Supplementary Material

Table S1. Independent values for dispersant effectiveness tests conducted in 250-mL Erlenmeyer flasks

Run	Speed (rpm)	Volume of oil and dispersant (μL)	Dispersant	Ratio
1	150	500	Petroclean	10:1
2	150	500	Petroclean	10:1
3	150	1000	Petroclean	10:1
4	200	100	Petroclean	10:1
5	250	200	Petroclean	10:1
6	250	1000	Petroclean	10:1
7	150	100	Petroclean	10:2
8	150	1000	Petroclean	10:2
9	200	1000	Petroclean	10:2
10	250	500	Petroclean	10:2
11	250	500	Petroclean	10:2
12	150	100	FFT 7%	10:1
13	150	1000	FFT 7%	10:1
14	200	200	FFT 7%	10:1
15	200	1000	FFT 7%	10:1
16	250	500	FFT 7%	10:1
17	250	500	FFT 7%	10:1
18	150	1000	FFT 7%	10:2
19	200	500	FFT 7%	10:2
20	200	500	FFT 7%	10:2
21	200	500	FFT 7%	10:2
22	250	100	FFT 7%	10:2
23	250	1000	FFT 7%	10:1

Table S2. Power number, Power consumed and energy dissipation at various rotational speeds-Lab scale with 2.5″ paddle impeller

Run	Speed (rpm)	Power number (Np)	Power consumed, (watts)	P	Energy dissipation, ε (W/kg)	Dispersant effectiveness %

1	45	24.05	0.010	0.029	0.66
2	80	24.56	0.060	0.167	2
3	115	24.67	0.179	0.498	3
4	150	24.49	0.395	1.098	11
5	200	24.08	0.921	2.559	14

Table S3. Power number, Power consumed and energy dissipation at various rotational speeds-Pilot scale using 4″ paddle impeller

Run	**Speed (rpm)**	**Power number (Np)**	**Power consumed, P (watts)**	**Energy dissipation, ε (W/kg)**	**Dispersant effectiveness %**
1	45	27.13	0.15	0.01	0.28
2	100	22.64	1.40	0.05	78
3	150	20.66	4.31	0.14	93
4	275	18.01	23.14	0.77	96

Table S4. Power number, Power consumed and energy dissipation at various rotational speeds-Pilot scale using 4.2″ helical ribbon impeller

Run	**Speed (rpm)**	**Power number (Np)**	**Power consumed, P (watts)**	**Energy dissipation, ε (W/kg)**	**Dispersant effectiveness %**
1	50	2.8	0.024	0.0008	29
2	85	2.3	0.103	0.0034	51
3	150	1.9	0.4726	0.157	89
4	275	1.6	2.4	0.08	95

Table S5. ANOVA table for fractional factorial analysis (see Equation 18 in text).

Source	**Sum of squares**	**df**	**Mean square**	**F-value**	***p*-value**	**Significance**
Model	8812.45	12	734.37	46.59	<0.0001	Significant
A-speed	2721.89	1	2721.89	172.69	<0.0001	Significant
B-volume	2346.96	1	2346.96	206.00	<0.0001	Significant
C-dispersant	115.53	1	115.53	7.33	0.0220	Significant
D-ratio	58.65	1	58.65	3.72	0.0826	
AB	2240.25	1	2240.25	142.13	<0.0001	Significant

AC	1.19	1	1.19	0.0753	0.7893	
AD	164.70	1	164.70	10.45	0.0090	Significant
BC	6.63	1	6.63	0.4207	0.5312	
BD	155.47		155.47	9.86	0.0105	Significant
CD	48.10	1	48.10	3.05	0.1112	
A2	2.28	1	2.28	0.1447	0.7116	
B2	6.52	1	6.52	0.4134	0.5347	
Residual	157.62	10	15.76			
Lack of fit	157.62	5	31.50	1494.04		
Pure error	0.1054	5	0.0211		<0.0001	significant
Cor Total	8970.07	22				

Derivation Equation 7. Expressing particle size in terms of M_{Sx}:

$$N_p = \frac{M_{Sxi}}{M_p} = \frac{6M_{Sxi}}{\rho_{Sx} * \pi * D_{Sxi}^3}$$

$$M_p = \frac{\rho_{Sx} * \pi * D_{Sxp}^3}{6}$$

$$M_{Sx} = N_p * M_p$$

Now putting the values of N_p and M_p in the above equation,

$$M_{Sx} = \frac{6M_{Sxi}}{\rho_{Sx} * \pi * D_{Sxi}^3} * \frac{\rho_{Sx} * \pi * D_{Sxp}^3}{6} = \frac{M_{Sxi} * D_{Sxp}^3}{D_{Sxi}^3}$$

Now calculating for the diameter of the sample particle,

$$D_{Sxp} = \frac{M_{Sx}^{\frac{1}{3}} * D_{Sxi}}{M_{Sxi}^{\frac{1}{3}}}$$

Expressing surface area in terms of M_{Sx}:

$$A_{surface} = 4 * \pi * r^2 \tag{E6}$$

$$r^2 = \frac{D_{Sxp}^2}{4} = \pi * D_{Sxp}^2 \tag{E7}$$

Now putting the value of diameter of sample particle from equation 10

$$A_{surface} = \pi * \left(\frac{M_{Sx} * D_{Sxi}^3}{M_{Sxi}}\right)^2 \tag{E8}$$

Expressing surface area and number of particles in terms of a constant

$$A_{surface} * N_p = \pi * \left(\frac{M_{Sx} * D_{Sxi}^3}{M_{Sxi}}\right)^2 * \frac{6M_{Sxi}}{\rho_{Sx} * \pi * D_{Sxi}^3} \tag{E9}$$

$$A_{surface} * N_p = 6 * \frac{M_{Sxi}^{\frac{1}{3}}}{D_{Sxi} * \rho_{Sx}} * M_{Sx}^{\frac{2}{3}} \tag{E10}$$