SIIC108

Sonocatalytic Degradation of Caffeine using Cerium Oxide: Reaction Kinetic Studies

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Abstract:
Two kinetic models were proposed which are apparent first order model and Langmuir-Hinshelwood model to compare the reaction kinetic. To obtain the apparent rate constant for Langmuir Hinshelwood and apparent first order, fitting was done by applying linear square regression method. The regression line obtained for Langmuir Hinshelwood model for sonocatalytic degradation of caffeine using cerium oxide without oxidant is 0.7823 and with oxidant is 0.9867, while the apparent rate constant, k app for apparent first order model for sonocatalytic degradation of caffeine using cerium oxide without oxidant is 0.9263 and with oxidant is 0.9934. The coefficient of determination (R^2) values for each experiment conditions shows that the sonocatalytic degradation of caffeine followed more to apparent first order model since the regression value is closer to 1.

***Keywords*:**
Sonocatalytic, apparent first order, Langmuir-Hinshelwood, kinetic

Objective:

- To compare the reaction kinetic order for Langmuir Hinshelwood and apparent first order for sonocatalytic degradation of caffeine using cerium oxide.

Methodology:

In this study, the reaction kinetic order of Langmuir Hinshelwood and apparent first order for sonocatalytic degradation of caffeine were compared.

The experimental data will be used from a previous study done by Nur Fadzeelah et al[8]. The parametric conditions used for sonocatalytic degradation of caffeine using CeO_2 were catalyst dosage of 1.0 g/L, pH 7.5 and initial caffeine concentration of 5 ppm without oxidant and 20mM of H_2O_2 with the oxidant. The sonication process was based on 150 minutes irradiation time with a frequency and an output power of 37 kHz and 150 W respectively. At 30 minutes interval time,

the sample concentration was withdrawn and determined using Lambda 25 UV-VIS Spectrophotometer.

To obtain the apparent rate constant for Langmuir Hinshelwood and apparent first order, fitting was done in Microsoft Office Excel Worksheet by applying linear square regression method. Apparent rate constant for Langmuir Hinshelwood is obtained by plotting graph of 1/r versus 1/C. Meanwhile, for apparent first order rate constant was obtained by plotting graph of ln (C_o/C) against time (minutes

Results:

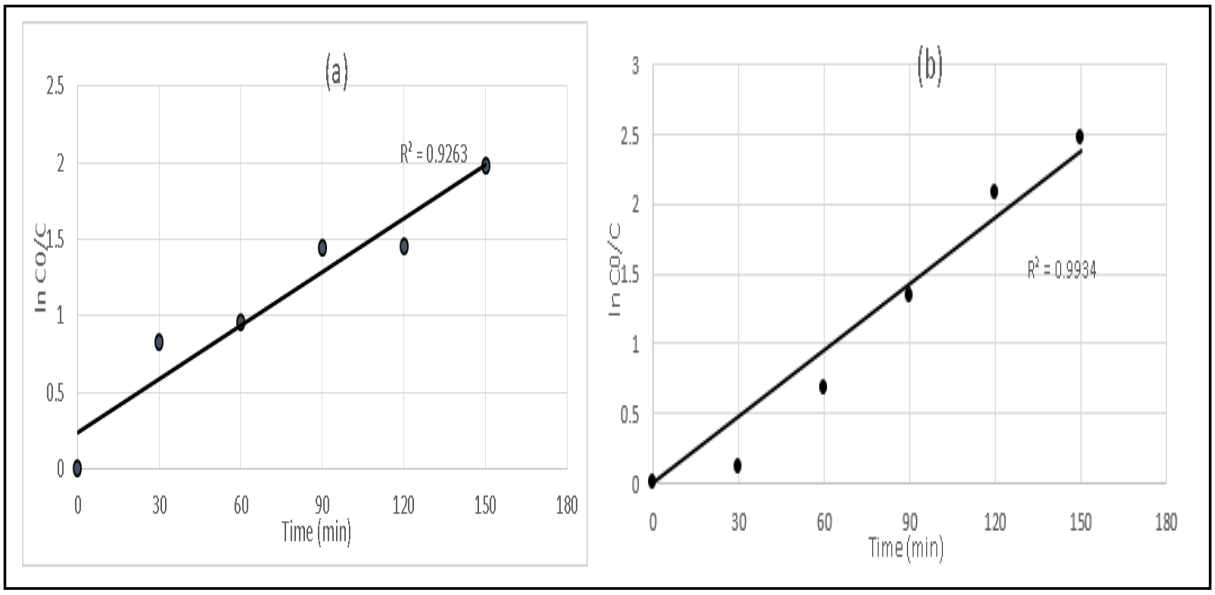

Figure 1: Apparent first order kinetic plot for sonocatalytic degradation of caffeine using CeO_2 (a) without oxidant and (b) with oxidant.

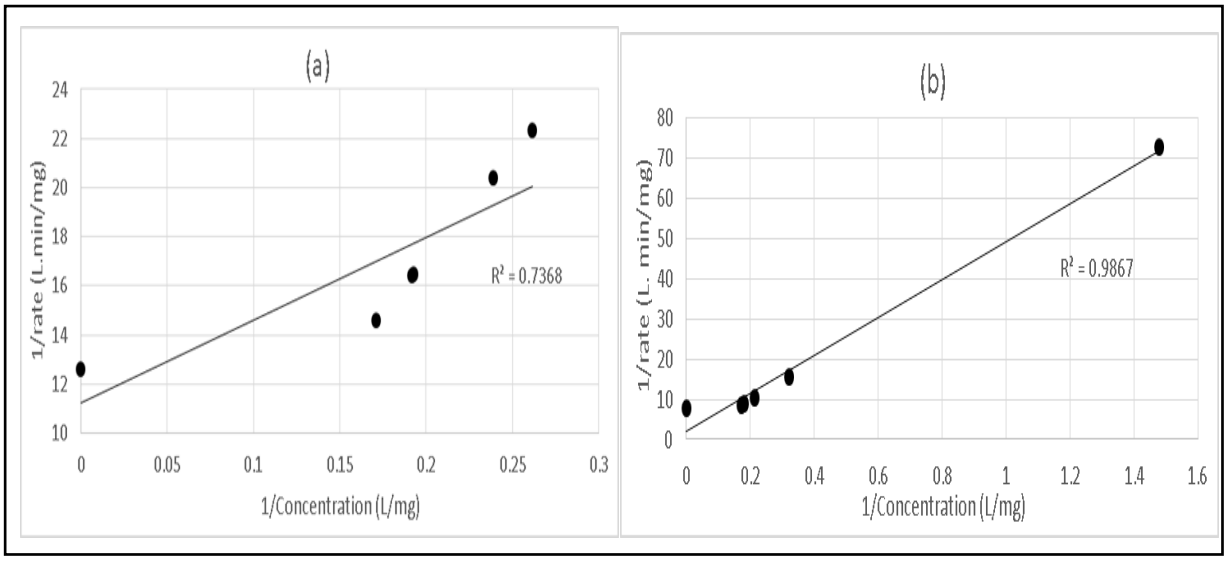

Figure 2: Reciprocal plot of 1/ r_0 against 1/ initial concentration of caffeine for sonocatalytic for degradation of caffeine using CeO_2 (a) without oxidant and (b) with oxidant.

Conclusion

This study has achieved the objective to compare the reaction kinetics for apparent first order and Langmuir Hinshelwood model. The apparent first order model well fitted to the experimental data of sonocatalytic degradation of caffeine by CeO_2 whereas, L-H model did not fit the experimental data at all. However, with the addition of enhancer, hydrogen peroxide as the oxidant, both model fitted properly to the data with the R^2 value more than 0.98. The regression for apparent first order which is 0.9934 showed the best fit to the model where it is much closer to 1 compared to Langmuir Hinshelwood model which is 0.9867. Hence, the sonocatalytic degradation of caffeine in the presence of CeO_2 was observed to behave more to apparent first order model than Langmuir Hinshelwood.