Supporting Information

Initial estimates of the lifetime of unsmoked cellulose diacetate and paper cigarette filters in the coastal ocean

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Table S1	Propertie	s of the	cigarette	filters
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Filter	Mass of Wrapper ^b (mg)	Mass of Filter Plug (mg)	Diameter ^b (mm)	Circumference ^b (mm)	Length (mm)	Pressure Drop (mmH ₂ O)	Density (g/cm ³) ^d
CDA 1	19.4 ± 0.3	120.6 ± 1.9	7.72 ± 0.13	24.25 ± 0.41	25.53 ± 0.10	-	0.12 ± 0.01
CDA 2	46.3 ± 1.0	130.3 ± 5.0	7.95 ± 0.08	24.98 ± 0.25	24.85 ± 0.38	66	0.14 ± 0.01
Paper 1	25.9 ± 0.8	217.1 ± 2.8	7.93 ± 0.10	24.91 ± 0.25	27.81 ± 0.07	-	0.18 ± 0.01
Paper 2	74.5 ± 0.9	189.8 ± 3.0	7.86 ± 0.06	24.69 ± 0.19	27.02 ± 0.14	72	0.20 ± 0.01
Paper 3	71.4 ± 0.5	193.6 ± 4.7	7.95 ± 0.15	24.98 ± 0.47	27.13 ± 0.30	68	0.20 ± 0.01

^aData are presented as the mean \pm standard deviation for three to five samples

^bIncludes the contribution from the tipping paper, plug wrap, and adhesive

^cMeasured by Eastman using a Custom Electronics Systems Pressure Drop and Ventilation Meter using a volumetric flow rate of 17.5 mL/s according to ISO/DIS 6565 Tobacco and tobacco products — Draw resistance of cigarettes and pressure drop of filter rods — Standard conditions and measurement

^dCalculated based on the mass and geometric dimensions of each CF assuming a cylindrical geometry



Figure S1. Schematic illustration of the components of a cigarette.



Figure S2. Representative photographs of the CFs in the mesocosm tank. The photo on the left was taken between time points one and two (August 10, 2022). The photo on the right was taken between time points one and two (August 22, 2022) and shows the degradation of lost tipping paper and plug wrap from the CFs.

Collection Date	Time (months)		Paper	1		Paper 2			Paper 3			CDA 1			CDA 2	
06/29/22	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07/27/22	1	-9.2	-21.2	-12.1	14.7	18.4	23.7	18.8	13.4	22.3	-10.2	-1.3	4.1	-4.4	-2.4	7.3
08/30/22	2	48.7	54.1	48.9	87.1	89.1	75.7	88.8	77.3	82.6	31.0	33.2	35.1	22.9	38.9	38.6
09/26/22	3	76.1	83.0	73.4	125.8	109.5	90.5	104.4	101.1	96.0	46.6	45.6	44.9	62.4	65.2	64.9
10/26/22	4	-	108.9	98.3	-	116.8	123.1	-	114.0	128.0	57.8	56.8	52.7	75.6	73.7	73.7
11/30/22	5	-	-	-	150.4	139.8	140.4	-	140.4	138.0	63.8	69.2	65.9	78.5	76.6	78.2
01/04/23	6.25	-	144.3	114.5	133.5	137.9	140.8	165.8	141.1	146.0	69.0	70.3	68.8	88.6	105.6	73.5

Table S2. Absolute mass loss (mg)

* samples in bold were identified as outliers by a ROUT removal step with a coefficient Q of 1%, and entries marked with " - " were those that fell to the bottom of the tank during collection (see **Sample collection for mass loss measurements** in the **Materials and Methods** for additional details).

Table S3. Relative mass loss (%)

Collection Date	Time (months)]	Paper 1		Paper 2		Paper 3			CDA 1			CDA 2			
06/29/22	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
07/27/22	1	-4.0	-9.2	-5.2	5.6	7.1	9.1	7.2	5.2	8.5	-7.3	-0.9	2.9	-2.7	-1.4	4.2
08/30/22	2	20.8	23.1	20.9	34.1	34.9	30.1	34.7	30.0	31.6	22.2	23.7	24.8	13.9	22.1	21.3
09/26/22	3	32.6	35.8	30.9	48.0	43.4	35.3	39.8	39.0	36.8	33.6	32.3	32.2	35.8	37.5	36.2
10/26/22	4	-	47.0	41.9	-	45.5	47.2	-	42.6	48.4	40.9	40.3	37.7	41.6	40.7	40.9
11/30/22	5	-	-	-	58.7	54.5	54.3	-	53.8	52.9	45.6	48.5	48.2	44.7	42.1	45.3
01/04/23	6.25	-	63.9	50.4	51.8	54.7	54.4	63.4	55.4	56.5	49.5	51.2	49.0	49.4	56.2	41.8

* samples in bold were identified as outliers by a ROUT removal step with a coefficient Q of 1%, and entries marked with " - " were those that fell to the bottom of the tank during collection (see **Sample collection for mass loss measurements** in the **Materials and Methods** for additional details).



Figure S3. Representative images of the axial view of paper (A) and CDA (B) CFs. Representative images of the paper (C) and CDA (D) CFs without tipping paper and plug wrap show the difference in the construction of the two types of CFs. Representative microscope images of the paper (E) and CDA (F) CFs, showing their fibrous networks. Scale bars are 500 μ m.



Figure S4. Regressions for the (A) Paper 1, (B) CDA 1, (C) Paper 2, (D) CDA 2, and (E) Paper 3 CFs. Dashed curves belong to the model fits. Vertical dotted lines indicate projected environmental lifetimes (i.e., 100% relative mass loss).

Material	Specific price ^a	Specific embodied GHG emissions ^b	Specific water usage							
	(\$/kg)	$(kg CO_2/kg)$	(L/kg)							
Paper	4.39	0.71	1700							
CDA	8.00	3.4	240							

Table S4. Economic and environmental material properties

^aPrice of CDA CF is presented as the median in the range of 6.00-10.00 \$/kg. The price of paper CF is presented as the median in the range of 3.77-5.00 \$/kg. Ranges were provided by an industry expert (Personal Communication 2024). This range is within historical values and assertions made by the tobacco industry, stating that the relative cost difference between paper and CDA CFs is 1 to 1.4 (reference 11 in the main text).

^bValues were collated from the literature (reference 34 in the main text).