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Cycle Time Optimization in Injection Moulding

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Abstract **-Injection moldings is plastics equivalent of metal die casting. This is the most widely used method of mass producing to close tolerance three dimensional articles over a wide range of sizes and variety of shapes. The parameters are evaluated against the problem of optimizing the cycle time for each part. The Experimental data were collected on IIM Milacron following the designed experiment procedures, and a statistical analysis was performed to give a basis for process improvement recommendations. The results of the experiment showed a way to achieve the goal of optimizing the cycle time in injection molding in a sensible and cost efficient way. In this paper we studied that how to minimize cycle time, how many possible ways are there to optimize the cycle time, what factors influences the cycle time.Any manufacturing activity would like to have optimized productivity and quality. In injection moldings of plastics, if quality is taken care of by part design, mold design and mold precision, then is also ensured on account of zero defect moldings without rejection and optimized cycle time.**

Keywords- **Cycle time & productivity, back pressure, cooling time, filling phase, injection rate.**

I.INTRODUCTION

Plastics are the material of today. It is hard to imagine a today's product that does not use plastics. In countless cases, the products that we take for granted cannot exist without plastics. From tooth brush to telephone, from computers to cars, from appliances to aero planes. Plastics are the wonder material of modern age. Making our lives comfortable, enjoyable and safeInjection moulding is an industrial technology first used in the 1920's.

The companies that use injection molding machines will have a need for optimizing the machine to decrease cycle time and increase as productivity as well profits. This research paper has the some desired objectives and analytical data. Injectionmoulding process involves plastic material, mould and injection molding machine.In additional to these, the MAN behind the operation is very important, as he should have good understanding of this subject.In the process the plastic granules are converted into melt (in the plasticizing unit of the machine) and then this is injected into a clamped Mould by the machine. Mold consists of twohalves; namely core half and cavity half.

The space between the core half and cavity half of the mould is filled with hot plastic melt.The melt then takes the shape provided by the mould on freezing the melt. The freezing of plastic melt in the mold is due to the cold water circulating in the core and cavity of the mould. The core of the moulds provided with water channel for this purpose. This is a very simple description of the process.

II.NEED FOR THE STUDY

- To optimize the cycle time
- To understand the procedure of optimization for cycle time
- To enhance the quality of the product by considering cycle time
- To Study about the factors that are responsible for cycle time.

III. INJECTION MOULDING CYCLE

A series of process at the time of injection molding of a plastic parts is called injection molding cycle.The cycle begins when the mold closes, followed by the injection of the polymer into the mold cavity. Once the cavity is filled, a holding pressure is maintained to compensate for material shrinkage. In the next step, the screw turns, feeding the next shot to the front screw. This causes the screw to retract as the next shot is prepared. Once the part is sufficiently cool, the mold opens and the part is ejected.

IV.CYCLE TIME

Cycle time is the time which is taken to complete all the stage of the injectionmolding. In injection molding of plastics, if quality is taken care of by part design, mold design and mold precision, then productivity is also ensured on account of zero defect moldingwithout rejection and optimized cycle time. Cycle-time optimization starts at design stage.
Cooling time takes up over 50% of cycle time.
Important. There are generally five stage to be complete the injection molding cycle:

- Mould open/ part ejection.
- Injection-fill (speed) phase, (few second).

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- Injection pressure phase, (few sec.).
- Cooling time, (40 to 60% of cycle time).
- Mould open/ part ejection.

1. Experiment

Before begins with optimizing, the injection molding machine (IMM) must necessarily be in the balance.

The parameters are to choose, that the process is stable and does not lead to minor external disturbance to committee, for example variation in the production hall.

Machine Spec- IIM Milacron 80to

- Power pack- 20 HP.
- 80to injection screw stroke.
- Inj.Cap.Max. (GPPS)- 64 gm.
- No. of pyrometer (Barrel &nozzle) -3+1.

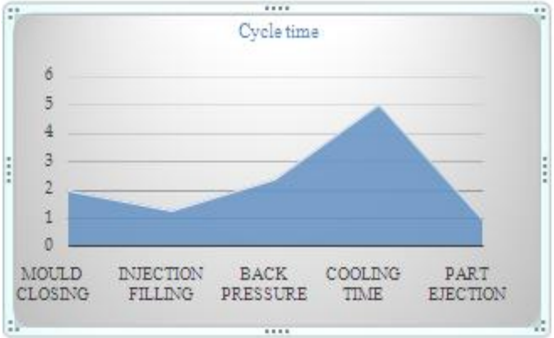

Fig.1 product cycle time.

- Total heat capacity-6.4 kW rpm.
- Screw diameter -28mm.
- Injection rate- 107 cc/sec.
- Screw speed – 400.

2. Product- Card Holder (Base and Cover), produced on IIM MILACRON 80to

- Specifications
- Raw material- Poly propylene
- Density of PP-0.91 grams per cubic centimetre (g/cm3).

Fig.2 Raw material-Poly propylene.

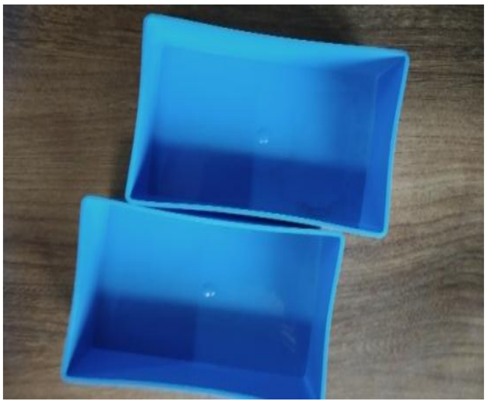

Fig.3 Card holder (wall thickness-0.3mm).

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3. Procedure

3.1 Temperature check

- Past- Barrel and melted material
- Target temp. are reached
- The malt temp. is in order
- The friction in nozzle, dispenser and sprue is in order Tools.
- Set temperature is reached (also hot runner)
- Mould cavity surface temperature and temp distribution in order.

3.2 Inject

- Select injection program with at least 3 stages(more better)
- Begin with slow moderate speeds for the respective material(prevent from jetting)
- In middle area moderate to fast inject speed (adapted to the part geometry and material)
- For wall thickness transition and geometry and geometry changes is the injection speed adjusted (a constant flow front speed is desirable)
- Shortly before volumetric filling point moderate to slow injection speed, last speed very slow (avoid overfeeding and peak pressure)

3.3 Switch over to holding pressure

3.3.1 Aim at soft- switching to volumetric filling, displacement or pressure dependent, depending on the application (travel dependent in packaging, pressure dependent at about 80% for technical application)

3.3.2 Pressure holding level- In thick walled parts with large cross-sectional and with low viscosity plastics some amount of injection pressure is adopted Pressure holding periods Choose so long that the sealing time is certainly exceeded.

3.3.3 Holding pressure profile- select slightly sloping profile, to machine and material compatibility as possible.

- A falling over time pressure profile can especially bring advantages in semi crystalline polymers.

4. Cooling time-

- Incorporate calculation. However as long as necessary, but as short as possible, so that the total cycle time be short as possible.
- DE moulding deformation must be avoided.

5. Closing time

- High enough that flash are avoided but not too much high so that the mould is not unnecessarily loaded.(wear and tear)
- About 10% higher than the minimum required closing force (determined by the stable injection process)

6. Dosing

- Use rest cooling time for dosing
- Note the screw RPM speed depending on the material
- Note exceed critical dwell time
- Check intake behaviour (plasticizing time constant)
- Set back pressure to the material and the metering accordingly

7. Cycle time

- Idle times are to be kept as short as possible so that a minimum cycle time results
- For example open forms closer close form closer, press down nozzle/relieve, dosing delay, injection start behaviour.

8. Data back up

- Afar completion of the optimization phase if necessary fill the notebook with important data (for example material MFI, drying time, water temp. etc.) Afterwards the machine data must necessary be protected. Also a hardcopy should be created.

9. Long-time monitoring

- The optimized setting can be considered as safe, if within two production hours no more changes must be made.

10. Reproducibility

- Ensure optimizes data when restart qualitative reproducibility.
- If unexpected errors occur the following point must be clarified.
- The temp. Conditions in the production hall.
- Is the humidity for example different seasonally
  Was the mold in the meantime in revision?

V.OPTIMIZE COOLING TIME

Short no.	Cooling time (second)	Cycle time (second)	DE molding Temperature (^oC)	Remark
1.	3	12	115	GP not proper
2.	3.5	12.3	110	GP not prop.
3.	4	13.8	110	GP not prop.
4.	4.5	14.0	105	GP not prop.
5.	5	14.9	104	GP not prop.
6.	5.5	15.3	103	GP not prop.
7.	6	15.6	102	GP not prop.
8	6.5	16.05	95	GP not prop.
9.	7	16.8	93	GP not prop.
10.	7.5	17.5	85	GP ok

*GP – Gate point.

With the DE molding temperature we must be pay attention primarily to two things:

- Part must be not be damaged when thrown from the mould
- Part must be in good shape when is ejected from the mould.

After the measurement control, the following cooling time is used7.5 sec this result in a cycle time of 17.5sec.

VI. CONCLUSION

This paper contents the analytical and experiment data which are collected by performing on IIM Milacron 80ton. In this paper the cycle time is optimized for the card holder by changing the cooling time. Best cycle time for the product is found 17.5 sec. This paper also represent the procedure for the optimization of cycle time. Cooling time, hold time and robot take out time are most effective parameters to reduce the cycle time. But in this paper the main focus is on the cooling time that is about 50% responsible for the cycle time. Optimization in cycle is most useful and important to reduce cost as well increase the quality of the product.

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