Manufacturing Machines in Production Process

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Abstract: *The aim of the thesis was to design and develop statistical methods that can be used in quality control. We have calculated the zone of dispersal S_M by the measuring device RHEOMETER MDR 2000. By the production facility we have proved the capacity by establishing the stability of values, constructing control charts, determination normality of the values and calculating the index of the machine capability. Consequently there will be assessed to determine that the process takes without any disturbances.*

Keywords: *capability, process, quality,*

INTRODUCTION

Any organization that establishes and maintains this system provides evidence of quality management in organizations [1, 9, 3]. It undertakes to use all available means, methods and tools for continuous improvement of processes, products, systems and services to meet all the needs of its customers. All the activities taking place in the organization are happening with regard to customer satisfaction, because only a satisfied customer is a loyal customer [17, 18, 6, 5].

Quality management is an integral part of all sections and activities taking place within the organization. To this step, there are ISO 9000 standards available, that following the implementation do not immediately constitute a guarantee of success for the organization, but facilitate its gradual achievement. It only depends on management and managing staff how they make use of methods and practices recommended and required by these standards [21, 22]. The obtained certificate for quality management systems according to these standards will ensure organizations evidence of the internationally agreed standards, which ensure the future higher interest from the current and future customers about its products or services [4, 13, 14, 15].

The organization provides extensive services and products in rubber manufacturing for all kinds of industries. Technical and capacity options and organization facilities enable to ensure the production of melded and extruded products according to specific customer requirements [20, 2, 10, 11].

Vegum a.s. is dealing with the production of a variety of products for the rubber industry. Compared with the production of finished products the company deals with mixing rubber compounds that it either further processes in the manufacture of its own products, or they are exported.

MATERIAL AND METHODS

Capability of manufacturing equipment

Of the samples that we measured, establish subgroups of size n = 5 When performing the stability test we calculate for each subgroup average value and a standard deviation. These values are calculated as follows:

Average value of the symbol in subgroup:

$$\overline{X}_i = \frac{1}{n}\sum_{j=1}^{n} X_{ij} \qquad (1)$$

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

where: i – serial number of a subgroup,

j – serial number of value measured in a subgroup,

k - number of subgroups,

n – range of subgroup,

X_{ij} – value measured in i-the subgroup.

Standard deviation in a subgroup:

$$s_i = \sqrt{\frac{1}{n-1}\sum_{j=1}^{n}\left(X_{ij} - \overline{X}_i\right)^2} \tag{2}$$

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

We set the calculated values $\overline{X}$ i and si in a regulation diagram for $\overline{X}$ i and si. In order to get a suitable scale for both diagrams, we must calculate the extreme values $\overline{X}$ max, $\overline{X}$ min, Smax As a next step we need to calculate the average common value $\overline{\overline{X}}$:

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

and the average standard value s:

$$\overline{s} = \frac{1}{k}\sum_{i=1}^{k}s_i \tag{4}$$

Setting the stability limits for the average value and standard deviation

The centre position of the process tested is considered stable if individual values $\overline{X}$ do not exceed the upper limit intervention HMZ or lower limit intervention DMZ:

$$HMZ_{\overline{X}} = \overline{\overline{X}} + 1{,}3.\overline{s} \geq \overline{X}_{\max} \tag{5}$$

$$DMZ_{\overline{X}} = \overline{\overline{X}} - 1{,}3.\overline{s} \leq \overline{X}_{\min} \tag{6}$$

If we get the maximum standard deviation of five groups s_{max} lower than 2.1.s, we can consider the standard deviation as stable:

$$HMZ_s = 2{,}1.\overline{s} \geq s_{\max} \tag{7}$$

RESULTS

Definition of selected process

Vegum a.s. is dealing with the production of a variety of products for the rubber industry. Compared with the production of finished products the company deals with mixing rubber compounds that it either further processes in the manufacture of its own products, or they are exported.

When producing mixtures, the majority of production capacities that the comp-any disposes of is used. So, we decided to choose 446A-9 rubber compound as a sample to determine eligibility in the manufacturing process [19, 12].

Rheometer MDR 2000 measuring equipment

This measuring equipment was developed by The Alpha Technologies RHEOMETER MDR 2000 to measure properties of mixtures from caotchouc. It consists of a heated, sealed, rotor-less plates, of which the upper is movable and lower one oscillates to 1.66 Hz.

During measurement, the sample is placed on the lower matrix (Fig. 1), the upper matrix comes closer and they join together tightly in a period of time at which the sample is baking at a certain temperature. Evaluating sample properties is going on during the baking of the mixture in matrix (Fig. 2). In our case, the Rheometer MDR 2000 assessed the stiffness, viscosity, and samples safety of the mixture [16, 7, 8].

Fig. 1 Rheometer MDR 2000

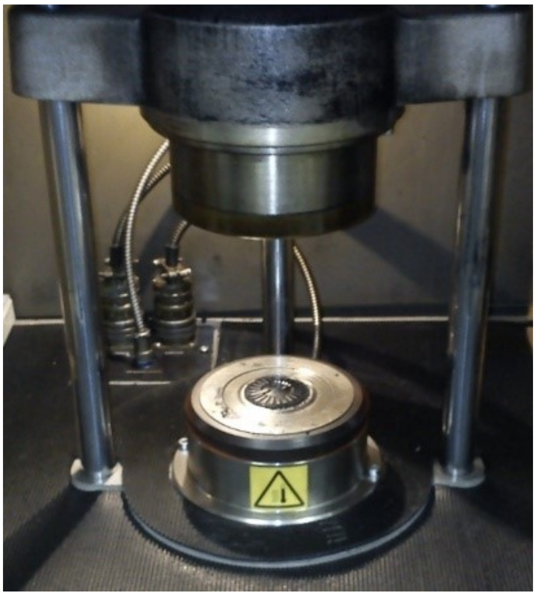

Fig. 2 Lower matrix of Rheometer

Capability of measuring equipment

We created subgroups of range ***n* = *5*** from the samples collected. When conducting stability test we calculated an average value $\overline{X}_i$ for each subgroup and a standard deviation s_i that are presented in Table 1.

Tab. 1 Table of values measured for mixture viscosity

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	6,65	6,64	6,56	6,39	6,85	6,73	6,33	6,55	6,85	6,75
2	6,42	6,65	6,53	6,42	6,48	6,38	6,2	6,4	6,23	6,55
3	6,63	6,34	6,52	6,41	6,3	6,64	6,55	6,32	6,54	6,64
4	6,81	6,76	6,84	6,42	6,82	6,71	7	6,66	6,54	6,09
5	6,72	6,74	6,29	6,74	6,72	6,64	6,52	6,45	6,6	6,57
X_i	6,646	6,626	6,548	6,476	6,634	6,620	6,520	6,476	6,552	6,520
s_i	0,084	0,114	0,153	0,088	0,224	0,079	0,370	0,070	0,195	0,256

We calculated:

Common average value: $\overline{\overline{X}} = 6{,}562 dNm$

Average standard deviation: $\overline{s} = 0{,}194$

Upper intervention limit $HMZ_{\overline{X_i}}$: $HMZ_{\overline{X_i}} = 6{,}814 dNm$

Lower intervention limit $DMZ_{\overline{X_i}}$: $DMZ_{\overline{X_i}} = 6{,}309dNm$

Upper intervention limit HMZ_{s_i}: $HMZ_{s_i} = 0{,}408$

Furthermore, we calculated $\overline{X_i}$ and s_i values and incorporated in the regulation diagram for $\overline{X_i}$ and s_i (Fig. 3) and determined extreme values:

$\overline{X}_{max} = 6{,}646dNm$ $\overline{X}_{min} = 6{,}476dNm$ $S_{max} = 0{,}304$

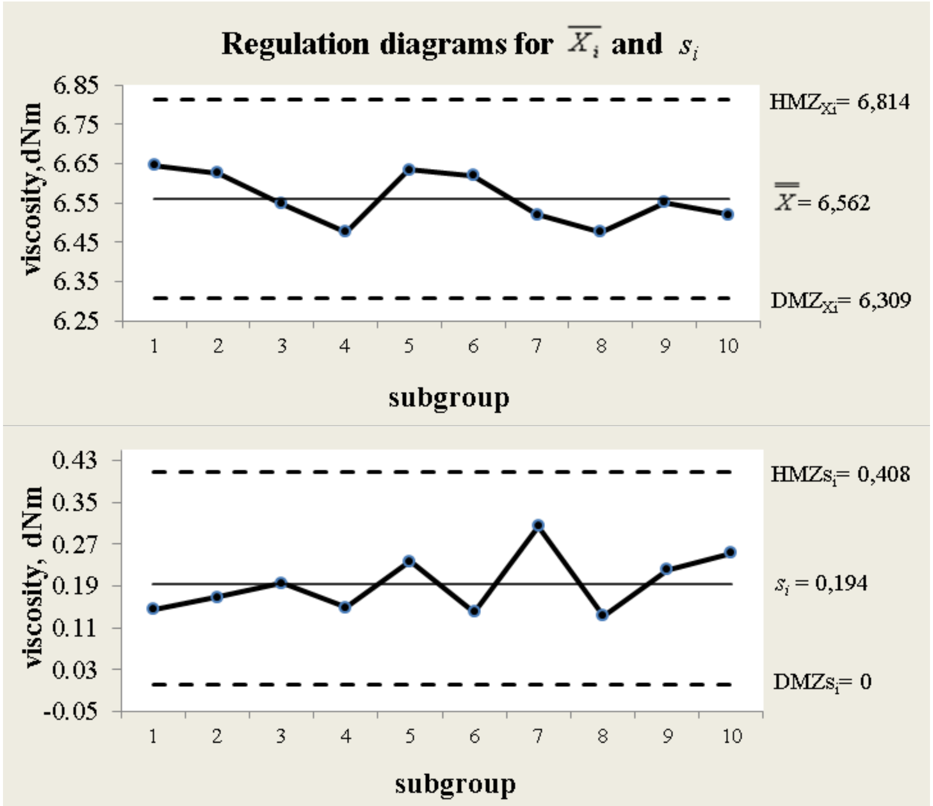

Fig. 3 Regulation diagrams $\overline{X_i}$ and si for mixture viscosity

CONCLUSION

Statistical methods that include the proposed regulation diagrams in particular allow graphical display during the process measurement. They immediately provide a picture of stability and conformity of examined processes. The advantage of these methods is that they can be used for any process in an organization with immediate assessment of the condition it is in. The use of regulation diagrams helps for example, when setting or changing the process to display graphical mastering that ensures its perfect management. These diagrams show even the smallest deviations and inaccuracies arising from the poor set of machines parameters and production equipment.

Statistical evaluation tools help to determine the character of each one of the on going processes in every manufacturing organization when identifying undesirable trends or sequences occurring in the process.

ACKNOWLEDGEMENT

This paper was created with financial support of the grant project KEGA no. 035SPU-4/2014 "Integrating innovative trends in metal machining, metrology and quality management in university studies."

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