Influence of Slurry Polymerization Conditions on the Polyethylene Molecular Weight Distribution

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Every polyolefin catalyst exhibits certain characteristics in terms of reaction profile and polymer properties. The response to hydrogen and monomer concentration can differ to a great extent. To get more information on a commercial single site-catalyst, experiments were carried out in a 5 L batch reactor.

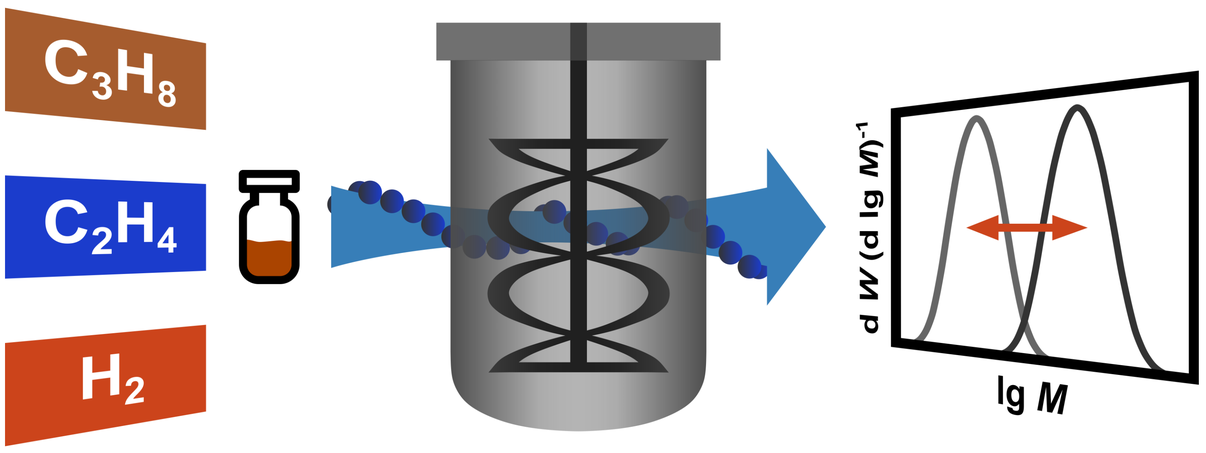

Figure 1: Depending on the reaction conditions the resulting polymers have different molecular weight distributions.

Experimental

All polymerizations were performed in slurry phase in liquid propane. The polymerization activity was evaluated with a mass flow controller that held the reaction pressure constant by continuously adding ethylene.

- 5 L Batch Reactor
- Mass Flow Controllers
  - precise dosing of
    - ethylene
    - hydrogen
- Jacket Heating
  - temperature control ± 0.05 °C
- Pneumatic Injection Unit
  - no *p*/*T*-fluctuations at reaction start

Varying the hydrogen concentration in the reaction mixture allowed to gain insight on the hydrogen response of the catalyst. Information on time dependent properties was obtained with time-split polymerizations, meaning the experiments were aborted after different reaction times.

Results

Investigations on the hydrogen response showed that some of the synthesized polymers possess a bimodal molecular weight distribution (MWD). Furthermore, the activity profile of the respective experiments exhibited a great increase of catalyst activity during the reaction time. The time-split experiments revealed that the bimodal distribution started to form during the time of the activity increase.

These results indicated a depletion of hydrogen. With a low hydrogen concentration, the catalyst activity increased and a higher molecular weight polyethylene formed, resulting in a bimodal MWD.

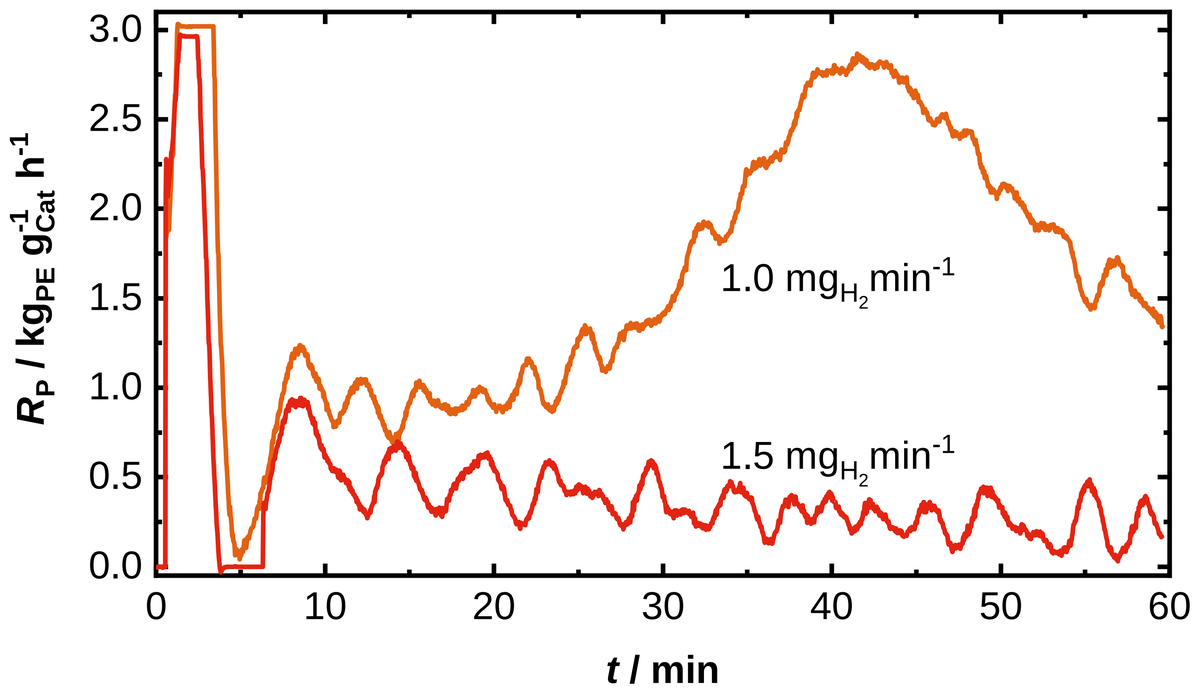

Figure 2: Catalyst activity during continuous hydrogen flow. Increasing activity at a flow rate of 1.0 mg min^{-1} is likely to be caused by H_2 depletion.

Polymerization runs using a continuous hydrogen flow allowed to verify the assumptions. With increasing flow, the activity decreased. Furthermore, the MWD changed from a bimodal to a monomodal distribution with a lower molecular weight.

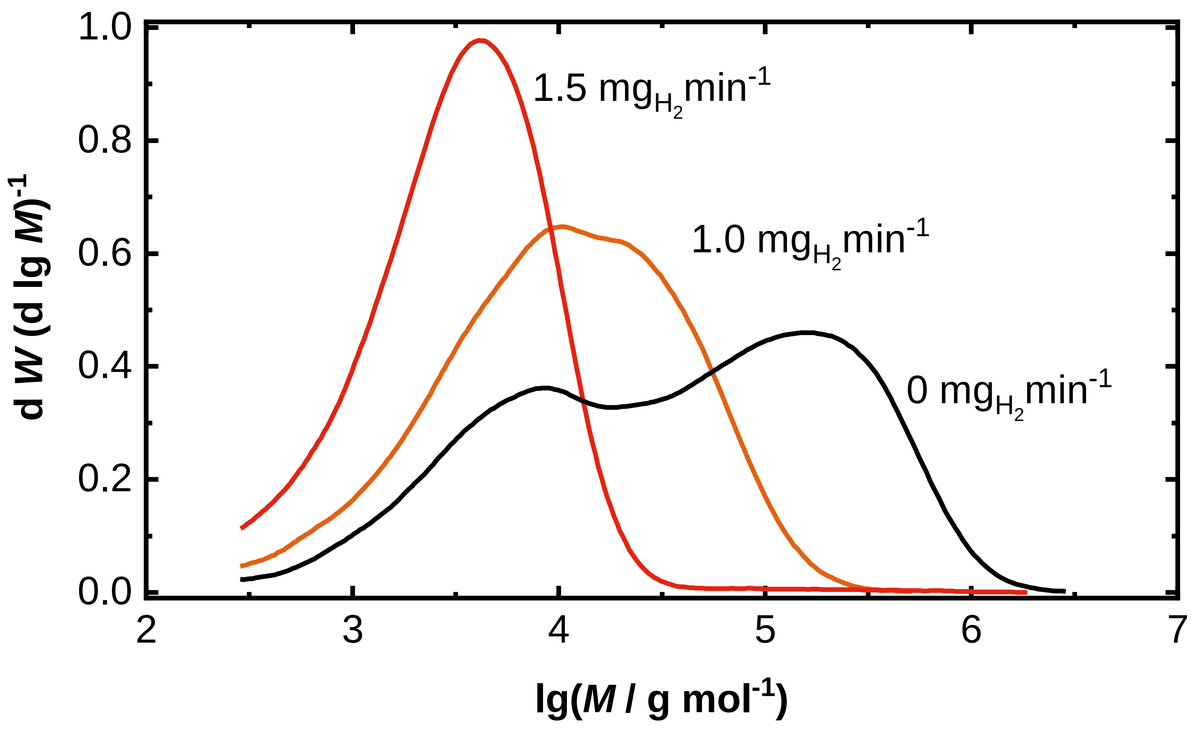

Figure 3: The molecular weight distributions of the polymers differed depending on the hydrogen flow during the experiment.

Conclusion

The presented work focused on the influence of hydrogen on the polymerization reaction and the polymer properties. The results, which are in good accordance with the literature, illustrate the importance of steady reaction conditions.

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