"DEEP-BAR FACTORS" OF INDUCTION MOTORS

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The resistance R_2 and reactance X_2 of induction motors are designed by the manufacturer to be functions of slip, so that they take advantage of what is called the 'deep-bar' effect. If the rotor bars are set deep into the surface of the rotor then the rotor resistance R_2 is not so influenced by surface eddy currents, and the rotor leakage reactance X_2 is relatively high due to the depth of the slot which gives a low reluctance path across the slot sides for the flux produced by the bars.

Conversely if the conductors are set near to the surface then R_2 becomes high and X_2 becomes low for a given slip. Some special motors actually have two separate cages in their rotors. These are called 'double-cage' motors and are used for driving loads that have high and almost constant torques, such as conveyor belts and cranes. Modern motors utilise the principle of deep bars by designing bars that are shaped rather than simple round bars. The shapes, or cross-sectional areas, are arranged to be narrower at the surface than at their bases. Manufacturers tend to have their own preferences for the shapes and geometries of the rotor bars.

The ratio of the standstill values of $R_2(s)$ and $X_2(s)$ to their full-load values are called the 'deep-bar factors' which are:

deep-bar resistance factor $u_{r2} = R_{21} / R_{20} > 1$;

deep-bar reactance factor $u_{x2} = X_{21} / X_{20} < 1$,

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

The values of these factors vary with the kW rating and number of poles for the motor, and from one manufacturer to another. Figures 1 shows the variations in the deep-bar factors for a range of motor ratings from 11 kW to 11 MW, taken from a small sample of typical oil industry two-pole and four-pole motors.

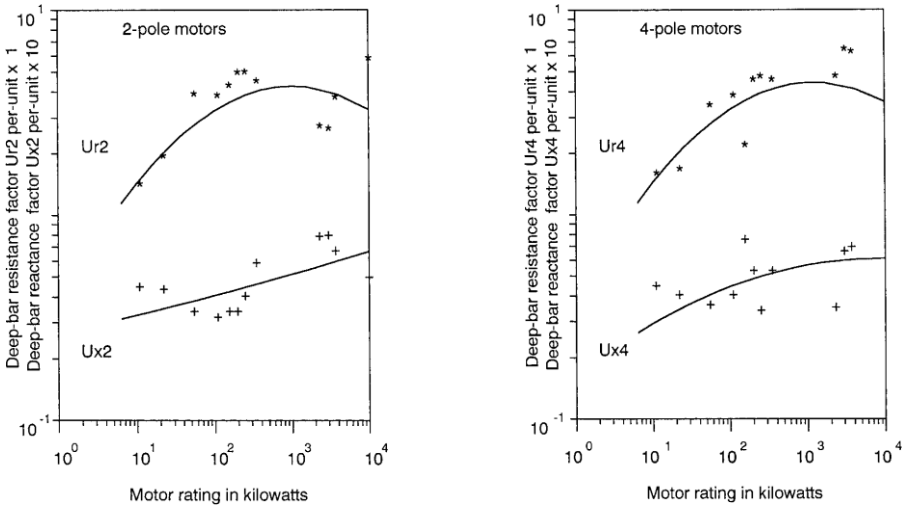

Fig. 1 Approximate deep-bar resistance and reactance factor curves for two-pole and four-pole motors rated from 10 kW to 10 MW.

Literature:

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