Agglomeration of polyethylene particles in a fluidized bed reactor

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Polyethylene (PE) is one of the most common plastic materials of today. It is commercially important due to its massive production and variety of applications. PE is produced by catalytic polymerization in gas-phase or slurry reactors. The polymerization reaction is strongly exothermic and can therefore cause particle overheating, especially in the gas phase reactors, where the heat transfer is less effective. One of the most significant problems in PE production is the agglomeration of PE particles in the reactors or in downstream processing, as it can lead to the shut-down of the whole production line.

If two polymer particles collide in a reactor, they can agglomerate by the following mechanisms: (i) van der Waals forces, (ii) liquid bridges, (iii) electrostatic forces, and (iv) chain entanglement. This contribution concentrates on polyolefin softening, which is a change in the mechanical properties of a polymer at elevated temperatures [1]. Softening increases the contact area and contact time of polymer particles during a collision, which leads to a larger probability of agglomeration. We used a mathematic model based on the Discrete Element Method (DEM) to compare the significance of the aforementioned agglomeration mechanisms at various conditions and also to quantify the effect of softening on these mechanisms. Softening also promotes agglomeration in degassing vessels, as softened particles are deformed and compacted more easily.

To study polyolefin softening, we developed a new experimental method that enables to evaluate the temperature above which enhanced agglomeration tendencies can be anticipated. This temperature is called the softening point. Our method can be used to study polymer softening in air and in hydrocarbon atmospheres, enabling to carry out experiments at industrially relevant conditions [1]. Furthermore, we proposed a theory relating the softening phenomenon to the Young modulus. The experimental part of this contribution presents the results of softening measurements carried out with a broad range of PE samples in various atmospheres (air, nitrogen, ethylene, 1-hexene, propane and hexane). The results elucidate the effects of polymer properties and penetrant sorption on the softening. We observed a linear dependence of the softening point on PE crystallinity and an increase of the softening point with increasing molecular weight. Penetrant sorption decreased the softening point, with this effect being stronger for the more soluble hydrocarbons and at higher pressures [1]. To conclude, we would like to point out that that the observed dependencies are in good qualitative agreement with the theory we propose.

Reference: Chmelar J., Matuska P., Gregor T., Bobak M., Fantinel F., Kosek J.: Softening of polyethylene powders at reactor conditions, *Chem. Eng. J.* **2013**, *228*, 907-916.