Effect of Palm Stearin on Rheological Properties of Metal Injection Molding (MIM) Feedstock

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Abstract

In this paper, rheological characteristics of Metal Injection Moulding (MIM) feedstock using locally binder of palm stearin are presented. The feedstock consisted of 316L-grade stainless steel powder with three different particle sizes and the binders comprise palm stearin and polyethylene. The viscosity of MIM feedstock at different temperatures and shear rates was measured and evaluated. Results showed that, the feedstock containing palm stearin exhibited suitable rheological properties and suitable to produce a homogeneous feedstock that is favorable for injection molding process.

Keywords: viscosity, shear rate, pseudoplastic, bimodal

1. Introduction

In MIM process, there are at least four important steps involved; mixing, injection molding, debinding and sintering. The raw materials consist of metal powder and mixed with multi-component binder system. The binder acts as a temporary vehicle for homogeneously packing a powder into the desired shape and holding the particles in that shape until the beginning of sintering. Binder selection in MIM process is very important since it promotes the fluidity and rigidity of the feedstock especially during mixing, injection molding and debinding [1]. There are many binder systems in used and being investigated [2-9], but different system implies different method of mixing in order to produce homogenous feedstock and different technique of debinding depending on the characteristics of each component involved in the binder system.

Many binder systems have been developed in MIM with the main aims of shorten the overall debinding time and at the same time remain shape integrity during the subsequence processing [4-9]. Another attributes for the binder are it should be of low cost and readily available to minimize the overall cost of manufacturing. It was reported that palm stearin had a good attribute as a binder system in MIM [2]. In previous study conducted by Iriany [2], it showed that palm stearin can be used as a binder component and homogeneous feedstock was successfully prepared with polyethylene (PE) and homogeneously mixed with stainless steel powder.

2. Experimental & Results

Three different particle sizes distribution of 316L-grade stainless steel powder were used in this study and their characteristics are summarized is Table 1. The binder system consisted of a locally available binder known as palm stearin and polyethylene with the weight ratio of 40/60. The volume of the powder was kept 60vol%. Mixing process was carried out using a sigma blade mixer with the setting temperature of 160^{o}C and holding time of 2 hours. Crushing process was carried out in the mixer by switching off the mixer heater while keeping the sigma blade rotate until palletized form was formed. Rheological characteristics of the palletized feedstock were then analyzed using a capillary rheometer model Shimadzu CFT-500D. A die with the diameter and length of 1mm and 10mm respectively were used. The palletized feedstocks were placed in the rheometer barrel and allowed to preheat for 120s under 3, 4, 5 and 6 MPa test-load before initiating testing. Figure 1 shows the viscosity of the feedstock as a function of shear rate at three different particle sizes and temperatures. It clearly shows that, with the increasing of shear rate, the viscosity decreases which exhibit the pseudolastic flow.

Table 1. Median Particle Size (D_{50}) of SS316L

Sample	A (fine)	B (coarse)	C (bimodal)
D_{50}	11.10	29.42	19.73

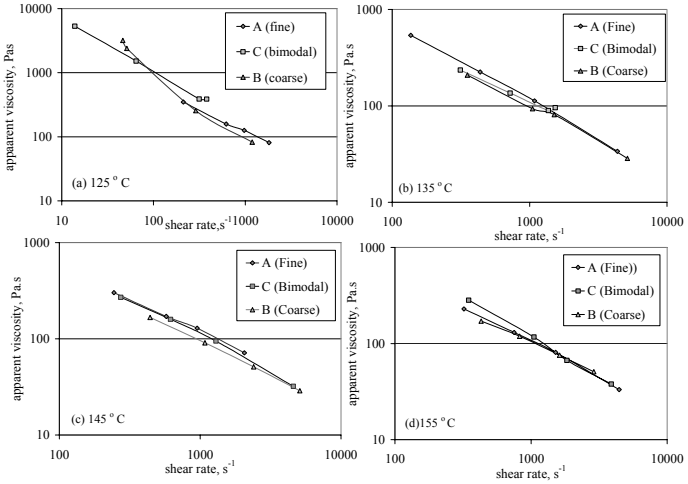

Fig. 1. Viscosity of the feedstock as a function of shear rate at different temperature and particle size

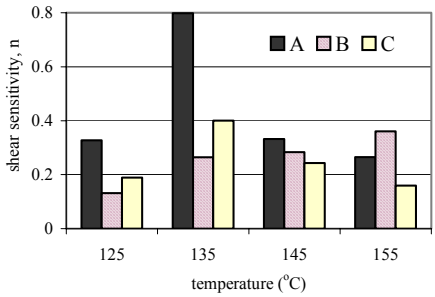

Fig. 2. Shear sensitivity of the feedstock as a function of temperature and particle size

3. Summary

Viscosity plays an important role in determining the quality of the feedstock and the injected components. From the rheological results obtained, the following points can be concluded:

1. The composite binder comprising palm stearin and polyethylene works successfully for 316L stainless steel.
2. From the standpoint of shear sensitivity, the bimodal system exhibit low index especially at the temperature of 145°C and 155°C respectively.
3. It showed that all feedstock pose a pseudoplastic behaviour with the viscosities of MIM feedstock decrease with temperature and increase with shear rate. This properties is favorable during injection in MIM application.

4. References

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