Experimental Research on Friction factor of glycerol based DES

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Introduction

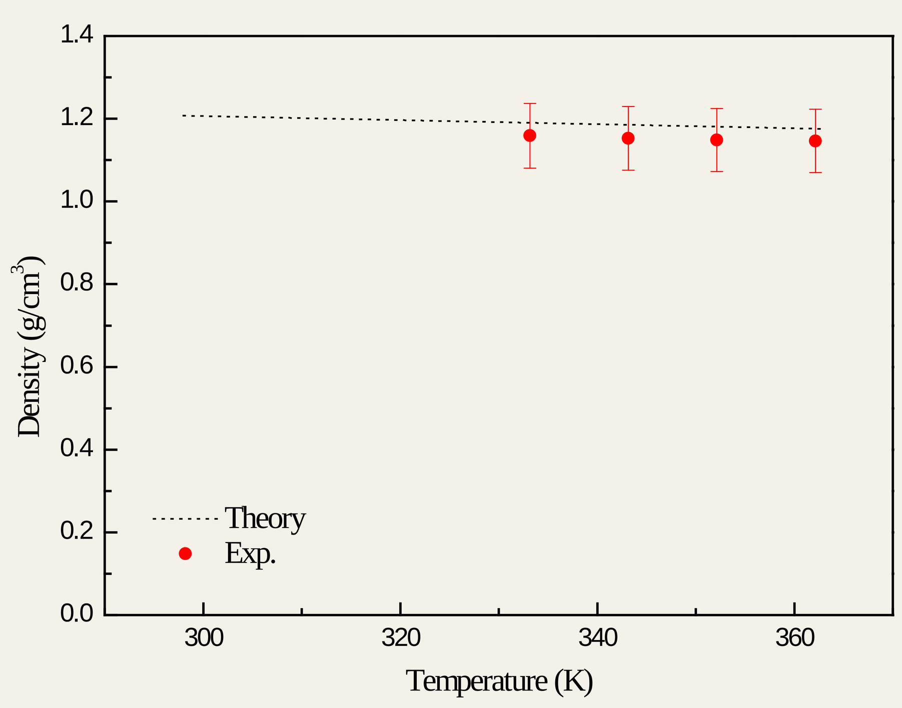
- Last 20 years, many researches have been carried out to apply Ionic Liquids.
- While the need for organic solvents increases, Ionic liquids have weakness on the high costs.
- These days DES(Deep Eutectic Solvent) which is similar object to ILs is emphasizing and also introduced on Abbot et al(2003].
- Basically, DES is mixture of two or more of compound, mixture has less melting point than each compounds.
- DES' s physical, chemical properties are similar with[6] existing ILs. However, DSE has more sustainable advantage than ILs not just synthesize method, low cost, non-toxic but also environmental and economic advantage[6,7,8].
- in this experiment, using DES based on glycerol, the experiment about dynamic characteristics as a heat transfer medium was conducted

Preparations and Methods

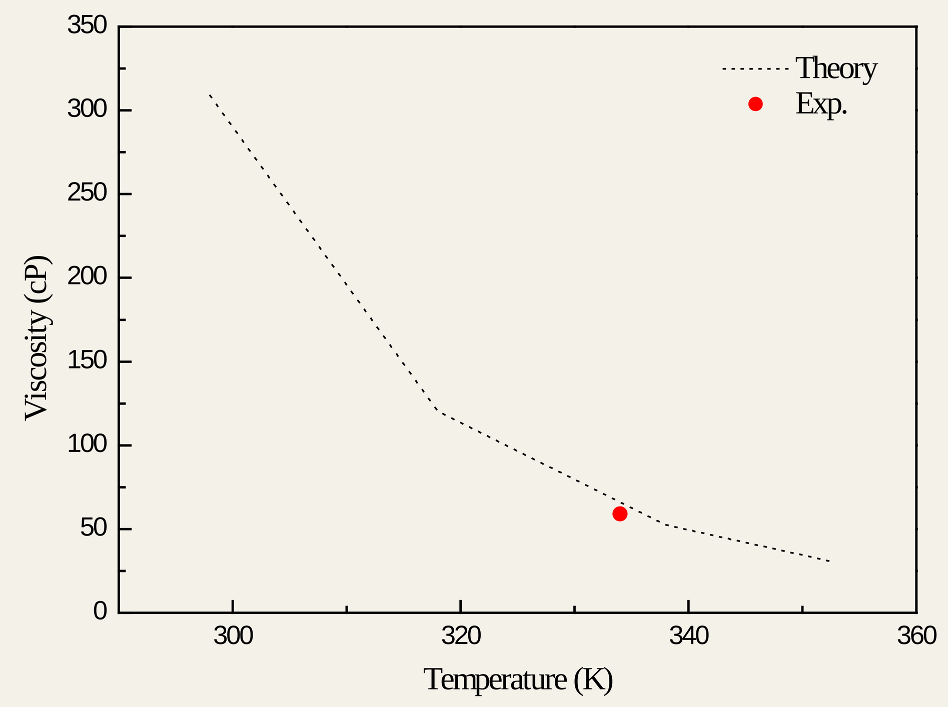
Manufacturind DES

- Glyceline which is DES, mixture by CHCl and Glycerol, 1:2 molar ratio will be mentioned.
- . By using 1:2 molar ratio of CHCl as a salt and Glycerol as a HBD, put them all together in the beaker or flask. Then using the heated stirrer, DES has made by mixing condition of 75℃, 600RPM for 2hours.

- Chemical formula of CHCl is C5H14ClNO, melting point is 302℃, molecular mass is 139.62 g/mol. Chemical formula of Glycerol is C3H8O2, melting point is 17.8℃, molecular mass is 92.094g/mol. Following, manufacturing 2kg of Glyceline, mass ratio of CHCl and Glycerol is 862.363g : 1137.637g.
- After measuring density and viscosity of manufactured Glyceline, then compared with Glyceline' s properties which were known by M. K. Alomar et al(2016][17].



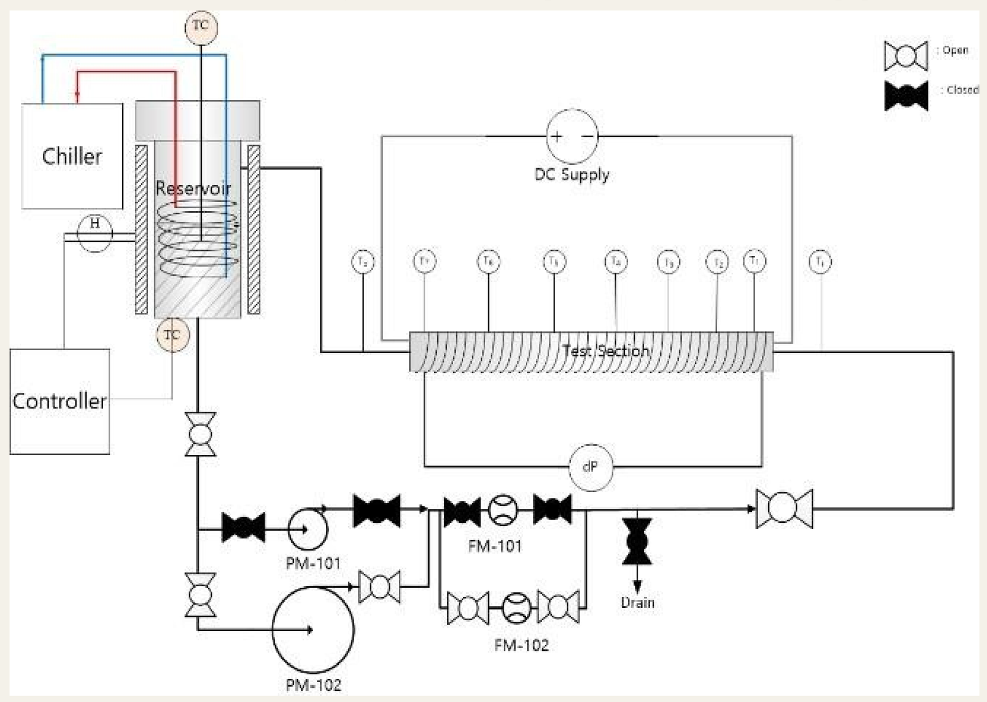
Preparations (cont.)



- Density of manufactured Glyceline for the main experiment is calculated average 2.5% lower than the theory value. If reflecting the uncertainty of measuring volume by using reservoir and measuring mass by using scales, theory value is in measurement error range.
- Viscosity was measured directly by using viscometer. It was measured on 334K, error between theory value is 3.708%. The reason why there occurs a little error is during manufacturing DES uncertainty of measuring mass causes uncertainty of molar ratio.
- Density and viscosity of manufactured Glyceline has a little gap between the theory value, through that this DES manufactured appropriately to carry out this experiment..

Experimental apparatus

- To measure the Glyceline' s dynamic characteristics, the experimental apparatus



- During dynamic characteristics experiment, calculate the DES' s friction factor by using the data from differential pressure gauge which installed in test section and flux from flow meter which installed following the pump.

Result

- Put DES on the reservoir and circulates DES while keeping the steady temperature and same flux.
- After measuring the flux and differential pressure at this moment, calculate friction facor according to the Reynolds number change, and compared with the Poiseuille friction factor and Blasius friction factor, which are theoretical valuesof the friction factor for water in a circular tube. Following equation shows how to calculate Reynolds number by following equation.

$$Re = \frac{\rho v d}{\mu}$$

- The friction factor can be calculated by using measured differential pressure and Darcy's formula. Darcy's formula is following equation.

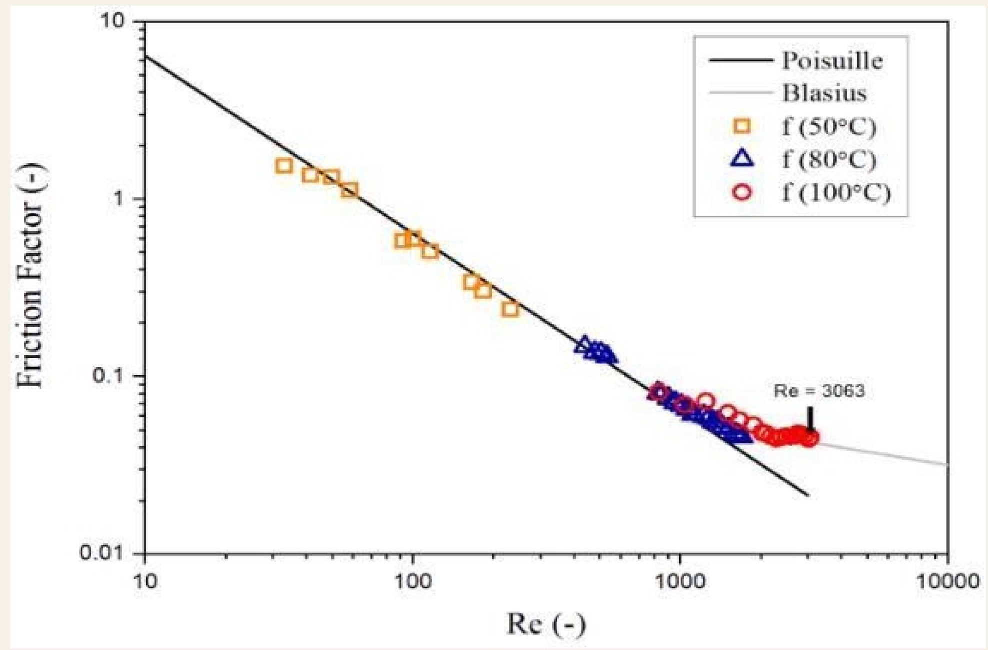
Result (cont.)

$$\Delta P = f \frac{L}{D}\frac{1}{2}\rho v^2$$

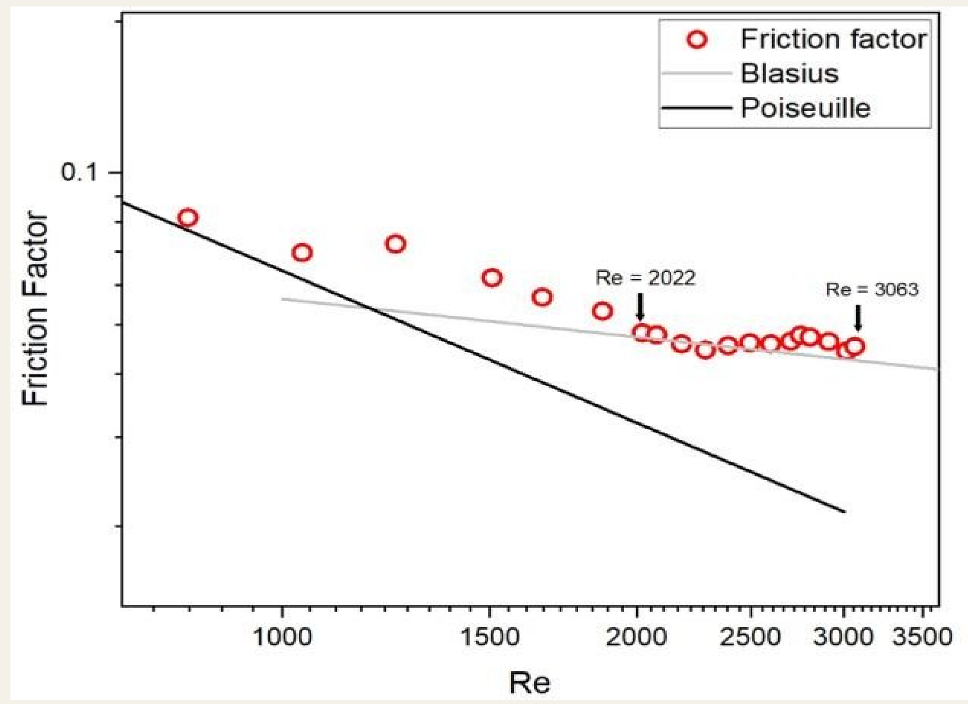
- The friction factor can be calculated by using differential pressure that measured, flux and following equation.

$$f = \Delta P \frac{D}{L}\frac{2}{\rho v^2}$$

- When Glyceline is steady on 50° C, 80° C, 100° C, then measured differential pressure.



- The experiment was carried out until the Reynolds number is 3063. As figures shows, the value of differential pressure increases linearly following Reynolds number.



- As figure shows, around Reynolds number is around 1000, it looks like transition region has started. Accordingly, the experimental friction factor value matches with Poiseuille friction factor and Blasius friction factor. The maximum error of the measured friction factor is 15%.

Conclusion

- The dynamic characteristics of DES, which is considered as an alternative to Ionic liquids, was conducted as an experimental study.
- The study was conducted by selecting Glyceline as DES, and carried out on laminar and turbulent region.
- Glyceline was confirmed that it is a Newtonian fluid. In the laminar region, friction factor matched almost the same as the Poiseuille friction factor and in the turbulent region, it matched almost the same as the Blasius friction factor.
- The fact that Glyceline' s dynamic characteristics are much similar to water has known already, therefore, by applying the theoretical value for water, the dynamic characteristics of Glyceline could be judged.

Acknowledgments

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