

## Supplementary Material

Effect of a modified silicone as a thickener on the viscosity and rheology of liquid CO<sub>2</sub> and the evaluation of fracturing capacity

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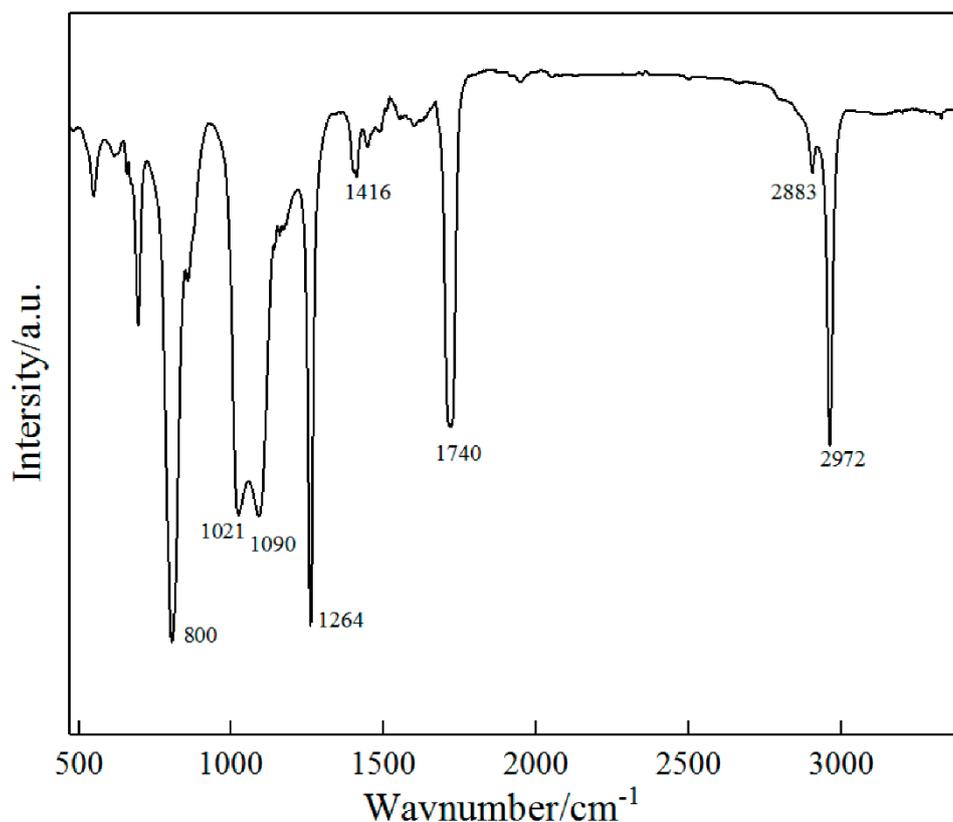
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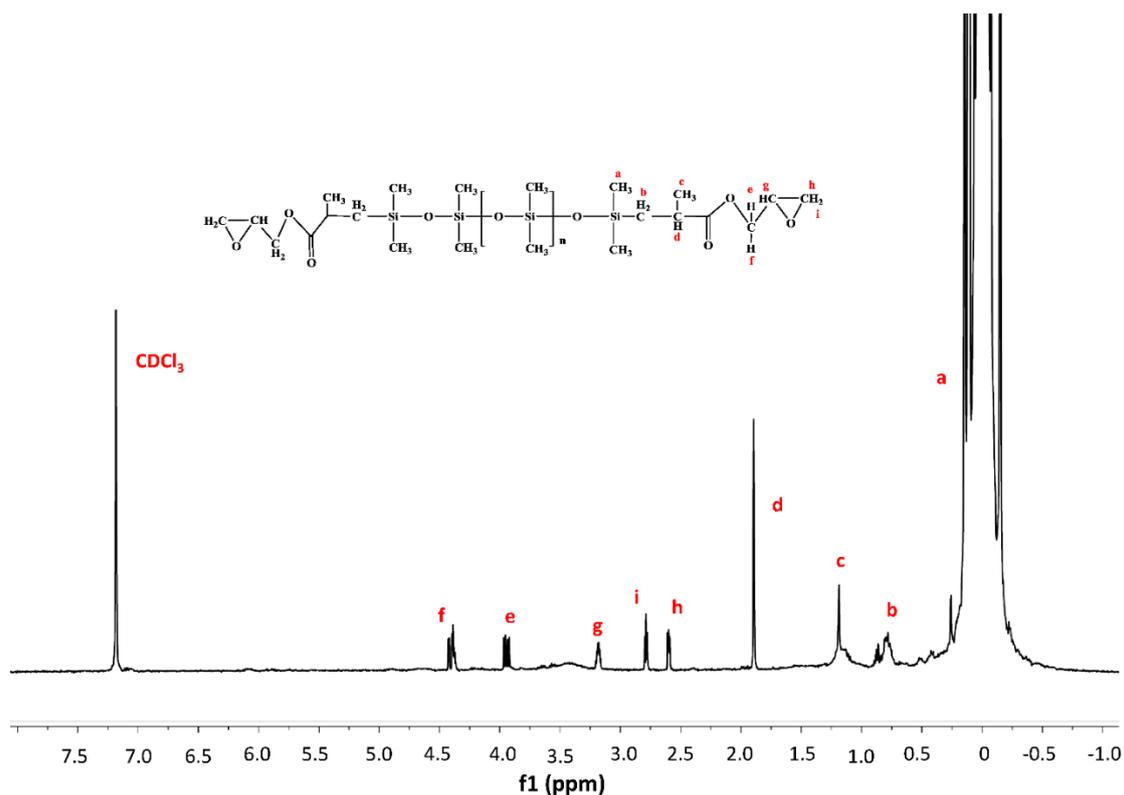


**Figure S1. FTIR spectra analysis of EEPDMS**

The synthesis and post-modifications of Polydimethylsiloxane, namely EEPDMS, was monitored by infrared spectroscopy (see Supplementary). It can be seen from the infrared spectroscopy that the sharp peak at 2972 cm<sup>-1</sup> and 2883 cm<sup>-1</sup> correspond to the C-H stretching vibration, and the peak at 1740 cm<sup>-1</sup> can be attributable to the C=O bending vibration [S1]. The sharp peak observed 1416 cm<sup>-1</sup> indicated the asymmetric vibration of Si-CH<sub>3</sub>. In addition, the narrow peak of 1170 cm<sup>-1</sup> (obstructed by the Si-O-Si peak at 1021-1200 cm<sup>-1</sup>) and 1018 cm<sup>-1</sup> indicated the stretching vibration of C-O-C group and the epoxy group respectively. The absorption band occurring between 1090±1020 cm<sup>-1</sup> indicated the symmetrical stretching vibration of the Si-O-Si [S2]. Meanwhile, the peak at 1264 cm<sup>-1</sup>, attributable to the symmetrical vibration of Si-CH<sub>3</sub> and CH<sub>3</sub>, and the peak at 800 cm<sup>-1</sup> confirmed the presence of the telescopic vibration of Si-C.

### Reference:

- [S1]: Gnanasambandam, R., Proctor, A. Determination of pectin degree of esterification by diffuse reflectance Fourier transform infrared spectroscopy. *Food. Chem.* **2000**, 68(3), 327-332.
- [S2]: Li, Q.; Wang, Y.; Li, Q.; Foster, G.; Lei, C. Study on the optimization of silicone copolymer synthesis and the evaluation of its thickening performance. *RSC Adv.* **2018**, 8(16), 8770-8778.



**Figure S2.**  $^1\text{H-NMR}$  ( $\text{CDCl}_3$ ) spectra at 400 MHz of EEPDMS

Each hydrogen element of EEPDMS is labeled in Figure S2. It is clear that the chemical shift from 0.11 ppm to 0.28 ppm presented the H (a) of a methyl group, the methylene H connected to a silicon atom attributed to the 0.69 ppm (b). Meanwhile, the 2.54 ppm (h), 2.79 ppm (i) and 3.17 ppm (g) were considered to be the H of the homomethyl and methylene respectively. The chemical shift of Si-H does not appear in the range of 4.5 to 5.3 ppm [S3] and the chemical shift of the C=C bond do not occur in the range of 5.0 to 5.8 ppm [S4, S5]. The chemical shift at 1.19 ppm was the Hydrogen on the methyl (c) [S4] and the 1.89 ppm (d) presented the chemical shift of the C-H. In addition, the chemical shift at 3.86 ppm (e) and 4.34 ppm (f) was view as two hydrogens on the methylene group respectively.

Reference:

[S3] Berlekamp, U. H., Jutzi, P., Mix, A., Neumann, B., Stammler, H. G., Schoeller, W. W. Stabilization of Organosilicium Ions by means of Intramolecular Coordination of O, S, or P Ligands. *Angew. Chem. Int. Edit.*, **1999**, 38, 2048-2050.

[S4] van, Dijk-Wolthuis. W. N. E., Franssen, O., Talsma, H., van Steenbergen, M. J., Kettenes-van den, Bosch, J. J., Hennink, W. E. Synthesis, characterization, and polymerization of glycidyl methacrylate derivatized dextran. *Macromolecules*, **1995**, 28(18), 6317-6322.

[S5] Virtanen, J., Tenhu. H. Studies on copolymerization of n-isopropylacrylamide and glycidyl methacrylate. *J. Polym. Sci. Pol. Chem.*, **2001**, 39(21), 3716-3725.