

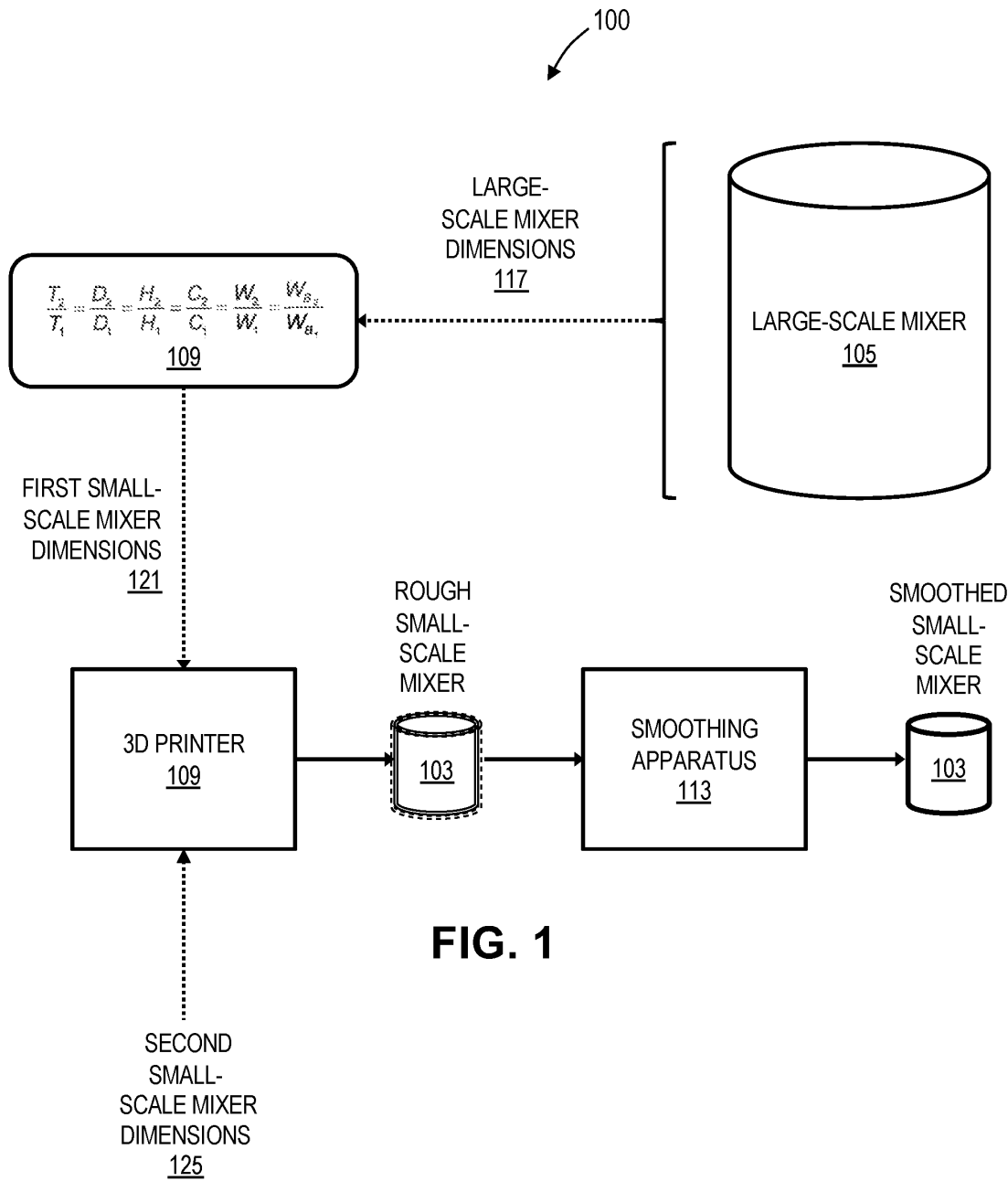


FIG. 1

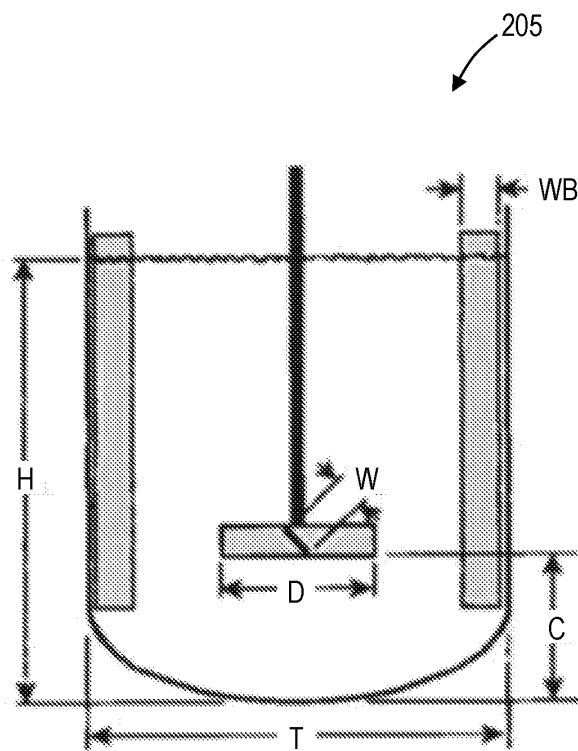


FIG. 2

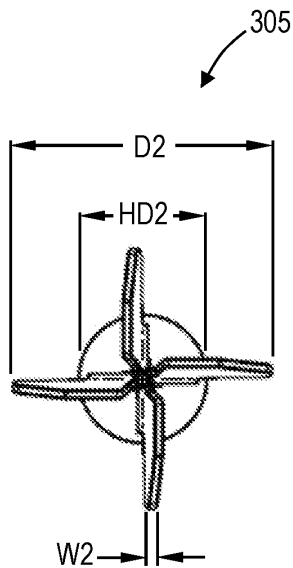


FIG. 3A

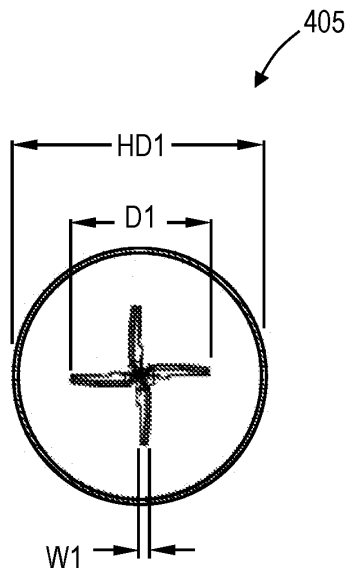


FIG. 4A

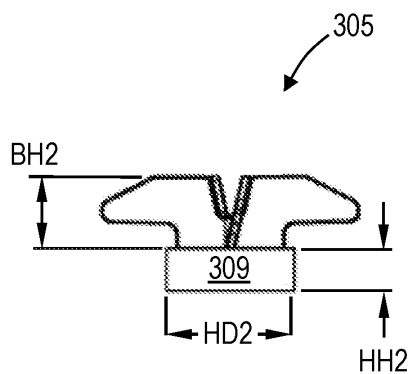


FIG. 3B

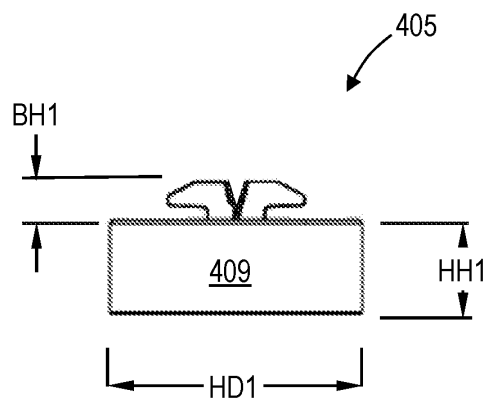
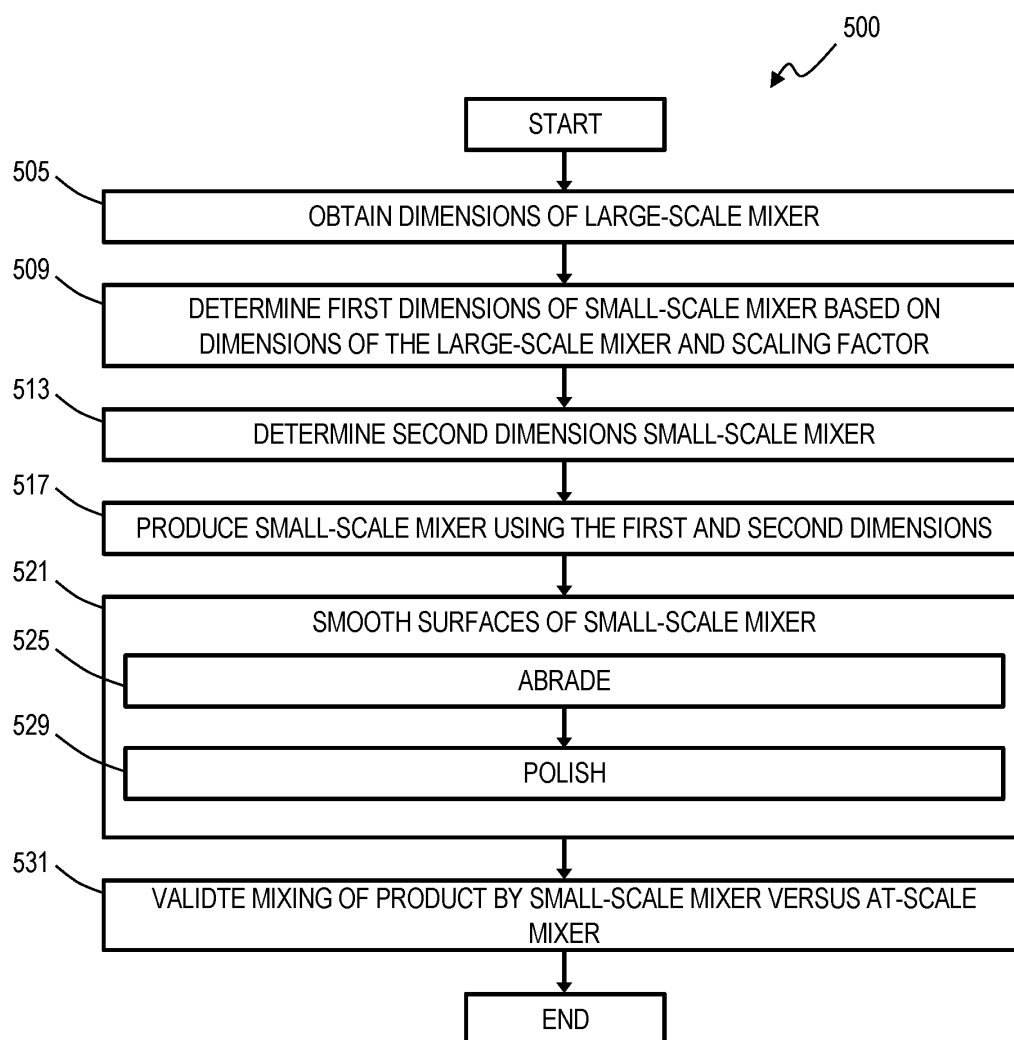


FIG. 4B

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**FIG. 5**

601

	Fill Volume (L)	Cone Height (cm)	Cylindrical Fill Height (cm)	Total Fill Height H (cm)	Tank Diameter T (cm)	Impeller Diameter D (cm)	Slant Height (cm)	Bottom Diameter (cm)	Scaling factor		Aspect Ratio (H/T)	Impeller Ratio (D/T)	Depth Ratio (D/H)	Cone Draft Angle (°)	Cone Volume (%)
603A	10	3.724	14.888	18.612	27.880	6.600	10.812	7.500	NA		0.667	0.237	0.356	69.850	10.12%
605A	1	1.729	6.872	8.601	12.905	3.064	5.019	3.482	2.2						
603B	50	5.198	48.282	53.480	38.880	6.600	17.340	5.715	3.7		1.172	0.170	0.145	72.556	4.79%
605B	1	1.412	10.912	12.324	10.539	1.793	4.710	1.552							
603C	100	7.010	44.070	51.080	52.330	10.000	25.627	3.000	4.6		0.977	0.191	0.196	74.126	5.32%
605C	1	1.510	9.500	11.010	11.265	2.154	5.520	0.646							
603D	200	8.762	56.476	65.238	65.400	10.000	32.487	3.000	5.8		0.998	0.153	0.153	74.314	5.14%
605D	1	1.498	9.659	11.157	11.183	1.710	5.541	0.513							
603E	500	12.111	73.726	85.837	90.400	17.500	45.247	3.000	7.9		0.950	0.194	0.204	74.509	5.36%
605E	1	1.526	9.289	10.815	11.390	2.205	5.713	0.378							

FIG. 6

Impeller dimensions			305	405	Scaling factor	405	Scaling factor
703	Diameter (mm)	(D)	65.9	30.59	2.2	17.90	3.7
705	Height (mm)	(BH)	18.3	8.49		4.95	
707	Thickness (mm)	(W)	2.4	1.10		0.64	

FIG. 7

Impeller dimensions			305	405	Scaling factor	405	Scaling factor
703	Diameter (mm)	(D)	100	21.54	4.6	17.10	5.8
705	Height (mm)	(BH)	28	6.03		4.79	
707	Thickness (mm)	(W)	2.9	0.63		0.50	

FIG. 8

Impeller dimensions			305	405	Scaling factor
703	Diameter (mm)	(D)	175	22.05	7.9
705	Height (mm)	(BH)	37.5	4.72	
707	Thickness (mm)	(W)	3.9	0.49	

FIG. 9

1001

Mixer system	609 Fill		613		617 Tank		619 Imp.		627 Aspect		629 Impeller	
	Volume (L)	Height H (cm)	Diameter T (cm)	Diameter D (cm)	Ratio (H/T)	Ratio (D/T)						
1003A	3	7.4	27.8	6.5	0.267	0.234						
1005A	20	14.0	52.3	10.0	0.267	0.191						
1007A	35	16.3	65.4	10.0	0.249	0.153						

FIG. 10

1101

1105A 1105B 1105C 1105D

615 617

615 617

615 617

615 617

615

TANK

Measurement	Tank #1		Tank #2		Tank #3		Tank #4	
	Tank Diameter	Cylindrical Height	Tank Diameter	Cylindrical Height	Tank Diameter	Cylindrical Height	Tank Diameter	Cylindrical Height
1	128.900	149.300	128.800	150.000	128.900	148.300	128.700	148.900
2	128.900	148.400	128.700	150.700	128.800	147.800	129.200	147.900
3	128.800	147.300	129.000	148.000	128.800	147.400	128.800	148.500
4	128.900	149.600	128.800	146.900	128.800	147.600	128.600	147.800
Average	128.875	148.650	128.825	148.900	128.825	147.775	128.825	148.275
Std.	0.050	1.034	0.126	1.757	0.050	0.386	0.263	0.519
Expected	129.048	149.500	129.048	149.500	129.048	149.500	129.048	149.500
% Error	0.13%	0.57%	0.17%	0.40%	0.17%	1.17%	0.17%	0.83%

1109 1111 1113 1115

FIG. 11

1201

IMPELLER											
Impeller #1				Impeller #2				Impeller #3			
Measurement	Blade Diameter	Blade Height	Blade Thickness	Blade Diameter	Blade Height	Blade Thickness	Blade Diameter	Blade Height	Blade Diameter	Blade Height	Blade Thickness
1	30.300	8.500	1.000	29.900	8.500	1.100	30.300	8.500	30.300	8.500	1.200
2	30.400	8.700	1.100	29.700	8.400	1.100	30.000	8.500	30.000	8.500	1.000
3	30.300	8.500	1.200	30.100	8.400	1.200	30.300	8.400	30.300	8.400	1.100
4	30.400	8.500	1.000	30.100	8.500	1.100	30.100	8.500	30.100	8.500	1.000
Average	30.350	8.550	1.075	29.950	8.450	1.125	30.175	8.475	30.175	8.475	1.075
Std.	0.058	0.100	0.096	0.191	0.058	0.050	0.150	0.050	0.150	0.050	0.096
Expected	30.590	8.490	1.090	30.590	8.490	1.090	30.590	8.490	30.590	8.490	1.090
% Error	0.79%	0.70%	1.40%	2.14%	0.47%	3.11%	1.38%	0.18%	1.38%	0.18%	1.40%

1205A

1205B

1205C

703 705

707 703 705

707 703 705

707 703 705

1209

1211

1213

1215

FIG. 12

1301

	Impeller Ratio		
	1	2	3
Model			
Tank Diameter	128.875	128.825	128.825
Impeller Diameter	30.350	29.950	30.175
Measured Ratio	0.235	0.232	0.234
Expected Ratio	0.234	0.234	0.234
% Error	0.64%	0.65%	0.10%

1105A 1105B 1105C

617 703 1305 1307 1309

FIG. 13

1401

1403

1405

SMALL-SCALE IMPELLER RPM ACCURACY

Setting speed (rpm)	Measured speed (rpm)
150	149.3
250	247.9
350	350.3
450	448.4
550	550.3
650	648.4
800	801.2
1000	1001

FIG. 14

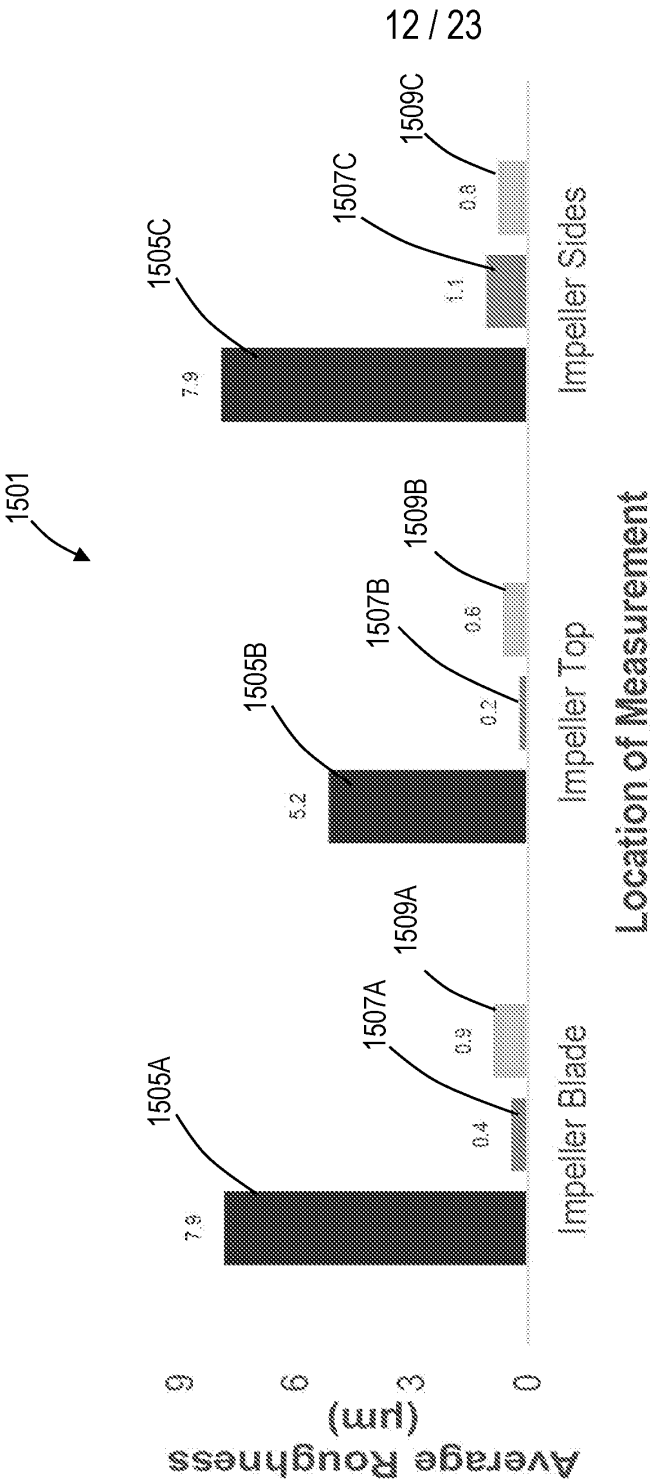


FIG. 15

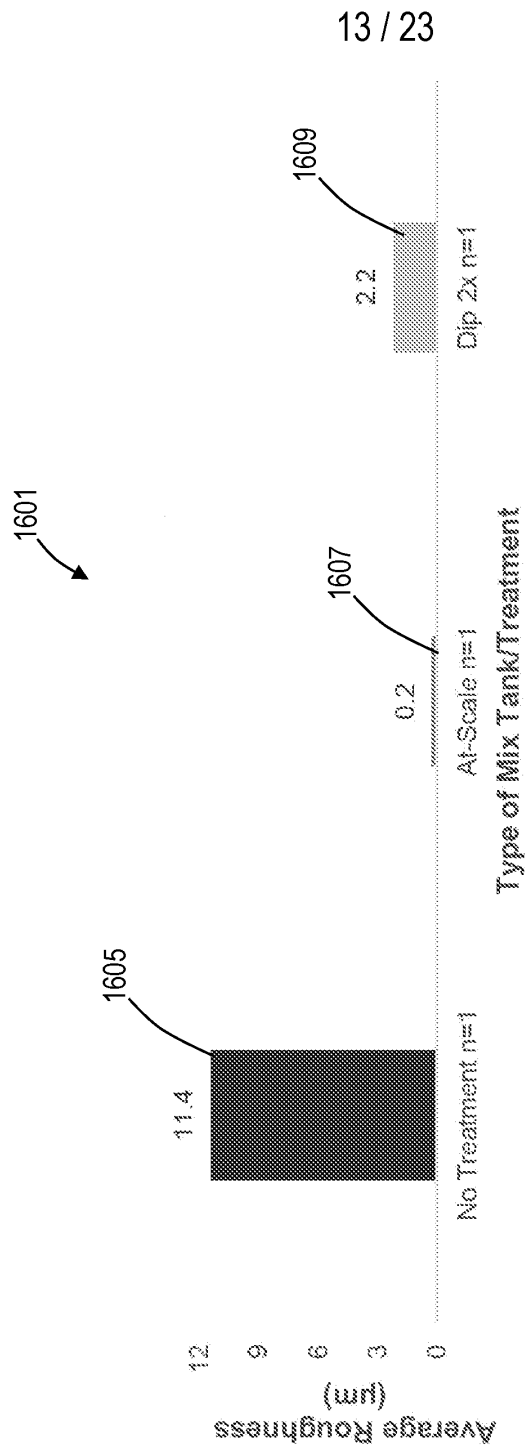


FIG. 16

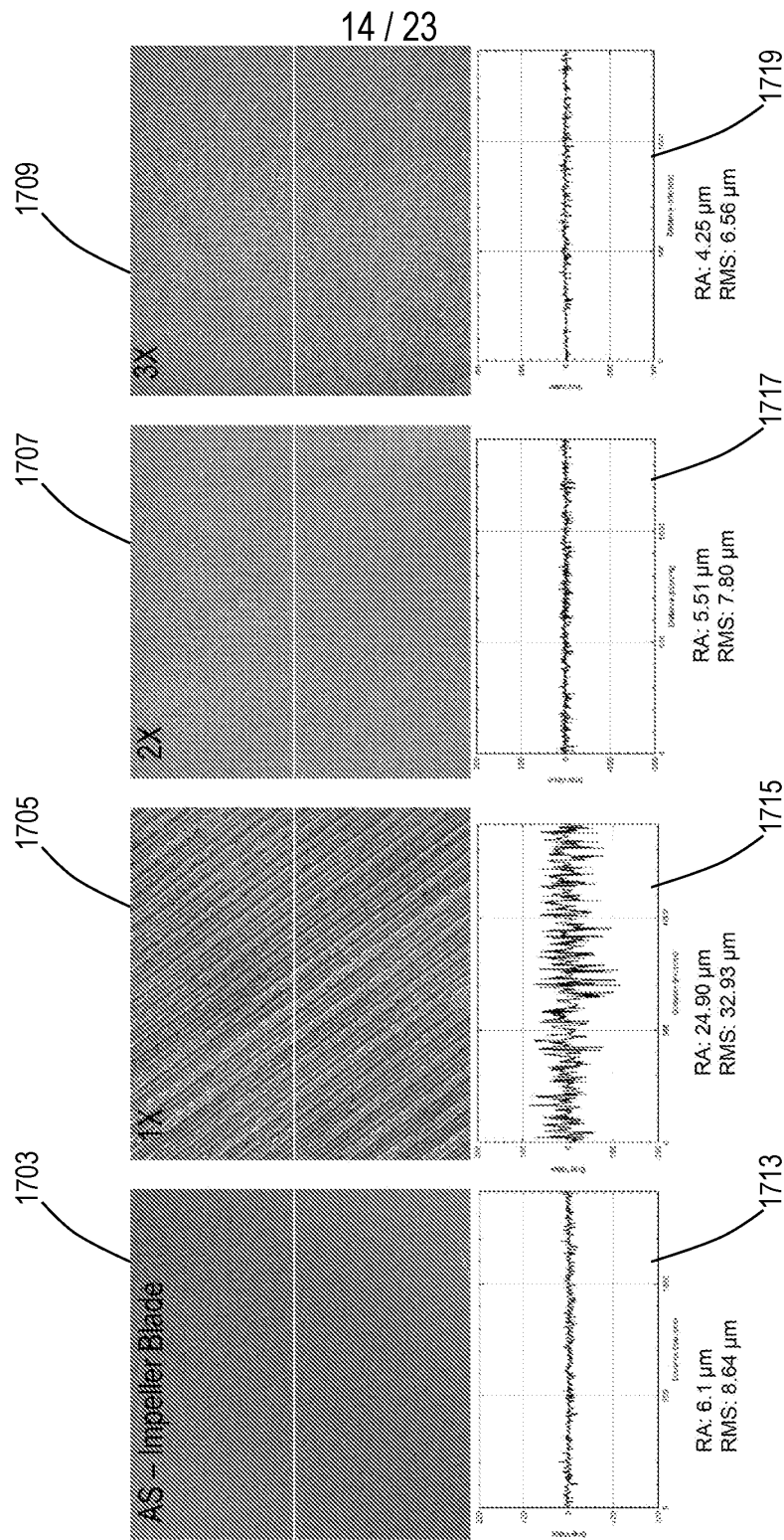


FIG. 17

1801

Mixer	1802	1803
Volume V (L)	2	0.2
Impeller D (mm)	65.9	31
Tank diameter T (mm)	278	129
Max RPM	180	390
Tip Speed (m/s)	0.621	0.626
Tip shear (s ⁻¹)	5.857	12.728
Mean shear (s-1)	5.355	7.967
Reynold number	8664	4270

1805

1807

FIG. 18

1901

Sample	1903		1905		1907		1909		1911	
	1802	1803	1802	1803	1802	1803	1802	1803	1802	1803
Control	6.2				19.3		0.05		0.069	
T0	6.3	6.3	19.3	19.4	0.049	0.049	0.064	0.064		
T30	6.3	6.3	19.5	19.4	0.050	0.049	0.068	0.066		
T60	6.3	6.3	19.3	19.4	0.049	0.049	0.066	0.068		
T90	6.3	6.3	19.4	19.3	0.049	0.049	0.069	0.067		
T150	6.3	6.3	19.4	19.4	0.049	0.049	0.070	0.068		
T240	6.3	6.3	19.3	19.4	0.049	0.049	0.068	0.065		
T300	6.3	6.3	19.4	19.3	0.049	0.048	0.069	0.069		
T480	6.3	6.3	19.3	19.4	0.050	0.049	0.072	0.067		
T1320	6.3	6.3	19.6	19.4	0.049	0.049	0.069	0.072		

FIG. 19

2001

2003

2005

2007

Sample	Purity				Particle #/ml (MFI)					
	1802		1803		1802		1803		1803	
	% HMW	% Main	% LMW	% HMW	% Main	% LMW	≥ 2 μm	≥ 10 μm	≥ 25 μm	≥ 25 μm
Control	1.86	97.42	0.71	1.90	97.40	0.71	313	15	0	2
T0	1.89	97.41	0.69	1.98	97.28	0.73	837	42	8	0
T30	1.99	97.30	0.71	1.99	97.29	0.72	600	98	42	0
T60	1.86	97.41	0.71	1.89	97.48	0.63	666	56	15	2
T90	1.98	97.29	0.73	1.96	97.35	0.70	724	58	8	0
T150	1.96	97.31	0.73	1.96	97.32	0.72	1041	111	29	2
T240	1.96	97.36	0.69	1.85	97.43	0.72	794	79	17	2
T300	1.84	97.42	0.73	1.96	97.31	0.73	772	61	17	0
T480	1.93	97.34	0.74	1.83	97.47	0.70	1448	83	8	4
T1320	1.85	97.41	0.74	1.84	97.42	0.73	1637	40	0	4

FIG. 20

2101

	2105	2107	2109
	1802B	1802A	1803
Mixer	(tip speed)	(P/V value)	
Volume V (L)	2	2	0.2
Impeller D (mm)	65.9	65.9	31
Tank diameter T (mm)	278	278	129
Max RPM	140	180	300
Power/Vol (W/m ³)	20.2	43.0	43.3
Tip Speed (m/s)	0.423	0.621	0.481
Tip shear (s ⁻¹)	4.555	5.857	9.791
Mean shear (s ⁻¹)	3.673	5.355	5.375
Reynold number	6739	8664	3285

FIG. 21

2201

2205

2207

2209

2211

Sample	pH		Protein concentration (mg/ml)		Turbidity	
	1802A (PV)	1802B	1802A (PV)	1802B	1802A (PV)	1803
Control	6.3	6.3	19.2	17.4	0.073	0.071
T0	6.3	6.3	19.2	17.2	0.071	0.072
T1h	6.3	6.3	19.1	17.3	0.072	0.079
T2h	6.3	6.3	19.1	17.3	0.075	0.081
T5h	6.3	6.3	19.1	17.3	0.082	0.107
T8h	6.3	6.3	19.2	17.4	0.086	0.128
T24h	6.3	6.3	18.9	17.3	0.114	0.234
T30h	6.3	6.3	19.3	17.4	0.127	0.261

FIG. 22

2301

2305

2307

Sample	Purity									
	1802A					1802B				
	% HMW	% Main	% LMW	% HMW	% Main	% LMW	% HMW	% Main	% LMW	1803
Control	1.0	99.0	0.0	2.0	97.5	0.5	1.7	97.8	0.6	
T0	0.9	99.1	0.0	2.0	97.6	0.5	1.7	97.8	0.5	
T1h	0.9	99.1	0.0	2.0	97.6	0.5	1.7	97.8	0.5	
T2h	0.9	99.1	0.0	2.1	97.4	0.6	1.7	97.9	0.5	
T5h	0.9	99.1	0.0	1.9	97.6	0.5	1.7	97.8	0.5	
T8h	0.9	99.1	0.0	1.9	97.6	0.5	1.6	97.9	0.5	
T24h	0.8	99.2	0.0	1.8	97.7	0.5	1.6	98.0	0.5	
T30h	0.8	99.2	0.0	1.7	97.7	0.5	1.5	98.0	0.5	

FIG. 23

2401

2405

2407

Sample	Particle #/ml (MFI)											
	<u>1802A</u>				<u>1802B</u>				<u>1803</u>			
	≥ 2 μm	≥ 10 μm	≥ 25 μm	≥ 2 μm	≥ 10 μm	≥ 25 μm	≥ 2 μm	≥ 10 μm	≥ 2 μm	≥ 10 μm	≥ 25 μm	≥ 25 μm
Control	10,380	2,076	467	3,529	572	123	2,259	345	86			
T0	12,681	2,489	505	7,297	557	71	3,411	502	77			
T1h	17,002	1,942	432	25,760	1,412	221	25,666	721	140			
T2h	31,769	2,187	452	41,921	1,742	274	46,362	661	150			
T5h	47,749	2,456	471	79,725	2,052	169	158,826	1,033	171			
T8h	65,678	3,617	678	114,730	3,150	194	242,874	1,317	139			
T24h	193,299	5,471	717	313,824	7,230	196	565,041	1,437	174			
T30h	221,912	4,575	469	355,354	8,142	172	866,723	4,880	176			

FIG. 24

2601

T4h-T24h

2605

2607

Mixer	1802	1803
Volume V (L)	2	0.2
Impeller D (mm)	65.9	31
Tank diameter T (mm)	278	129
Max RPM	250	540
Tip Speed (m/s)	0.863	0.867
Tip shear (s ⁻¹)	8.134	17.623
Mean shear (s ⁻¹)	8.765	12.980
Reynold number	12034	5912

FIG. 26

2501

T0h-T4h

2505

2507

Mixer	1802A	1803
Volume V (L)	2	0.2
Impeller D (mm)	65.9	31
Tank diameter T (mm)	278	129
Max RPM	360	780
Tip Speed (m/s)	1.242	1.232
Tip shear (s ⁻¹)	11.713	25.455
Mean shear (s ⁻¹)	15.146	22.534
Reynold number	17329	8540

FIG. 25

Sample	pH		Protein concentration (mg/ml)		Turbidity		Purity						Particle #/ml (MFI)					
							1802B			1803			1802B			1803		
	1802B	1803	1802B	1803	1802B	1803	% HMW	% Main	% LMW	% HMW	% Main	% LMW	≥ 2 μm	≥ 10 μm	≥ 25 μm	≥ 2 μm	≥ 10 μm	≥ 25 μm
Control	6.3	6.4	19.0	19.2	0.070	0.070	2.00	97.49	0.50	1.84	97.67	0.49	5.130	524	92	1.736	275	52
T0	6.3	6.4	18.9	19.0	0.071	0.065	1.96	97.55	0.51	1.83	97.61	0.56	5.010	785	167	3.620	635	151
T30	6.3	6.4	19.0	18.8	0.073	0.073	1.91	97.53	0.56	1.89	97.55	0.56	16.102	974	165	24.637	745	134
T60	6.4	6.4	19.0	19.0	NR	0.091	2.03	97.48	0.57	1.93	97.58	0.49	13.571	465	155	56.529	574	88
T90	6.4	6.4	19.1	18.9	0.095	0.095	1.95	97.49	0.56	2.05	97.47	0.49	27.615	959	192	78.551	574	127
T150	6.4	6.4	18.9	18.8	0.082	0.120	1.97	97.56	0.59	2.28	97.23	0.49	43.146	1,510	200	143,526	1,303	209
T240	6.4	6.4	19.1	18.9	0.088	0.152	2.09	97.39	0.52	2.63	96.77	0.59	63.533	1,217	142	248,584	966	81
T300	6.4	6.4	19.1	18.9	0.089	0.177	2.16	97.26	0.59	2.81	96.62	0.58	78.697	1,171	69	313,102	1,113	138
T360	6.4	6.4	19.0	18.9	0.094	0.219	2.02	97.42	0.56	2.99	96.43	0.58	88.562	1,940	157	400,984	1,375	169
T420	6.4	6.4	19.1	18.7	0.099	0.263	2.15	97.26	0.59	3.10	96.40	0.50	97.854	1,809	202	490,344	1,433	195
T480	6.4	6.4	19.0	18.9	0.099	0.337	2.02	97.47	0.51	3.58	95.84	0.58	105.829	1,779	36	596,324	1,656	155
T1440	6.4	NA	19.1	NA	0.155	NA	2.00	97.46	0.54	NA	NA	NA	327.946	5,573	192	NA	NA	NA

FIG. 27