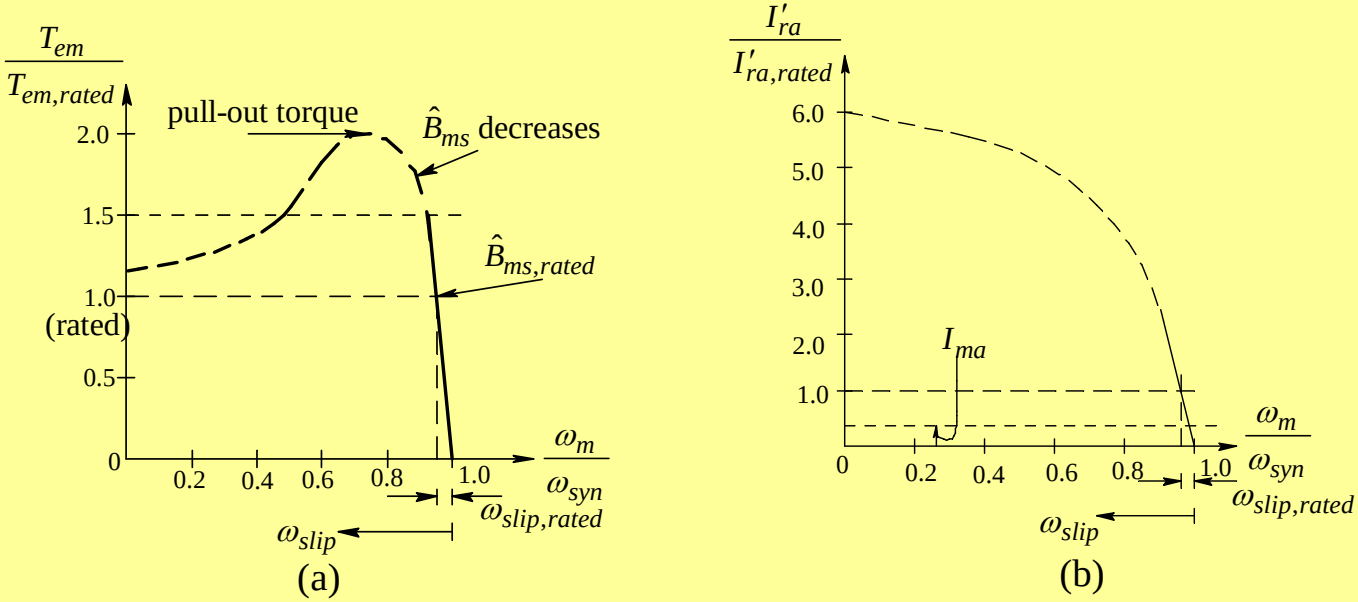
Induction Motors:
Balanced, Sinusoidal Steady State Operation

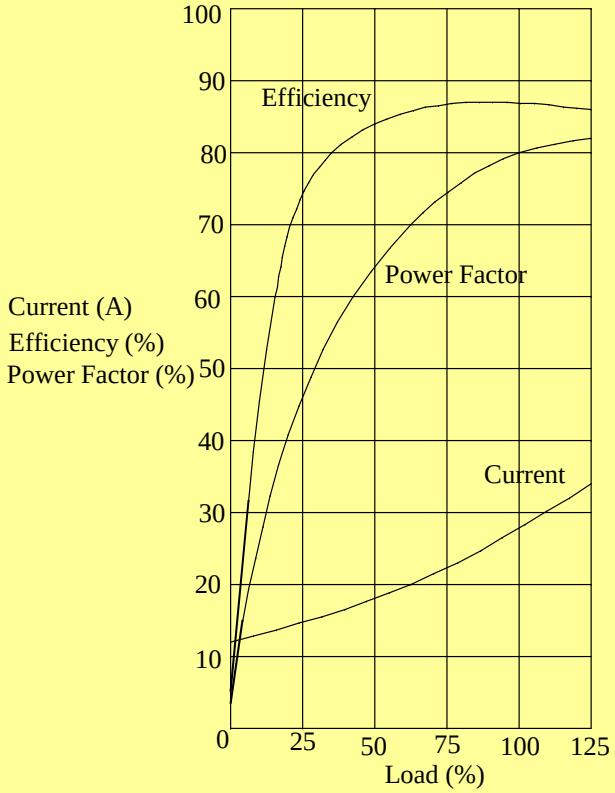
- Line-Fed Operation
  - Characteristics at rated voltage and rated frequency
  - Motor Currents, power factor and efficiency as a function of load
  - Line Start
  - Soft-Start

Characteristics at Rated Voltage and Rated Frequency



- Nearly linear near ω_{syn}
- At higher slip (ω_m smaller) leakage inductances and stator resistance reduce torque
- High currents at low speeds (start-up condition)

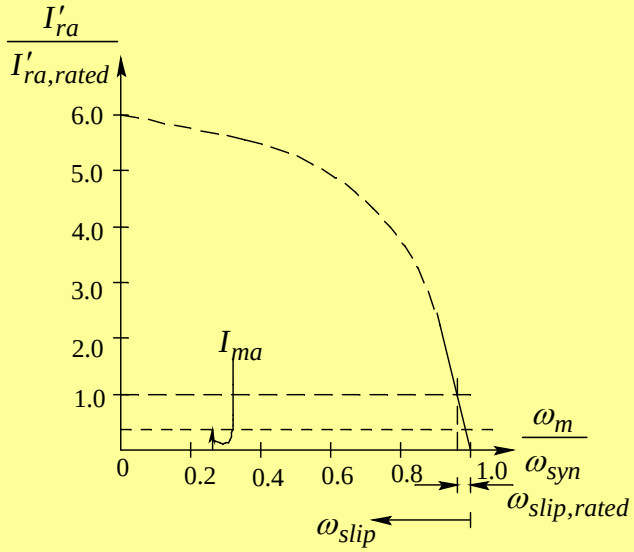
Motor Currents, Efficiency, Power Factor As a Function of Load



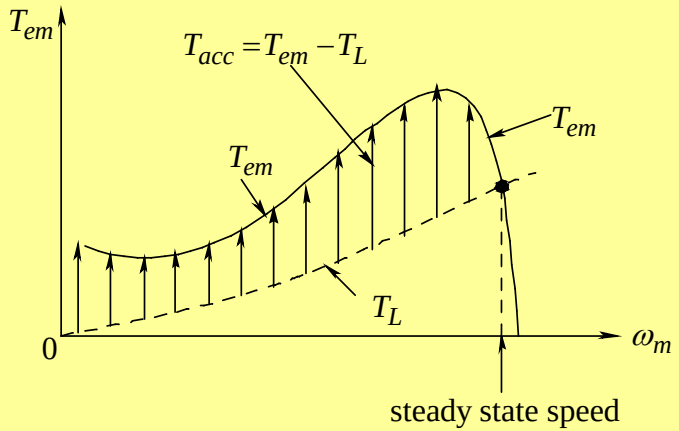
Typical for design B 10 kW, 4 pole, three-phase induction motor

Line Start

- When started directly off the line, induction motor draws a very large current (approx. 8 x rated)
- At the same time the torque available to accelerate the motor/load is limited
- Motor can quickly overheat – Solution: Reduced voltage soft start

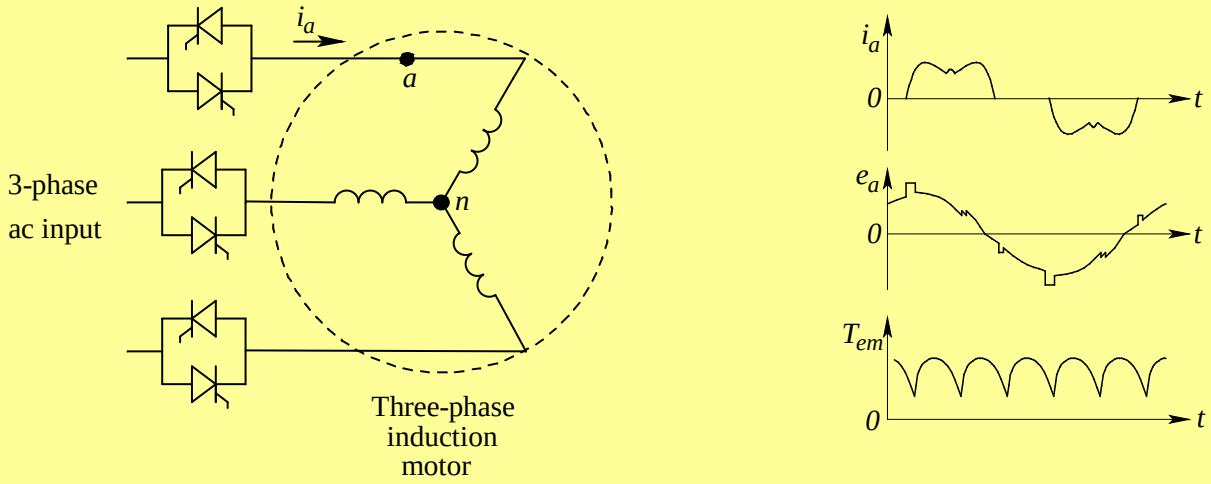


Current vs. Speed



Accelerating Torque

Reduced Voltage Starting (Soft Start) Energy Savings in Lightly – Loaded Machines



- Circuit applies reduced voltage to motor during start-up to avoid large currents and over heating
- Circuit also used to reduce voltage to motor under light load steady state conditions. This improves efficiency

Summary

- Line-Fed Operation
  - Characteristics at rated voltage and rated frequency
  - Motor Currents, power factor and efficiency as a function of load
  - Line Start
  - Soft-Start