Mathcad spreadsheet dedicated for induction motor model parameter estimation
Objective

- The objective is to derive parameters for a motor model such that the model behaves as close as possible to the real motor.
- Develop a Mathcad spreadsheet which estimates input parameters for the induction motor model used in PSCAD/EMTDC (two-axis model with two rotor circuits).
- Input data is to be data easily available for induction motors.
Illustration of model

- The equivalent circuit of the PSCAD/EMTDC induction motor model
Input data to spreadsheet

- Rms rated phase voltage
- Rated output mechanical power
- Rated electrical frequency
- Efficiency at rated operation
- Rated power factor
- Number of poles
- Rated speed
- Start current (relative to rated current)
- Start torque (relative to rated torque)
- Inertia
Output data

- Stator resistance (R1)
- First cage resistance (R2)
- Second cage resistance (R3)
- Stator unsaturated leakage reactance (X1)
- Mutual unsaturated reactance (Xm)
- Rotor unsaturated mutual reactance (X23)
- Second cage unsaturated reactance (X3)
- Polar moment of inertia (MW/MVA)
- Mechanical damping (p.u)
Additional input data

- User must also specify:
  - Approximate amount of stator losses relative to total losses (minor influence on final model)
  - Stator reactance relative to the motor reactance when rotor is blocked (minor influence on final model)
  - Artificial factor K not reflecting any physical motor parameter (see next slide)
Effect of the artificial factor $K$

- Influences the shape of the torque curve and the current amplitude ($I_s$) during the start-up

- Figure shows torque and current for two different $K$ values
Verification

The verification part of the spreadsheet presents curves and percent error between desired quantities and model quantities:

- **Rated speed**
  \[
  \frac{N_v - N_{\text{rated}}}{N_{\text{rated}}} = 0.0028\%
  \]

- **Start torque**
  \[
  \frac{T_{\text{start, Nm, v}} - T_{\text{start, ref, T, rated, Nm}}}{T_{\text{start, ref, T, rated, Nm}}} = 1.3268\%
  \]

- **Power factor**
  \[
  \frac{\cos \phi_v - \cos \phi}{\cos \phi} = 0.1868\%
  \]

- **Output power**
  \[
  \frac{P_{\text{mech, kW, v}} - P_{\text{out}}}{P_{\text{out}}} = 0.2052\%
  \]

- **Efficiency**
  \[
  \frac{\eta_v - \eta}{\eta} = 0.0183\%
  \]

- **Start current**
  \[
  \frac{|I_{\text{start, v}}| - |I_{\text{start}}|}{|I_{\text{start}}|} = 0.0096\%
  \]

- **Rated torque**
  \[
  \frac{T_{\text{rated, Nm, v}} - T_{\text{rated, Nm}}}{T_{\text{rated, Nm}}} = 0.2079\%
  \]
This memo presents a method for estimation of parameters for the induction motor-model in the PSCAD/EMTDC simulation software.

The parameter estimation is based on the following motor data:

- Rms rated phase voltage
- Rated output mechanical power
- Rated electrical frequency
- Efficiency at rated operation
- Rated power factor
- Number of poles
- Rated speed
- Start current (relative to rated current)
- Start torque (relative to rated torque)
- Inertia

In addition it is possible to “tune” one free input variable to get a desired break down torque (peak torque)

The method is implemented in a Mathcad spreadsheet. The spreadsheet also includes a verification part. It is therefore possible to directly see the resulting performance data of the model including a torque-speed curve

The estimated parameters are those needed for “Explicit” parameter specification in the induction motor model in the PSCAD/EMTDC simulation software. This method of specification gives behaviour much closer to the input data than the alternative “EMTP Type 40” parameter input that are found in the PSCAD/EMTDC simulation software.
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