SPC and CpK

Statistical Process Control (SPC) for the thermal process is critical for any manufacturing program that involves continuous quality monitoring and improvement. SPC provides the ability to understand the predictability of the process and to know in real-time when a process may be changing and affect product quality.

Process Capability Index (Cpk) gives a continuous indication of how current production is keeping within specifications and will indicate if the process is drifting towards a condition where defective product may be produced. It is a measure of where the process spread falls within the *Process Window*. Monitoring this and alarming when it becomes too low allows you to proactively address issues in the process before a single defect occurs.

Note: Cpk is only calculated and displayed when Virtual Profiling is running.

Alarm on Cpk – This option will enable or disable the Cpk chart Alarm while *Virtual Profiling* is running. KIC Automatic System software will automatically display SPC charts while *Virtual Profiling* is running. If the Cpk drops below the defined value, the software will activate a software alarm on the screen, or optional hardware alarm. The default alarm setting is 1.33.

Minimum – Used if the *Alarm on Cpk* option is enabled, this value determines the lower threshold for the Cpk alarm. In the event the Cpk value drops below this minimum value, the software will activate a software alarm, or optional hardware alarm. The default alarm setting is 1.33.

- **Points to Compute Cpk**
  - **Minimum -**Enter the minimum number of data points for the software to begin calculating Cpk.
  - **Maximum** – Enter the maximum number of data points to calculate Cpk. The Cpk value will be calculated over a rolling window of data, only using up to the maximum data points at any given time.
  - **Maximum PWI to enable Virtual Profiling** -This value will determine the maximum *PWI* allowable in order for any given profile to qualify as a *Virtual Profile baseline*. If the *PWI* for a profile is lower than this value, it can be used as a *Virtual Profile baseline*. By default this value is 90%.

How KIC Calculates Cpk

$CpK = (100 - |\mu|) \div 3\sigma$

μ = Mean of the data points
σ = Standard deviation of the data points calculated for a whole population

$\sigma = \sqrt{(N\Sigma X^2 - (\Sigma X)^2) \div N^2}$

N = Number of items in a population, process, or lot.
X = Set or group of data, observations, or measurements

In the calculation of CpK on PWI values, the Upper Spec Limit is always "100" and the lower spec limit is always "-100". If we take the absolute value of the mean then we can always use 100 as the spec limit.

Here is a simple example. Let us set the Points to Compute Cpk to 5, and the five PWI values are as follows: 68%, 83%, 70%, 64%, and 55%.

Mean $= (68 + 83 + 70 + 64 + 55) \div 5$
$= 68$

StdDev $= \sqrt{((5 \bullet (68^2 + 83^2 + 70^2 + 64^2 + 55^2)) - (68 + 83 + 70 + 64 + 55)^2) \div 5^2}$
$= \sqrt{(117670 - 115600) \div 25}$
$= \sqrt{82.8}$
$= 9.10$

Cpk $= (100 - |68|) \div (3 \bullet 9.10)$
$= 32 \div 27.31$
$= 1.17$

Though the worst PWI is 83%, the Cpk is 1.17, which is below the typical target minimum of 1.33. This tells us that the chance that the process will drift out-of-spec is too high, and this process should be improved.

Now, here is five more sample PWIs: 91%, 91%, 92%, 89%, and 90%.

Mean $= 90.6.$

StdDev $= \sqrt{(205235 - 205209) \div 5^2}$
$= 1.02$

Cpk $= (100 - |90.6|) \div (3 \bullet 1.02)$
$= 3.07$

Even though every PWI in the second list is considerably worse (farther from 0) than the worst PWI in the first list, the Cpk is a very good 3.07. Such a high Cpk indicates that there is very little chance this process will drift out of spec. The second process is better than the first because the second process has very little variation in it.