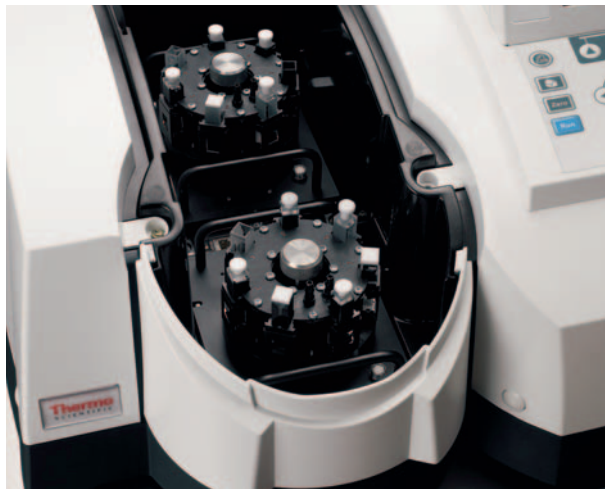
For users looking to increase the throughput of their laboratory, UV-Visible cell changer accessories allow the automated analysis of multiple samples. By analyzing multiple samples simultaneously with the same method, the operator can spend time preparing other samples or doing another type of analysis, saving time and increasing productivity.

Configurations for Kinetics Experiments

Cell changers are also extremely useful for the analysis of kinetics. The Smart Thermostatted Rotary 7-Cell Changer allows the same temperature to be maintained for each sample while varying the contents of each cell. Using kinetics to determine reaction or biological mechanisms relies on varying the conditions of each reaction slightly and analyzing the effect each change has on the reaction rate. For example, some enzyme reactions are pH dependent; therefore, it is advantageous to change only the pH of each reaction. With seven cell positions available, a control and six samples can be analyzed simultaneously. When seven reactions are analyzed, 1.6 measurements per minute are possible on each cell.

Performance of the Smart Thermostatted Rotary 7-Cell Changer

Users looking to reduce the volume of sample used for UV-Visible analysis frequently use semi-micro cuvettes. Semi-micro cuvettes offer the advantage of allowing the analysis of as little as 500 µL of sample in a 4 mm-wide semi-micro cuvette with the Evolution™ 300 and 600 UV-Visible spectrophotometers. This volume of sample is sufficient to cover the beam, which is centered 8.5 mm above the floor of the cuvette. The volume of semi-micro cuvettes is reduced by increasing the thickness of the walls of the cuvette, thus positioning the liquid in the center of the cell. Frequently, the sidewalls of the cuvette are masked in black to eliminate scattered light.



Smart Thermostatted Rotary 7-Cell Changer shown in the Thermo Scientific Evolution UV-Visible spectrophotometer

The thicker side walls of semi-micro cells reduce both the clear beam aperture and the contact of the solution with the temperature control surface of the cell changer accessory. The smaller clear beam aperture makes the repeatable positioning of the cell with respect to the beam critical. Any minor variation in position would cause a portion of the light to be clipped by the cell, resulting in an erroneously high absorption reading.

The insulating quartz present on the side of the cuvette reduces the amount of solution that is in direct contact with the temperature-controlled portion of the cell changer. This insulating layer of quartz will reduce the heat transfer to the liquid sample. This technical note demonstrates the temperature performance and the photometric accuracy performance of the Smart Thermostatted Rotary 7-Cell Changer.

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Cell-to-Cell Temperature Variation with Semi-Micro Cells

One important performance characteristic of cell changers is the ability to keep each cell at the same temperature. This requires excellent contact of the cuvette with the body of the cell changer. The Smart Thermostatted Rotary 7-Cell Changer uses re-circulating water to maintain the temperature equilibrium of each cell.

To demonstrate the performance of the Smart Rotary 7-Cell Changer accessory, a 4 mm semi-micro quartz cell was placed in each of the seven positions of the cell changer. The Cell Changer was attached to a Thermo Scientific Haake DC-10 recirculating water bath that maintains the fluid temperature within ±0.02 °C providing 12.5 L/min of recirculating fluid to the accessory. The temperature of each cell was monitored after thermal equilibrium was reached. The time required to reach thermal equilibrium depends strongly on the room temperature and the desired final temperature.

Typically, a 5% block-to-cell temperature differential was observed at all temperatures tested for the 4 mm semi-micro cells. The performance improves if standard, 1 cm cuvettes are used for analysis, as the insulating layer of quartz would be removed thus allowing better contact of the liquid sample with the thermal block of the cell changer. Temperature measurements reported here were made using a calibrated thermocouple probe with ±0.0005 °C accuracy.

The Temperature Probe accessory for the Evolution 300 and 600 spectrophotometers allows the accurate temperature measurement of liquid samples in the 4 mm semi-micro cells.

The cell-to-cell temperature results are shown in Table 1 and Figure 1 that follow.

Figure 1 clearly demonstrates the temperature performance of the cell changer. The Temperature Probe accessory can be used to measure the temperature of the liquid sample in the cuvette to determine the ideal temperature of the liquid in the recirculator. Once equilibrium is established, the variation of the temperature is minimal and is determined by the configuration of the recirculating bath used to control the temperature.

Recirculator Fluid Temperature	Median Cell Liquid Temperature	Maximum Cell-to-Cell Variation	Minimum Sample Temperature	Maximum Sample Temperature
37.00 °C	35.45 °C	± 0.18 °C	35.25 °C	35.62 °C
50.00 °C	48.54 °C	± 0.19 °C	48.41 °C	48.72 °C
80.00 °C	76.05 °C	± 0.22 °C	75.83 °C	76.23 °C

Table 1: The temperature performance of the Smart Thermostatted Rotary 7-Cell Changer. The temperature of the liquid in each cell was measured by a precision thermocouple. The median, minimum and maximum sample temperature observed for all seven cells is tabulated, along with the maximum cell-to-cell variation observed.

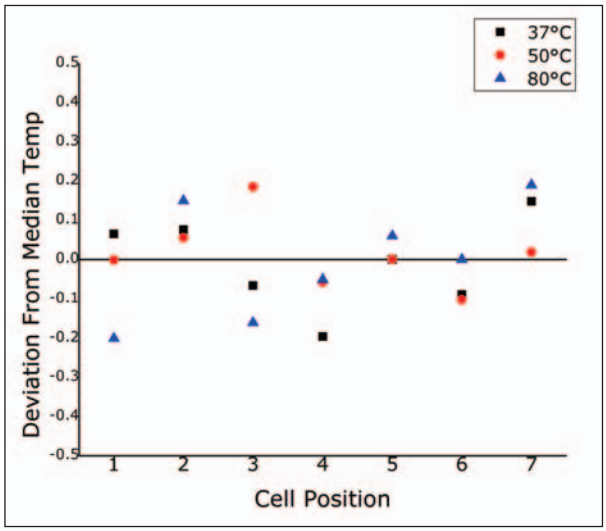

Figure 1: The variation of the liquid temperature in each cell from the median temperature. Data at a recirculating liquid temperature of 37, 50, and 80 °C is reported.

Photometric Performance with Semi-Micro Cells

The positioning repeatability of the cell changer has a dramatic impact on the photometric performance of the accessory. If the position of the cell in the light beam causes a portion of the beam to be blocked by the masking sidewalls of the semi-micro cell, a higher than actual absorbance will be measured. Repeatable positioning of the cell, such that the beam is not obstructed, is crucial for photometerically accurate data.

The variation of multiple absorbance readings was used to measure the positioning stability of the Rotary 7-Cell Changer. A sample of green dye with an approximate absorbance of 1.00 AU was placed in each of the 7 cells and 200 measurements at 620 nm were made for each sample in the cell changer. A one-second integration time was used for all measurements. The absolute reading-to-reading variation was determined for each cell and the average of these variations of these readings was calculated.

Table 2 details the performance of individual cells in the cell changer. The average absorbance of the solution is reported for each cell position. The average variation is the average absolute reading-to-reading variation for that cell and the maximum and minimum variation are also tabulated. The same solution was measured in 4 mm semi-micro cuvette placed in the single cell holder for comparison.

The average variation of the seven cells was 0.000079 AU. This is nearly identical to the variation of the absorption readings obtained using a standard 1 cm cuvette in a single cell holder (0.000075 AU). Figure 2 shows the variation of the sample in each cell position from the average variation value of all seven cells. This figure also shows that the average absolute reading-to-reading variations are evenly distributed around the mean value of 0.000079 AU, indicating the performance of the cell changer does not vary from one position to the next.

This data clearly demonstrates that photometric accuracy is not influenced by the positioning repeatability of the cell changer. Similar reading-to-reading variations were observed for each position of the 7-Cell Changer relative to measurements made with a cuvette in a single cell holder.

Conclusion

In this technical note, we have demonstrated the temperature and positioning performance of the Smart Thermostatted Rotary 7-Cell Changer using 4 mm semi-micro cells. Using semi-micro cells reduces the volume of solution required for analysis. Furthermore, the quality of the photometric data and the temperature stability of the samples is not affected when semi-micro cells are used for analysis.

A small, but consistent block-to-cell temperature drop is reported along with a minimal cell-to-cell temperature variation within the cell changer. A small reading-to-reading variation similar to the variation obtained when a single cell holder is used is also reported. This data proves the utility of the Smart Thermostatted Rotary 7-Cell Changer to increase the throughput of your laboratory without sacrificing data quality.

	Position 1	Position 2	Position 3	Position 4	Position 5	Position 6	Position 7	4 mm Semi-Micro Cell in Single Cell Holder
Average Abs	0.2769	0.2767	0.2772	0.2767	0.2772	0.2770	0.2768	0.2768
Average Variation	0.00007	0.00006	0.00007	0.00010	0.00008	0.00009	0.00008	0.00008
Max Variation	0.00040	0.00030	0.00030	0.00020	0.00050	0.00020	0.00030	0.00010
Min Variation	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

Table 2: Average absorption and reading-to-reading variation of a green dye solution in 4 mm semi-micro cells. The variation reported is the absolute reading-to-reading variation. Similar data is presented for the same measurement made with a 4 mm semi-micro cell placed in a single cell holder.

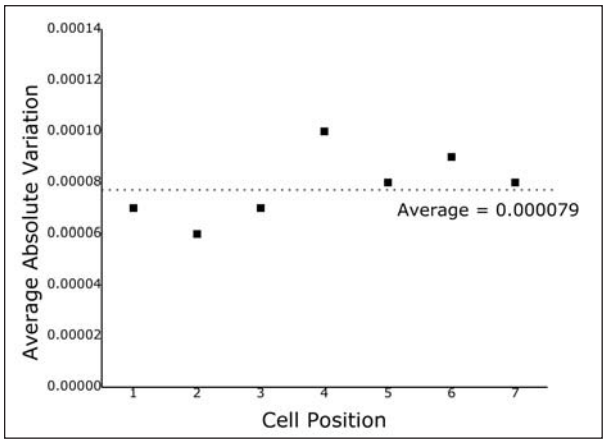

Figure 2: The average absolute reading-to-reading variation as a function of cell position

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