

Exploring the application of Ethylcellulose oleogels in skin foundations

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INTRODUCTION

Waterless products, such as oleogels, eliminate water as a primary ingredient, reducing the direct water footprint [1]. Ethylcellulose (EC) is an oleogelator that offers flexibility for various applications [2], including in colour cosmetics. EC oleogels have been explored as lip products [3], however, not as skin foundations, probably due to their greasiness. **The aim of this project was to explore potential applications of EC oleogels in skin foundations.**

MATERIALS & METHODS

Ethylcellulose (**EC**); Ricinus communis (Castor) oil (**CO**); Ethylhexyl Palmitate (**EHP**); Coco-Caprylate/Caprate (**CCC**); Caprylyl Methicone (**CM**); Dimethicone (**D**); **BHT**; Ricinus communis (Castor) oil (and) CI77499 / CI77492 / CI77491 / CI77891 were CO dispersions of black Iron Oxide (**black IO**)/ yellow Iron Oxide (**yellow IO**)/ red Iron Oxide (**red IO**) / Titanium Dioxide (**TiO₂**), respectively.

Materials combined as per Tables 1, 2 and 3, and prepared following Figure 1. **Rheological characterisation:** HAAKE MARS iQ Air rheometer (Thermo Fisher Scientific, UK); parallel plate geometry (0.500 mm gap; ø 60 mm); 20° C. Strain-controlled amplitude sweep (0.01–100%; 1 Hz); frequency sweep (0.1–10 Hz, within LVR); and continuous flow shear rate sweep (0.001–100 s⁻¹).

Texture analysis: TA.XTPlus Texture Analyser (Stable Micro Systems, UK); TTC spreadability rig; triplicate measurements; 21° C.

Table 1: Composition of oleogels with Ethylcellulose (EC), castor oil (CO), Ethylhexyl Palmitate (EHP), Coco-Caprylate/Caprate (CCC) and BHT. **E2 was chosen as the main base due to its tactile properties.**

Phase	Ingredient	F1	F3	E1	E2	E3	E4
A	EC	5.00	5.00	5.00	5.00	5.00	5.00
	CO	94.99	47.50	47.50	47.50	47.50	47.50
	EHP	-	23.75	31.66	15.83	47.49	-
	CCC	-	23.75	15.83	31.66	-	47.49
	BHT	0.01	0.01	0.01	0.01	0.01	0.01

Table 2: Composition of oleogels derived from E2, containing pigments Titanium Dioxide (TiO₂), yellow Iron Oxide (yellow IO), red Iron Oxide (red IO) and black Iron Oxide (black IO).

Phase	Ingredient	E2	P1	P2	P3	P4	P5
A	EC	5.00	5.00	5.00	5.00	5.00	5.00
	CO	47.50	47.50	47.50	47.50	47.50	47.50
	EHP	15.83	13.33	13.33	13.33	13.33	13.33
	CCC	31.66	29.16	29.16	29.16	29.16	29.16
	BHT	0.01	0.01	0.01	0.01	0.01	0.01
B	TiO ₂	-	5.00	-	-	-	4.09
	Yellow IO	-	-	5.00	-	-	0.62
	Red IO	-	-	-	5.00	-	0.15
	Black IO	-	-	-	-	5.00	0.14

Table 3: Composition of oleogels derived from E2, containing pigments, and counterparts with added Caprylyl Dimethicone (CM) and Dimethicone (D).

Phase	Ingredient	E2	P5	CM2	CM4	D2	D4
A	EC	5.00	5.00	5.00	95.00	95.00	95.00
	CO	47.50	47.50	42.50	37.50	42.50	37.50
	EHP	15.83	13.33	14.16	14.16	14.16	14.16
	CCC	31.66	29.16	28.33	28.33	28.33	28.33
	BHT	0.01	0.01	0.01	0.01	0.01	0.01
B	TiO ₂	-	4.09	-	4.09	-	4.09
	Yellow IO	-	0.62	-	0.62	-	0.62
	Red IO	-	0.15	-	0.15	-	0.15
	Black IO	-	0.14	-	0.14	-	0.14
C	CM	-	-	10.00	10.00	-	-
	D	-	-	-	-	10.00	10.00

CONCLUSION

EC-CO/EHP/CCC oleogels have shown considerable potential as foundation bases, especially when **Dimethicone** or **Caprylyl Methicone** are included, reducing stickiness and strengthening the oleogel structure. With additional textural and sensory optimisation, these prototypes could meet consumer acceptance.

[1] Lukić, M. and Krajišnik, D. (2024) Challenges and advances in waterless cosmetic product development – raising awareness of water sustainability, Archives of Pharmacy, 74, pp. 735-757.
[2] Gravelle, A.J., Davidovich-Pinhas, M., Zetzl, A.K., Barbut, S. and Marangoni, A.G. (2016) 'Influence of solvent quality on the mechanical strength of ethylcellulose oleogels', Carbohydrate Polymers, 135, pp. 169–179. doi: 10.1016/j.carbpol.2015.08.050. [3] Baltazar, D., Shamaei, S., Csöngé, N. and Tamburic S. (2024) Ethylcellulose oleogel lip glosses: the effects of different emollients and pigments on rheology and textural properties, 34th IFSCC Congress, Brazil.

RESULTS

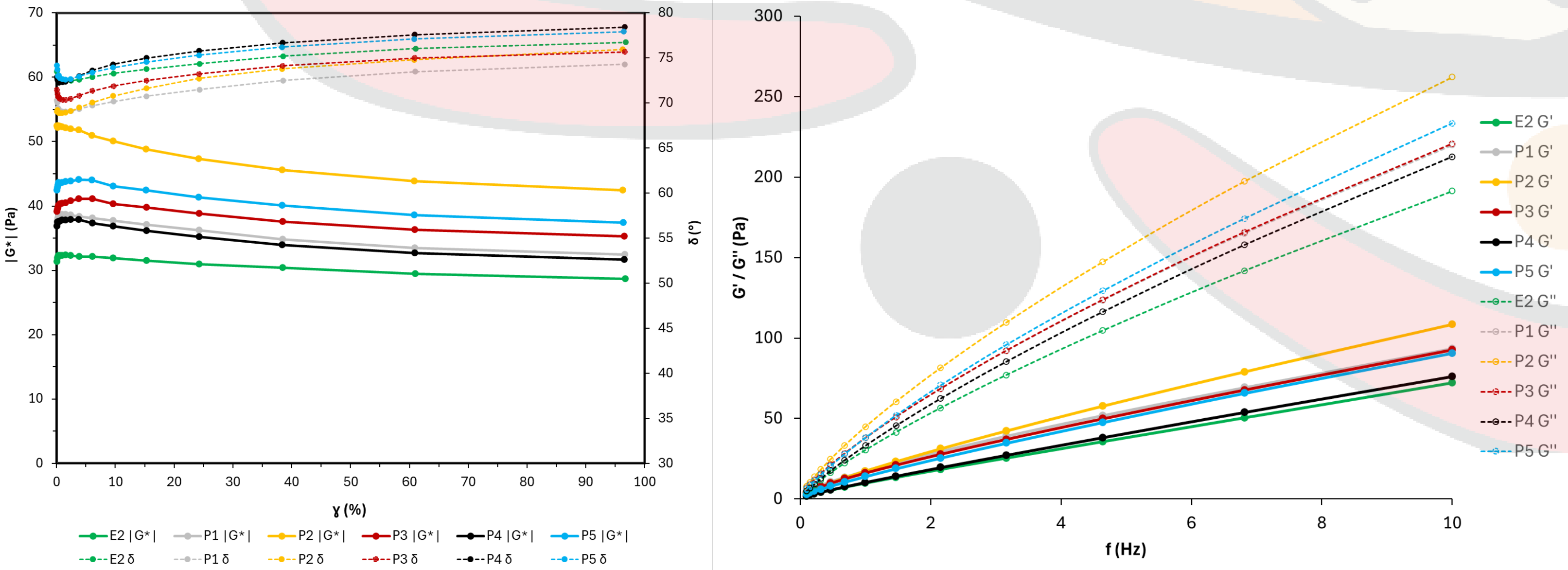


Figure 2: Oscillatory rheology results of the EC-CO/EHP/CCC oleogel E2 and its counterparts with pigment, TiO₂ (P1), yellow IO (P2), red IO (P3), black IO (P4) and a pigment mixture (P5) [a] Amplitude sweep: complex modulus G* (Pa) (full lines); phase angle δ (°) (dashed lines). [b] Frequency sweep: storage modulus, G' (Pa) (full lines); loss modulus, G'' (Pa) (dashed lines).

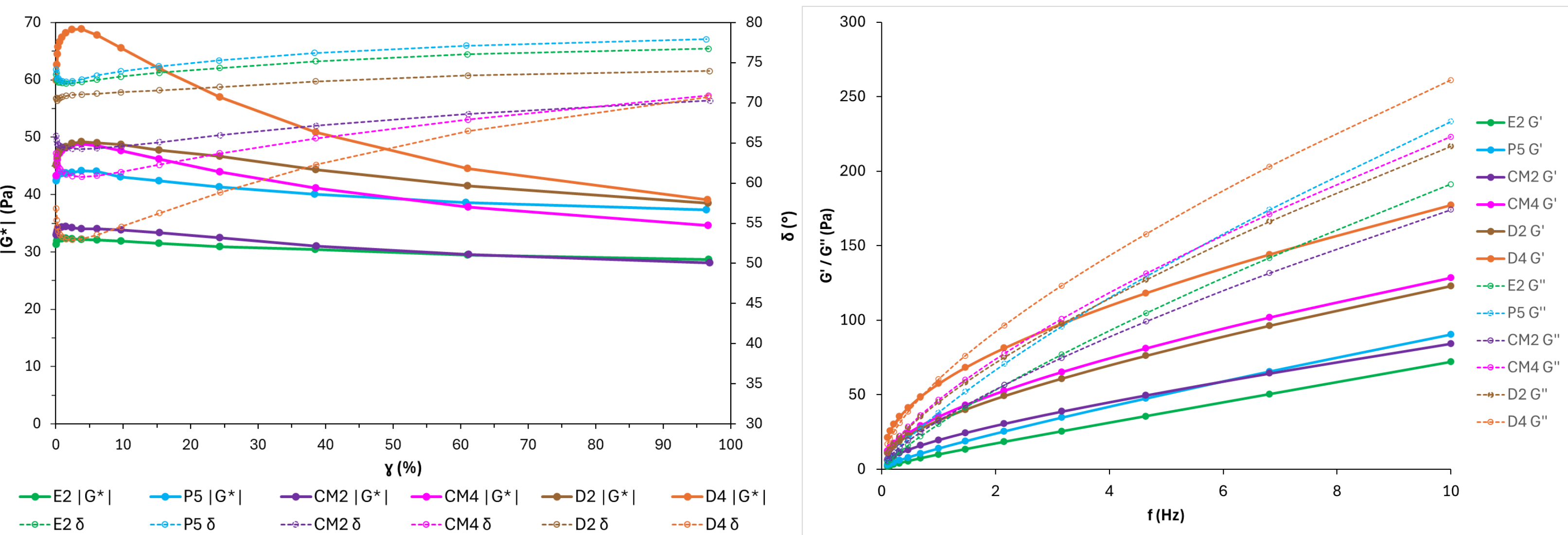


Figure 3: Oscillatory rheology results of the EC-CO/EHP/CCC oleogel E2, its counterparts containing 10% CM (CM2) and 10% D (D2), and their pigment mixture versions (P5, CM4 and D4, respectively) [a] Amplitude sweep: complex modulus G* (Pa) (full lines); phase angle δ (°) (dashed lines). [b] Frequency sweep: storage modulus, G' (Pa) (full lines); loss modulus, G'' (Pa) (dashed lines).

Figure 2a: pigment increased rigidity (G*), in line with previous results [3], while phase angles were similar among samples [3].

Figure 2b: E2 and all pigmented oleogels (P1–5) exhibited G'' > G' across the frequency range, showing predominantly viscous properties.

Figure 3a: 10% CM (CM2) resulted in similar rigidity (G*) to E2, however, 10% D (D2) sharply increased G*; CM and D increased elasticity (δ). The gel-strengthening effect of silicones is probably due to lower EC solubility in the oil phase [2]. Similarly to Figure 2a, pigments increased G*. The combined effects of pigment and silicones sharply increased elasticity (δ).

Figure 3b: CM and D maintained G'' > G' across the frequency range. However, when combined with pigments, predominantly elastic properties (G' > G'') were observed at low frequency.

Figure 4: pigment increased viscosity, congruently with previous findings [3]. CM and D increased viscosity at low shear rates, followed by lower viscosity at higher shear rates. This was also observed between D2 and D4, suggesting an increase in spreadability.

Table 4: CO drastically affected texture, as expected (F1 vs others) [3]. Pigments increased firmness and stickiness, and reduced spreadability, unlike previous results [3]. CM and D reduced oleogel stickiness and increased firmness, but unexpectedly reduced spreadability.

Table 4: Texture parameters of EC/CO oleogel (F1), EC/CO+EHP:CCC (1:1) oleogel (F3), EC/CO+EHP:CCC (1:2) E2, its counterparts with a pigment mixture (P5), with 10% CM (CM2), with 10% D (D2) and D2's counterpart with a pigment mixture (D4).

Sample	Firmness (g)	Work of Shear (g s)	Stickiness (g)	Work of Adhesion (g s)
F1	1477.76	963.95	-1663.02	-461.08
F3	339.49	227.70	-503.79	-107.67
E2	224.94	119.87	-392.13	-79.12
P5	310.61	182.54	-501.74	-107.41
CM2	240.39	162.62	-344.89	-74.16
D2	288.75	218.88	-360.55	-85.34
D4	343.05	255.71	-446.76	-97.36

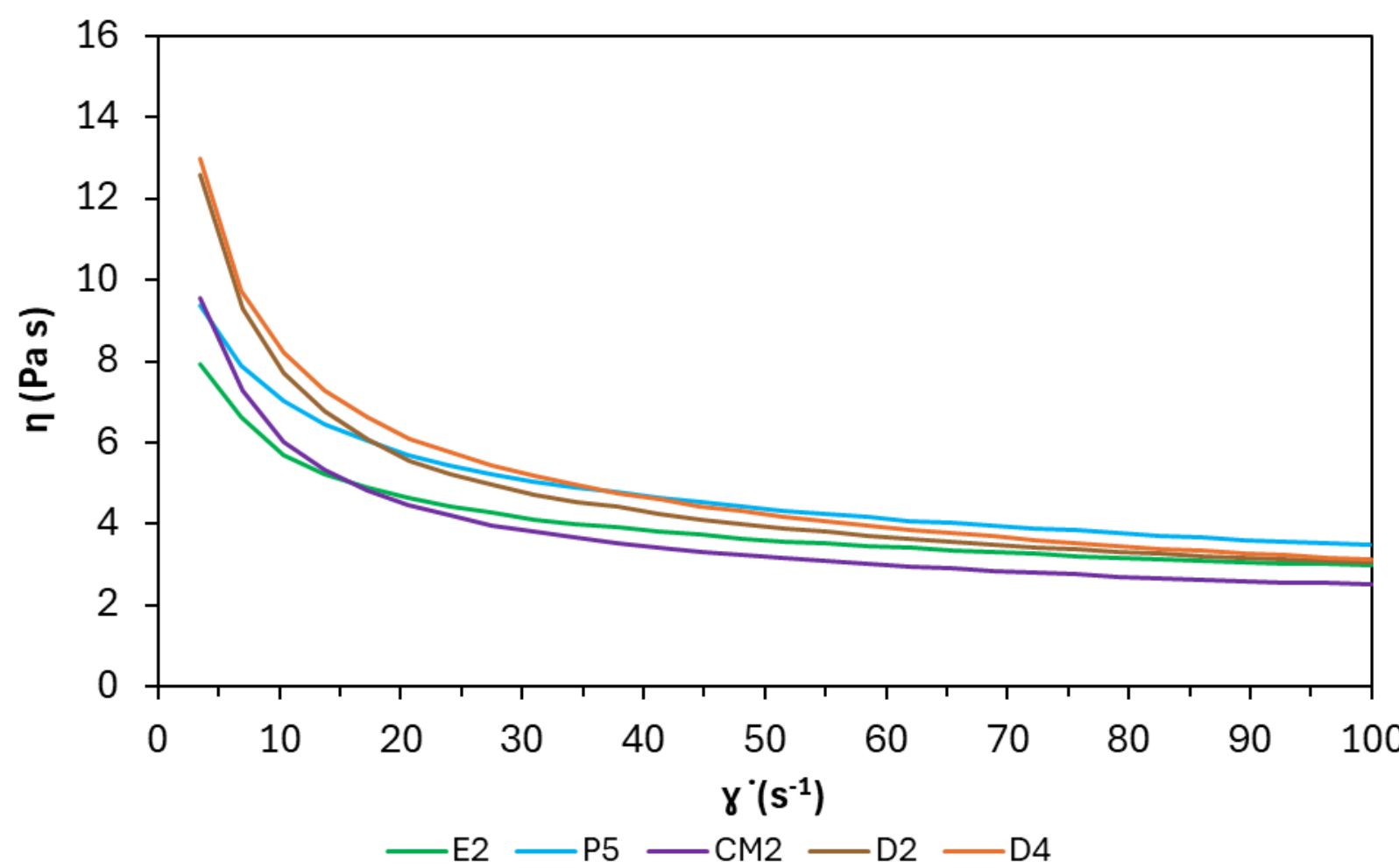


Figure 4: Viscosity of the EC-CO/EHP/CCC oleogel E2 and its pigment mixture counterpart (P5); EC-CO/EHP/CCC oleogel containing 10% CM (CM2) and 10% D (D2), and D2's counterpart with a pigment mixture (D4).