Understanding Polyolefin Processes: Fact 4

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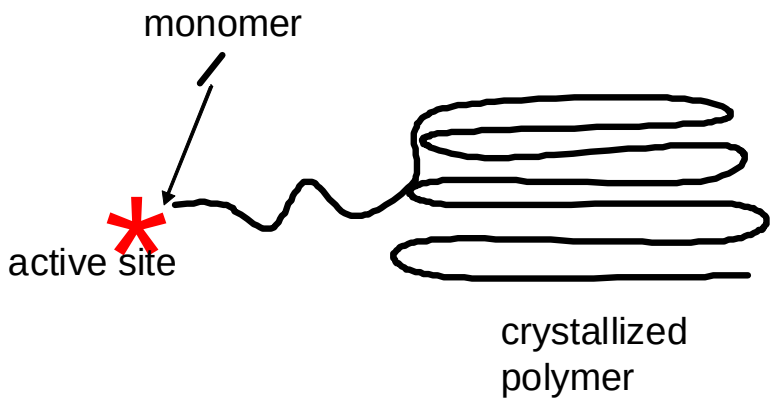
How long does it take to produce one single polyolefin molecule?

The figure shows a growing polyolefin chain: monomer diffuses to the active site and is – after coordination with the active site - incorporated between the metal atom (for Ziegler-Natta catalysts usually Ti) and the growing polymer chain.



If one would know the exact average insertion time of one single monomer molecule then the growth time of one chain is simply given by the product of insertion time t_{ins} and chain length l_{chain}::

$$t_{life} = t_{ins} \cdot l_{chain}$$

This is not as easy as it seems to be: the reactivity of the active site depends on many factors, especially at the beginning of the chain growth… and such a site can be dormant ("sleeping") for a while after chain termination, before starting a new chain, see "fact 7".

For the estimation of an average chain life time, we assume – for example - our catalyst shows an ethylene polymerization rate of 36kg PE/gCat h = 10g PE per gram catalyst and second, see also "Fact 2". One gram catalyst contains 0.1g (= 5.27 10^{-4} Mol) TiCl4, 10%[1] of which is supposed to be active – this gives 5.27 10^{-5} Mol active sites per gram catalyst. These sites consume 10g ethylene or 0.357 Mol ethylene per second. This corresponds to the polymerization of 6780 monomer units per second and active site. If the number average molecular weight of the polymer produced is 50.000 g/Mol then 3.8 polymers are produced by such a site per second – this results in a chain life time of

0.26s.

[1] 1% or 10% … this value differs a lot and depends on catalyst preparation, fragmentation, activation by co-catalyst etc. see facts 2 and 3, for example