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THE PROCESS CAPABILITY STUDY OF PRESSING PROCESS FOR FORCE CLOSED

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Abstract

Objective of the statistical assessment process is to determine whether all major manageable causes of instability of the process have been removed. The basis for statistical regulation is management of production processes. If a process operates a large number of random effects, the resulting distribution has the character of a normal distribution. Processes are considered as eligible if the indexes Cp and Cpk are greater than 1.33.

Key words

process, stability, normality, capability

Introduction

Objective of the statistical assessment process is to determine whether all major manageable causes of instability of the process have been removed. It is necessary, that average value of observed reference of quality and its variability have been constant over time. It can be managed through control charts and forms in the preparatory stage of statistical control.

The basis for statistical regulation is management of production processes. Production process is considered to be managed when only accidental impacts are active. If a process operates a large number of random effects, the resulting distribution has the character of a normal distribution. (3)

Currently, the process capability is assessed by the indicators of process capability Cp (characterizes the scattering process) and Cpk (characterizing the position of the tolerance field process). Processes are considered as eligible if the indexes Cp and Cpk are greater than 1.33.

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Input data which should be necessary to known prior to the survey process capability are:

- manufacturing conditions of mass production,
- capable measuring equipment,
- capable manufacturing facility
- statistically managed process,
- assess normality,
- technical and other specifications accurately reflecting the requirements of the customer,
- nominal value of the proposal is in the middle of the tolerance field.

By using this method, it is important that information and knowledge from previous observations of the process are considered and applied.

Materials and methods

Description of the pressing process

Operating step: pressing cross valve type B on the injection press
Mark*:* force required to close the valve
Rating value: 25±10 N
Lower Specification limit (LSL): *15 N*
Upper Specification limit (USL): *35 N*
Check centre: universal material tester Loyd Instruments LF*PLUS* 1455 with precision 0.5%
Production device: *injection press DEMANG*
Volume of subgroup: *N = 125 pressings*
Measure of subgroup: *n = 5 pressings*
Interval of taking: *every 60 minutes*
Number of subgroups: *k = 25*

Criteria for valuation of competence indicators are Cp and Cpk.

In terms of product specification, the force necessary to close the valve the range of 25 ± 10 N is considered a critical sign. The force necessary to close the valve is measured using a digital tester with an accuracy of ± 0.5% and proven capability of measuring equipment. In regulating the process, we will use Shewhart's control chart for average and range ($\overline{X}$, R). In the process of molding/ pressing is used injection molding/pressing equipment facility Sumitomo DEMANG.

Calculation of specification limits

Regulation charts work with the data from the manufacturing processes at approximately regular intervals (in hours or quantities). Each subgroup consists of the same product or service. Each subgroup obtains one or more characteristics of the subgroup.The Shewhart's control chart is a graph of values of the characteristics of the subgroups compared to subgroup number. It consists of a central line (CL) located in the reference value of visualization features. In evaluating whether the manufacturing processes are or are not in statistically managed state, the reference value is usually considered the average value. Control chart has

two statistically established regulation limits, one on each side of the central line, called the upper regulation limit (UCL) and lower regulation limit (LCL). They are at the distance of 3σ on each side of the central line, where σ is standard deviation of the monitored statistics for the file [1].

Average range in subgroups

$$\overline{X_i} = \frac{1}{n}\sum_{j=1}^{n} X_{ij} \ , \tag{1}$$

i = 1, 2 ....k and j = 1, 2 ...n,

X_{ij} *– measured value in i- subgroups*

J – serial number of measured value in i- subgroups
K – number of subgroups
N – file size.

Span in subgroups

$$R_i = MAX(X_{ij}) - MIN(X_{ij}), \tag{2}$$

i = 1, 2 ... k and j = 1, 2 ...n
MAX (X_{ij}) *and MIN*(X_{ij}) *is maximum and minimum value in i-th subgroup.*

Average of process

$$\overline{\overline{X}} = \frac{1}{k}\sum_{i=1}^{k} \overline{X_i} \ , \tag{3}$$

$\overline{X_i}$ *- average of j – th subgroup*

Average of span

$$\overline{R} = \frac{1}{k}\sum_{i=1}^{k} R_i \ , \tag{4}$$

R_iX_i are spans and averages in *i*-th subgroups (*i*=1, 2, ...*k*). $\overline{R}$ and $\overline{\overline{X}}$ in quality control charts are central lines (*CL*).

Calculation of specification limits

$$UCL_R = D_4 \, . \, \overline{R} \ , \tag{5}$$

$$LCL_R = D_3 \, . \, \overline{R} \, , \tag{6}$$

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2 . \, \overline{R} \, , \tag{7}$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - A_2 . \, \overline{R} \, , \tag{8}$$

where D_4 ,D_3 and A_2 are constants moving in dependence on volume of subgroups *n,* in our case n = 5: $D_3 = 0.000$, $D_4 = 2.114$, $A_2 = 0.577$.

Qualification of pressing process

$$C_p = \frac{USL - LSL}{6.\hat{\sigma}} = \frac{T}{6.\hat{\sigma}} \ , \tag{9}$$

$$C_{PK} = \frac{USL - \overline{\overline{X}}}{3.\hat{\sigma}}, \tag{10}$$

$$C_{PK} = \frac{\overline{\overline{X}} - LSL}{3.\hat{\sigma}}, \tag{11}$$

USL – Upper Specification limit,

LSL – Lower Specification limit [2].

Results

In pressing process, we obtained the values for 25 subgroups. Characteristics $\overline{X}$ and *R* are applied in quality control charts ($\overline{X}, R$):

UCL_X = 28.0428 N UCL_R = 9.3016 N
LCL_X = 22.9652 N.

General average $\overline{\overline{X}}$ = 25.504 N, average span $\overline{R}$ = 4.4 N. The process is considered as eligible, indexes C_p and C_{pk} are greater than 1.33. **Cp = 2.07** a **Cpk = 2.00**.

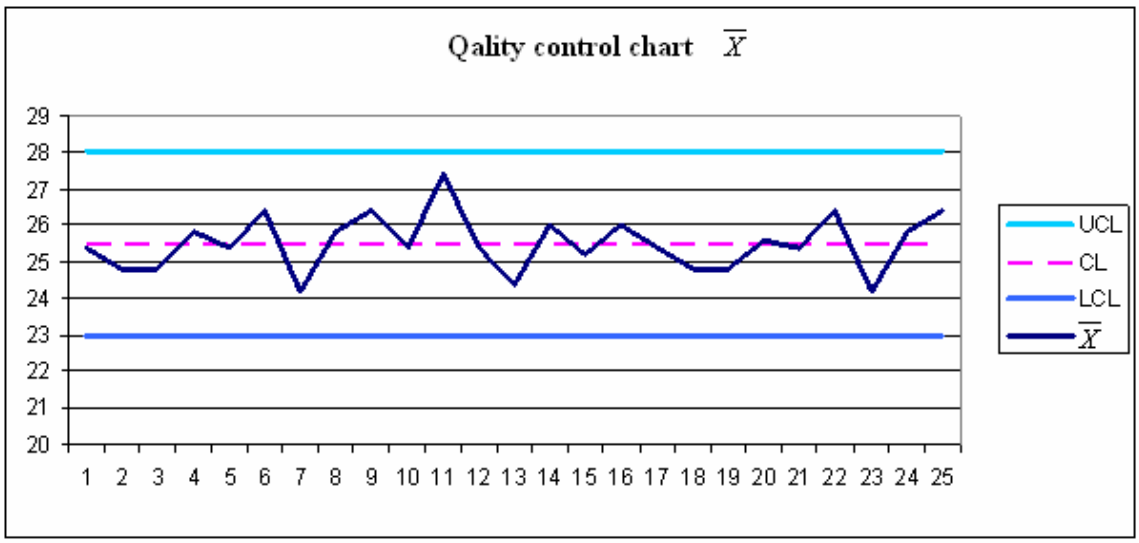

Fig. 1 *Quality control chart* $\overline{X}$

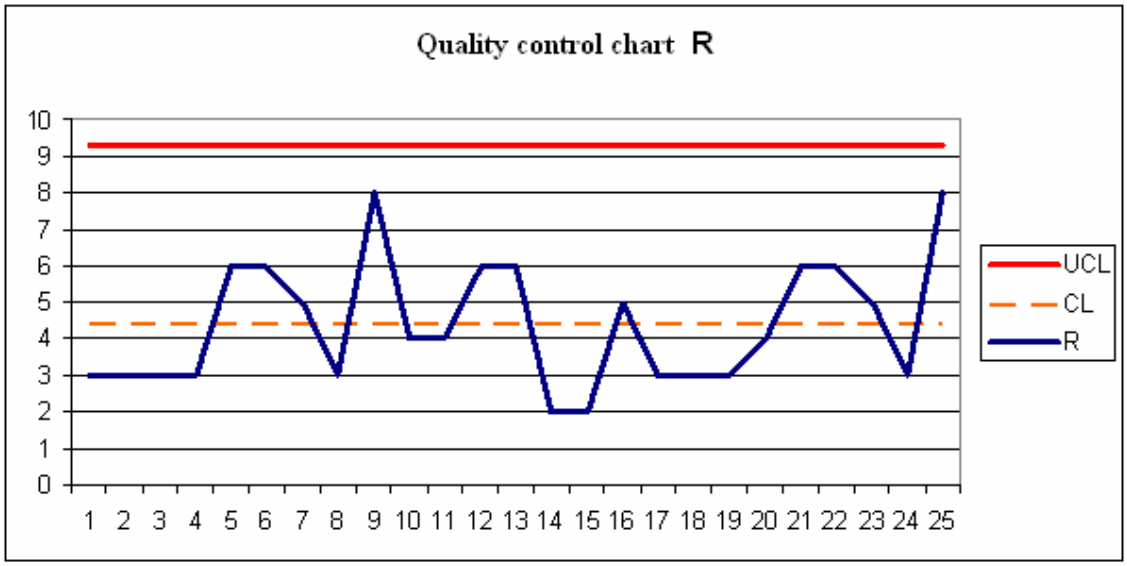

Fig. 2 *Quality control chart R*

We can see the process variance in histogram (Fig.3), where the position of the process was appreciated, variability and figure compared to tolerance zone. Based on the bell-shaped histogram, we note the confirmation of normality; the process runs at constant conditions. All measured values are inside the tolerance zone and moving around the median value of 25 N. All results are illustrated in protocol of process capability (Fig. 4).

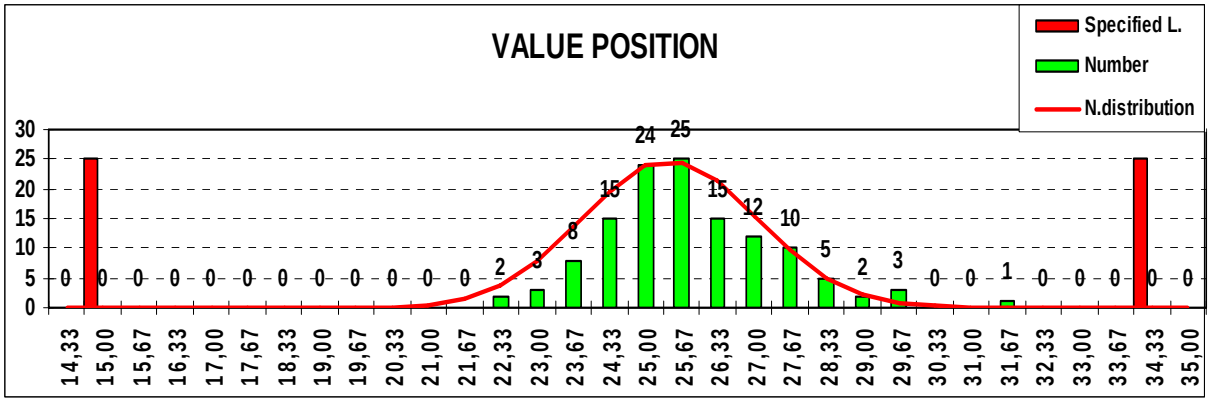

Fig. 3 *Histogram*

PROCESS CAPABILITY CALCULATION

Knudsen Plast
injection moulding for healthcare

Process Capability Study for Force Closed

Main data

Product:	**Cross Valve B**
Batch no.:	**1254665**
Specification:	**125456 ver.1**
Nominal value acc to spec.:	**25**
Parameter:	**Operation Force**
Designation:	**N**

Specifications

Upper specified limit (USL):	**35**
Lower specified limit (LSL):	**15**
Target:	**25**
Allowable tolerance range	**20**

Calculations

Completed by	**Jozefina Kudičová**
Date for capability study	**2011.02.22**
No measured	**125**
Average	**25**
Max	**31**
Min	**22**
Range	**9.3**
Standard deviation	**1.6**
6 x St dev range	**9.7**
Number of test outside Upper limit	**0**
Number of test outside Lower limit	**0**
Cp	**2.07**
Cpk	**2.00**

Fig. 4 *Protocol of process capability*

Summary

The capability of pressing process in Knudsen Plast s.r.o. showed that the process provides the products that meet the claimed quality criteria. Values of a potential process capability $C_p = 2.07$ and a real process $C_{pk} = 2.00$. These values are higher than the rate 1.33 and the process is able to provide the products in compliance with the tolerance zones.

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