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Comment on acp-2021-110

Anonymous Referee #1

Referee comment on "Viscosity and phase state of aerosol particles consisting of sucrose mixed with inorganic salts" by Young-Chul Song et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-110-RC1, 2021

The manuscript describes very nice and comprehensive measurement results of viscosity for binary and ternary mixtures of sucrose, calcium/magnesium nitrate, and water, using the bead-mobility and poke-and-flow techniques that cover two ranges of viscosity. A thermodynamic model was also used to obtain viscosity of those mixtures and to compare with those from measurements. The extension of viscosity measurements to more complex aerosol composition is surely important to understand the physical properties of atmospheric particles. The study is also well designed, and results well interpreted. I therefore recommend Minor Revision, with some minor comments below.

- It is interesting to compare results in Figure 4b and 4d. When AIOMFAC-VISC predicted better for the inorganic salt (magnesium nitrate), it also predicted better for the corresponding ternary mixture in Figure 4d. Does this result mean that ZSR-type mixing rule suffices for viscosity prediction? That is, if one can capture the viscosity of the individual component well, one can predict the viscosity of mixed components well, at least for non-reactive and non-interacting mixtures such as those in this study? I am also particularly interested in why the mixing rule works on a natural-log basis (P9/L227). Any physical reason behind that?

- P5/L138: Any reason for using two different equilibrating durations for these two techniques? And indication of water evaporation is complete for 30 min equilibrating time, especially for more viscous particles?

- P12/L309: Any specific evidence to suggest that at least one of these mixtures went through a gel transition? Are the electrolytes in the study (calcium, magnesium, and nitrate) capable of forming contact ion pairs as magnesium-sulfate pair and calcium-gluconate pair? Would love to see the viscosity measurement results of magnesium sulfate, which has been suggested to form gel.

- It would be nice to see the results being put in a broader context of viscosity measurements using other techniques (e.g., particle rebound and particle merging etc.) for similar species, if any.

- P13/L359: please delete “to be” after “were”.