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Application Note

Mobius® Single-use Mixing Solution

Characterizing Liquid Blend Times Versus Viscosity

Introduction

This technical study characterizes the liquid blend time for each Mobius® single-use mixing system at a range of volumes, RPM, and viscosities, using a pH shift technique.

Liquid blending via mixing is a common process step in the production of biopharmaceutical products. Some examples of liquid blending applications that can be achieved in single-use mixers include batch conditioning, small aliquot additions, temperature and pH maintenance or adjustment, pooling of drug substance or drug product streams, and product formulation. It is informative to understand the blend time in such vessels; therefore, a comprehensive set of blend time data was generated for each Mobius® MIX system. These data help to characterize the performance and suitabilityof Mobius® MIX systems for blending operations.

The Mobius® MIX system offers effective mixing performance and efficient process changeover. Each single-use mixing container includes a magnetically-driven, levitating impeller for improved mixing consistency and efficiency. Vessels are offered in sizes of 10 L, 50 L,..., and 1000 L. In this Application Note, blend time data is generated for the entire portfolio of Mobius® Mix systems.

Experimental Method

Blend time data have been generated for each Mobius® MIX system (e.g. 10 L, 50 L, 100 L, 200 L, 500 L, and 1000 L) at full and half volume and at high, medium, and low mixing speed with a solution at up to 56 centipoise, shown in Table 1. With steady-state agitation achieved, the solution pH has been monitored at intervals of 1 second following additions of 0.05 to 0.1 % (v/v) strong acid or base tracer at the liquid surface. A pH probe was installed beneath the surface near the vessel wall, where fluid motion is less vigorous. In the 2 largest vessels, the Mobius® MIX 500 and Mobius® MIX 1000, tracer was added through a dip tube to the bottom of the vessel, opposite the pH probe, representing a sub-surface addition. A second pH probe location has been added to the Mobius® MIX 1000 L system at the sample window. The time to achieve 99% of homogeneity (T99) is determined from the logged data, with each set of conditions tested with triplicate acid and triplicate base additions. The mean result is reported for each condition.

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	Volume			Viscosity			RPM		
Mobius® MIX system	Low	Medium	High	Low	Medium	High	Low	Medium	High
10		5	10	1	13	45	250/350	500	1000
50		25	50	1	13	45			
100		50	100	1	13	56	120	250	500
200		100	200	1		30			
500	50	250		1	20	53	70	120	250
			500	1	10	53			
1000		500		1	10	53			
			1000	1	10				

Table 1

Test Matrix for effects of volume, rpm, and viscosity on blend time in Mobius® Mix system

Results & Discussion

Examples of pH shift with addition of tracer base into Mobius® MIX 100 systems are shown in Figure 1. An increase in blend time is seen as the RPM decreases and when blending into higher viscosities. The mean blend times achieved among various viscosities tested in the Mobius® MIX systems at nominal volume are summarized in Figure 2. The complete results are shown in Table 2. Results for individual mixers are shown in Figures 3–8.

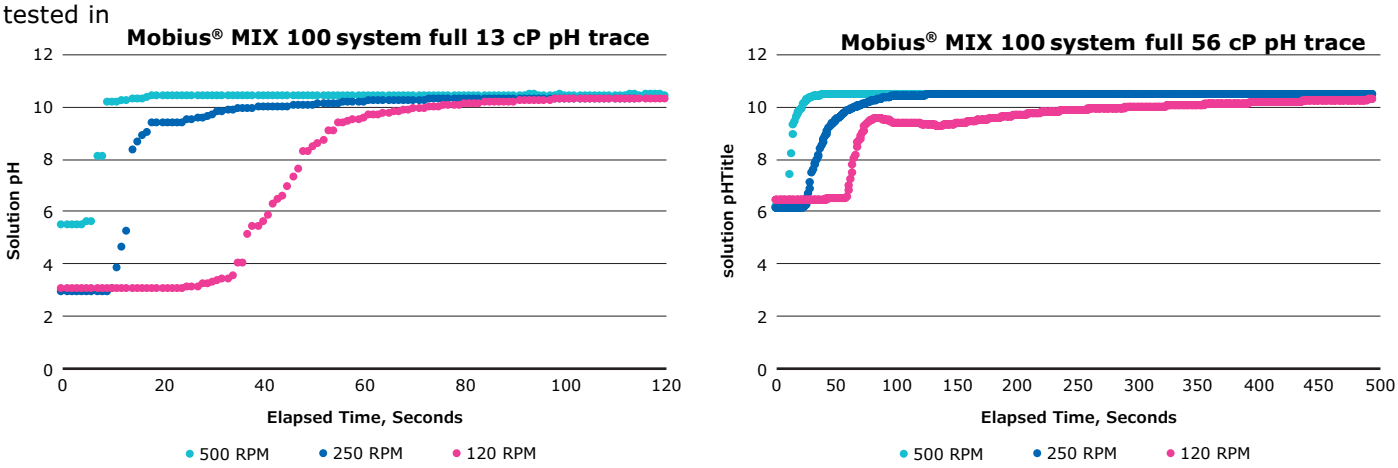


Figure 1

Examples of pH traces for liquid-liquid blending in Mobius® MIX 100 system at two viscosities and three RPM

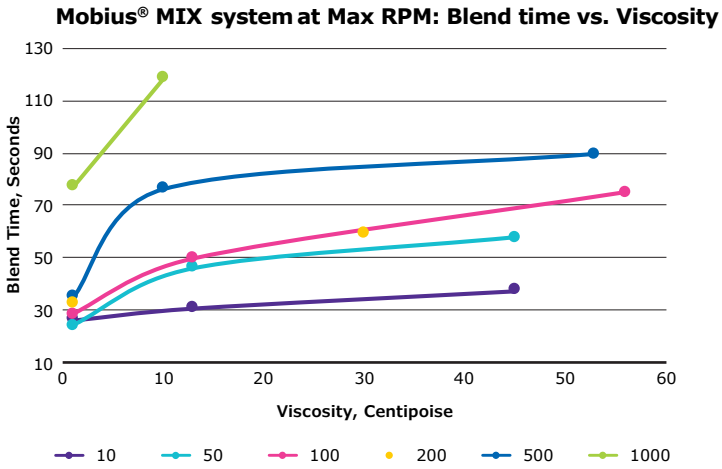


Figure 2

Relationship between liquid-liquid blend times (mean) and solution viscosity for each Mobius® MIX system at nominal volume

Mixer Size	Volume (L)	Viscosity (cP)	Blend time at RPM (second)			Blend time at RPM (minutes)		
			Low	Medium	High	Low	Medium	High
		1	33	35	26	0.6	0.6	0.4
		13	79	48	31	1.3	0.8	0.5
	10	45	126	76	38	2.1	1.3	0.6
		1	25	21	20	0.4	0.4	0.3
		13	22	20	16	0.4	0.3	0.3
10	5	45	60	45	32	1.0	0.8	0.5
		1	45	28	24	0.8	0.5	0.4
		13	79	81	46	1.3	1.4	0.8
	50	45	319	119	58	5.3	2.0	1.0
		1	49	27	25	0.8	0.4	0.4
		13	103	57	32	1.7	1.0	0.5
50	25	45	359	179	73	6.0	3.0	1.2
		1	78	46	29	1.3	0.8	0.5
		13	109	74	50	1.8	1.2	0.8
	100	56	845	163	75	14.1	2.7	1.3
		1	50	36	30	0.8	0.6	0.5
		13	132	64	29	2.2	1.1	0.5
100	50	56	2364	108	96	39.4	1.8	1.6
		1	96	51	33	1.6	0.9	0.6
	200	30	514	127	59	8.6	2.1	1.0
		1	83	52	36	1.4	0.9	0.6
200	100	30	307	150	76	5.1	2.5	1.3
		1	89	50	35	1.5	0.8	0.6
		10	250	154	77	4.2	2.6	1.3
	500	53	557	196	90	9.3	3.3	1.5
		1	65	36	25	1.1	0.6	0.4
		20	259	95	44	4.3	1.6	0.7
	250	53	339	219	59	5.7	3.7	1.0
		1	73	32		1.2	0.5	0.0
		20	125	57	31	2.1	1.0	0.5
500	50	53	254	195		4.2	3.3	0.0
		1	189	112	77	3.2	1.9	1.3
	1000	10	264	142	119	4.4	2.4	2.0
		1	162	114	58	2.7	1.9	1.0
		10	233	100	53	3.9	1.7	0.9
1000	500	53	576	372	126	9.6	6.2	2.1

Table 2

Blend Times (mean) for all test conditions, in seconds

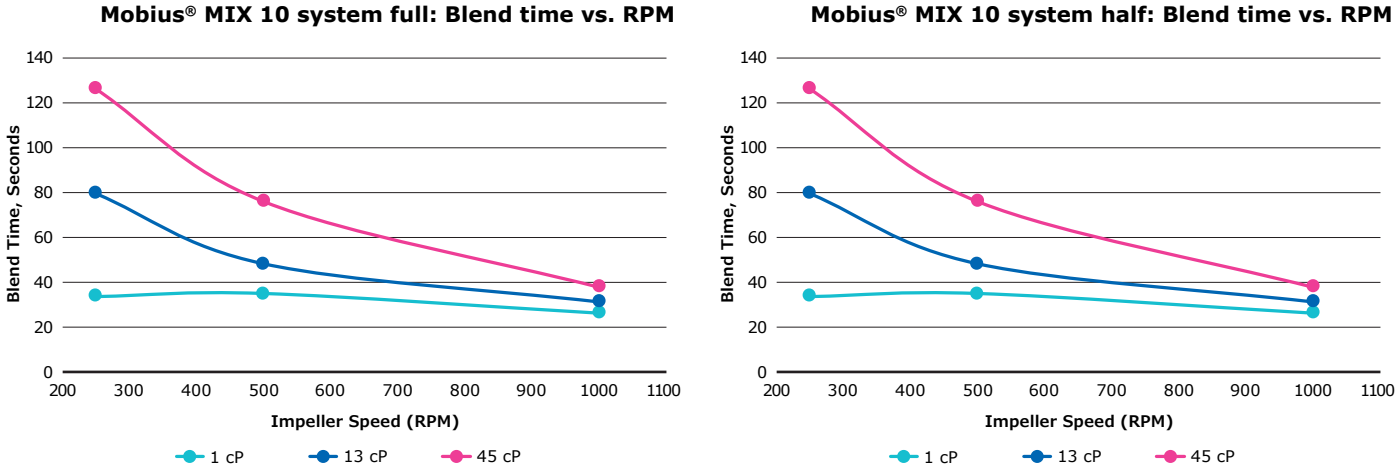
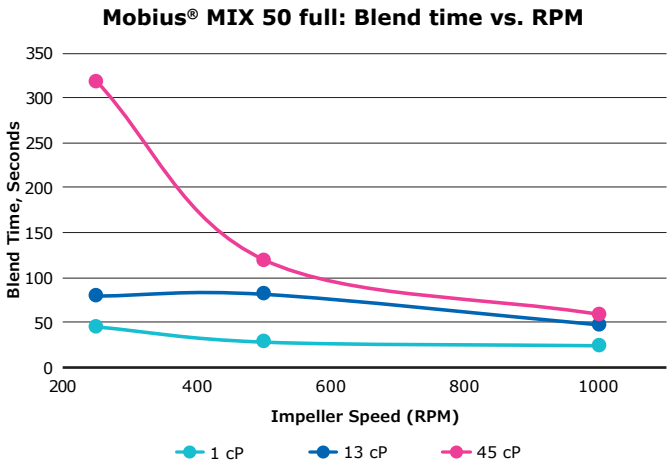


Figure 3:

Blend Times (mean) for Mobius® MIX 10 system full and half volume, in seconds



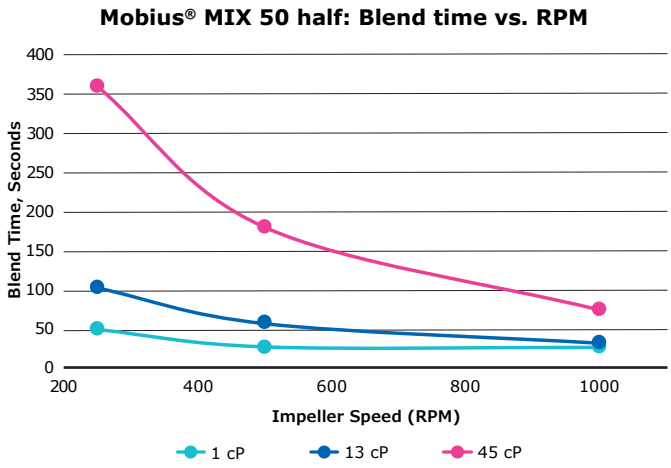
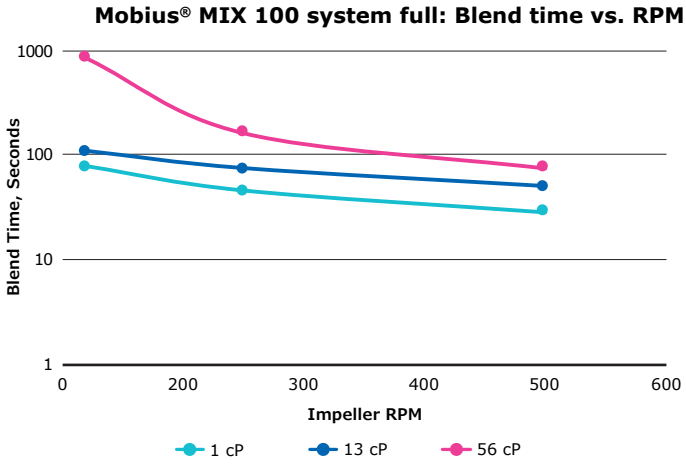


Figure 4

Blend times (mean) for Mobius® MIX 50 system full and half volume, in seconds



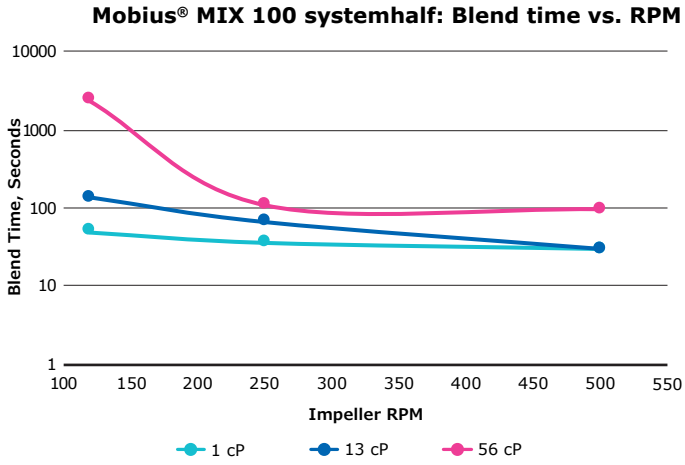
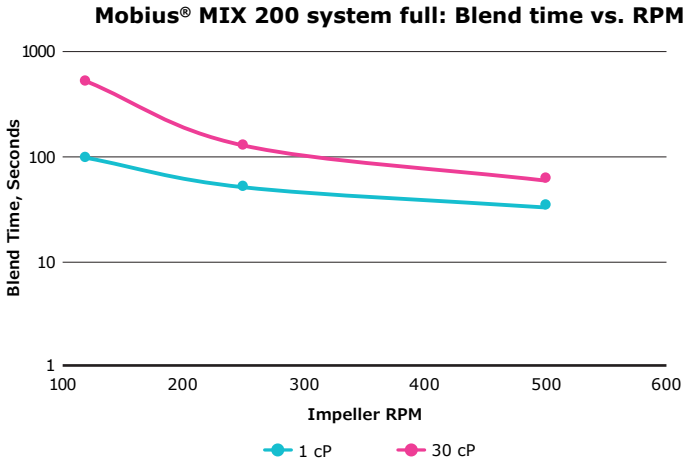


Figure 5

Blend times (mean) for Mobius® MIX 100 system full and half volume, in seconds



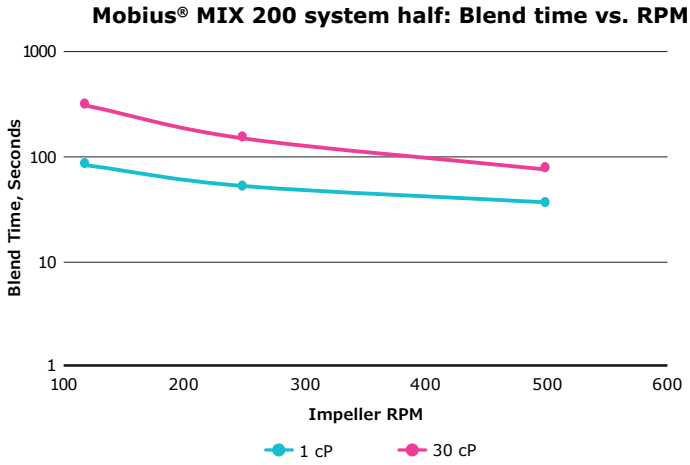
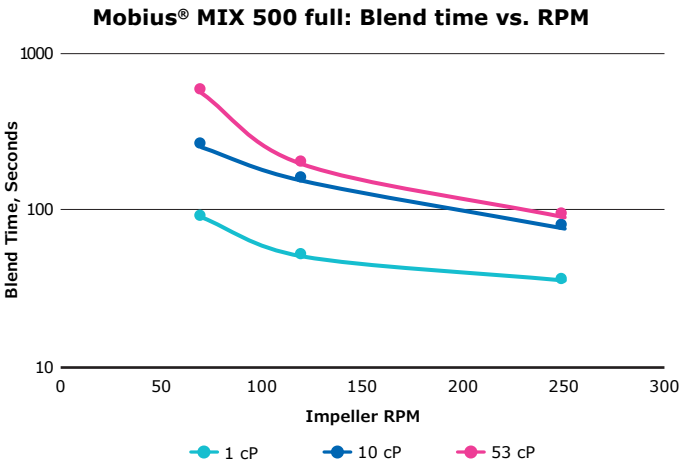
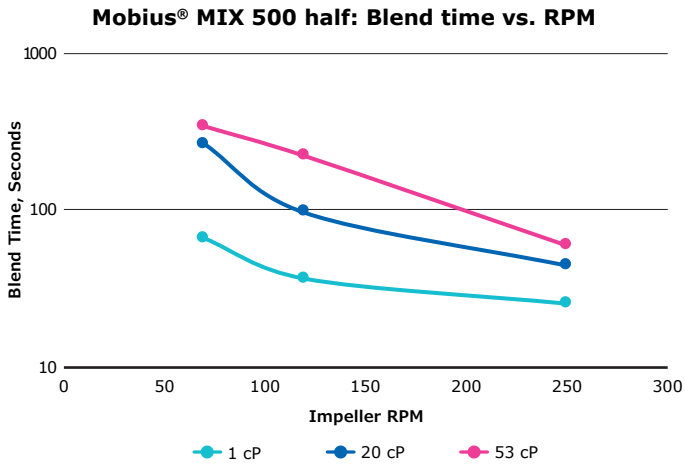


Figure 6

Blend times (mean) for Mobius® MIX 200 system full and half volume, in seconds





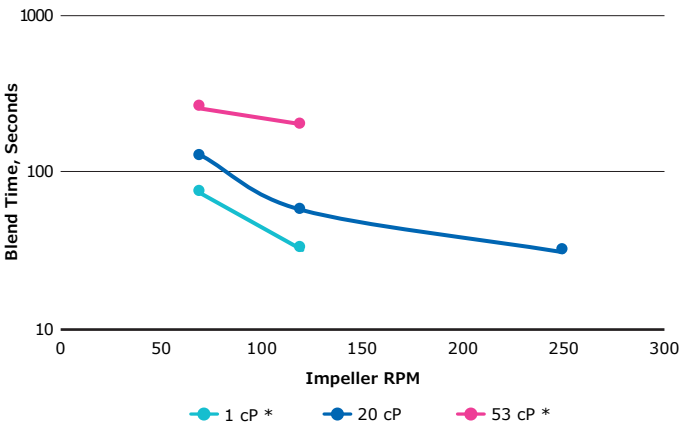
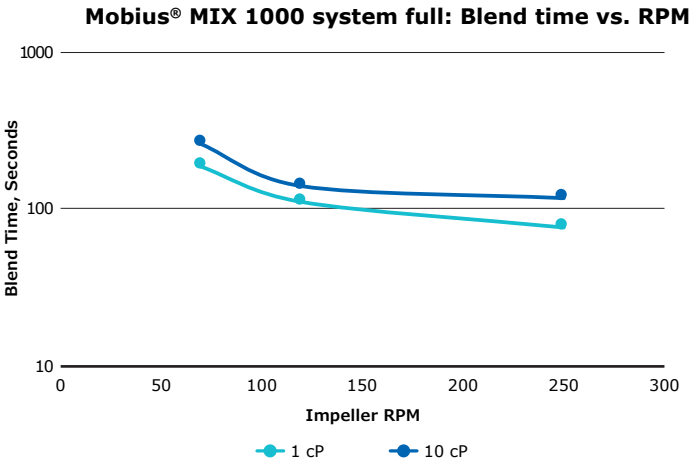


Figure 7

Blend times (mean) for Mobius® MIX 500 system full, half, and 10% volume, in seconds

* Mixing at 250 rpm for 1 cP and 53 cP solutions was too vigorous, with air entrainment which could be detrimental to product.



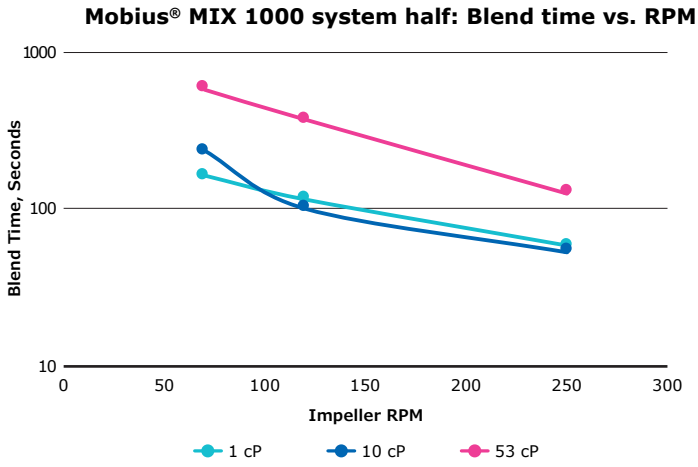


Figure 8

Blend times (mean) for Mobius® MIX 1000 system full and half volume, in seconds

Conclusions

The liquid blend time is reported for each Mobius® MIX system at a range of volumes and RPM for viscosities up to 56 cP. The blend times increase as RPM decrease or as solution viscosity increases. For blending higher viscosity solutions, using the highest RPM will produce lowest blend times by providing a higher power input.

This characterization study is intended to help end-users understand the performance of the Mobius® MIX system with higher viscosity solutions. Our information and advice do not relieve our customers of their own responsibility for checking the suitability of our products for the envisaged purpose.

We provide information and advice to our customers on application technologies and regulatory matters to the best of our knowledge and ability, but without obligation or liability. Existing laws and regulations are to be observed in all cases by our customers. This also applies in respect to any rights of third parties.

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