Controlled rheology polypropylene

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MOTIVATIONS FOR PRODUCING CR-PP

The first studies on peroxide-induced degradation of polypropylene (PP) date back to the 1960s. Most of the systematic work in this area was carried out in the 1970s. In 1983, about 5% of the world-wide PP production was finalized in controlled rheology (CR) processes; nowadays, this number is about 20%.

One motivation to produce CR-PP via controlled degradation of a reactor product was the demand for special grades not easily accessible otherwise. Some finalization processes for PP, especially the production of glass-mat reinforced PP (GMT-PP) or of melt-blown fibers, require extremely high flowability, which cannot be achieved in a polymerization process at all or only under extremely uneconomical conditions. Apart from that, problems in the extrusion line as well as in the pelletising process occur with grades having a melt flow index, MFI (230°C/2, 16 kg), higher than 50 g/10 min. CR-PP also shows a number of specific advantages regarding processability and the final material profile in mechanics and optics, which will be discussed in detail below.

Moreover, adjusting the flowability (MFI) of a certain grade in the CR-process allows us to produce a reduced number of reactor grades, thus facilitating production and storage logistics as well as reducing the ‘transition’ quantities produced when changing the grade in the reactor.
This aspect is even more important for large production units and therefore is a factor of growing importance in recent years.

A certain competition may arise for CR-grades from the novel family of metallocene-(MC-)catalyst based PPs, which possess an inherently narrow molar weight distribution (MWD) similar to the characteristics of CR-PP. However, these grades are only just penetrating the market in some applications and it is difficult to judge their actual applicability. The remaining advantage is the rather easily adjustable final shape of the MWD through a variation of the relation between initial and final MFI, a factor which is often referred to as 'crack length'.

PRINCIPLES OF CONTROLLED DEGRADATION

Peroxide-induced degradation of PP is a radical reaction induced by the thermal decomposition of the peroxide, which acts as initiator. The reaction scheme is given in Figure 1. The actual result of a CR-process depends not only on the MWD of the base polymer, but also on its structure. While for PP-homopolymers and most random-copolymer with ethylene as well as for related terpolymers the reaction scheme is straightforward, competing reactions occur in case of high-impact-PP-copolymers with ethylene (termed heterophasic or – falsely – block copolymers). In contrast to the effect on PP, peroxides/radicals promote branching, chain transfer and crosslinking in other polyolefins. Especially relevant in connection with CR-PPs is the effect on polyethylene (PE) and ethylene-propylene-'rubber' (EPR), which leads to problems in degrading (heterophasic) EP-copolymers with high contents of ethylene, where branching and crosslinking becomes dominant in the elastomeric and PE-phase.

![Figure 1](image)

**Figure 1** Reaction scheme of peroxide-initiated degradation of PP, with initialization through thermal decomposition of peroxide, and termination by recombination of two radical species.