



Calculations from a Siemens Motor Start/Stop Profile

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DESCRIPTION

Given a Siemens motor Start/Stop Profile, the starting thermal capacity (TC_{start}) and the steady state running thermal capacity ($TC_{running}$ at 1pu) can be calculated.

These values must be considered when selecting the thermal curve and the stall ratio.

EXAMPLE

The Siemens motor thermal data sheet is comprehensive and allows the calculation of the thermal capacity (TC) at continuous full load current and the starting TC. The running and stopped cool time constant are given as:

$$\tau_{run} = 20 \text{ minutes}; \quad \tau_{stop} = 300 \text{ minutes} \quad (\text{EQ 1})$$

COLD STARTING

The *stopped criteria* shows that if the motor is at ambient, and you are allowed 2 consecutive starts, stop and wait 15 minutes, start again and stop, wait 15 minutes, and start again. The motor is now at 100% TC.

To calculate TC_{start} , we have:

$$\begin{aligned} (TC_{start} + TC_{start})e^{-(15 \text{ min}/30 \text{ min})} + TC_{start} &= 100\% \\ \Rightarrow TC_{start} &= 27\% \text{ per start} \end{aligned} \quad (\text{EQ 2})$$

The *running criteria* shows that if the motor is at ambient, you are allowed 2 consecutive starts after which it runs 5 minutes and stops, starts again and runs 5 minutes and stops, and finally starts again. The motor is now at 100% TC.

To calculate TC_{start} , we have

$$\begin{aligned} ((TC_{start} + TC_{start})e^{-(5 \text{ min}/20 \text{ min})} + TC_{start})e^{-(5 \text{ min}/20 \text{ min})} + TC_{start} &= 100\% \\ \Rightarrow TC_{start} &= 33\% \text{ per start} \end{aligned} \quad (\text{EQ 3})$$

Be conservative and use $TC_{start} = 33\%$ for setting application.

HOT STARTING

The *stopped profile* shows that the motor has been running a rated load and stopped, after which a start/stop is allowed followed by a 15 minute wait. Another start/stop is permitted, followed by a 15 minute wait and then a final start. The motor is now at 100% TC.

To calculate $TC_{\text{running at 1 pu}}$, we have $TC_{\text{start}} = 27\%$ from the cold starting calculation and:

$$\begin{aligned} ((TC_{\text{running at 1 pu}} + TC_{\text{start}})e^{-(15/300)} + TC_{\text{start}})e^{-(15/300)} + TC_{\text{start}} &= 100\% \\ \Rightarrow ((TC_{\text{running at 1 pu}} + 27\%)e^{-15/300} + 27\%)e^{-15/300} + 27\% &= 100\% \quad (\text{EQ 4}) \\ \Rightarrow TC_{\text{running at 1 pu}} &= 26\% \end{aligned}$$

The *running profile* shows that the motor has been running a rated load and then stopped, after which it is started and it runs for 5 minutes and then stops. Another start, followed by 5 minutes of running, then a stop and a final start. The motor is now at 100% TC.

To calculate $TC_{\text{running at 1 pu}}$, we have $TC_{\text{start}} = 33\%$ from the cold starting calculation and:

$$\begin{aligned} ((TC_{\text{running at 1 pu}} + TC_{\text{start}})e^{-(5/20)} + TC_{\text{start}})e^{-(5/20)} + TC_{\text{start}} &= 100\% \\ \Rightarrow ((TC_{\text{running at 1 pu}} + 33\%)e^{-(5/20)} + 33\%)e^{-(5/20)} + 33\% &= 100\% \quad (\text{EQ 5}) \\ \Rightarrow TC_{\text{running at 1 pu}} &= 35\% \end{aligned}$$

Be conservative and use $TC_{\text{running at 1 pu}} = 35\%$ for setting application.

HOT/COLD STALL RATIO

The Hot/Cold Stall Ratio for thermal reduction setting should be calculated as:

$$\begin{aligned} TC_{\text{used_end}} &= I_{eq} \times (1 - \text{Hot/Cold}) \times 100\% \\ \Rightarrow 35\% &= 1 \text{ pu} \times (1 - \text{Hot/Cold}) \times 100\% \quad (\text{EQ 6}) \\ \Rightarrow \text{Hot/Cold} &= 0.65 \end{aligned}$$

For this specific motor, the actual ratio is $7 / 8 = 0.875$, resulting in a steady state TC of 12.5%.

The first method for calculation is preferred.