Polymerization kinetics of Ziegler-Natta PP catalysts

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Ziegler-Natta catalysts are commonly used for the production of polypropylene. One interesting aspect about these catalysts is the kinetic behavior during polymerization [1]. Influences like temperature and hydrogen amount can change the activity profile of the catalyst. In this study, four different catalysts (A, B, C and D) have been investigated with respect to the influences of temperature and hydrogen amount on the activity of the catalysts.

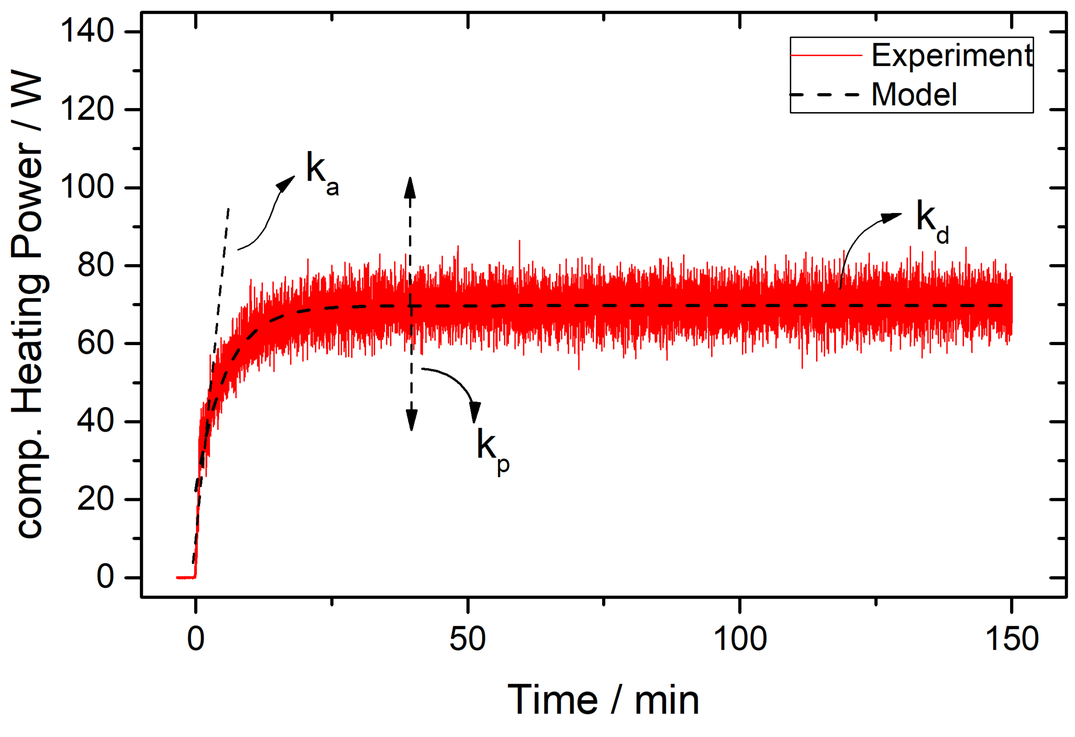

Figure 1: Activity profile showing the kinetic parameters of activation (k_a), propagation (k_p) and deactivation (k_d) [1].

Experimental

The experiments where conducted in a 0.5 L reactor system equipped with a compensating internal heating system in order to monitor the activity profile of a given catalyst. The internal heating coil keeps the reactor temperature constant and compensates for endo- and exothermal processes. The recorded power of the heating coil directly corresponds to the activity of the catalyst.

Figure 2: The internal heating coil compensates for heat loss or heat build-up.

The catalysts have been tested at different temperatures and hydrogen concentrations.

Results

The results show that both temperature and hydrogen amount have an effect on the activity. With increasing hydrogen amount, as shown in **Figure 3**, the polymerization activity increases. The effect is less distinct by increasing the polymerization temperature (**Figure 4**). For some catalysts, the activity dropped at 90 °C compared to lower temperatures.

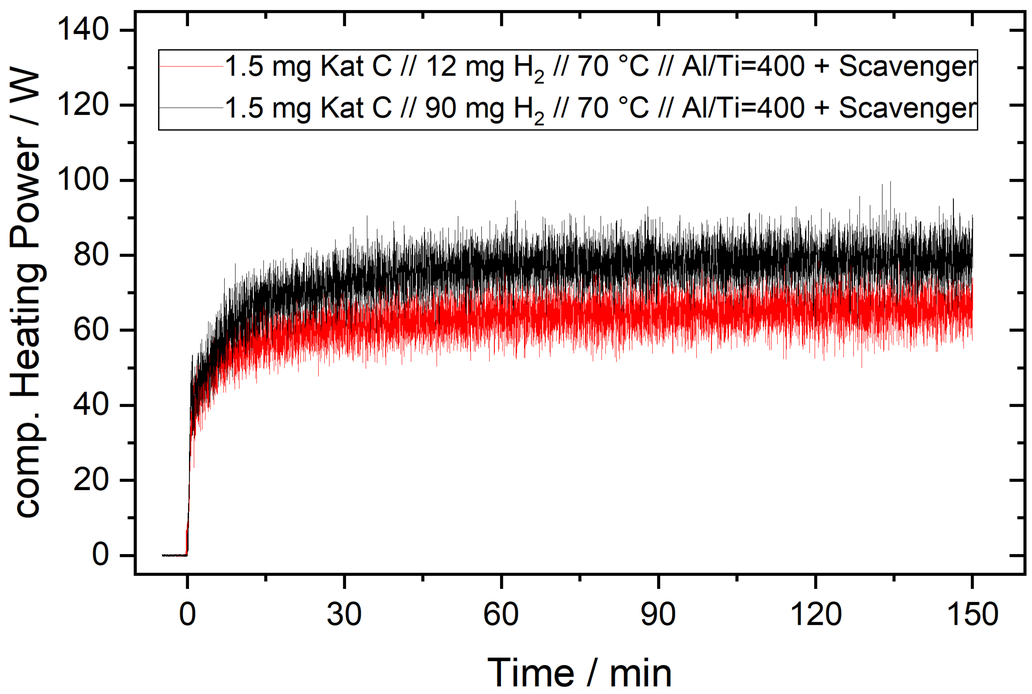

Figure 3: Polymerization activity derived from the compensating heating power of the internal heating system.

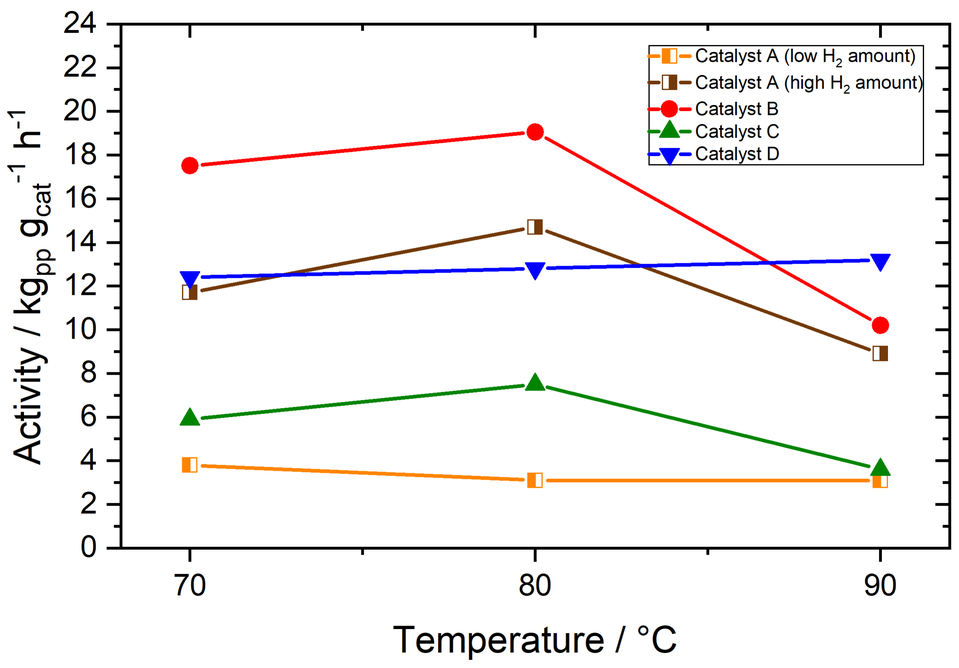

Figure 4: Graph showing different activities of each catalyst (A-D) in dependency of the polymerization temperature.

Conclusion

Four different catalysts were tested at different temperatures and hydrogen concentrations. The hydrogen concentration had the biggest effect on polymerization activity. The experiments show, that using a compensatory heating method can help to acquire activity curves and kinetic parameters for a better understanding of given catalyst systems.

Additional information
[1] V. Touloupidis, A. Albrecht, J.B.P. Soares, *A Methodology for Estimating Kinetic Parameters and Reactivity Ratios of Multi-site Type Catalysts Using Polymerization, Fractionation, and Spectroscopic Techniques,* Macromol. React. Eng. 2018.