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Inner centering in parting line area of injection mould using side locks

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Abstract
Injection moulding is characterized by high precision requirements. In particular, the demands regarding the mould plates alignment are in order of few micro meters. This research introduces a methodology to measure the misalignment in injection moulding. Eddy current sensors are used in the system to perform measurements for a whole cycle. In a long run of the mould, a comparison of mould deviation between the first and the last cycles is obtained.

Keywords: Injection moulding, centering, misalignment, displacement sensors, guiding system

1. Introduction

The injection molding process is a high volume manufacturing operation widely used for mass production of discrete precision plastic parts of complex shape cost effectively. Depending on the complexity, the process is capable of manufacturing parts with very tight dimensional and surface tolerances. Owing to growing plastics applications, increasing customer demand, and rapid growth of the global marketplace, the quality requirements of injection-molded components have become more stringent for various market sectors such as the automotive, computer, consumer appliances, medical, micro-electro-mechanical systems (MEMS), optical, and telecommunication industries. Traditionally, the quality of the injection-molded product is inherently difficult to predict and/or control without intervention by the machine operator during the production stage.

When the machine is properly set up, periodic inspection of part's quality is still necessary as a measure of quality assurance. There is a good possibility that the part quality may wander outside the quality limits due to a number of unpredictable reasons, which include variation in material properties (particularly when reground resins are used), change in the ambient environment (e.g., humidity or temperature in the workshop), machine characteristics and mold (misalignment). If that happens, the process conditions and mould have to be readjusted in order to bring the part quality back within the tolerance limits.

The challenges are to detect errors, which can cause significant changes in part dimensions and surface finish. The challenge has been addressed primarily in industrial practice via statistical quality control (SQC) [1]. That is, employees routinely sample parts and reports back to the operator regarding recent machine performance. Quality control via set point adjustments is then left to operator experience.

This study focuses on the errors due to tool misalignment. Tool wear, tooling elastic deflection, low performance guiding system on machine and tools are the sources for generating tool misalignment. The aim of this research is to obtain an insight into the effect of this error on part quality. The misalignment error often appears after a long run of production. To observe possible error effects in laboratory, the movement of tool inserts are monitored using three displacement sensors mounted on the mold. The testing procedure consists of running the mould without plastic injection. The misalignment are compared together for possible errors. The results of this study have the potential to develop one-axis analytical error model of the tools and machine in injection molding with the aim for online-measurement of mold misalignment.

2. Materials and method

The experimental setup consists of a three-plate mould and three displacement sensors. The mould dimension is 346 (mm) x 346 (mm) x 313 (mm) and has 230 kg weight. While not showing the testing mould, the mould schematic can be viewed in Figure 1. For this research, centering system includes two round guide pillars and three side locks (square guide bars).

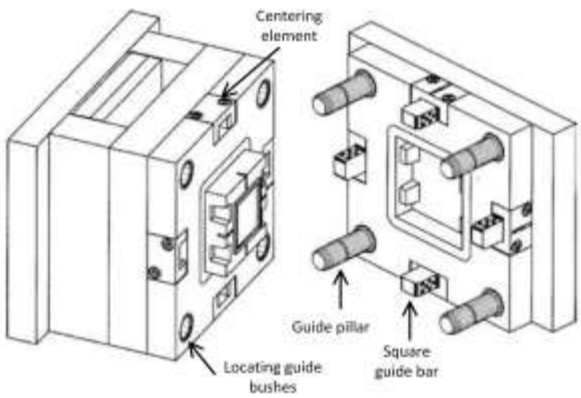

Figure 1. Inner guiding system in the parting line [2]

For displacement measurements, three eddy current sensors are mounted on the plates A and B where inserts with cores and cavities are located. The sensors monitor real displacement between the plates. The entire setup schematic can be observed in Figure 2. When detecting x displacement at one end of plate, two sensors (y1 and y2) measure y variations at the both ends of plate. Therefore, the movements of plates with respect to each other are measure for x, y and rotation θ_z.

The sensors have measuring range of 0 to 2 mm and resolution of 200 nm.

Figure 2. Sensor layout mounted on mould plates

To verify the variations over time, the mould is run for 100 cycles. The measurements are performed every fifth cycle. The whole tests are performed with no plastic injection, since the purpose of testing is to establish the efficiency of guiding system for mould alignment. The sensors are synchronized for measurements.

3. Results

The curves of the displacement versus time for the first (#1) and the last (#20) cycles associated with x direction is shown in Figure 3. The time shown in the plot for horizontal axis is not a real time and it is used to match the curves in one graph. When interpreting this image, the curves represent the movement for the entire cycle. It must be noted that the region A where the mould closes is of interest. The details of this region for sensors x, y1 and y2 can be seen in Figure 4, Figure 5 and Figure 6 respectively.

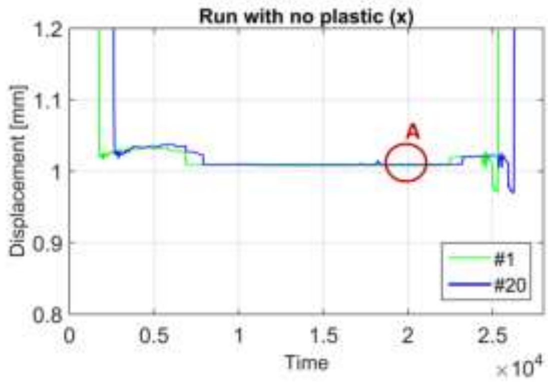

Figure 3. Entire measurement for cycles #1 and #20

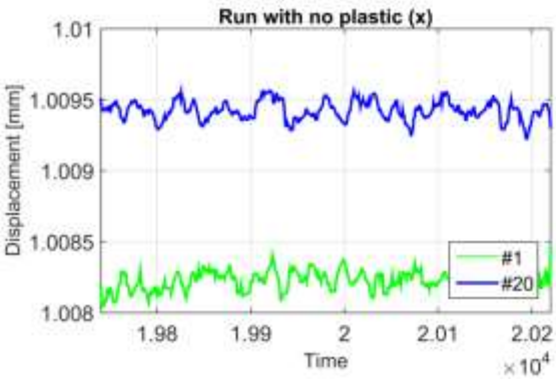

Figure 4. Displacement of mould plates in x direction

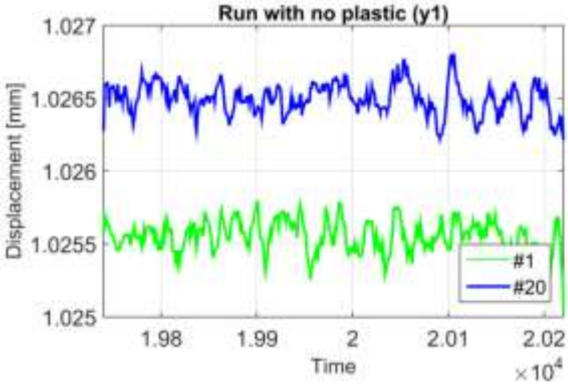

Figure 5. Displacement of mould plates in y1 direction

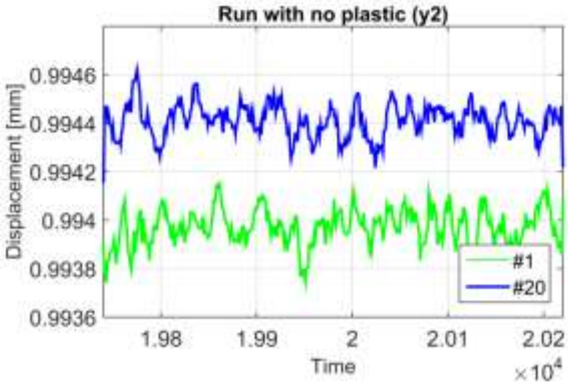

Figure 6. Displacement of mould plates in y2 direction

When comparing the average positions for cycles #1 and #20 from sensor x, an increase of 1.2 µm is observed (Figure 4). This deviation is 1 µm for sensor y1 (Figure 5) and 0.5 µm for sensor y2 (Figure 6). In comparison of deviations at sensor y1 and y2, it becomes apparent that almost no rotation exists around z axis.

4. Conclusion

This research focuses on the efficiency of a guiding system to align mould plates in injection moulding. In particular, the displacement of mould plates at the time of plastic injection is important. The centering system includes three side locks and two round guide pillars. The measurements for 100 cycles show maximum 1.2 µm displacement for mould plate in x direction. While this allows for performance analysis of the aligning system (mould and machine), further test is highly recommended for the same measurements with plastic injection.

References

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