Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information

Green assessment of polymer microparticles production processes: a critical review

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Abbreviations

m_m:	Mass of monomer
m_r:	Mass of raw material
m_{or}:	Mass of organic solvents
m_{aq}:	Mass of aqueous solvents
m_{SC}	Mass of super critical CO_2
$m_{p:}$	Mass of product
m_{pol}:	Mass of polymer solute
$m_{core:}$	Mass of core material before process
m_{shell}:	Mass of polymer solute before process
m_{core}*:	Mass of core material after process
m_{cap}:	Mass of the formed capsule
m_{shell}*:	Mass of shell material after process
m_{dr}:	Mass of loaded drug
$m_{d:}$	Mass of dispersed phase
m_c:	Mass of continuous phase
φ:	m_d/m_c
T:	Process duration
t_p:	Post-processing duration
T:	Process temperature
T_p:	Post-processing temperature
T_{air}:	Air temperature
E_{eff}:	Encapsulation efficiency
PL:	Payload
Q_{core}:	Flow rate of core material phase
Q_d:	Flow rate of dispersed (shell material) phase
Q_c:	Flow rate of continuous phase

Sustainable Assessment of Suspension polymerization: Calculation Details

Process	m_m (g)	m_r (g)	m_{or} (g)	m_{aq} (g)	m_{SC} (g)	T (°C)	t (h)	φ	Conv (%)	Yield (%)	m_p (g)	sEF	EF	cEF
P1	0.4	0.1	0	1	0	50	24	0.4	68	=conv	0.3	0.7	0.7	4.3
P2	0.8	0.1	0	1	0	50	24	0.8	69	=conv	0.6	0.6	0.6	2.3
P3	1.1	0.1	0	1	0	50	24	1.1	69.5	=conv	0.8	0.5	0.5	1.8
P4	75	3.5	0	225	0	83	8	0.3	72	=conv	54	0.5	0.5	4.6
P5	75	2.4	0	225	0	83	1.3	0.3	82	=conv	61.5	0.3	0.3	3.9
P6	59	3	0	175	0	87	5	0.3	74	=conv	43.7	0.4	0.4	4.4
P7	120	3.7	0	180	0	87	5	0.7	93	=conv	111.6	0.1	0.1	1.7
P8	75	2.4	0	225	0	83	1	0.3	88	=conv	66	0.2	0.2	3.6
P9	6.7	12.5	100	44	0	55	1	0.1	60	=conv	4	3.8	28.9	39.9
P10	6.7	12.5	100	44	0	85	1	0.1	82.5	=conv	5.5	2.5	20.7	28.7
P11	6.7	12.5	100	44	0	75	1	0.1	97.5	=conv	6.5	2	17.4	24.2
P12	6.7	12.5	100	44	0	75	2	0.1	97.5	=conv	6.5	2	17.4	24.2
P13	6.7	12.5	100	44	0	75	0.3	0.1	65	=conv	4.3	3.4	26.6	36.7
P14	207.6	0.4	0	0	457	75	1.5	0.5	-	97	201.4	0.03	2.3	2.3
P15	203.9	2.1	0	0	454	75	1.5	0.4	-	97	197.8	0.04	2.3	2.3

Table 1 : Details for the calculation of the E-factors for the suspension polymerization process (section 4.1).

Sustainable Assessment of Coacervation: Calculation Details

Process	m_{core} (g)	m_{shell} (g)	m_r (g)	t (h)	T (°C)	T_p (°C)	m_{aq} (g)	m_{or} (g)	E_{eff} (%)	PL (%)	m_{core}^* (g)	m_{shell}^* (g)	m_{cap} (Product) (g)	sEF	EF	cEF
P16	12.6	6	17.7	58	40	−30	100	0	88	54	11.1	9.4	20.5	0.7	0.7	5.5
P17	12.6	6	4.5	58	40	−30	100	0	53	43	6.7	8.8	15.5	0.5	0.5	7.2
P18	23.4	6	24.1	58	40	−30	100	0	70	67	16.3	8.1	24.4	1.2	1.2	5.1
P19	2.5	1	63.1	42	25	N/A	408	66.8	30.5	59.8	0.8	0.5	1.3	51.7	104.6	383.3
P20	3	2	0.6	78	4	−50	102	0	43.5	47.5	1.3	1.4	2.7	1	1	38.9
P21	3	2	0.2	84	4	−50	100	0	46.5	57.7	1.4	1	2.4	1.2	1.2	43.3

Table 2 : Details for the calculation of the E-factors for the Coacervation process (section 4.1).

Sustainable Assessment of Atomization: Calculation Details

Process	m_{dr} (g)	m_{shell} (g)	m_{aq} (g)	m_{or} (g)	Yield (%)	E_{eff} (%)	T_{air} (°C)	sEF	EF	cEF
P22	0.06	0.6	140	47.3	35	92	100 to 140	2.1	224.9	883.6
P23	0.07	1.407	1.6	28	37.1	100	−50	1.7	52.8	55.7

Table 3 : Details for the calculation of the E-factors for the Atomization processes (section 4.2).

Sustainable Assessment of Microfluidics: Calculation Details

1. Comparison between traditional solvent evaporation process and microfluidics

a. Traditional solvent evaporation

	m_{pol} (g)	m_{dr} (g)	m_{or} (g)	m_r (g)	m_{aq} (g)	m_p (g)	sEF	EF	cEF
P24	0.03	0.006	3.95	0.21	70	0.03	6.9	2318	2450

b. Microfluidics

	Flow rates		Dispersed Phase					Continuous Phase			Product	E-factors		
	Q_d (mL.h^{-1})	Q_c (mL.h^{-1})	m_{pol} (g)	m_{dr} (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	m_p (g)	sEF	EF	cEF
P25	1.02	1.26	0.03	0.006	0	0	3.95	0.037	3.7	0	0.0335	1.2	119	228.2

2. Monomer-based processes to produce simple polymer microparticles

	Flow rates		Dispersed Phase				Continuous Phase			Product		E-factors		
	Q_d (mL.h^{-1})	Q_c (mL.h−1)	m_m (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	Yield (%)	m_p (g)	sEF	EF	cEF
P26	0.08	0.42	0.48	0.58	0	0	0.16	5.09	0	100	0.48	1.6	1.6	12.2
P27	0.1	1.5	0.48	0.58	0	0	0.45	14.55	0	100	0.48	2.2	2.2	32.7
P28	0.035	2.1	1.00	0.04	0	0	1.2	58.8	0	97	0.97	1.3	1.3	61.7
P29	0.0002	0.01	1.01	0.04	0	0	1	49	0	100	1.01	1	1	49.8
P30	0.0002	0.01	1.01	0.04	0	0	1	49	0	100	1.01	1	1	49.8
P31	0.0005	0.004	0.35	0.003	0	0.78	0	5.62	0	100	0.35	0	16.0	18.2

Table 4 : Details for the calculation of the E-factors for the monomer-based microfluidic processes used to produce simple polymer microparticles (section 4.2).

3. Monomer-based processes to produce core-shell polymer microparticles

	Flow rates			Core		Shell		Continuous Phase			Product		E-factors		
	Q_{core} (mL.h^{-1})	Q_{shell} (mL.h^{-1})	Q_c (mL.h^{-1})	m_{core} (g)	m_r (g)	m_m (g)	m_r (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	Yield (%)	m_p (g)	sEF	EF	cEF
P32	0.1	0.9	16	0.93	0	8.9	0.2	3.2	156.8	0	100	9.8	0.3	0.3	16.3
P33	0.1	0.9	16	0.93	0	8.6	0.5	3.2	156.8	0	100	9.6	0.4	0.4	16.8
P34	0.045	0.3	20	0.91	0.019	6.7	0.3	8.9	435.6	0	100	7.7	1.2	1.2	58.1
P35	0.052	0.11	8	0.91	0.019	2.1	0.1	3.1	150.8	0	100	3.1	1	1	50.3
P36	0.05	0.16	12	0.91	0.019	3.2	0.1	4.8	235.2	0	100	4.2	1.2	1.2	57.8
P37	0.054	0.155	9	0.91	0.019	2.9	0.1	3.3	163.3	0	100	3.8	0.9	0.9	43.6
P38	0.052	0.165	10	0.91	0.019	3.2	0.1	3.8	188.5	0	100	4.1	1	1	46.6
P39	1.5	3	30	0.98	0.020	1.8	0.2	0.4	19.6	0	99	2.8	0.2	0.2	7.2

Table 5: Details for the calculation of the E-factors for the monomer-based microfluidic processes used to produce core-shell polymer microparticles (section 4.2).

4. Polymer solution-based processes to produce simple polymer microparticles

	Flow rates		Dispersed Phase					Continuous Phase			Product		E-factors		
	Q_d ($mL.h^{-1}$)	Q_c ($mL.h^{-1}$)	m_{pol} (g)	m_{dr} (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	m_r (g)	m_{aq} (g)	m_{or} (g)	Yield (%)	m_p (g)	sEF	EF	cEF
P40	2	14	0.045	0	0	0	0.85	1.60	6.41	0	97	0.043	37	56.5	204
P41	2	14	0.009	0	0	0	0.89	1.60	6.41	0	97	0.009	185	287	1024
P42	2	8	0.030	0.01	0	0	1.29	0.05	5.26	0	100	0.04	1.33	33.6	165
P43	2	40	0.030	0.01	0	0	1.29	0.27	26.3	0	100	0.04	6.6	39	696
P44	0.1	6	0.010	0.0001	0	0	1.32	0.8	80	0	93	0.009	85.4	226	8764
P45	0.1	6	0.010	0.0001	0	0	1.07	0.6	60	0	92	0.009	64.8	180	6653
P46	0.1	6	0.040	0.0004	0	0	1.04	0.6	60	0	93	0.04	16	43.7	1639
P47	0.00008	0.0067	0.020	0.002	0.0033	0.97	0	1.33	0	65.07	100	0.02	60.4	3018	3062

Table 6 : Details for the calculation of the E-factors for the polymer solution-based microfluidic processes used to produce simple polymer microparticles (section 4.2).