NEWSLETTER

No.6- August 2025

VISIMIX NEW PRODUCT: SENSITIVITY ANALYSIS

VisiMix has introduced a new Sensitivity Analysis module that allows users to compare how varying a single input parameter impacts process results—enabling faster optimization and deeper insight. This tool helps users understand the influence of key variables such as RPM, temperature, or concentration on mixing performance and process outcomes.It's especially useful during scale-up or process development to select optimal operating conditions with minimal experimentation.

Watch the full video here

We present two case studies demonstrating the use of **VisiMix LAMINAR** for scaling up paint production and **VisiMix RSDE** for shampoo homogenization, ensuring consistent quality and efficient scale-up.

Case Study-1: Paint Production Scaling UP Using VisiMix Laminar

Scaling up paint production from laboratory scale to industrial scale is a crucial step in ensuring consistent product quality. In the laboratory, mixing is performed in small tanks under controlled conditions, making it easier to achieve uniform dispersion and to break down aggregates. However, when the same formulation is transferred to large-volume production tanks, the mixing behavior changes significantly due to variations in geometry, flow patterns, and energy distribution.

For paint production, complete treatment of the media is essential to achieve uniform properties. Achieving the same level of homogenization at production scale requires careful analysis of **key mixing parameters**.

With VisiMix LAMINAR, engineers can simulate lab-scale mixing conditions and accurately predict performance at industrial scale before running trials. In this case, a viscous paint formulation was successfully scaled up to a 1500 L tank, maintaining uniformity and quality without trial-and-error.

The Challenge

The goal was to reproduce the successful laboratory mixing process in an existing industrial system while ensuring the same product quality.

In the laboratory:

- Mixing was performed in an unbaffled **flat-bottom tank** with a tooth-disk agitator.
- The tank held 1.85 liters of media and achieved uniform mixing when the agitator speed exceeded 1800 RPM with a mixing time of 8 minutes.
- The media was highly viscous, non-Newtonian fluid requiring thorough treatment in the high-stress zone near the agitator baldes.

At production scale:

- The available tank had an **elliptical bottom,** a 52-inch diameter, and a working volume of 1200 L, equipped with a similar tooth-disk agitator operating at 800 RPM.
- The challenge was to determine whether this industrial setup could achieve the same level of homogenization as the laboratory process and, if so, how long the process would take.
- Any portion of the media left untreated in the high-shear zone would compromise product quality, so precise calculation of key parameters was essential.

Key Challenges:

✓Replicating lab-scale mixing performance in a 52″ elliptical-bottom tank with different geometry and lower RPM

✓ Ensuring the **same shear stress** at the industrial scale.

✓ Achieving **complete treatment of media** with no untreated zones

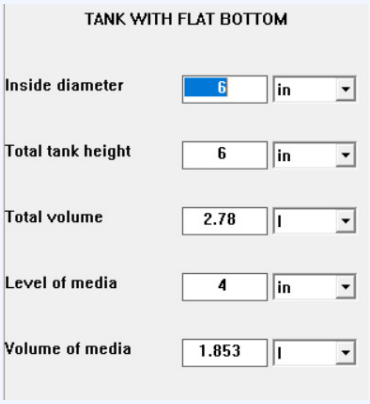
✓ Determining the **optimum process time** to meet lab-scale quality.

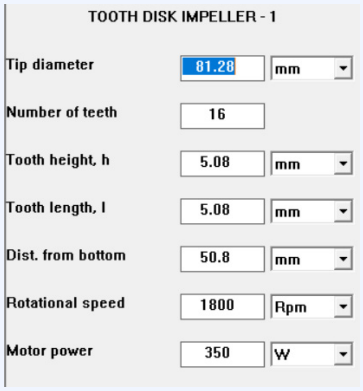
The Solution

To address the scale-up challenge, **VisiMix LAMINAR** is used to simulate both the laboratory and industrial systems and determine the critical parameters before actual plant trials.

Step-1: Laboratory simulation:

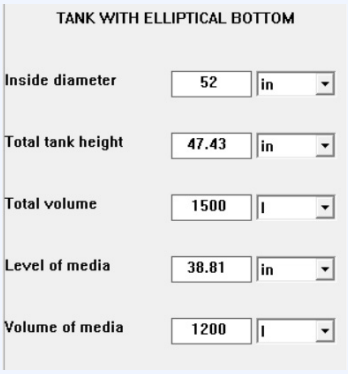
The laboratory setup (6″ unbaffled tank, 1.85 L media, tooth-disk agitator) was first modeled in VisiMix LAMINAR to establish baseline parameters for successful homogenization.

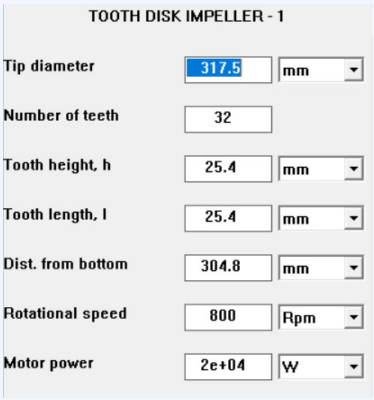


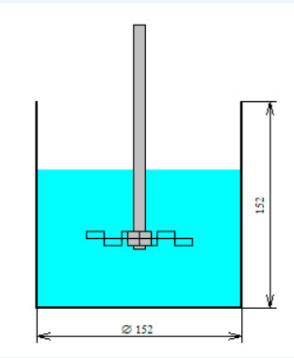


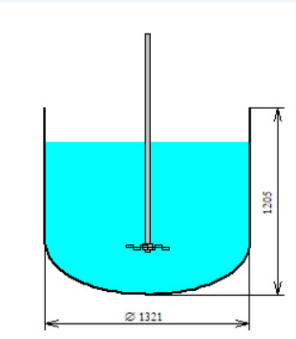
Step-2: Creating the industrial model:

Using the lab project as a base, a second project was configured for the industrial tank (52″ diameter, 1200 L media) with the same agitator type operating at 800 RPM.









The diagrams of the laboratory and industrial systems

Simulation Results:

VisiMix calculated the critical mixing parameters for both systems and identified the process time required to match lab-scale quality:

- **Shear stress near the agitator blades** – to ensure sufficient energy for breaking down aggregates.
  Lab: 6200 N/sq.m
  Plant: 7720 N/sq.m (sufficient for breaking down aggregates).
- **Unmixed part of media (%)** – to check if any portion of material never enters the high-shear zone.
  Lab: 0.0431%
  Plant: 0.0401% (For process time - 1 hr)
- **Untreated fraction of media** – to evaluate how thoroughly the material is treated in the high-shear zone.

Parameter	Lab (480 s)	Plant		
		1 hr	2 hrs	2.5 hrs
Untreated fraction of media (%), less than 1 cycle of treatment	1.09e-06	0.036	1.31e-05	1.02e-06
Untreated fraction of media (%), less than 2 cycles of treatment	2.10e-05	0.322	0.00022	1.98e-05
Untreated fraction of media (%), less than 5 cycles of treatment	0.00643	10.4	0.045	0.00612

- Untreated fraction at plant scale was initially much higher than lab values but steadily decreased with longer mixing time.
- 2.5 hours achieved untreated fraction values comparable to lab conditions.

Key Observations

- **Shear stress at plant** (7,720 N/m^2) exceeded lab requirement (6,200 N/m^2) which is sufficient for breaking down aggregates.
- **Unmixed part of media** remained low and within limits (≈0.0401 %).
- **Untreated fraction of media** reduced significantly with increased process time, meeting lab standards at 2.5 hours.

Conclusion

- Through simulation with VisiMix LAMINAR, the team confidently scaled up a viscous paint formulation from lab to plant while maintaining product quality.
- No costly trial runs were required.
- The simulation identified that the industrial system can achieve the same level of homogenization as the laboratory system with a process duration of 2.5 hours.

Case Study -2: Homogenization of Shampoo - Scaling Up using VisiMix RSDE

Achieving consistent micro-scale homogeneity is a key requirement in shampoo manufacturing, particularly during scale-up, where replicating lab-scale results at production scale can be challenging. High-shear mixing using Rotor-Stator Devices (RSDs) plays a critical role in ensuring uniform dispersion and emulsification.

VisiMix RSDE is a new and revolutionary simulation tool developed specifically for modeling rotor-stator mixing systems. It is the first of its kind to enable users to simulate high-shear processes for both Newtonian and non-Newtonian fluids, supporting a wide range of viscosities. With intuitive input of geometrical and process data, RSDE delivers fast, accurate predictions of shear rates, shear stress, power consumption, and flow performance.

This case study demonstrates how VisiMix RSDE was used to scale up a shampoo formulation from a 2.5 L lab setup with a portable RSD to a 500 L production tank equipped with a bottom-entering RSD and anchor agitator—ensuring process efficiency, product quality, and eliminating the need for trial-and-error scale-up.

The Challenge

Scaling up the homogenization of a shampoo formulation from a 2.5 L lab setup to a 500 L production tank introduced several technical and operational challenges, particularly due to the need for both micro- and macro-scale homogeneity of a non-Newtonian product.

In the laboratory, a portable rotor-stator device (RSD) operating between 15,000 and 20,000 RPM successfully achieved the desired product uniformity. At 15,000 RPM, the shampoo exhibited good microstructure and quality, while the maximum speed of 20,000 RPM also produced excellent results—though it caused some air entrapment that required settling. However, when the RSD was operated at 10,000 RPM or lower, the resulting product quality deteriorated significantly, highlighting a critical **minimum shear** threshold for effective homogenization.

Transferring this process to a 500 L production system equipped with a bottom-entering RSD and an anchor agitator presented several key challenges:

- **Replicating Shear Conditions:** The lab process relied on specific shear rates (8270–12600 s^{-1}) to achieve product quality. These conditions needed to be matched in the industrial RSD.
- **Ensuring High Treatment Coverage:** At least 99.9% of the batch was required to pass through the high-shear zone to ensure uniformity and product performance.
- **Process Duration Uncertainty:** The lab process required only 10–15 minutes, but it was unclear how much time would be needed at production scale.
- **Avoiding Over-Shearing:** Excessive shear could introduce air or degrade product quality, while under-shearing could lead to poor consistency.

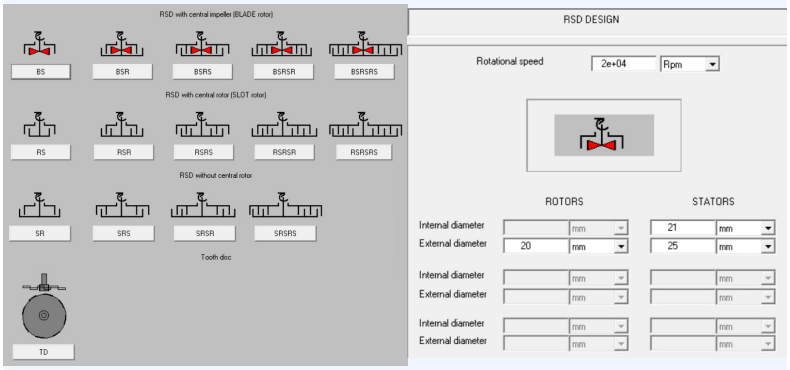
The main challenge was to determine whether the bottom-entering RSD and anchor agitator system could meet these requirements—and to define the optimal operating speed and mixing time to ensure complete, efficient, and uniform treatment of the entire batch.

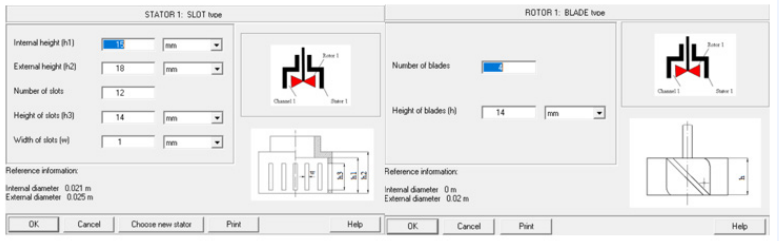
The Solution

Step 1: Laboratory Simulation

A simulation of the 2.5 L portable RSD setup was conducted to establish the reference conditions required for product quality. By inputting the rotor-stator geometry and process parameters into VisiMix, the software calculated the shear rates generated at various rotational speeds:

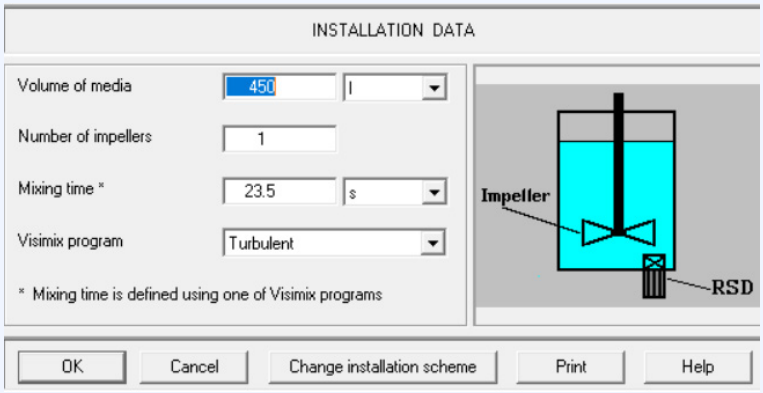
- At 20,000 RPM, the shear rate reached 12,600 s^{-1}.
- At 15,000 RPM, the shear rate dropped to 8,270 s^{-1}—still sufficient for good quality.
- Below 10,000 RPM, performance degraded, confirming a minimum required range of 8,270–12,600 s^{-1} for successful homogenization.

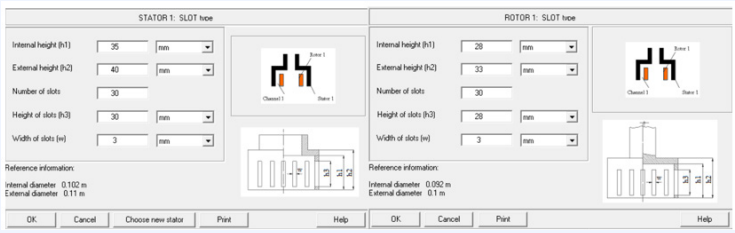




Step 2: Production System Modeling

Next, the geometry and operating parameters of the bottom-entry RSD in the 500 L tank were entered into VisiMix.





The simulation revealed that:

The industrial RSD could produce shear rates within the target range at rotational speeds between 1500 and 2100 RPM.

Power consumption remained well below the 3 kW motor limit, even at maximum speed, confirming that energy demand would not be a constraint.

Simulation results

Lab & Plant results - Shear rate Vs RPM

Lab Results	
RPM	**Shear rate, 1/s**
3000	22000
15000	8270
20000	12600

Plant Results	
RPM	**Shear rate, 1/s**
1500	8180
1700	9670
1900	11300
2100	13000

Time required for homogenization		
Time for 95% homogenization	sec	846
Time for 98% homogenization	sec	1100
Time for 99% homogenization	sec	1300
Time for 99.9% homogenization	sec	1950
Time for 99.99% homogenization	sec	2600

Process Duration (min)	Non-homogenized fraction of media final value (%)
30	0.17
40	0.0203

Simulation predicted batch homogenization time accurately:

- A 30-minute duration resulted in 0.17% untreated fraction, slightly above the 0.1% threshold.
- Increasing the duration to 40 minutes brought the untreated fraction down to 0.1%, meeting the quality requirement.

Key Observations

- The required shear rate for good quality was found to be between 8270 and 12,600 s^{-1} in lab trials.
- The plant RSD achieved similar shear rates (8180 to 13,000 s^{-1}) at much lower RPMs (1500–2100).
- Product quality dropped significantly in the lab when RPM fell below 10,000.
- Power consumption in the plant setup remained well within the 3 kW motor limit.
- At 30 minutes, the untreated fraction was 0.17%, which exceeded the acceptable limit.
- Increasing the process time to 40 minutes reduced the untreated fraction to 0.0203%.
- VisiMix predicted 1950 seconds (32.5 minutes) for 99.9% homogenization.
- A 40-minute process time is sufficient to meet the required product quality.
- Simulation avoided the need for trial-and-error or pilot batch testing.

Conclusion

- The use of VisiMix RSDE enabled a smooth and data-driven scale-up of the shampoo homogenization process from a 2.5 L lab setup to a 500 L production tank. By accurately simulating shear rates, power consumption, and process duration, the team was able to define optimal operating conditions—1900 RPM and 40 minutes—to achieve the required >99.9% homogenization without relying on trial-and-error.
- The simulation confirmed that the industrial bottom-entry RSD could match lab-scale performance, ensuring product quality and process efficiency. This approach saved time, reduced risk, and validated equipment suitability—highlighting VisiMix RSDE as a powerful tool for scale-up of high-shear mixing systems.