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Data Article

Viscoplastic properties of laponite-CMC mixes



Z. Tarhini, S. Jarny, A. Texier

Institut Pprime, Université de Poitiers, CNRS, ISAE-ENSMA, F-86962 Futuroscope-Chasseneuil, France

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ABSTRACT

In this dataset, 15 samples of laponite-CMC mixes were realized and their viscoplastic properties are determined. Rheological parameters are then expressed as a function of age and components concentrations.

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Specifications Table

Subject area	Physics
More specific subject area	Viscoplastic properties
Type of data	Table, graph
How data was acquired	Rheometer (Gemini, Malvern)
Data format	Raw, analyzed
Experimental factors	15 samples of laponite-CMC were made with different concentrations of components (synthetic clay and polymer) and analyzed with a rheometer
Experimental features	Rheometrical tests are carried out and viscoplastic properties are linked to the concentration of components
Data source location	n/a
Data accessibility	Data is available in this paper

E-mail address: sebastien.jarny@univ-poitiers.fr (S. Jarny).

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Value of the data

- The data can be compared to other recipes to obtain transparent viscoplastic mixes for optical measurements such as PIV.
- The data can be used directly to make transparent viscoplastic model fluids with rheological controlled properties for civil engineering, agroalimentary, sediment transport, cosmetic field,...
- The data show effects of clay and polymer concentrations on viscoplastic parameters to reach the desired rheological properties.

1. Data

Rheological properties on 15 samples of laponite-CMC mixes are determined varying mass concentration of the components (laponite and carboxymethylcellulose) [1,2]. Rheograms are established and a viscoplastic model (Herschel–Bulkley) is fitted. Model parameters are expressed as a function of time or components concentration.

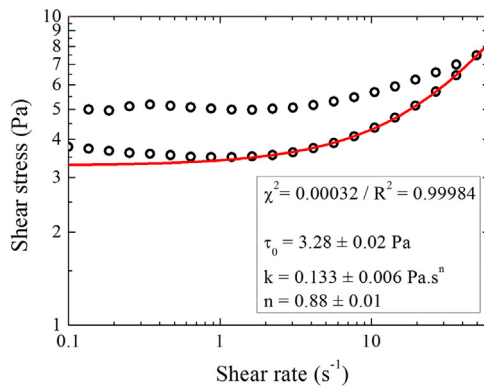


Fig. 1. Fitted curve with Herschel–Bulkley model on sample 0.5% CMC+0.5% laponite for D+1.

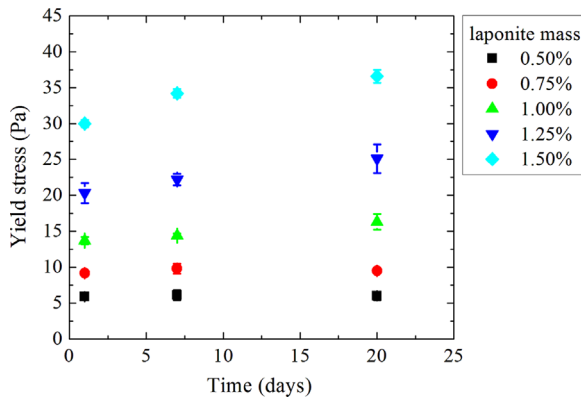


Fig. 2. Yield stresses as a function of time for a CMC mass concentration of 0.75%.

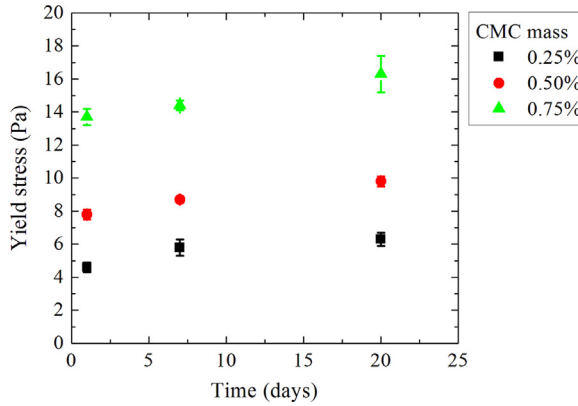


Fig. 3. Yield stresses as a function of time for a laponite mass concentration of 1.0%.

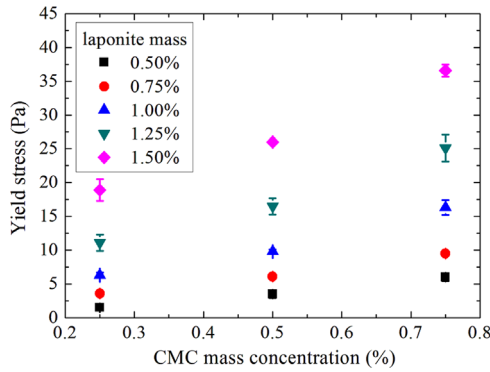


Fig. 4. Yield stresses as a function of CMC mass concentration for D+20.

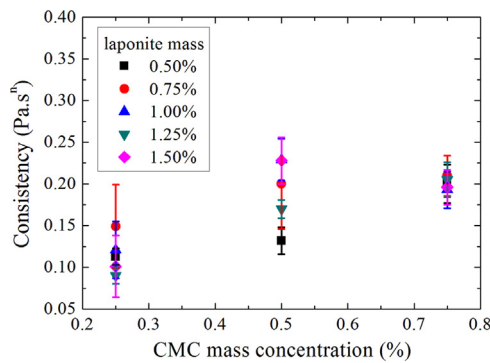


Fig. 5. Consistencies as a function of CMC mass concentration for D+20.

2. Experimental design, materials and methods

2.1. Materials

Transparent mixes are prepared from a synthetic clay (laponite RD, Rockwood) and polymer (carboxymethylcellulose (CMC), Prolabo) [3]. For the polymer solution, CMC powder is poured gently

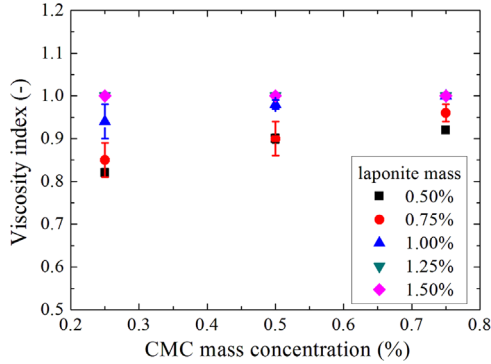


Fig. 6. Viscosity indexes as a function of CMC mass concentration for D+20.

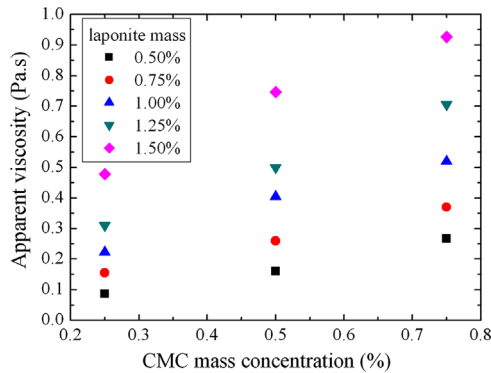


Fig. 7. Apparent viscosity for $\dot{\gamma} = 50 \text{ s}^{-1}$ as a function of CMC mass concentration for D+20.

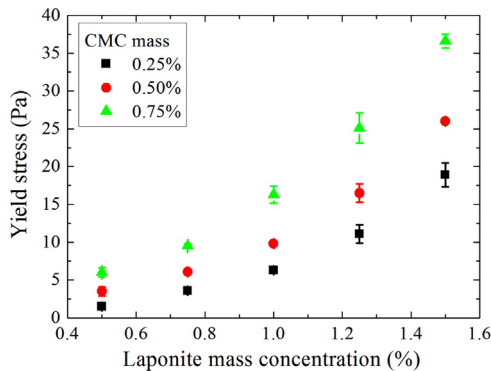


Fig. 8. Yield stresses as a function of laponite mass concentration for D+20.

to deionized water stirred with a magnetic agitator (C-100, Prolabo) at 600 rpm. The solution is then stirred for 1 h more at 600 rpm. For the laponite suspension, laponite powder is poured gently to deionized water stirred with a homogenizer (Ultraturrax T25, IKA) at 11,000 rpm. The suspension is then stirred for 15 min more at 11,000 rpm. The preparation of laponite suspension begins 15 min before the end of the stirring period of CMC solution. Then laponite suspension is poured on the CMC solution and the mixture is stirred for 1 h more with a magnetic agitator (C-100, Prolabo) at 1100 rpm.

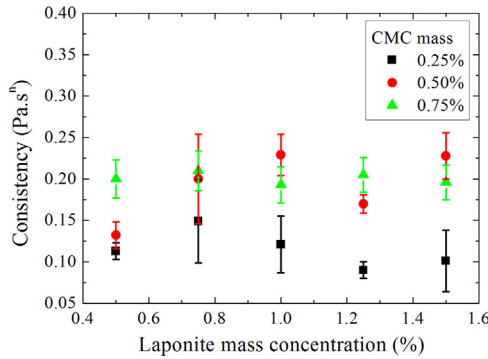


Fig. 9. Consistencies as a function of laponite mass concentration for D+20.

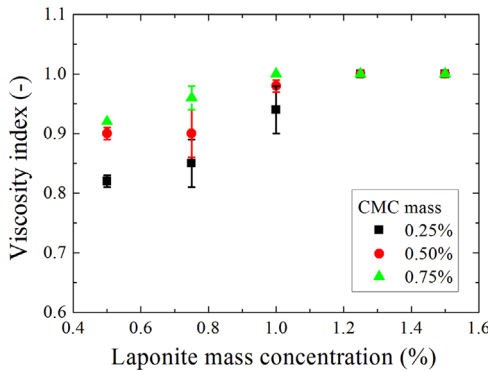


Fig. 10. Viscosity indexes as a function of laponite mass concentration for D+20.

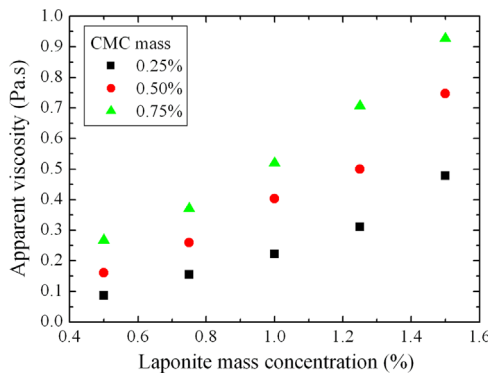


Fig. 11. Apparent viscosity for $\dot{\gamma} = 50 \text{ s}^{-1}$ as a function of laponite mass concentration for D+20.

Table 1
Herschel–Bulkley parameters for 15 samples.

Sample	Yield stress (Pa)						Viscosity index (-)						Consistency (Pa s ⁿ)					
	<i>D</i> +1		<i>D</i> +7		<i>D</i> +20		<i>D</i> +1		<i>D</i> +7		<i>D</i> +20		<i>D</i> +1		<i>D</i> +7		<i>D</i> +20	
	Avg	Std dev	Avg	std dev	Avg	Std dev	Avg	Std dev	Avg	Std dev	Avg	Std dev	Avg	Std dev	Avg	Std dev	Avg	Std dev
Laponite 0.50%+CMC 0.25%	1.6	0.2	1.5	0.2	1.5	0.2	0.87	0.02	0.87	0.01	0.82	0.01	0.079	0.003	0.083	0.012	0.113	0.010
Laponite 0.50%+CMC 0.50%	3.5	0.3	3.4	0.3	3.5	0.6	0.87	0.02	0.89	0.01	0.90	0.01	0.160	0.032	0.137	0.023	0.132	0.016
Laponite 0.50%+CMC 0.75%	5.9	0.5	6.1	0.7	6.0	0.6	0.88	0.01	0.87	0.01	0.92	0.00	0.239	0.021	0.254	0.025	0.200	0.023
Laponite 0.75%+CMC 0.25%	2.7	0.0	2.9	0.2	3.6	0.4	0.85	0.02	0.84	0.04	0.85	0.04	0.141	0.023	0.162	0.042	0.149	0.050
Laponite 0.75%+CMC 0.50%	5.5	0.2	5.3	0.5	6.1	0.3	0.88	0.02	0.89	0.02	0.90	0.04	0.200	0.035	0.178	0.032	0.200	0.054
Laponite 0.75%+CMC 0.75%	9.2	0.4	9.8	0.7	9.5	0.3	0.97	0.01	0.94	0.00	0.96	0.02	0.217	0.022	0.256	0.025	0.210	0.024
Laponite 1.0%+CMC 0.25%	4.6	0.3	5.8	0.5	6.3	0.4	0.88	0.02	0.89	0.01	0.94	0.04	0.152	0.023	0.166	0.017	0.121	0.034
Laponite 1.0%+CMC 0.50%	7.8	0.3	8.7	0.2	9.8	0.3	0.96	0.01	0.97	0.01	0.98	0.01	0.221	0.029	0.243	0.030	0.229	0.025
Laponite 1.0%+CMC 0.75%	13.7	0.5	14.4	0.3	16.3	1.1	0.96	0.01	0.97	0.01	1.00	0.00	0.288	0.022	0.288	0.020	0.193	0.022
Laponite 1.25%+CMC 0.25%	7.8	0.4	10.0	0.9	11.1	1.2	0.93	0.02	1.00	0.00	1.00	0.00	0.155	0.010	0.112	0.007	0.090	0.010
Laponite 1.25%+CMC 0.50%	12.9	1.3	13.9	0.3	16.5	1.2	0.99	0.01	1.00	0.00	1.00	0.00	0.170	0.045	0.154	0.008	0.170	0.011
Laponite 1.25%+CMC 0.75%	20.3	1.4	22.2	0.8	25.1	2.0	1.00	0.00	1.00	0.00	1.00	0.00	0.224	0.043	0.226	0.024	0.205	0.021
Laponite 1.50%+CMC 0.25%	12.9	0.2	16.1	0.5	18.9	1.6	1.00	0.00	1.00	0.00	1.00	0.00	0.131	0.014	0.123	0.001	0.101	0.037
Laponite 1.50%+CMC 0.50%	20.8	0.3	22.7	0.8	26.0	0.3	1.00	0.00	1.00	0.00	1.00	0.00	0.251	0.028	0.244	0.025	0.228	0.028
Laponite 1.50%+CMC 0.75%	30.0	0.5	34.2	0.6	36.6	0.9	1.00	0.00	1.00	0.00	1.00	0.00	0.270	0.031	0.261	0.026	0.196	0.021

Mixtures are then put in hermetic flacons and let at rest before experiments at ambient room temperature (almost 20 °C). Each batch has a weight of 150 g and masses of laponite and CMC are calculated from this reference.

2.2. Rheometrical tests

Rheometrical tests are carried out with controlled stress rheometer (Gemini, Malvern) using plate-plate geometry of 4 cm diameter. Both surfaces are covered with sandpaper to prevent slippage effects. Each measurement is realized for a 1 mm gap and temperature is kept constant at 20 °C.

The procedure begins with a pre-shearing phase to put samples in an initial state and to ensure reproducible results. It consists on applying a constant shear rate (10 s^{-1} during 120 s) following by a rest period (600 s). Flow curves measurements are then obtained by applying shear rate steps ranging from 0.1 to 50 s^{-1} in a logarithmic repartition, first by increasing values follow by decreasing values. Each shear rate step is applied for 40 s but only the last 10 s are averaged to obtain a measure point. Down flow curve is fitted with a Herschel–Bulkley model (Fig. 1) to determine yield stress (τ_0), consistency (k) and viscosity index (n):

$$\tau = \tau_0 + k\dot{\gamma}^n$$

Measurements are realized on 15 samples for three different ages: D+1; D+7 and D+20 where D is the day of sample making. For each day, three measurements are made and determined Herschel–Bulkley parameters correspond to the average of these three measurements (Figs. 2–11 and Table 1).

Transparency document. Supplementary material

Transparency data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.dib.2017.02.002>.

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