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MAGNETO-RHEOLOGICAL CHARACTERIZATION OF POLYMER-BONDED MAGNETS

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In recent years, polymer-bonded magnets have been widely used for several engineering applications because of their ease of processing, low weight, and low cost compared to sintered permanent metallic magnets. The polymer-bonded magnets are prepared by blending a magnetic powder with a polymeric binder in a mixer or extruder. The resulting composite material can be shaped by the powder injection moulding process into magnets with complex shapes. Generally, the used fillers can have a magnetic isotropic or anisotropic structure. The latter presents a high degree of orientation, which is often desired because it results in high magnetic properties. In order to obtain this structure, the fillers need to be oriented by a magnetic field during the filling of the cavity and before the melt freezes. However, the application of the magnetic field tends to influence the rheological behaviour of the material. Therefore, in order to accurately simulate the injection moulding of polymer-bonded magnets it is important to characterize the magneto-rheological behaviour of the material. To this aim, a new magneto-rheology apparatus was especially developed. The instrument is made of a special capillary, mounted on the die of a laboratory extruder. The melt flowing throw the capillary is subjected to perpendicular magnetic fields. The magnetic fields are generated by an enamelled copper wire solenoid fed by a direct current. The desired geometry of the magnetic flux was obtained by using a mild steel circuit. The distribution of the magnetic flux density in the capillary was simulated and a geometrical optimization of the mild steel circuit was performed. An extensive experimental campaign was carried out to determine the interactions between the presence of the magnetic field and the main process variables, namely temperature, pressure and shear rate.