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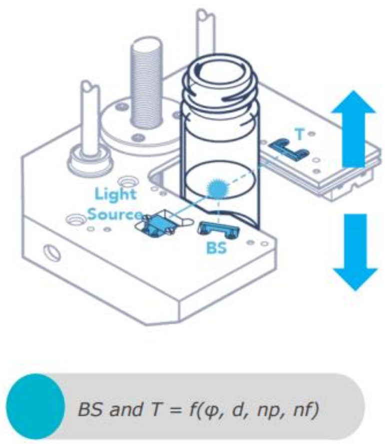
ACCELERATED DETERGENT PERFORMANCE TESTING

Context

The laundry industry plays a vital role in both household and commercial settings, offering solutions for fabric care, cleanliness, and hygiene. As consumer expectations rise for effective and sustainable cleaning, manufacturers face significant challenges such as formulating detergents that efficiently remove a wide range of soils while maintaining fabric integrity and meeting environmental regulations. Evaluating the cleaning performance of detergents is crucial for product development; however, traditional testing methods are often labor-intensive and time consuming. Rapid and reliable analytical techniques, such as those provided by the TURBISCAN, are therefore increasingly important for accelerating detergent evaluation and innovation.

TURBISCAN: How it works

TURBISCAN technology, based on Static Multiple Light Scattering, consists on sending a light source (880 nm) on a sample and acquiring backscattered (*BS*) and transmitted (*T)* signal all over the height of a sample. By repeating this measurement over time at an adapted frequency, the instrument enables to monitor physical stability. The signal is directly linked to the particle concentration (φ) and size (d) according to the Mie theory:



The measurement of the *BS* and *T* can be performed either in scanning mode, to provide homogeneity and stability measurement, or with very high frequency for fast time-resolved and online measurement. The measurements are done without any dilution & on the native sample.

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Additionally, the TURBISCAN DNS can monitor signal evolution via:

- Mixing function (**TMIX**) for automated fast formulation screening with a stirring bar directly inside the measurement cell. (see Notes Flow 1-3).
- Circulating function (**TLOOP**) for online measurements and scale-up or process optimizations. Topic of this note.

(TURBISCAN DNS)

Method to evaluate detergency efficiency of laundry formulation

A 1 cm² piece of tissue is stained with 50 µL of palm oil containing 5 wt.% curcumin to simulate a persistent fabric stain. The stained tissue is placed at the bottom of a dedicated glass vial, secured by a secondary seal. the vial is closed with a specialized cap designed for optimal flow in the TLOOP module. The vial is then positioned inside the TURBISCAN DNS. After rinsing the system with pure water, a second vial containing the laundry formulation (diluted in water to 3 wt% concentration) is connected, establishing a closed loop that circulates the solution between the two vials (see ***Figure 1***).

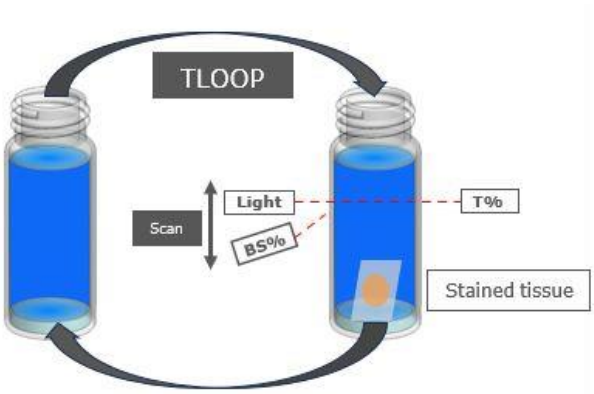

***Fig.1**: Representation of the liquid flow to study stain removal with detergent liquid with TURBISCAN DNS*

Transmission and backscattering profiles are recorded every 30 seconds over 3 hours. The results show an increase of the backscattering at the bottom of the vial, corresponding to the stained tissue, and high transmission at the top, indicating the presence of emulsified stain molecules and laundry actives in the aqueous phase (see ***Figure 2***).

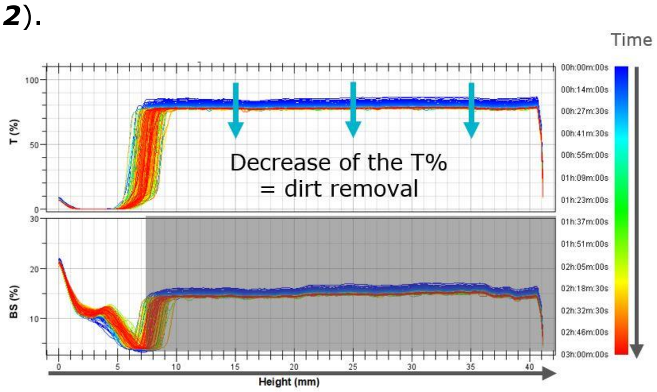

***Fig.2**: Transmission and backscattering in function of sample height and time for formulation 1*

From the transmission measurement during detergent liquid circulation, we observed a decrease of the transmission profile. The reduced light transmission results from the dispersion of dirt within the detergent solution, which causes the liquid to become increasingly less transparent.

During the circulation of the detergent solution, the transmission measurements exhibited a progressive decrease through the liquid phase. This reduction in transmission directly correlates with the increasing removal of the stain into the detergent solution; as more stain components are removed from the fabric and dispersed or emulsified in the liquid, the solution becomes less transparent to light. This change in optical properties provides a quantitative indication of the detergency efficiency, as higher levels of stain removal and dispersion result in greater decreases in transmission.

To further assess detergency performance, we compared the cleaning efficiency of three different detergent formulations alongside pure water as a control. By monitoring the evolution of transmission* in function of time (***Figure 3***) for each sample, we were able to directly evaluate and contrast their ability to remove and emulsify the stain under identical conditions.

**In cases where the detergent formulations differ significantly in composition or initial optical properties, it is advisable to use normalized transmission ($\Delta T/T_0$) values, calculated relative to the initial transmission of each sample.*

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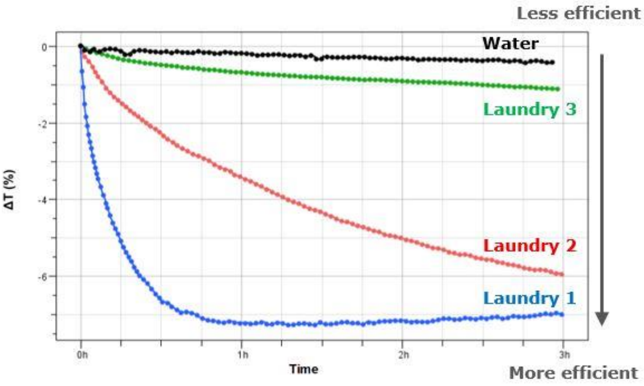


Fig.3*: Transmission variation in function of detergent circulation time.*

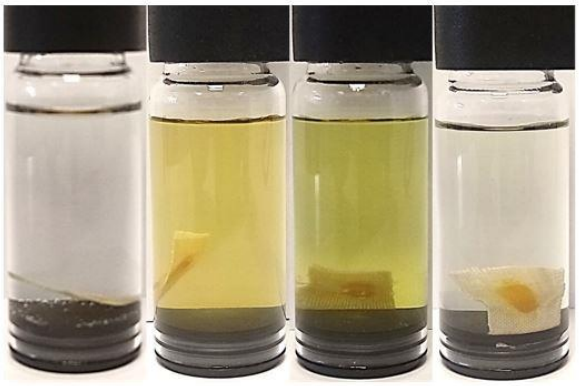
From the ***Figure 3***, we can conclude:

- Detergent solution shows a clear advantage in removing dirt from the tissue (vs water).
- Among the 3 formulations tested, the **Formulation 1** displays the highest decrease of the Transmission (less transparent, so the higher dirt removal).
- Not only having the lowest Transmission value (so highest efficiency to remove the dirt), it also shows the fastest kinetic (reach the lowest transmission value in 45min).

Formulations can be ranked from the most efficient to the least.

Laundry 1 > **Laundry 2** >> **Laundry 3** > **Water**

More efficient ← Less efficient



Pure water | Laundry formulation n°1 | Laundry formulation n°2 | Laundry formulation n°3

Fig.4*: Pictures of samples tested after the washing process*

Conclusion

The TURBISCAN DNS offers a rapid, quantitative, and non-destructive approach to evaluating detergency efficiency, providing real-time insights into stain removal dynamics. Its ability to monitor transmission and backscattering without sample dilution enables precise comparison between formulations under realistic conditions. This accelerates product development, supports robust formulation optimization, and ensures reliable performance benchmarking, making TURBISCAN an essential tool for advancing innovation in laundry detergent evaluation.

TURBISCAN RANGE

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