Overview of Energy Saving Motor Technologies Emerging on the Market

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MAIN TYPES OF ELECTRIC MOTORS

DC MOTORS

- CONVENTIONAL DC MOTORS
- PERMANENT MAGNET DC MOTORS

AC MOTORS

- SQUIRREL-CAGE INDUCTION MOTORS (used in more than 90% of the industrial applications)
- WOUND-ROTOR INDUCTION MOTORS

- PERMANENT MAGNET SYNCRONOUS MOTORS
- SYNCHRONOUS MOTORS WITH SEPARATED EXCITATION
- SWITCHED RELUCTANCE MOTORS

DOMESTIC APPLICATIONS

- TERTIARY AND SERVICES
- PUBLIC FACILITIES (WATER PUMPING AND TREATMENT PLANTS)

INDUSTRIAL APPLICATIONS

- 0.1 kW
- 1 kW
- 10 kW
- 100 kW
- 1000 kW

Power
Technology Categorisation – AC Motors

- Induction
  - Squirrel Cage
  - Wound Rotor

- Synchronous
  - Separated Excitation
  - Permanent Magnet
    - Line Start
    - EC
  - Switched Reluctance
Permanent Magnet Synchronous Motors
Permanent Magnet Synchronous Motors

TORQUE-SPEED CURVE OF BLDCs
Main advantages:
• Excellent torque-speed curve;
• Excellent dynamic response;
• High efficiency and reliability => low maintenance;
• Longer lifetime;
• Low acoustic noise;
• High speed capability;
• High torque/volume ratio or high power density.

Main disadvantage:
• High cost
• Need of a controller for EC. LSPM no need
PMSMs are applied in areas where it is necessary high efficiency e low maintenance, as well as good dynamic performance and high power/weight ratio.

• EXAMPLES OF APPLICATIONS:
  • Automobiles: fuel pumps, traction, etc.;
  • Aeroespatial: pumps, robotics, etc.;
  • Industry: automation, CNC machines, fans, pumps and compressors, etc.;
  • Medical equipment;
  • Domestic and commercial equipment: washing and drying machines, HVAC, computers, etc.;
EC PM Vs high Efficiency Induction Motors

- MEPS for AC motors starting from June 16, 2011: IE2
- MEPS for AC motors starting from January 2015: IE3 or IE2 + VSD

- EC: "2-pole"
- EC: "4-pole"
- EC: "6-pole"
- IE3: 4-pole
- IE3: 2-pole
- IE3: 6-pole
- IE2: 4-pole
- IE2: 2-pole
- IE2: 6-pole

Shaft power: 0.2 0.3 0.4 0.5 0.6 0.8 1 2 3 4 5 6 7 8 [kw]

Efficiency: 75 80 85 90

VSD
EC PM Vs high Efficiency Induction Motors

- **Efficiency class IE2**
- **Motor efficiency without electronics**
- **AC 1,1kW***
- **EC 1,1kW***
PM and Induction Motors

![Graph showing efficiency of different motors at 1500 RPM.](image)

- **Inverter-fed IE3 Motor**
- **Inverter-fed IE2 Motor**
- **Inverter-fed PM Motor**
- **Inverter-fed IE1 Motor**

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PM Motor Part-Load Efficiency

![Graph showing efficiency vs. speed for different motor types. The graph compares Inverter-fed IE2 Induction motor and Inverter-fed PM motor.]
LSPM motors

• Hybrid motor with squirrel cage rotor fitted with high energy permanent magnets (NeFeB) making it suitable for direct on line start

• Interchangeable with induction motors (same output x frame ratio, similar starting torque)
Commercial LSPM motor at rated voltage

Source: ISR-UC

Line-Start PM Motor
3 kW, 400 V, 50 Hz

Ambient Temperature: 25°C

- Efficiency
- Power Factor
- IE3 Efficiency
- IE4 Efficiency
LSPM motors

**Efficiency - 4 poles - 50 Hz - IEC**

<table>
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<tr>
<th>Frame</th>
<th>Efficiency (%)</th>
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<tr>
<td>80</td>
<td>84,2</td>
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<td>80L</td>
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<td>L90S</td>
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<td>90L</td>
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<td>90,4</td>
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<tr>
<td>112M</td>
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<td>132S</td>
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<td>132M</td>
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<tr>
<th>Rated output (kW)</th>
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<th>1,5</th>
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<tr>
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</table>

* Upcoming IE4 levels

Efficiency values shown are according to IEC60034-31 ed 1 - DTS - FE
Switched Reluctance Motors

An SR motor is a doubly salient design with phase coils mounted around diametrically opposite stator poles. Energisation of a phase will cause the rotor to move into alignment with the stator poles, so minimizing the reluctance of the magnetic path. As a high performance variable speed drive, the motor's magnetics are optimized for closed-loop operation. Rotor position feedback is used to control phase energisation in an optimal way to achieve smooth, continuous torque and high efficiency.
Switched Reluctance Motors

**Main advantages:**
- High efficiency;
- High torque and high speed capability;
- High reliability and long lifetime;
- Simple construction, robustness;
- Low cost;
- Simpler controller (1 power switch per phase);
- High power density;
- Available in different sizes and shapes.

**Main disadvantage:**
- Ripple torque, high vibration level and high acoustical noise
- The controller is always necessary.
Main applications:

- centrifugal machines
  - Compressors
  - Pumps
- washing machines,
- vacuum cleaners,
- vacuum pumps,
- HVAC,
- variable-speed drive systems,
- machine-tools,
- automation,
- traction,
Typical efficiency at 7.5kW

Constant 50Nm torque to 1500 rev.min, constant 7.5kW power thereafter