CFD simulation of the laboratory-scale anaerobic digester to study the impacts of impeller geometric and operational parameters on its performance

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Table *S*1. Physical features of wastewater for T=35℃ [a].

TS (%)	k (Pa.s^n)	n (10^{-1})	$\dot{\gamma}$ (s^{-1})	$\max(\eta)-\min(\eta)$ (Pas)	ρ (kg/m^3)
0	Newtonian	10	Newtonian	Newtonian	998
2.5	0.042	7.1	226-702	0.008-0.006	1000.36
5.4	0.192	5.62	50-702	0.03-0.01	1000.78
7.5	0.525	5.33	11-399	0.17-0.03	1001
9.1	1.052	4.67	11-156	0.29-0.07	1001.31
12.1	5.885	3.67	3-149	2.93-0.25	1001.73

[a] Verified by Meister et al. [25].

The Coefficient Of Performance, COP, is defined as the ratio of the power production to the power input. The case with the highest COP has the most desirable performance, and is selected as the optimal model (among the 144 cases).

Table *S2*. Details of different configurations of numerical simulation in an agitated anaerobic digester at **(a)** TS=2.5 **(b)** TS=7.5 **(c)** TS=12.1 (%).

(a)

TS (%)	Impeller type	N (rpm)	P_{in} (W)	P_{out} (W) [35]	COP (P_{out}/P_{in})
2.5	4-blade, 45°, d/3	250	0.071	0.4949	6.97
		500	0.58	0.5224	0.9
		750	1.96	0.5247	0.27
		1500	15.2	0.5252	0.034
	4-blade, 30°, d/3	250	0.037	0.3898	10.5
		500	0.26	0.5111	1.97
		750	0.79	0.5206	0.66
		1500	6.6	0.525	0.079
	6-blade, 45°, d/3	250	0.094	0.5095	5.42
		500	0.73	0.5234	0.72
		750	2.59	0.5249	0.203
		1500	21.4	0.5252	0.025
	6-blade, 30°, d/3	250	0.052	0.4578	8.8
		500	0.36	0.5175	1.44
		750	1.13	0.5225	0.46
		1500	8.6	0.5251	0.061
	4-blade, 45°, d/2	250	0.32	0.5212	1.63
		500	2.6	0.5251	0.202
		750	8.8	0.5252	0.0597
		1500	72.3	0.5252	0.0073
	4-blade, 30°, d/2	250	0.15	0.5143	3.43
		500	1.1	0.5239	0.476
		750	3.61	0.525	0.145
		1500	31.4	0.5252	0.0167
	6-blade, 45°, d/2	250	0.45	0.5225	1.16
		500	3.67	0.5252	0.14
		750	12.57	0.5252	0.042
		1500	103.7	0.5252	0.0051
	6-blade, 30°, d/2	250	0.21	0.5185	2.47
		500	1.57	0.5247	0.33
		750	5.1	0.5251	0.103
		1500	42.9	0.5252	0.012

	4-blade, 45°, 2*d*/3	250	1.02	0.5251	0.515
		500	7.8	0.5252	0.067
		750	26.7	0.5252	0.0197
		1500	204.2	0.5252	0.0026
	4-blade, 30°, 2*d*/3	250	0.52	0.5238	1.01
		500	4.14	0.5252	0.127
		750	13.82	0.5252	0.038
		1500	109.2	0.5252	0.0048
	6-blade, 45°, 2*d*/3	250	1.4	0.5252	0.37
		500	11	0.5252	0.048
		750	36	0.5252	0.015
		1500	283	0.5252	0.0019
	6-blade, 30°, 2*d*/3	250	0.79	0.525	0.66
		500	6.1	0.5252	0.086
		750	21.2	0.5252	0.025
		1500	168.1	0.5252	0.003

(b)

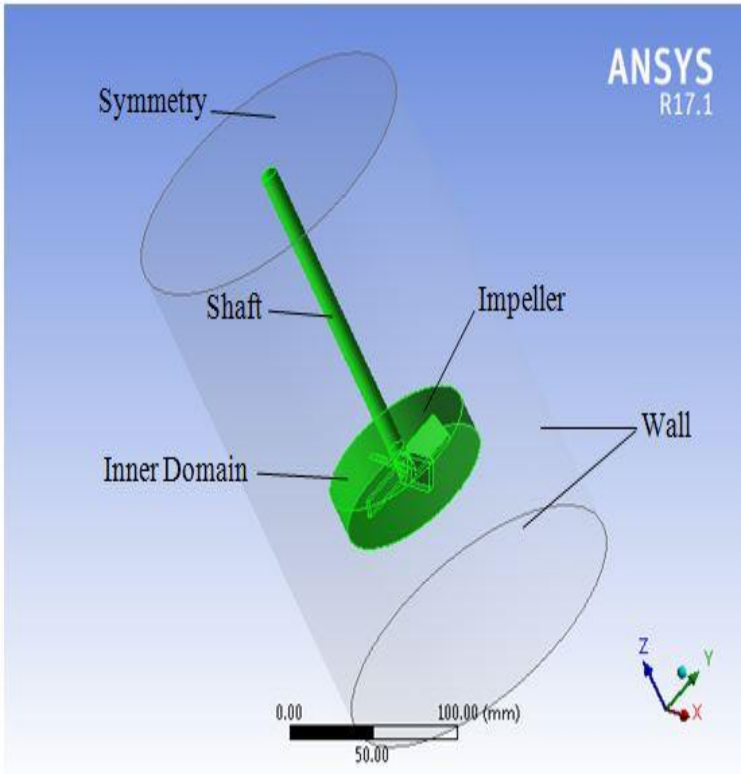
TS (%)	Impeller type	*N* (rpm)	P_{in} (W)	P_{out} (W) [35]	COP (P_{out}/P_{in})
7.5	4-blade, 45°, *d*/3	250	0.09	0.5883	6.54
		500	0.65	0.8749	1.35
		750	2.1	1.0354	0.49
		1500	15.7	1.0714	0.068
	4-blade, 30°, *d*/3	250	0.056	0.464	8.29
		500	0.36	0.7649	2.12
		750	1.08	0.8869	0.82
		1500	7.54	1.0454	0.139
	6-blade, 45°, *d*/3	250	0.12	0.6633	5.53
		500	0.89	0.9657	1.1
		750	2.75	1.0516	0.38
		1500	20.4	1.0742	0.053
	6-blade, 30°, *d*/3	250	0.079	0.5335	6.75
		500	0.52	0.8090	1.56
		750	1.57	0.9454	0.6
		1500	11	1.0632	0.097
	4-blade, 45°, *d*/2	250	0.37	0.8278	2.24
		500	2.78	1.0573	0.38
		750	9.11	1.0718	0.12
		1500	70.7	1.0759	0.015
	4-blade, 30°, *d*/2	250	0.21	0.7284	3.47

		500	1.47	0.9959	0.678
		750	4.56	1.0589	0.23
		1500	31.4	1.0750	0.034
	6-blade, 45°, *d*/2	250	0.5	0.9155	1.83
		500	3.77	1.0652	0.28
		750	12.5	1.0739	0.086
		1500	100.5	1.0761	0.011
	6-blade, 30°, *d*/2	250	0.29	0.794	2.74
		500	2	1.0395	0.52
		750	6.13	1.0671	0.17
		1500	44	1.0757	0.0245
	4-blade, 45°, 2*d*/3	250	1.18	1.0548	0.89
		500	8.8	1.0748	0.12
		750	29.1	1.0759	0.037
		1500	220	1.0761	0.0049
	4-blade, 30°, 2*d*/3	250	0.68	0.9765	1.44
		500	4.87	1.0696	0.22
		750	15.7	1.075	0.068
		1500	117.8	1.076	0.009
	6-blade, 45°, 2*d*/3	250	1.62	1.0646	0.657
		500	12.3	1.0754	0.087
		750	40.8	1.076	0.026
		1500	315.7	1.0761	0.0034
	6-blade, 30°, 2*d*/3	250	0.92	1.0259	1.12
		500	6.81	1.0723	0.157
		750	22	1.0754	0.049
		1500	172.8	1.0761	0.006

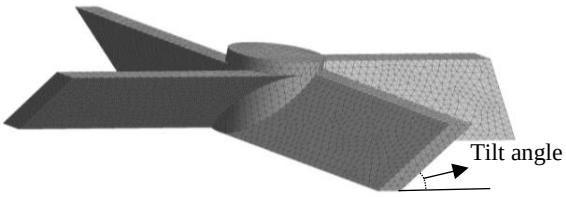
(c)

TS (%)	Impeller type	*N* (rpm)	P_{in} (W)	P_{out} (W) [35]	COP (P_{out}/P_{in})
12.1	4-blade, 45°, *d*/3	250	0.17	0.4229	2.5
		500	0.94	0.6654	0.71
		750	2.86	0.7993	0.28
		1500	18.85	1.2162	0.06
	4-blade, 30°, *d*/3	250	0.14	0.3747	2.68
		500	0.68	0.5909	0.87
		750	2	0.7014	0.35
		1500	12.6	1.091	0.087
	6-blade, 45°, *d*/3	250	0.2	0.4597	2.3
		500	1.26	0.7204	0.57

		750	3.93	0.9032	0.23
		1500	26.7	1.3726	0.05
	6-blade, 30°, *d*/3	250	0.16	0.4095	2.56
		500	0.88	0.6328	0.72
		750	2.67	0.7695	0.29
		1500	17.3	1.1652	0.067
	4-blade, 45°, *d*/2	250	0.52	0.795	1.53
		500	3.35	1.0568	0.32
		750	10.2	1.2731	0.125
		1500	78.5	1.5184	0.019
	4-blade, 30°, *d*/2	250	0.4	0.6475	1.62
		500	2.25	0.8908	0.396
		750	6.6	1.0677	0.162
		1500	45.6	1.44	0.032
	6-blade, 45°, *d*/2	250	0.68	0.8262	1.22
		500	4.5	1.1203	0.25
		750	14.1	1.3583	0.096
		1500	108.4	1.5231	0.014
	6-blade, 30°, *d*/2	250	0.5	0.7564	1.51
		500	3.04	0.9974	0.328
		750	9.4	1.1745	0.125
		1500	62.8	1.5082	0.024
	4-blade, 45°, 2*d*/3	250	1.4	1.0956	0.78
		500	9.9	1.4251	0.14
		750	32.98	1.5126	0.045
		1500	246.6	1.5291	0.0062
	4-blade, 30°, 2*d*/3	250	1.05	0.9404	0.89
		500	6.5	1.2085	0.18
		750	20.4	1.4176	0.069
		1500	148.4	1.525	0.01
	6-blade, 45°, 2*d*/3	250	1.96	1.108	0.56
		500	14.1	1.491	0.1
		750	45.9	1.5221	0.033
		1500	344	1.5296	0.0044
	6-blade, 30°, 2*d*/3	250	1.4	0.9801	0.7
		500	9.16	1.2185	0.13
		750	29.1	1.4892	0.05
		1500	207.3	1.5276	0.007

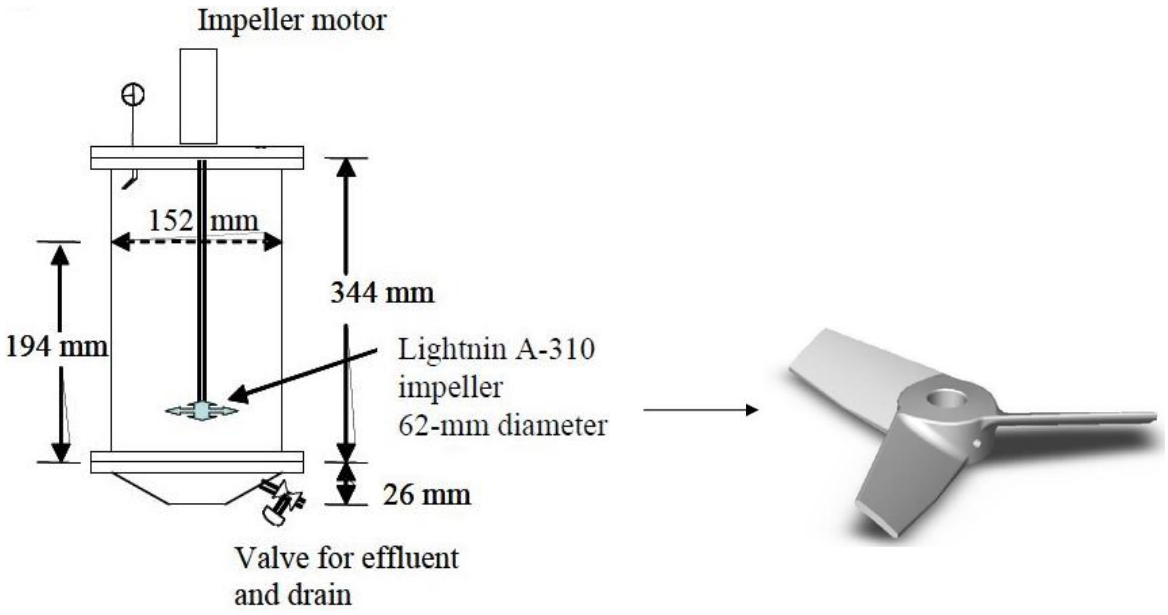


(a)

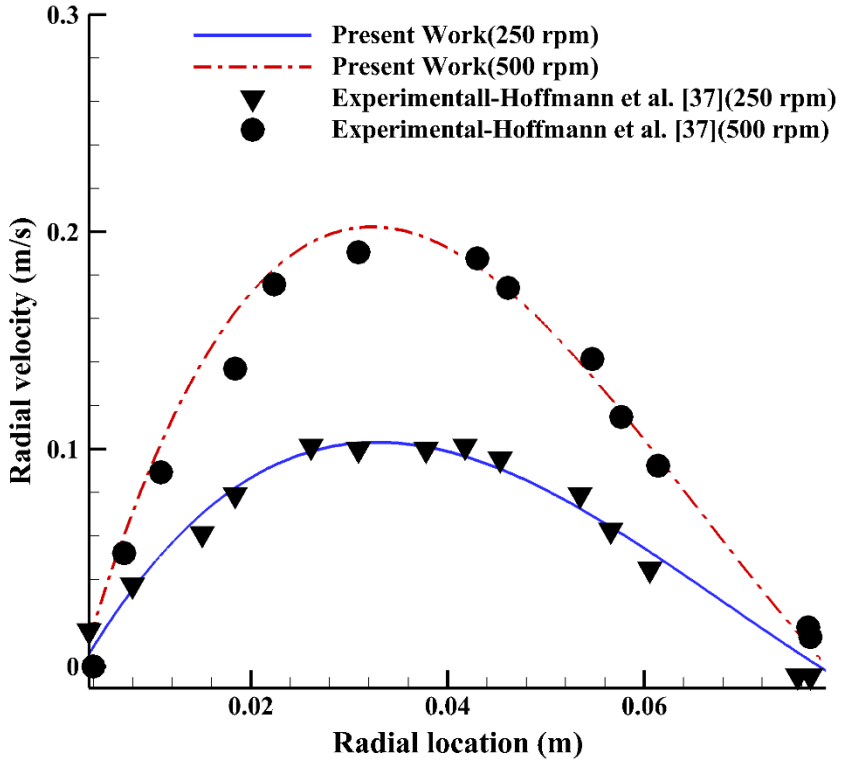


(b)

Figure *S*1. Sketch of **(a)** model's geometry **(b)** the geometry and meshing of the impeller [35].



(a)



(b)

Figure *S*2. Geometrical details of **(a)** the reactor and impeller **(b)** confirmation of the present work CFD simulation for the agitation speeds of 250 and 500 rpm [37].