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THE USE OF RADIATION FOR THE PRODUCTION OF HIGH MELT STRENGTH POLYPROPYLENE

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Controlled rheology PP or visbreaking PP was already introduced in the market and produced in some case by irradiation. For example, Williams [1], discloses a process for reducing the molecular weight of a propylene polymer by activating a first portion of the polymer by exposure to ionizing radiation, adding the irradiated polymer to a second portion of unirradiated polymer, adding a stabilizing amount of an antioxidant to the mixture, and visbreaking by shear mixing in an extruder.

PP have been extensively studied , as already shown, during many years, and even industrially used to produce PP grades of controlled rheology, nevertheless it was never reported the use of irradiation of PP under N2 to promote long chain branching in order to improve the elongational viscosity before the clever patents of Scheve [2] and DeNicola [3] to Himont now Montell.

PP suffers from low melt strength, i.e., the melted PP does not exhibits an increase in resistance to stretching during elongation. It is well known that the melt-strength properties of a polymer increase with molecular weight and with long chain branching due to the increase in the entanglement level (high melt strength PP – HMSPP). In spite of been the most fast growing polymeric commodity nowadays those new grades of PP and its development have been barely studied and its general chemical characterization have been even less studied with few exceptions [4,5,6].

HMSPP as proposed by Montell patents are produced by low temperature and low dose irradiation of high molecular weight isotática PP in N_2 atmosphere. So the well-known reactions would be mostly degradation and crosslinking. Degradation however is supposed to be the first and more intense reaction at the initial steps as already shown. So, according to Montell patents, another reaction is likely to occur, branching or T links competing with crosslinkings or H links. Radical are likely to decay very fast in amorphous phase, but under annealing the radicals entrapped in the crystal phase is likely to move to the boundary and react. The group of professor Silverman [7] has already hypothesized in T links formation and also studied the radical decay of PP. It is easy to understand the difficulties in differentiate Hs from Ts links and even these links if in very small amount from the bulk or from virgin polymer, as the chemical groups and links are chemically speaking essentially the same.

This work proposes a new method for the synthesis of HMSPP based on the combination of degradation , branching and crosslinking of PP under reactive atmosphere of acetylene and irradiation.

This new process was based on the simultaneous irradiation of high molar mass PP and acetylene, followed by the same recombination step as proposed in previous patents. Table 1. shows standards resins of OPP company and one sample prepared according to the new process.

Table 1. Rheological characteristics of the irradiated samples

Sample N°	sample	FlowIndex [g/10 min]	Melt Strength [cN]	Extensibility [cm/s]
1	Virgin H603 PP	1,50	16,34	7,94
2	Virgin H503 PP	3.50	9,3	11,2
2	C_2H_2 irradiated 20 kGy	3.33	96.2	10.90

Table 1 shows the relation of IF with MS from commercial OPP resins. It is possible to get acquainted with the direct relation o IF and MS, as both are related to molar mass and branching structure. Also table 1 shows the rheological features of one PP subjected to IPEN-OPP proprietary process.. It is possible to observe the tremendous enhancement in the processing characteristics of PP. Even increasing the flow index after irradiation, the resin showed much higher values of MS and also higher values of extensibility, showing improved performance. IT is importante to obseve that If we compare the results of MS with standard resins of the same level of IF, the HMS resin had numbers of MS 10 times higher than the standard ones. So our proprietary process proved itself as capable of producing a HMS resin with excellent processing ccharacteristics.

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