Supplementary information - Shear-thinning mediation of elasto-inertial Taylor-Couette flow

Tom Lacassagne[1,2]†, Neil Cagney[3], and Stavroula Balabani[1]‡

[1]Flume, Department of Mechanical Engineering, University College London (UCL), London, WC1E 7JE, UK

[2]IMT Lille Douai, Institut Mines-Télécom, Univ. Lille, Centrer for Energy and Environment, F-59000, Lille, France

[3]School of Engineering and Materials Science, Queen Mary University of London, E1 4NS, UK

Pre- and post-experiment rheological characterisation

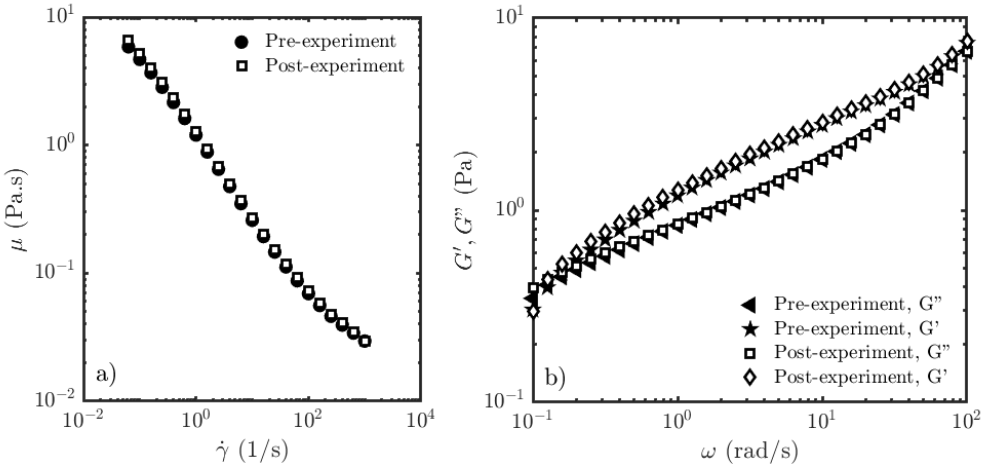

Figure 1: Comparison between steady shear (a) and oscillatory shear (b) rheological characterisations on a XG2000-50 sample before (full markers) and after (empty markers) a Taylor-Couette experiments. The overlapping curves show the absence of polymer degradation.

Nahme-Griffith number

From (White & Muller 2002*b*,*a*), the Nahme-Griffith number can be written as

$$NaG = S_\mu \mu \frac{r_i^2 \Omega^2}{kT_0} \tag{0.1}$$

where

† Email address for correspondence: tom.lacassagne@imt-lille-douai.fr
‡ Email address for correspondence: s.balabani@ucl.ac.uk

- T_0 is the wall temperature assumed here equal to 293 K.
- μ, r_i and Ω are defined in the main text as the (shear-rate dependent) dynamic viscosity, inner cylinder radius, and rotation speed, respectively. μ is estimated at T_0.
- k is the thermal conductivity of the fluid, assumed equal to that of the water glycerol solvent ($k \simeq 0.3$ W.m^{-1}.K^{-1} for 72% glycerol, using a simple mixture law).
- $S_\mu = (T/\mu \times \partial\mu/\partial T)_{T_0}$ is the temperature sensitivity of the dynamic viscosity of the polymer solution, which can also be assumed similar to that of the water glycerol solvent given the weak temperature dependency of xanthan gum viscosity (Whitcomb & Macosko 1978) ($S_\mu \simeq 17$ for 72% glycerol, computed from Volk & Kähler (2018)).

Summary of critical Re values

Sample	Test	Re_c^{TVF}	Re_c^{WTVF}	Re_c^{RSW}	Re_c^{EIT}	Re_c^{SVF}
N72	1	107	218	-	-	-
N72	2	107	218	-	-	-
P500-72	1	82	-	92	100	-
P500-72	2	81	-	92	100	-
P500-72	3	97	-	103	128	-
P500-72	4	99	-	105	135	-
P500-72	5	99	-	108	127	-
XG200-72	1	46	111	51	52	-
XG200-72	2	56	124	-	72	-
XG200-50	1	66	91	72	-	-
XG200-50	2	67	89	72	-	-
XG200-50	3	64	88	72	-	-
XG1000-72	1	-	-	-	53	-
XG1000-72	2	-	-	-	54	-
XG1000-72	3	-	-	-	48	-
XG1000-72	4	-	-	-	47	-
XG1000-25	1	72	109	-	-	-
XG2000-50	1	51	-	71	86	60
XG2000-50	2	37	-	65	78	47
XG2000-50	3	65	-	78	88	69
XG2000-50	4	66	-	79	89	69

Table 1: Summary of critical Re values for experiments reported in table 2 of the main text.

REFERENCES

Volk, A. & Kähler, C. J. 2018 Density model for aqueous glycerol solutions. *Experiments in Fluids* **59** (5).

Whitcomb, P. J. & Macosko, C. W. 1978 Rheology of Xanthan Gum. *Journal of Rheology (1978-present)* **22** (5), 493–505.

White, J. M. & Muller, S. J. 2002*a* Experimental studies on the stability of Newtonian Taylor–Couette flow in the presence of viscous heating. *Journal of Fluid Mechanics* **462**, 133–159.

White, J. M. & Muller, S. J. 2002*b* The role of thermal sensitivity of fluid properties, centrifugal destabilization, and nonlinear disturbances on the viscous heating instability in Newtonian Taylor–Couette flow. *Physics of Fluids* **14** (11), 3880–3890.