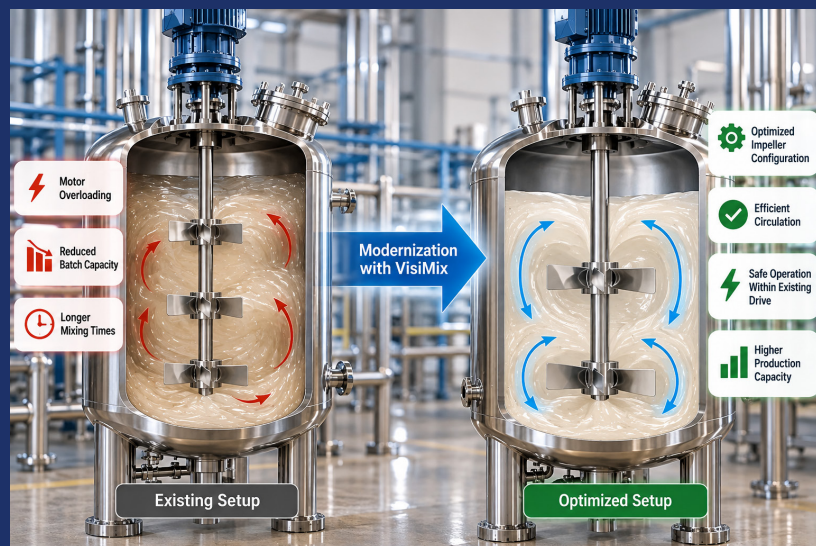


Introduction

- As product portfolios evolve, manufacturers are increasingly challenged to process **higher-viscosity formulations** using existing mixing tanks. Although reactors are often designed for moderate-viscosity products, introducing a more viscous process can lead to **motor overloading, reduced batch capacity, longer mixing times, and increased operating costs**, making reactor modernization a significant engineering challenge.
- Rather than replacing the reactor or installing a larger drive, a more effective approach is to understand the hydrodynamic behavior of the mixing system. The interaction between impeller configuration, power consumption, circulation patterns, and blending efficiency determines whether an existing reactor can be successfully adapted for a new process.
- This case study demonstrates how VisiMix Laminar was used to modernize an existing 2600 L mixing tank with a 2100 L working volume through hydrodynamic simulation, enabling higher-viscosity production without replacing the existing drive.



The Process Challenge

An existing 2600 L mixing tank with a 2100 L working volume, equipped with a **3-stage INTERMIG impeller** was successfully used for manufacturing a product with a maximum viscosity of **7,000–8,000 cP**. However, when the same reactor was introduced for a new formulation reaching **22,000–24,000 cP**, the process became problematic due to **motor overloading**.

To avoid overloading the existing drive, production had to be restricted to approximately **1600 L working volume per batch**, resulting in reduced manufacturing capacity and lower operational efficiency. The challenge was to determine whether the existing reactor could be modernized to process the higher-viscosity product **without replacing the drive while maintaining efficient mixing performance**.

Objective

The objective of this study was to evaluate whether an existing 2600 L mixing tank with a **2100 L working volume** could be successfully modernized for processing a **22,000–24,000 cP** product using **VisiMix Laminar**. The study focused on identifying an optimal impeller configuration that would maximize batch capacity while maintaining efficient mixing and avoiding drive overloading.

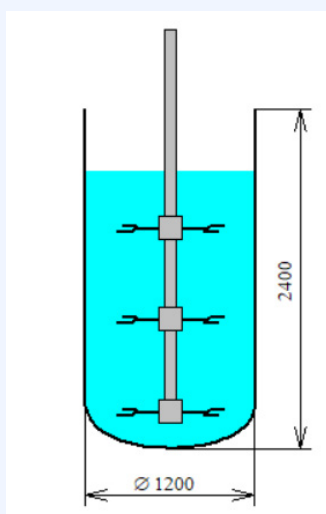
The study aimed to:

- Evaluate the impact of high viscosity on mixing power and blending performance.
- Compare the hydrodynamic behavior of **3-stage, 2-stage, and 1-stage impeller** configurations.
- Identify the optimum impeller arrangement based on power consumption and mixing time.
- Develop a practical modernization strategy for increasing production capacity using the existing reactor.

VisiMix Simulation Approach

The existing mixing tank was first simulated in VisiMix Laminar using the actual reactor dimensions, impeller geometry, and operating conditions. The simulation model accurately represents the physical reactor and serves as the foundation for evaluating the effect of different impeller configurations on power consumption, mixing time, and circulation performance.

TANK WITH ELLIPTICAL BOTTOM		RADIAL TURBINE 2	
Inside diameter	1200 mm	Tip diameter	720 mm
Total tank height	2400 mm	Impellers number	3
Total volume	2601 l	Dist. between stages	650 mm
Level of media	1957 mm	Pitch angle, fi	26 deg
Volume of media	2100 l	Width of blade, W	75 mm
		Length of blade, L	105 mm
		Dist. from bottom	250 mm
		Rotational speed	120 Rpm
		Motor power	4 KW

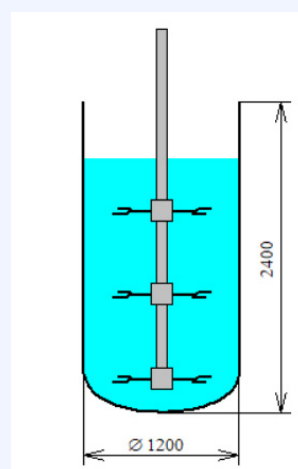


Dynamic viscosity	8000 cP
Kinematic viscosity	0.007273 sq.m/s

Figure 1: VisiMix Laminar model of the existing reactor showing the reactor geometry, 3-stage INTERMIG impeller, and fluid properties (8,000 cP)

High-Viscosity Process Simulation

To evaluate whether the existing reactor could process the new formulation, the **fluid properties of the medium** were updated in the VisiMix Laminar model. The **viscosity was increased from 8,000 cP to 24,000 cP** while maintaining the same reactor geometry, 3-stage INTERMIG impeller configuration, and operating speed. The modified reactor model was simulated to assess the effect of the high-viscosity formulation on mixing performance and drive loading.



Dynamic viscosity	2.4e+04 cP
Kinematic viscosity	0.0233 sq.m/s

Figure 2: High-viscosity process simulation (24,000 cP)

The modified reactor model was simulated using the **24,000 cP** formulation while retaining the original **3-stage INTERMIG** configuration. VisiMix predicted that the required mixing power exceeded the available drive capacity, indicating that the existing configuration was unsuitable for the higher-viscosity process.

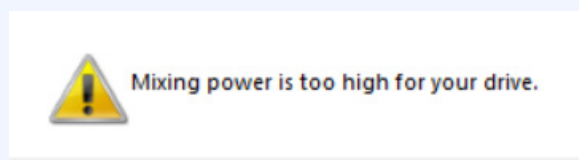


Figure 3: VisiMix warning indicating that the required mixing power exceeds the available drive capacity for the 3-stage configuration.

Simulation Results

To reduce the required **mixing power**, the simplest engineering approach is to decrease the **number of impeller stages**. However, reducing the number of impellers may also affect the reactor's circulation pattern and lead to longer mixing times. Therefore, VisiMix Laminar was used to compare the **3-stage, 2-stage, and 1-stage configurations** under identical reactor conditions.

The performance of each configuration was evaluated using **mixing power** and the **mixing time required to attain 10%, 5%, and 2% non-uniformity**, enabling an objective assessment of the optimum impeller design.

Parameter	3-Stage Impeller	2-Stage Impeller	Single-Stage Impeller
Process Viscosity (cP)	24000	24000	24000
Mixing power (W)	4110	2800	1430
Mixing time necessary to attain 10% non-uniformity (s)	465	363	614
Mixing time necessary to attain 5% non-uniformity (s)	569	459	931
Mixing time necessary to attain 2% non-uniformity (s)	706	584	1320

Table 1: Performance comparison of 3-stage, 2-stage, and 1-stage Impeller configurations (24,000 cP)

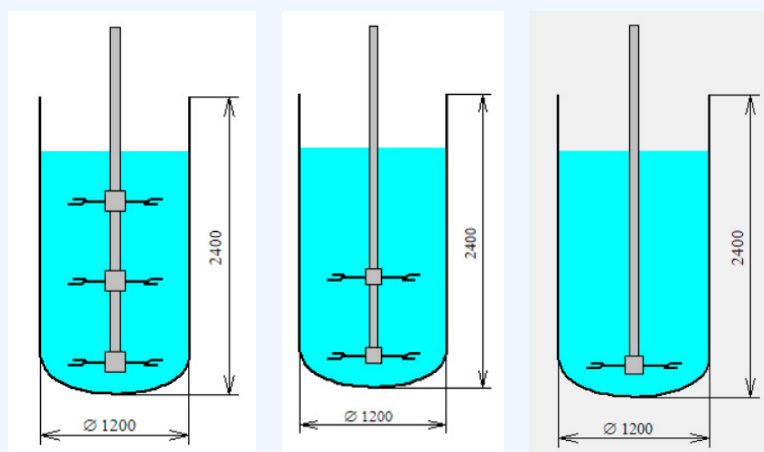


Figure 4: Reactor models showing the 3-stage, 2-stage, and 1-stage impeller configurations evaluated in VisiMix Laminar

Key Observations

The comparative simulations revealed that the number of impeller stages alone does not determine mixing performance. The overall circulation pattern within the reactor had a much greater influence on both mixing time and power consumption.

- **3-stage impeller:** Although the 3-stage configuration generated good circulation, it divided the reactor into a larger number of **circulation zones** with limited liquid exchange between them. As a result, the fluid required more time to travel between zones, leading to the **longest mixing time** and the highest power requirement (**4110 W**).
- **2-stage impeller:** Removing the third impeller improved the hydrodynamic circulation pattern by reducing the number of isolated circulation zones. This allowed better liquid exchange throughout the vessel, resulting in a **reduction in mixing time** while simultaneously lowering the power consumption to 2800 W. The 2-stage arrangement therefore provided the optimum balance between efficient blending and safe drive loading.
- **Single-stage impeller:** Further reducing the system to a **single impeller** decreased the power requirement to 1430 W, but the circulation became inadequate for the reactor volume. The simulation predicted significantly longer mixing times at all non-uniformity levels, demonstrating that excessive reduction in impeller stages negatively affects bulk mixing performance.

Engineering Insight

This study demonstrates that **more impeller stages do not necessarily result in better circulation or faster mixing**. The optimum design is achieved by selecting an impeller configuration that provides effective circulation throughout the reactor while maintaining acceptable power consumption, rather than simply increasing the number of impellers.

Conclusion

- This study demonstrates how **VisiMix Laminar** transformed reactor modernization from a trial-and-error approach into a scientifically optimized engineering solution. By evaluating the hydrodynamic performance of **3-stage, 2-stage, and 1-stage** impeller configurations, the optimum design was identified based on both **mixing power** and **mixing time**.
- The **2-stage INTERMIG** configuration delivered the best balance between energy efficiency and mixing performance, enabling the existing reactor to process a **24,000 cP** product while operating safely within the available drive capacity. The study also highlights an important engineering insight: **more impeller stages do not necessarily result in better circulation or faster mixing**—effective hydrodynamic flow is the key to successful reactor modernization.
- VisiMix provides an engineering-based approach to modernize existing mixing tanks, minimize plant trials, and increase production capacity while utilizing the existing reactor and drive.

Please refer: [Modernization of mixing tank for processing highly viscous liquid](#)

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