Fundamentals of Color and Appearance

Module 9

Haze, Turbidity, Opalescence

Color Science Educational Series

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

In manufacturing environments where visual appearance matters, terms like clarity and cloudiness are commonly used to describe how well light passes through a material or liquid.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color HunterLab

While "clarity" is not a standardized or directly measurable scientific parameter, it serves as a practical and intuitive way to describe the visual impression of transparency.

Conversely, "cloudiness" reflects the presence of visible or sub-visible light scatter, often perceived as haze or milkiness.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color HunterLab

To move from subjective descriptions to objective, quantifiable measurement, we rely on three distinct but related scientific optical properties.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color HunterLab

These are **Haze**, **Turbidity**, and **Opalescence**. At the heart of all three properties is the principle of light scatter.

Let's begin with a definition and everyday example for each property.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Let's start with **Turbidity**.

Imagine standing by a clear stream on a calm day. The water is transparent. You can see the pebbles on the bottom, the fish swimming, even the shadows they cast.

Module 9:

Haze, Turbidity, Opalescence

Now picture that same stream after a heavy rain.

The water is muddy and murky from Suspended soil, silt, and debris that scatter and absorb light. This is turbidity in action.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

This is an important measurement parameter for many liquids including food and beverage manufacturing.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Now let's talk about **Haze**.

Imagine gazing out at a mountain range on a clear day. You can see the contours of each mountain ridge and even the shadows on the slopes. Every detail is sharp and vivid.

Module 9:

Haze, Turbidity, Opalescence

Now imagine the same view on a hot, humid summer day or during wildfire season.

A thin veil of atmospheric haze made of dust, moisture, or smoke fills the air. The mountains are still visible, but their edges blur, colors fade, and everything looks washed out.

Module 9:

Haze, Turbidity, Opalescence

This is how haze affects transparent materials. Scattered light blurs the view, reducing contrast and clarity. This is an important measurement parameter for applications like food and beverage packaging.

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

And Haze is an important measurement parameter for ophthalmic lenses used in eyeglasses.

Module 9:

Haze, Turbidity, Opalescence

Finally, let's look at **Opalescence**.

Imagine walking by a lake that appears sharp, distinct and bright blue.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Now imagine walking by a lake that looks like it has a soft glow, maybe a gentle teal or white shimmer. This is opalescence.

It's not the full-on cloudiness of turbidity, It's a slight, pearly scatter of light, often caused by microscopic particles. It's most noticeable when light passes through at the right angle.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color HunterLab

In pharmaceutical manufacturing, especially for injectable drugs and biologics, this delicate visual disturbance can signal a critical issue.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Though all three properties relate to light scattering, they are quantified using different scientific measurement methods.

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

Turbidity is measured using nephelometers or turbidimeters.

The results, in NTU or nephelometric turbidity units, help determine whether a sample is acceptably clear, especially critical for water, clear beverages, and some injectable solutions.

Module 9:

Haze, Turbidity, Opalescence

Haze is used to evaluate the amount of light scatter in transparent solids using ASTM method D1003, which outlines two optional procedures:

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

ASTM D1003:

- **Procedure A** uses a dedicated haze meter and an integrating sphere to compare total transmitted light with scattered light beyond a 2.5° angle.
- **Procedure B** allows use of a spectrophotometer with an integrating sphere—ideal for labs already measuring color and transmittance.

In both cases, the result is expressed as a percentage of scattered light, with lower values indicating clearer, higher-quality materials.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

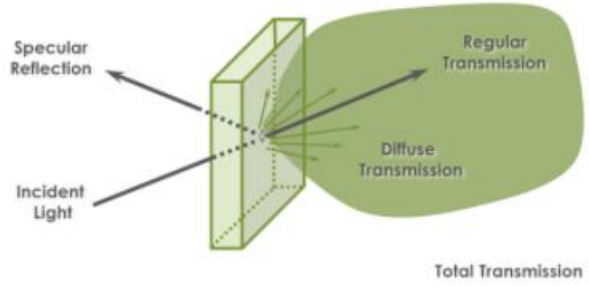
The world's true measure of color HunterLab

It is important when measuring haze to understand the difference between **Total Transmission**, or **TTRAN**, and **Regular Transmission**, or **RTRAN** for accurate measurements.

Total Transmission is the total amount of light that passes through a transparent sample. It includes both direct and diffusely scattered light at all angles.

Regular Transmission measures only the direct, non-scattered light that passes through the sample in a straight line.

- TTRAN (Total Transmission) is the total amount of light that passes through a transparent sample.
  - It includes both direct (unscattered) light and diffusely scattered light at all angles.
- RTRAN (Regular Transmission) measures only the direct, unscattered light that passes through the sample in a straight line (within a very narrow angle—typically ±2.5° of the incident beam).

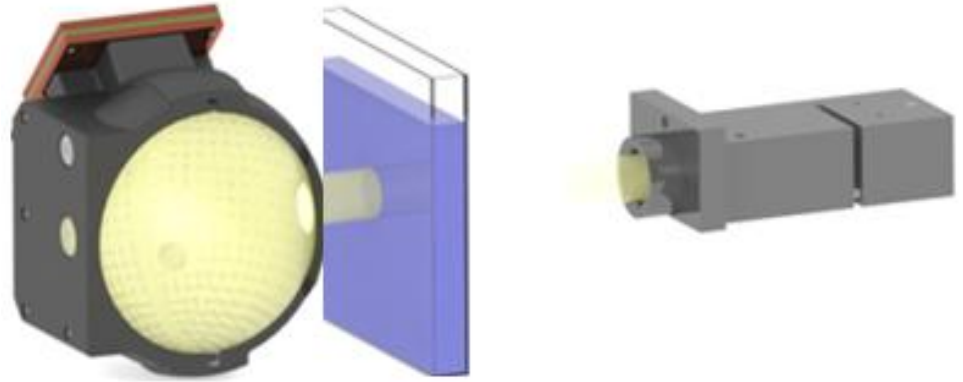


Fundamentals of Color and Appearance

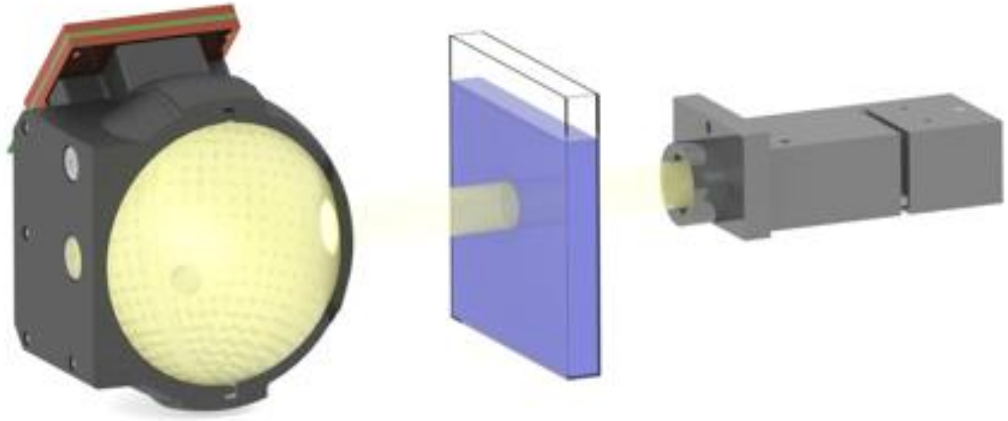
Module 9:

Haze, Turbidity, Opalescence

Total Transmission (TTRAN) is measured by placing the sample flush against the sphere port. This captures the total amount of light that passes through a transparent sample and includes both direct light and diffusely scattered light at all angles.



Regular Transmission (RTRAN) is measured by placing the sample anywhere away from the sphere port, capturing only the direct light that passes through the sample in a straight line.

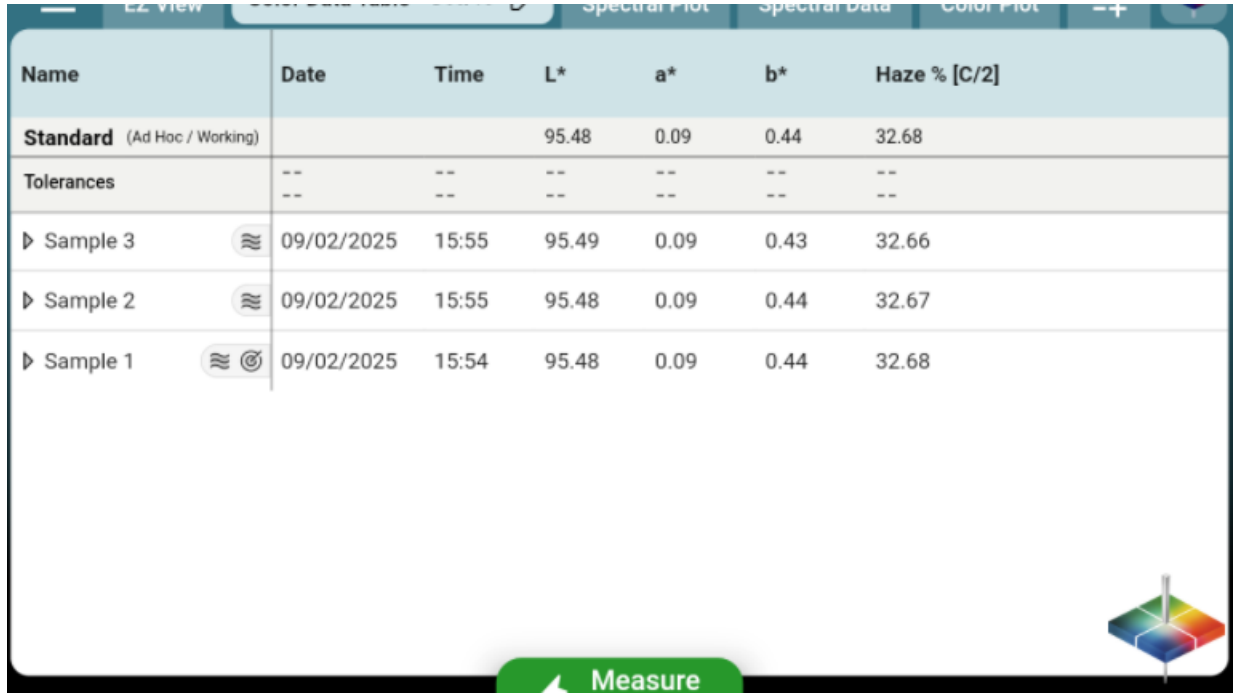


Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Separating **direct** vs. **scattered** light transmission allows precise quantification of haze, critical for evaluating optical clarity in plastics, films, lenses, and other transparent materials.



Module 9:

Haze, Turbidity, Opalescence

Lastly, **Opalescence**, typically assessed in pharmaceutical quality control using visual comparison, is guided by pharmacopeial standards like the European Pharmacopoeia which defines reference suspensions at known NTU levels.

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

For greater accuracy and precision however, instrumental nephelometry is used, as defined in USP method 855 or European Pharmacopoeia method 2.2.1.

Instruments are calibrated using liquid Formazin suspensions, just like turbidity measurements, but with greater sensitivity for very low turbidity levels.

Opalescence is typically assessed in pharmaceutical quality control using Visual comparison, guided by pharmacopeial standards

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Understanding, measuring and controlling haze, turbidity and opalescence isn't just about aesthetics, it's about safety, performance and brand trust.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

In consumer packaging, haze affects brand perception and purchasing decisions.

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

In beverages, turbidity can signal quality or spoilage.

Module 9:

Haze, Turbidity, Opalescence

The world's true measure of color
HunterLab

And in injectables, opalescence can mean the difference between a stable, safe drug and one that must be rejected.

Fundamentals of Color and Appearance

Module 9:

Haze, Turbidity, Opalescence

Each property acts as a quality control checkpoint, whether in material production, formulation, or final product inspection.

Fundamentals of Color and Appearance

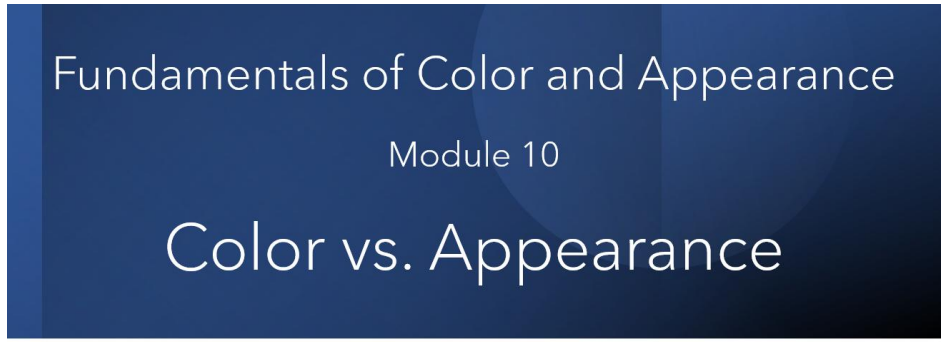
Module 9:

Haze, Turbidity, Opalescence

Thank you for joining us on this journey through color science.

Be sure to watch Module 10, **Color verses Appearance** next, where we will explore how a materials surface characteristics like texture and gloss not only influence how we perceive color but also present real challenges in accurately measuring color..

And be sure to visit **hunterlab.com** to learn more about how our solutions can help you achieve color confidence, every time, or to schedule a consultation with one of our color experts.



Color Science Educational Series

www.hunterlab.com | support.hunterlab.com

Schedule a free color consultation with our experts

www.hunterlab.com