TECHNICAL ARTICLE 1

Effect of Injection End Position on Defects Formation in HDPE Injection Moulding

Jun Yi Goo[1], Jiawei Ng[1], Tian Hung Chang[1], Her Jie Tang[1], Wai Han Yeow[1] and Ming Yeng Chan[2]

[1]Department of Manufacturing Technology, Faculty of Engineering and Technology, Tunku Abdul Rahman University of Management and Technology, Jalan Genting Kelang, Setapak, 53300 Kuala Lumpur, Malaysia.
[2]Centre for Advanced Materials, Faculty of Engineering and Technology, Tunku Abdul Rahman University of Management and Technology, Jalan Genting Kelang, Setapak, 53300 Kuala Lumpur, Malaysia.

Introduction

Injection moulding is one of the processing methods used to produce polymeric parts or components. The injection moulding cycle includes feeding, filling, packing/holding, cooling, and ejection stages. Among the various stages, the cooling process takes the longest time in a cycle. Furthermore, the injection moulding process can produce complex shaped end products with good dimensional accuracy and surface finish (Farooque, et al. 2021; Fei, et al. 2013). This is one of its advantages compared to the extrusion process for polymeric materials.

In injection moulding process, parameters such as melt temperature, mould temperature, cooling time, injection end position, plasticising unit, injection pressure, and injection speed strongly affect the quality of final products. Several common defects (e.g., short shots, sink mark, flash, warpage, burn mark, shrinkage, jetting and internal voids) may appear on the moulded parts if inappropriate processing parameters are used (Mourya, et al. 2023). In this study, the effect of injection end position on the quality of injection-moulded part was investigated experimentally.

During injection moulding, the screw moves forward to push the molten polymer into the mould cavity. Once filling is completed, the screw stops at a certain position. The injection end position refers to this final screw location and is measured in millimetres (mm) (LS Mtron Injection Molding Machine, 2021; Dayamac Daya Machinery, 2018). Moreover, the injection end position is closely related to the cushion distance, which ensures sufficient material remains in front of the screw to maintain effective packing pressure transmission (Ratzlaff and Giovannetti, 2017). If the injection end position is set too high or too small, different types of defects may appear on the moulded parts. Therefore, in this experiment, different values of the injection end position were tested to determine the optimum setting that produces defect-free parts.

Material

Injection-grade high density polyethylene (HDPE) pellets were purchased from Lotte Chemical, Korea and used in this experiment. The manufacturer-recommended processing parameters are listed in Table 1.

Table 1: Manufacturer-recommended processing parameters of the HDPE pellets.

Melting Temperature Processing	200 – 240 °C
Melt Flow Rate	8.0 g/10 min (at 230 °C/2.16 kg)
Mould Temperature	20 – 60 °C

Experimental parameters

The injection moulding was carried out using HWAMDA 60M8-S, with processing parameters listed in Table 2. All parameters were kept constant except the injection end position.

Table 2: Processing parameters of injection moulding.

Mould Temperature (°C)	40
Barrel Temperature (°C)	180 – 195
Holding Pressure (MPa)	50
Injection Pressure (MPa)	75
Injection Speed (mm/s)	60
Cooling Time (s)	15
Holding Time (s)	1.5
Screw Speed (rpm)	80
Injection End Position (mm)	10, 15, 20, 25

Results and Discussion

Figures 1 and 2 show the defects from injection moulded parts produced at injection end positions of 10 and 15 mm, respectively. It can be observed that short shot defect occurred at lower injection end position values. The short shot defect occurred due to the incomplete filling of molten HDPE during the process. When the injection end position is set to lower values, the screw stops earlier, causing less molten HDPE to be injected into the mould cavity.

Additionally, sink marks and jetting defects were present in both injection moulded samples. The sink mark defect normally occurs as a result of uneven shrinkage in the moulded part (Strong, 2005). The presence of sink marks in the short shot area may be due to insufficient packing material available to compensate for shrinkage during solidification. Whereas jetting (often appearing as a worm-like pattern) may result from the screw stopping too early, which leads to irregular flow patterns.

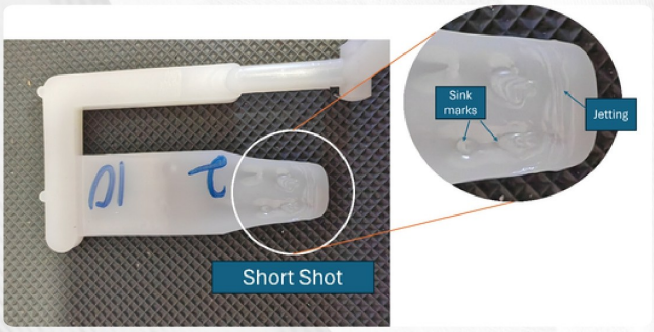

Figure 1: Injection moulded part produced at injection end positions of 10 mm.

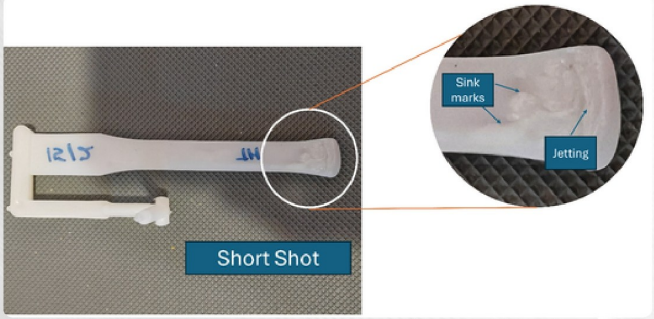

Figure 2: Injection moulded part produced at injection end positions of 15 mm.

The injection moulded parts with an injection end position of 20 mm, as shown in Figure 3, showed no visible defects. This indicates that the 20 mm setting was the optimum injection end position for this HDPE injection moulding process on the HWAMDA 60M8-S.

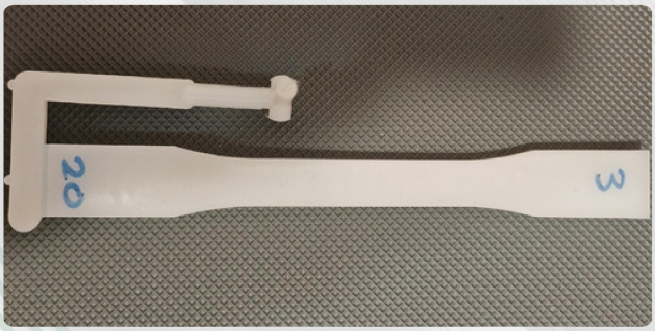

Figure 3: Injection moulded part produced at injection end positions of 20 mm.

In contrast, when the injection end position was increased to 25 mm, flash defects were observed, as shown in Figure 4. This occurred because excessive molten material was injected into the mould cavity, generating higher packing pressure that forced the material to escape through the mould parting line (Strong, 2005). Moreover, a higher injection end position means that the screw travels further forward during the injection stage, resulting in a greater amount of molten HDPE being injected into the mould cavity.

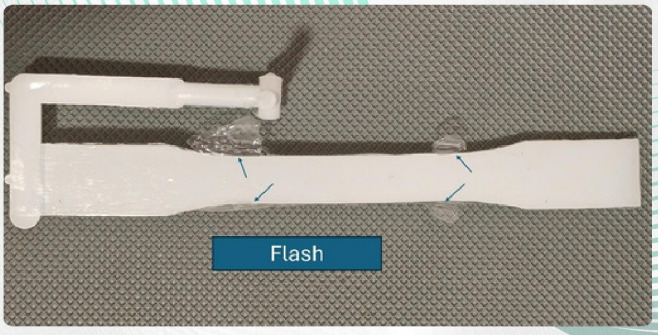

Figure 4: Injection moulded part produced at injection end positions of 25 mm.

Conclusion

In summary, the optimum injection end position was determined to be 20 mm for the HDPE injection moulding process on HWAMDA 60M8-S. Based on the experimental results, when the injection end position was set lower than the optimum value, defects such as short shot, jetting, and sink marks were observed. Conversely, when the injection end position was set higher than the optimum value, flash defect appeared on the end products. Therefore, the injection end position significantly influences the appearance quality of the injection moulded parts. An appropriate injection end position is essential for achieving defect-free products and maintaining stable injection moulding operations.

Figure 5 shows the Diploma in Manufacturing Technology students who carried out this experiment (from left to right: Her Jie, Wai Han, Jun Yi, Tian Hung and Jiawei).

Figure 5: Group photo.

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- Students Dive into Microbiologically Influenced Corrosion at Universiti Tun Hussein Onn Malaysia

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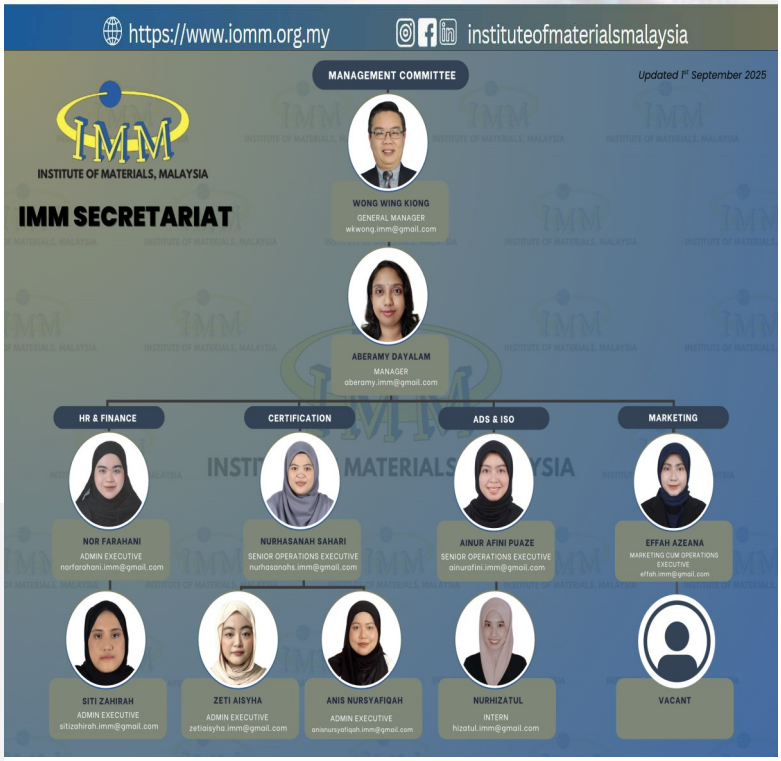

INSTITUTE OF MATERIALS, MALAYSIA

Suite 1006, Level 10, Block A, Kelana Centre Point,
No. 3 Jalan SS 7/19, 47301 Petaling Jaya, Selangor.
Tel: 03-76611591
03-76611592

secretariat@iomm.org.my

www.iomm.org.my

+60 18-911 3480

Institute of Materials, Malaysia