Quality Indices: Ca, Cp and Cpk

Question

Every quarter one of our customers insists that we give them a quality summary. The customer wants us to report the following quality indices regarding our ability to hit the ordered chemistry specifications: Ca, Accuracy Index; Cp, Capability Index; and Cpk, Quality Index. It used to be that if we provided steel with the desired elements within the specification limits, the customer was happy. Now, even though the customer has not changed the specification limits it seems that they are insisting that we produce steel with more consistent chemistry. How are quality indices derived and what do they mean? W.H., USA

Answer

Quality indices provide a quantitative measure of your factory's ability to maintain and improve the consistency within specifications from heat to heat and hit the target average. Many companies calculate the quality indices for each specified element in the customer order. They may also be calculated for achievement of scheduled delivery time, gauge and width functions, compliance with order weight, or any other quantitative measure of the customer order. Perhaps the best way to answer your question is through the use of examples.

Ca: Accuracy Index

The Accuracy Index determines how close the process average is to the specification average. The smaller the number, the better the Accuracy Index.

Formula: Ca = ((|Target average – Process Average|) x 100)/((Specification Range Maximum – Specification Range Minimum)/2).

Example: A customer gives an order for a grade of steel with carbon ranging from 0.20 % to 0.30 % and a target average of 0.24 %. During one week of production, the melt shop makes this grade with an actual process average of 0.27%. What is the Ca, Accuracy Index?

Solution: Ca **=** ((|0.24% - 0.27%|) x 100)/((0.30% - 0.20 %)/2)

Ca = 60

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Cp: Capability Index

The Capability Index determines how close the process range is to the specification range, the larger the number greater than or equal to one, the better the Capability Index.

Formula: Cp = (Specification Range Maximum – Specification Range Minimum)/(6 x Process Standard Deviation).

Example: A customer orders a grade of steel with carbon ranging from 0.20 % to 0.30 %. During one week of production, the melt shop makes this grade with a process standard deviation of 0.02 %. What is the Cp, Capability Index?

Cp = (0.30%-0.20%)/(6 x 0.02%)

Cp = 0.833 Note, this result indicates that the process needs improvement with respect to the customer's specification.

Cpk: Quality Index

The Quality Index determines how close both the process average and the process standard deviation are to the middle of the specification and the specification limits. The larger the number greater than or equal to one, the better the Quality Index.

Formula: Cpk = Minimum of [(Upper Specification Limit – Process Average) / (3 x Process Standard Deviation) or (Process Average – Lower Specification Limit) / (3 x Process Standard Deviation)].

Example: A customer orders a grade of steel with carbon ranging from 0.20% to 0.30%. During one week of production, the melt shop makes this grade with a process average of 0.27% and a process standard deviation of 0.02%. What is the Cpk, Quality Index?

Cpk = Minimum of [(0.30% - 0.27%)/(3 x 0.02%) or (0.27% - 0.20%)/(3 x 0.02%)]

Cpk = Minimum of [0.5 or 1.167]

Cpk = 0.5 Note, this result indicates that this process needs improvement with respect to the customer's specifications.

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If a process needs improvement with respect to the quality indices, the supplier can take steps to reduce the process standard deviation, supply material closer to the target average or renegotiate the specification limits and target average with the customer.

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