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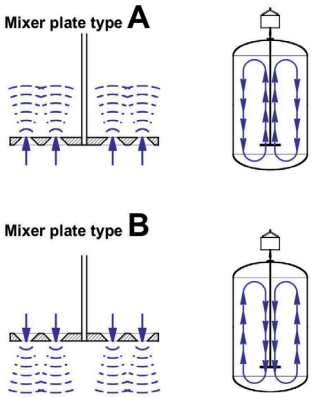
Comparison of the FUNDAMIX® Vibromixer with a Rotational Impeller

Introduction:

The FUNDAMIX® is a sophisticated mixing device that finds widespread use in the chemical, microbiological, victual and pharmaceutical industries. Uniform mixing is achieved by vertically oscillating a plate with conical perforations, taking advantage of the Bernoulli effect. The flow direction can be upward (type A), which minimizes the heel volume, or downward (type B), excelling in applications where the product tends to sediment, foam, or requires gas dispersion. Unlike rotating impellers, the FUNDAMIX® does not have any rotating parts, requires no baffles and mechanical seals on the vessel, induces no vortices and has a low OPEX.

In order to quantify its mixing performance, the FUNDAMIX® was compared with traditional rotational impellers. The mixing time, maximum (tip) speed, and shear rates were determined using electrical resistance tomography (ERT) [1] and computational fluid dynamics (CFD) [2], respectively. The results demonstrate that the FUNDAMIX® achieves faster and gentler mixing.



FUNDAMIX® Models:

Model	FM-1	FM-2	FM-3	FM-3+	FM-4	FM-4+	FM-5
Mixing Volume [L]	1-10	10-200	50-1'000	300-2'000	1'000-10'000	6'000-12'000	8'000-40'000
Max. pump capacity [L/min]	60	340	1'100	1'500	3'400	4'500	5'400
Mixing Plate Diameter [mm]	25-65	145	215	300	395	475	550

Mixing Time:

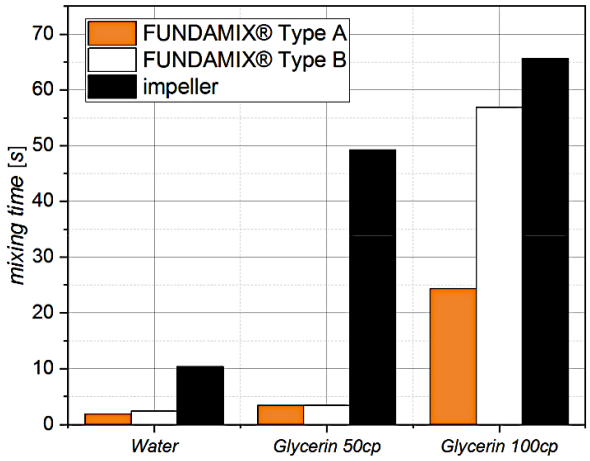


Figure 1: A FM-2 with a 135 mm diameter plate was used, running at a 2.3 mm amplitude and 100 Hz. The data was compared with the average mixing times of a two-blade Ekato Isojet and a 3-blade Lightnin A310 impeller, both having a 132 mm diameter and running at 500 rpm [1].

The FUNDAMIX® yields significantly lower mixing times than impellers for fluid viscosities up to 100 cP. Furthermore, mixing is more efficient, since the maximum speed of the FUNDAMIX® (<1 m/s) is much smaller than the tip speed achieved by the impellers (3.5 m/s).

Power Consumption:

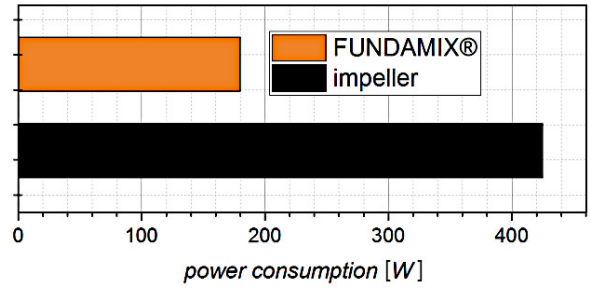


Figure 2: The same FUNDAMIX® and impellers were used as in Fig. 1, running at an amplitude of 2.3 mm and a rotational speed of 500 rpm, respectively [1].

The FUNDAMIX® consumes less power than conventional rotational impellers, despite achieving shorter mixing times. The increased efficiency of the FUNDAMIX® is due to the electromagnet-induced motion being mechanically reverted by springs.

Shear Rate:

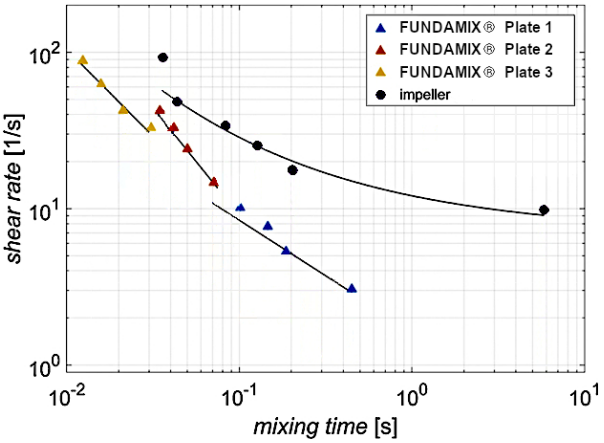


Figure 3: A FM-1 with type A plates of diameters 22, 45, and 65 mm was tested at 100 Hz and amplitudes of 1, 1.5, 2, and 2.5 mm. The data was compared with a 4-blade glass impeller (IKA) with 29 mm diameter, running at 50 – 2'000 rpm [2].

The shear rate is a measure of how straining the environment is that the fluid is subjected to. Depending on the plate geometry, the FUNDAMIX® can yield (1) lower shear rates at the same mixing time as impellers, (2) lower mixing times at the same shear rate, or (3) both lower shear rates and mixing times simultaneously.

Conclusion:

- The FUNDAMIX® yields on average more than 5 times shorter mixing times than rotational impellers, while also consuming less than half the power
- Tip speeds are nearly 5 times lower, allowing for a reduction in the shear forces up to 75%
- The FUNDAMIX® excels in applications where fast, uniform mixing and low shear rates are paramount

References

[1] Deutschmann, A., and Jobst, A., 2019, «Bewertung des Vibrationsmischers FUNDAMIX® Mittels Prozess-Tomographie,» Fraunhofer-Institut für Keramische Technologien und Systeme IKTS, Dresden, Germany.

[2] Orlewski, P.M., Wang, Y., Hosseinalipour, M.S., Kryscio, D., Iggland, M., Mazzotti, M., 2018, "Characterization of a Vibromixer: Experimental and Modelling Study of Mixing in a Batch Reactor," Chemical Engineering Research and Design, 137, pp. 534-543.