SENSITIVITY OF CHARACTERISTICS TO CHANGES IN RESISTANCES AND REACTANCES OF AN INDUCTION MOTOR

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The international standards set recommended limits on the variations of the parameters given by manufacturers. These limits are given as percentage tolerances, and their recommended values are generally not too difficult to achieve. IEC60034 part 1 describes the requirements for duty (as S1 to S9), ratings, operating conditions, temperature rise, tolerances and the like for rotating electrical machines. Regarding tolerances its section 9, Table VIII, gives values for the performance parameters such as losses, running power factor, slip, locked rotor current, locked rotor torque, breakdown torque, pull-up torque and moment of inertia. The standard does not set tolerances on the particular resistances and reactances of the equivalent circuit. In order to show how sensitive the torque–speed and stator current–speed curves are to changes in impedance values, Figure 1 was prepared for a typical 200 kW two-pole motor of the Design D type. The six components R_1, X_1, R_2, X_2, R_c and X_m were individually increased by 20% from their nominal values and the appropriate slip recalculated so that the nominal shaft output power was re-established. The following can be seen: changes in R_1, R_c and X_m have little effect; changes in R_{20} and R_{21} increase the starting and run-up torque, but only change the current by a small amount; changes in X_1, X_{20} and X_{21} reduce both the torque and the current.

The functions $R_2(s)$ and $X_2(s)$ can be approximated by the following simple linear expressions:

$R_2(s) = (R_{21} - R_{20})s + R_{20}$ and $X_2(s) = (X_{21} - X_{20})s + X_{20}$,

where the suffix $_1$ refers to the standstill value, and suffix $_0$ to the full-load value.

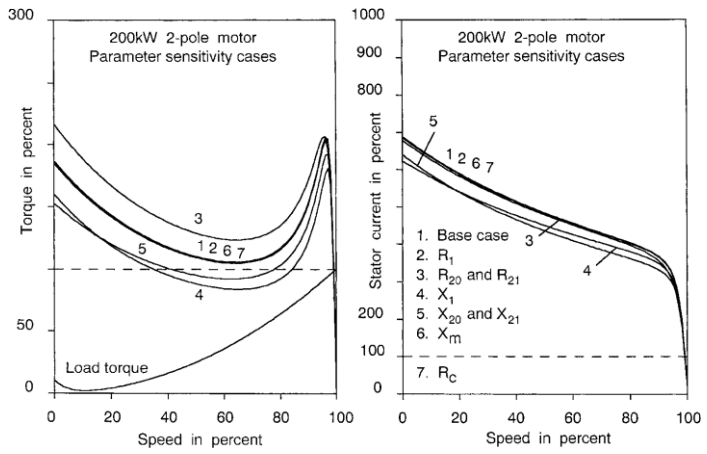

Figure 1 Sensitivity of the torque and current versus speed curves to a 20% increase in the nominal value of the resistance or reactance for a 200 kW two-pole motor

A 22 kW two-pole motor drives a water pump and is supplied from a 415 V, 50 Hz power system. Assume that there is no voltage dropped between the supply and the motor. The full-load slip is 0,02208 per-unit. The following ohmic values apply at 415 V for an equivalent star-wound stator: R_1= 0,179, X_1 = 0,438, R_{20} = 0,0145, X_{20}= 0,823, R_{21} = 0,253, X_{21}=0,333, R_c= 115, X_m = 17.

References:

1. Handbook of Electrical Engineering: For Practitioners in the Oil, Gas and Petrochemical Industry. Alan L. Sheldrake, 2003 John Wiley & Sons, Ltd.