Selective Silica Separations from Waste Water using Ion-Exchange Media

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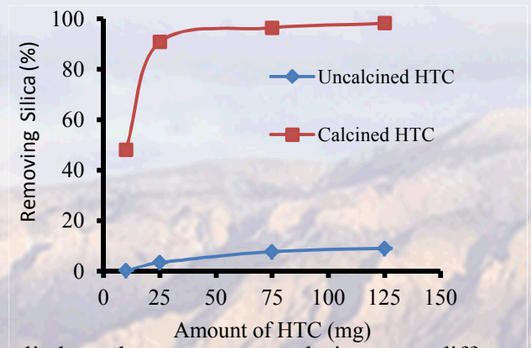
Introduction

Fresh water scarcity is going to be a global great challenge in the near future because of the increasing population. Water resources are limited and, hence, water treatment and recycling methods are vital alternatives for fresh water procurement in the upcoming decades.[1] Silica has been labeled the most challenging constituent to be removed during water treatment as it can exist in the ground and surface water in form of various dissolved and particulate species. The limitation of silica solubility is the main reason behind the requirement of silica removal for many industrial applications and water treatment.[2]

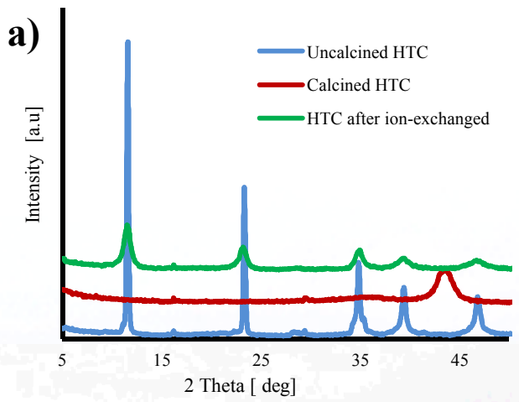
Form… …er on th… …be and walls which disrupts the boiler function due to the very low thermal conductivity of the silica scale.[3]

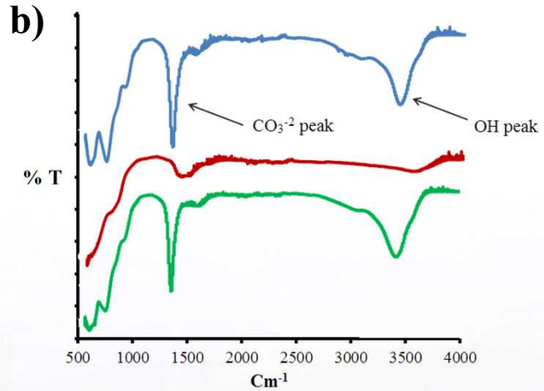
Experimental Result of Silica Removal

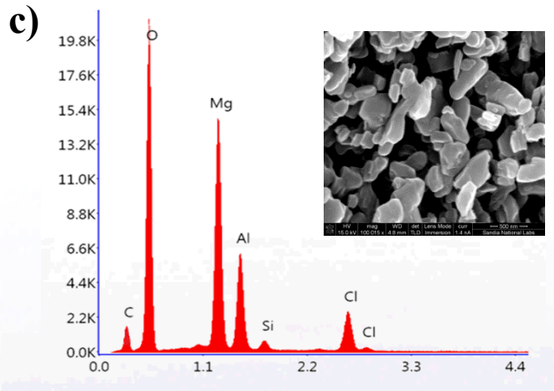


The applied sorbent was tested in two different forms: uncalcined HTC and calcined HTC at 550 °C. This result indicated that the calcined HTC removes greater amounts of silica compared to uncalcined HTC.

Characterizations of Hydrotalcite (HTC)

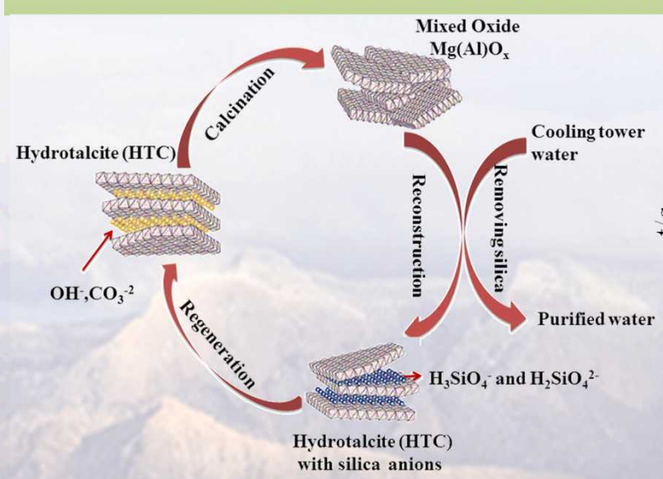


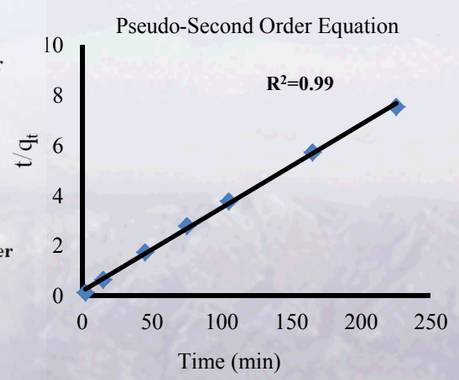




FTIR and XRD analysis support the fact that calcined HTC can be reconstructed to original structure by exposure to the cooling tower water containing silica ions (figures a and b). The presence of silica at HTC structure after reconstruction was confirmed by SEM-EDS spectroscopy (figure c).

Silica Removal Mechanism and Kinetic





The activation of HTC is initiated by a calcination in the air at 550 °C. The structural memory effect of HTC provides silica anions ($H_3SiO_4^-$ and $H_2SiO_4^{2-}$) accessibility to insert into the interlayer spacing of the calcined HTC.

The pseudo-second order kinetic model fits the experimental data with the relative high R^2 value (0.99) and it is the most suitable model in describing silicate anions removal kinetic by calcined HTC.

Conclusions

- ❖ Reconstruction of calcined HTC to its original structure thorough structural memory effect results in silica removal
- ❖ Batch sorption studies indicate that using ~600 mg/L calcined HTC can effectively remove all silica from the cooling tower water.
- ❖ The pseudo-second order model was found to fit best to experimental data with the relative high R^2 value (0.99).
- ❖ Unlike ion-exchange resins, hydrotalcites are layered materials formed by inorganic oxides which make them quite stable over a wide range of pH and temperature.

Future Work

- ❖ Our results indicate that the ion-exchange is an effective way to remove silica from cooling tower water. Ongoing studies into technoeconomic modeling and scale-up analysis will help direct this research toward real word implementation of HTC.

References

1. Gupta, V. K.; Ali, I.; Saleh, T. A.; Nayak, A.; Agarwal, S. *RSC Advances*. 2012, 2, 6380-6388.
2. Sheikholeslami, R.; Al-Mutaz, I. S.; Koo, T.; Young, A. *Desalination*. 2001, 139, 83-95.
3. http://www2.claritywatertech.com/blog/topic/how-to-choose-a-water-treatment-company

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