Monitoring of Production Processes Capacity at Injection Moulding Manufacturing Company

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Abstract **Paper deals with monitoring of production processes capacity at injection moulding manufacturing company. Samples were removed from two different types of machines for injection moulding during normal production. Samples have to stay 24 hours that was guaranteed equal conditions. After 24 hours samples were measured and all data was automatically transferred into PC to a special programme. According to measuring values and by special software was determined production process capacity and at the same time was by software evaluated process capacity index cp and process capacity exploitation index cpk.**

Keywords - **capacity, plastics, process, injection moulding**

I. INTRODUCTION

It would be difficult to imagine our modern world without plastics. Today they are an integral part of everyone's lifestyle with application varying from commonplace domestic articles to sophisticated scientific and medical instruments. Injection moulding is a major processing technique for converting thermoplastic materials. The basic concept of injection moulding is the ability of a thermoplastic material to be softened by heating, formed under pressure, and hardened by cooling.

Production process capacity cp, cpk is parameter, which expressed when the production process is stable or unstable. Based on observation of this capacity we can determine if the production process is responsible and good centred. If no we have to change some technological parameter into production process and next we have to observed this production system again and determine if the capacity curves is situated near the asked tolerance.

II. INJECTION MOULDING

Injection moulding is a major processing technique for converting thermoplastic materials. The basic concept of injection moulding is the ability of a thermoplastic material to be softened by heating, formed under pressure and hardened by cooling. In a reciprocating screw injection moulding machine, granular material (the plastic resin) is fed from hopper (feeding device) into one end of the cylinder (the melting device).

It is heated and melted (plasticized or plasticated), and it is forced out the other end of the cylinder (while still melted) through a nozzle (injection) into a relatively cool mold (cooling), held closed by the clamping mechanism. The melt cools and hardens (cures) until it is set up.

Injection moulding process is usually divided to basic parts – process times. These times can be changed according to production, based on type of produced product.

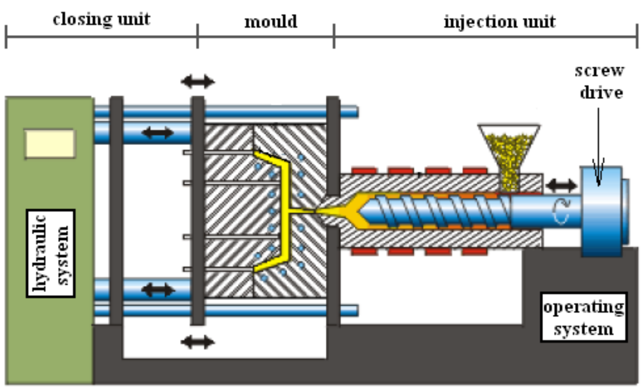

Fig. 1. Basic parts of injection moulding machine

Table 1 shows basic process times which can be changed according to type of production.

TABLE 1
BASIC PROCESS TIMES

PARAMETER	AVERAGE VALUE
Unit closing time	1 second
Mould closing time	4 seconds
Injection time	3 seconds
Holding time	5 seconds
Cooling	12 seconds
Screw back	8 seconds
Mould opening	4 seconds
Plastic suspension	1 second
Remove plastic	2 seconds
Moulding inspection	2 seconds

III. PRODUCTION OF EXAMINED SAMPLES

As was mentioned examined samples were removed from two different types of machines for injection moulding during normal production. In first case it was injection moulding machine DEMAG (fig. 2)

Fig. 2. Injection moulding machine DEMAG EXTRA

Examined sample in first case was color feeder in printing station (fig. 3). This color feeder was made from material SICOFLEX ABS GF S 299.

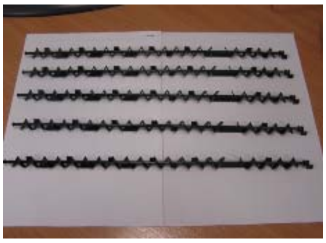

Fig. 3. Color feeder in printing station

In second case examined sample was made by injection moulding machine ARBURG (fig. 4).

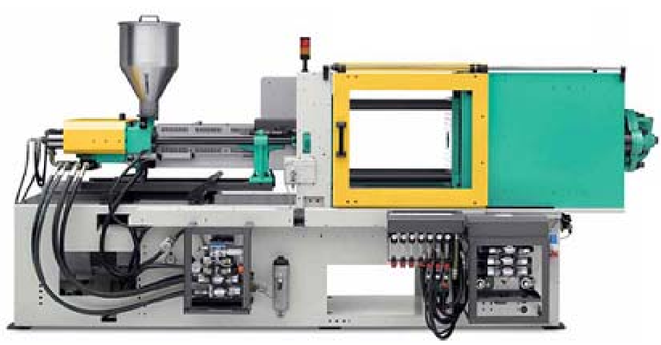

Fig. 4. Injection moulding machine ARBURG

Examined sample in second case was car light cover (fig. 5) which was made from material DURETHAN BKV 230 H2.0 901510. Car light cover was made by duo-cavity mold.

Fig. 5. Car light cover

IV. MEASUREMENTS OF SAMPLES

Measurements needed for monitoring of production process capacity was made at the special measuring laboratory. For monitoring was used caliper Mitutoyo and exact analytic balance Mettler Toledo. Caliper Mitutoyo was used for measuring of length dimensions and diameter. Exact analytic balance was used for measuring of total weight. Figure 6, 7 shows measuring equipments using in this experiment.

Caliper MITUTOYO ABSOLUTE DIGIMATIC 450

- Measuring range: 0 – 450 mm,
- 005"/0.01 mm digital reading.
- Resolution: .0005"/0.01 mm.
- Direct inch/mm conversion.
- Zero setting at any position within entire range.

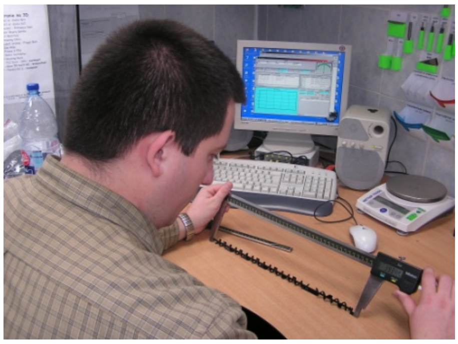

Fig. 6. Measurement of length dimensions

Exact analytic balance METLER TOLEDO PL 1502 S

- Maximum capacity1510 g
- Readability 0.01 g
- Taring range 0...1510 g
- Repeatability 0.02 g
- Linearity ± 0.03 g
- Settling time (typical)3 s
- Size of weighing pan ø 160 mm

Fig. 7. Measurement of total weight

V. SAMPLES EVALUATION

As was mentioned during monitoring of production process capacity was evaluated two samples

- color feeder in printing station
- car light cover.

Color feeder in printing station

By color feeder was measured and evaluated three quality parameters:

- total length l_1
- diameter d_1
- total weight m_1

Measuring of total length l_1

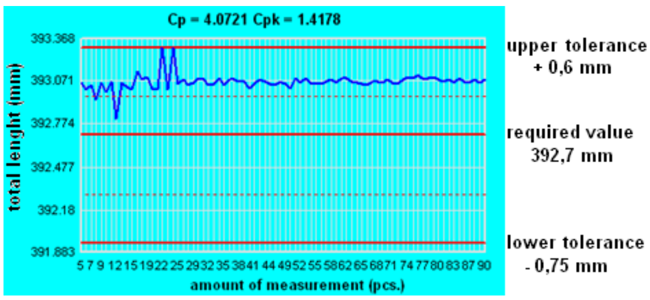

Fig. 8. Diagram of production process capacity according to the total length

As we can see in figure 8, capacity curve is situated near the upper tolerance. It comes to this, that we have to intervene into the production process and changed some technological parameter. After this the capacity curve is go back near to the required value.

Measuring of diameter d_1

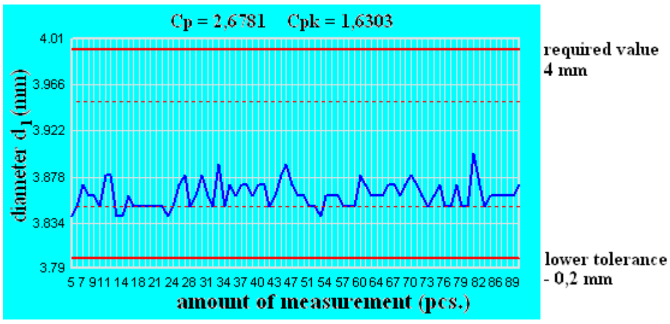

Fig. 9. Diagram of production process capacity according to the diameter

As we can see in figure 9, capacity curve is situated near the lower tolerance. It comes to this, that we have to intervene into the production process and changed some technological parameter. After this the capacity curve is go back near to the required value.

Measuring of total weight m_1

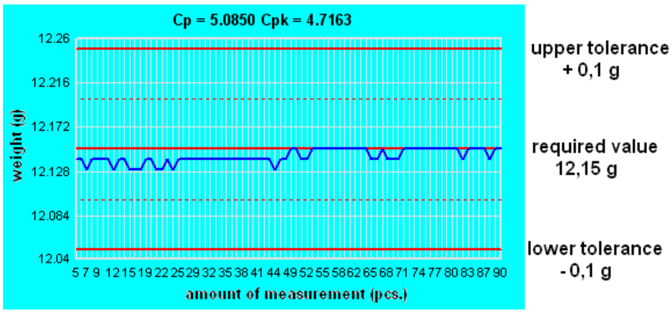

Fig. 10. Diagram of production process capacity according to the total weight

Production process capacity is very good. Capacity curve is situated near the required value.

Car light cover

By color feeder was measured and evaluated three quality parameters:

- total length l_2,
- total width s_2,
- total weight m_2.

Measuring of total length l_2

Required value of total length of car light cover was 68,1 mm with tolerance ± 0,28 mm. Curves of measuring values by both cavities are situated in the middle of tolerance field.

Based on measuring values, process capacity index and process capacity exploitation index we could say that production process is stable and good centered.

Figure 11 shows curves of measured values by measuring of total length l_2.

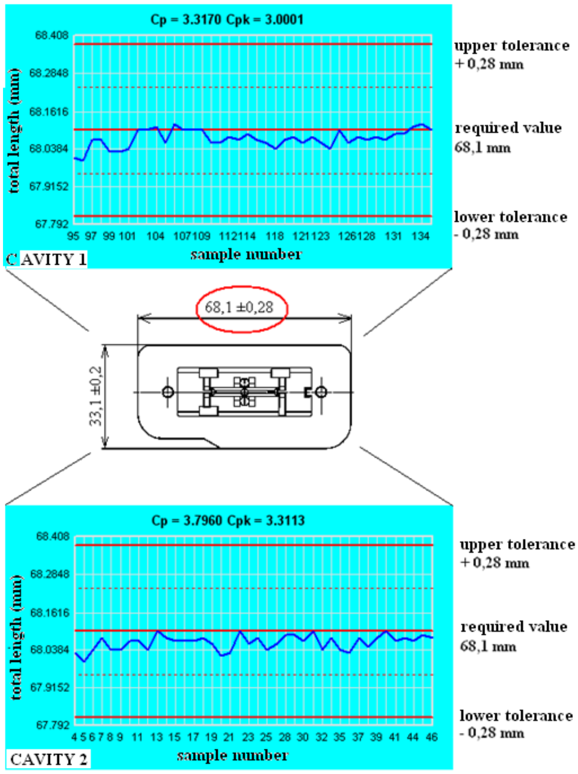

Fig. 11. Measuring of total length l_2

Measuring of total width s_2

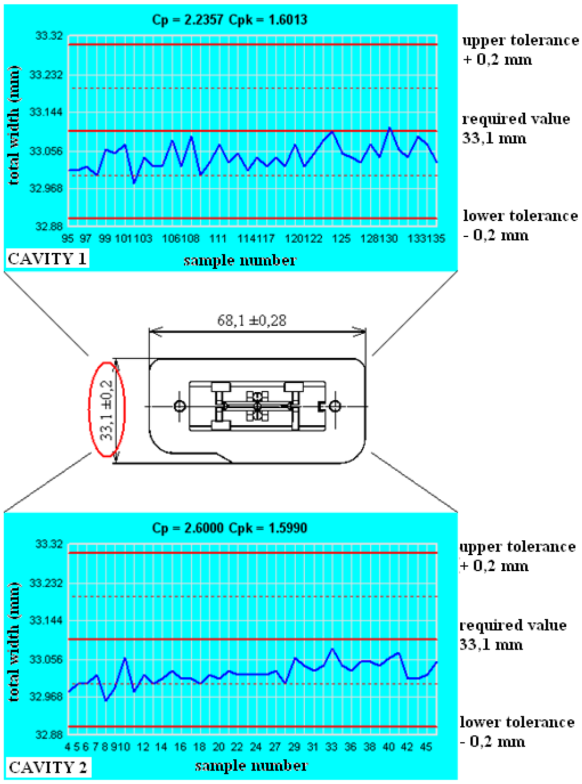

Fig. 12. Measuring of total width s_2

Required value of total width of cover was 33,1 mm with tolerance ± 0,2 mm. Curves of measuring values by both cavities are situated in the middle of tolerance field. Based on measuring values, process capacity index and process capacity exploitation index we could say that production process is stable and good centered.

Measuring of total weight m_2

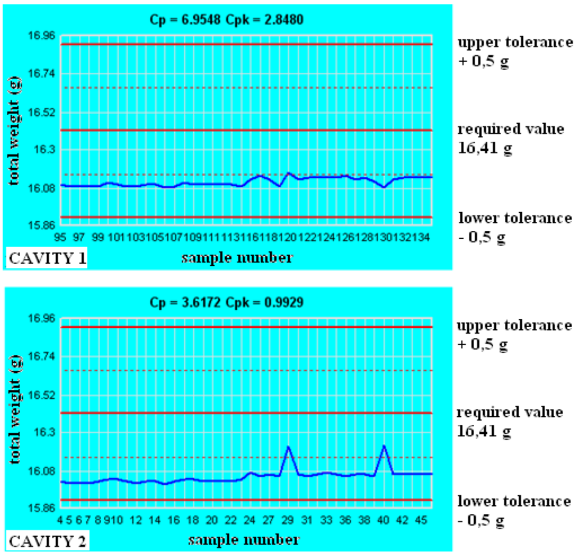

Fig. 13. Measuring of total weight m_2

Last measuring value was total weight of car light cover. Figure 13 shows curves of measured values by measuring of total weight. Required value of total weight was 16,41 g with tolerance ± 0,5 g. As we can see on this figure by cavity 2 curves of measuring values is situated near the lower tolerance. Process capacity exploitation index has value 0,9929 what is under the required limit.

Based on measuring values, process capacity index and process capacity exploitation index we could say that production process is stable but wrong centered.

Based on this detection is needed to intervene to production process and change some technological parameter. After this the capacity curve is going back near to the required value.

VI. CONCLUSION

Paper deals with monitoring of production processes capacity at injection moulding manufacturing company. Samples were removed from two different types of machines for injection moulding during normal production.

After 24 hours samples were measured and all data was automatically transferred into PC to a special programme. According to measuring values and by special software was determined production process capacity and at the same time was by software evaluated process capacity index cp and process capacity exploitation index cpk.

In the aggregate we can evaluate production process as capable which is useful to observed specified tolerances.

By measuring of some quality parameters, especially by diameter of color feeder and total weight of car light cover was determinate that process capacity curves are situated near the tolerances and process capacity index cp and process capacity exploitation index cpk had values under required tolerances.

Based on this detection is needed to intervene to production process and change some technological parameters. Than we have to monitoring production process again if the capacity curve is going back near to the required value.

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