

Supplementary material

Volumetric energy benchmarks in underloaded fixed-film wastewater treatment plants: evidence from a full-scale trickling filter in semi-arid Morocco

Table S1. Monthly operational data for the Khenifra wastewater treatment plant, 2023, with derived removal efficiencies and load-normalised energy indicators.

Month	Flow (m ³ d ⁻¹)	BOD ₅ in	BOD ₅ out	COD in	COD out	TSS in	TSS out	Energy (kWh mo ⁻¹)	SEC (kWh m ⁻³)	Rem. BOD ₅ (%)	Rem. COD (%)	Rem. TSS (%)	kWh kg ⁻¹ BOD ₅	kWh kg ⁻¹ COD	kWh kg ⁻¹ TSS
January	6,200	325	18	690	45	190	36	28,754	0.150	94.5	93.5	81.1	0.487	0.232	0.971
February	6,060	365	32	626	63	267	32	25,089	0.148	91.2	89.9	88.0	0.444	0.263	0.629
March	7,774	310	53	590	106	438	86	28,149	0.117	82.9	82.0	80.4	0.454	0.241	0.332
April	8,596	342	47	750	102	280	45	26,929	0.104	86.3	86.4	83.9	0.354	0.161	0.444
May	6,390	297	27	658	88	268	39	28,704	0.145	90.9	86.6	85.4	0.537	0.254	0.633
June	6,350	325	45	625	90	325	40	28,451	0.149	86.2	85.6	87.7	0.533	0.279	0.524
July	7,872	304	34	569	88	313	28	28,356	0.116	88.8	84.5	91.1	0.430	0.242	0.408
August	9,124	338	29	530	74	399	25	27,732	0.098	91.4	86.0	93.7	0.317	0.215	0.262
September	9,158	270	19	692	92	295	17	26,160	0.095	93.0	86.7	94.2	0.379	0.159	0.343
October	7,348	348	19	696	75	331	20	27,651	0.121	94.5	89.2	94.0	0.369	0.195	0.390
November	7,050	301	30	503	82	250	19	28,380	0.134	90.0	83.7	92.4	0.495	0.319	0.581
December	9,703	255	33	616	65	257	38	27,874	0.093	87.1	89.4	85.2	0.417	0.168	0.423

Note: concentrations in mg L⁻¹. SEC denotes volumetric specific energy consumption. Daily electricity was obtained by dividing the monthly total by the number of days in the month. Removal efficiencies and load-normalised indicators were computed from the monthly values shown.