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Spectrophotometers

Tips for Optimal Performance

Spectrophotometers designed specifically for the measurement of colored materials, are at the center of any modern color formulation, color production, or color quality control system. Although these color spectrophotometers are designed to measure samples both accurately and repeatably, they accomplish these measurements only within a range of applicable tolerances. Spectrophotometers are not perfect measuring devices, and how well they measure is often dependent upon factors under the control of the system operator.

The purpose of this document is to provide “tips” (recommendations) on how to better operate and control color spectrophotometers, so that their measurements are as accurate and repeatable as possible.

These tips are intended for those attempting to get the best possible measurement performance from their color measuring spectrophotometer(s). They do require an investment in time and care, and one must decide if implementing some (or all) of these tips is worth the effort.

These tips are suggested to those who are attempting to maximize the accuracy and repeatability of their color measurement operations. In many cases, failure to follow specific tips may have little or no effect on overall system performance, since correctable measurement errors may be much smaller than the color acceptability tolerances involved.

No matter how well the color spectrophotometer is maintained and operated, its performance is limited to its inherent capabilities. Therefore, it is best to:

- Purchase only from a reliable supplier with a history of producing quality instruments and satisfied customers.
- Purchase the model spectrophotometer that has the features and capabilities necessary to meet the needs of the specific application involved.

Summary of Color Spectrophotometer Tips

- Maintain the spectrophotometer according to manufacturer recommendations, including periodic testing and preventative maintenance, by qualified service personnel.
- Operate the spectrophotometer in a temperaturecontrolled, clean environment, and (if possible) leave it under power at all times.
- Maintain the white and black calibration standards so that they are clean, and safe from potential damage.
- Recalibrate more often, perhaps every 2 to 4 hours and immediately before important jobs, even if the manufacturer normally suggests that recalibration is necessary only every 8 (or more) hours.
- Consider that almost all dyes and pigments change color as temperature changes. Measure samples at the same temperature each time, if possible.
- For samples that are not opaque; prepare them by increasing sample thickness, so that they are opaque (or nearly so), unless one is intentionally measuring over white and/or black backgrounds.
- For samples with directional surface orientation; measure them always at the same single orientation, or measure them at the same four (4) orientations (90 degrees apart) with data averaged.
- For samples with inconsistent color and/ or surface effects measure them multiple times (moving the sample between reads to increase the effective area measured), with data averaged.
- As practical, utilize the largest sample measuring area available (LAV, SAV, USAV), to achieve aver aging over a larger sample area (see #10).
- If possible, always measure standards and batches (of colors to be compared), using the same sample measuring area.
- If possible, always measure standards and batches (of colors to be compared), using the same spectrophotometer, under the same conditions.

More about the recommended tips:

1. Qualified regular preventative maintenance will assure that the spectrophotometer's integrating sphere coating is within acceptable reflectance parameters, and that the instrument continues to operate within specification.

2. A constant temperature environment will eliminate measurement variability caused by thermal changes within the instrument. Therefore, it is best to maintain power to the spectrophotometer (to eliminate warm-up thermal drift), and to keep the room environment at nearly constant temperature.

3. Maintain carefully the white and black standards, since the photometric scale (0 to 100%) of the spectrophotometer is calibrated to these standards. Handle and store the white tile so that it does not become soiled or scratched. If soiled, clean the tile using water (and if necessary a mild soap), drying with a clean non-abrasive, non-optically whitened paper towel or cloth. If dirt or dust enters the black trap, clean it using a compressed air flow.

4. Recalibrate more often because the photometric scale (0 to 100%) of any spectrophotometer may "drift" over time between calibrations, due to temperature, light source and/or photo detector factors. Any "drift error" is eliminated at calibration, and greatly reduced by recalibrating often.

5. The fact that pigments and dyes change their color properties as their temperature changes, is potentially a major source of errors in any color measurement operations. Almost all colorants (except white and black and some blues) change color as their temperature changes. The color changes can be significant, and are typically in the range of about 0.6 to 1.1 dE CIELAB for most high chroma colorants, for a 10 degree C temperature change. If production samples (batches) must be measured at a temperature different from that when the standard was measured, then (if possible) re-measure the standard at the new temperature.

6. Non-opaque samples usually must be measured as if they were opaque, to meet particular color application needs. In these cases, it is best to increase sample opacity by increasing sample thickness, so that the color measurement will not be influenced adversely by the "show-through" of a black (or white) background. Textile cloth can be folded multiple times, yarns and threads wound in multiple layers, and papers stacked, to meet the desired opaque (or most nearly so) requirement.

7. Optically directional samples (such as corduroy fabric, calendared vinyl, and card wound yarns and threads), often measure differently as they are rotated in the sample port. The directional geometric properties of these samples can result in measurement errors, whenever the standard and batch are measured differently. The measurement errors can be virtually eliminated by always measuring with the same sample orientation, or by measuring the sample 4 times (at 90 degree intervals) and averaging the data.

8. Inconsistent (or irregular) samples can yield different measurements, depending upon what part of the sample is measured. This measurement variability can be greatly reduced by measuring the sample multiple times and averaging the results, moving the sample between measurements.

9. The largest viewing area available should generally be utilized, as it extends the measurement over a larger portion of the sample.

10. Use the same viewing area for measuring the standard, as will be used in measuring production batches. This technique is desirable since different viewing areas (even of the same spectrophotometer), will typically not measure exactly the same.

11. If possible, use the same spectrophotometer, under the same conditions, to measure any samples to be compared, since no two spectrophotometers agree exactly.

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