TEQ Training & Consulting GmbH | Dr.-Ing. Wolfgang Schultz | April 2016

Process Capability – a Simple Illustration

Process capability describes the ability of a (production) process to produce characteristics meeting the specification. You usually conduct a process capability analysis to establish this capability. Process capability analysis is even used as a generic term for machine performance studies and process capability analyses, i.e. a two-stage approach.

In order to perform a machine performance study, a machine or production facility normally produces 50 parts in one continuous production run over a short period of time. The influencing factors remain quite stable while the values of the characteristic to be inspected are measured. In many cases, the values approach a normal distribution function. Now you determine average and standard deviation s. You need them to calculate capability indices C_m and C_{mk}. When the values are normally distributed, the capability index C_m is the ratio between the tolerance range T and the sixfold standard deviation 6s. It thus refers to the relation between the variation range and the tolerance. The capability index C_{mk} is calculated from the ratio between the shorter ("critical") distance from the average to the upper or lower specification limit USL / LSL and the threefold standard deviation 3s. C_{mk} considers the variation range and the centred process average within the specification. Non-normally distributed values require a different calculation method as defined in the ISO 22514 series of standards. The result of a machine performance study is also referred to as short-term capability. As an example, ISO 22514-3 recommends to establish machine performance based on 100 observations. ISO standards apply the symbols P_m and P_{mk} to short-term capability indices where P refers to performance.

The second step is the actual process capability analysis which follows the machine performance study. It is important to record all or at least most influencing factors, such as change of batch, change of shift, change of operator, change of tool, changes in the room temperature, etc. You take 25 samples each including 5 parts from the running production process in a "representative" period of time and measure the characteristic values. These values rarely approach a normal distribution function. In order to establish process capability, i.e. to calculate process capability indices C_p and C_{pk}, you stick to the approach that the 99.73% variation range of the distribution of characteristic values – which refers to the variation range 6s of the normal distribution – serves as a reference quantity. ISO 22514-2 (formerly ISO 21747) recommends the percentile method as a calculation method. Different time-dependent distribution models given in this standard provide the required classification.

Process capability is only established when the location and variation parameters of the distribution remain constant over time; however, most processes in the real world are not able to fulfil this requirement over a longer period. This is the reason why ISO 22514-2 distinguishes between process capability and process performance. In any case where the location and variation parameters of the resulting distribution do not remain constant, you have to specify the process performance indices P_p and P_{pk} instead of the process capability indices C_p and C_{pk}.

It is important to mention that some corporate guidelines use capability indices P_p and P_{pk} to indicate preliminary process capability instead. Even T_p and T are sometimes applied as temporary capability indices.

TEQ Training & Consulting GmbH
Eisleber Str. 2
69469 Weinheim / Germany
+ 49 6201 3941-15

Interested in this topic?
www.teq.de
Contact the author
stephan.conrad@teq.de