High-Speed, High-Power Motor Elements for Turbomachinery

Permanent Magnet Motor Elements

Permanent Magnet (PM) Motors and Generators are the most common choice for turbo-machinery applications.

PM configurations offer higher efficiencies, higher speeds, larger rotor bores, lower rotor temperatures and increased power densities over induction machines.

Rotors can be installed quickly without prior thermal treatment of the rotor or shaft, and PM rotors can be removed and reused.

Rotors are typically made of carbon fiber overwraps of steel cores populated with high-temp permanent magnets, or covered with the new MEBA™ metallic rotor sleeve.

Permanent Magnet Synchronous Motor Elements are available in 2-, 4-, 6-, or 8-pole configurations (same as Induction Rotors and Stators) for high-performance turbomachinery applications.

Induction Motor Elements

Induction motors are the "work-horses" of the rotating machinery field. Simple, rugged construction and the ability to handle high temperatures allow them to withstand difficult environments.

2-pole machines tend to be smaller, simpler motors running at high speed; but larger, higher power motors can also be constructed in this configuration. The attraction of the 2-pole design is the ability to use a lower frequency (less expensive) drive.

4-pole machines are high-performance, high-power devices with large rotor bores, and offer a greater energy density than 2-pole machines; 6/8 pole motors are for high-torque, lower speed applications.

Stators

The same stators are used for both induction and PM systems. Stators can be constructed with 3-phase or 6-phase windings, with potted end caps (ENCA™), potted and covered end caps (ALKA™) or end caps with no coverings. Stators are made of slotted steel laminations, then hand wound to specifications.

ENCA™ stators with potted end-caps.

Stators are hand wound in 3-phase or 6-phase winding configurations. Hand winding offers significantly higher wire densities than machine wound alternatives, resulting in higher energy densities for the equivalent footprint.

ALKA™ stators have a patented end-cap technology that covers the end windings and pots them under vacuum with a resin filling. Since a majority of the stator heat is contained in the end-windings this technology allows the best heat transfer out to a cooling jacket.

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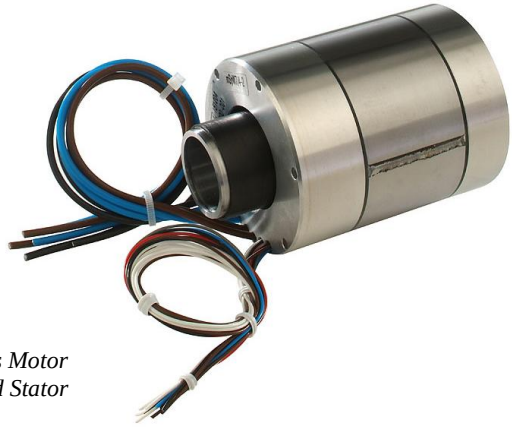
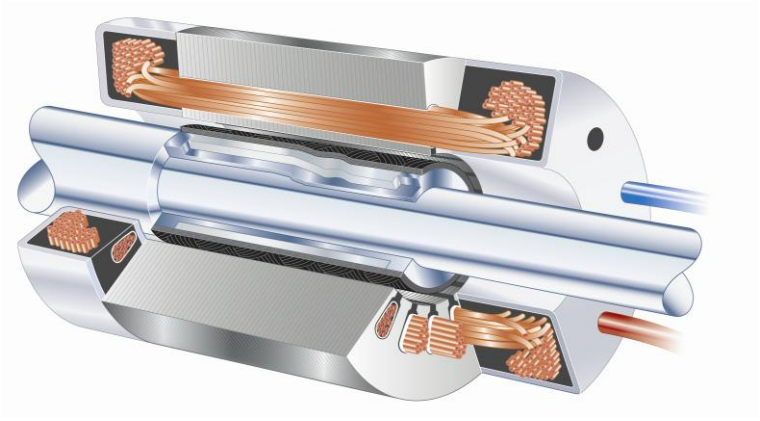
Examples of e+a Applications with Motor/Generator Elements:

- **500K+ RPM portable generator** – generator set for portable energy generation (man packable, f1>8K Hz)
- **Fuel Cell Air Supply Unit** (compressor application), 12KW @ 120K RPM
- **Gas & Oil Supply Industry** (200kW @ 21krpm)
- **Motor-Generator** (prototype for test purposes) – 100 KW @100K RPM. Rotor circumferential speed > 400 meters/sec.
- **Energy Generation & Storage**: 350KW @ 28K RPM
- **Machine Tool Applications**: 100KW @ 20K-40K RPM; 140 KW @ 18K-30K RPM
- **Laser Light Application** (vacuum unit) 35 KW @ 70K RPM
- **High-Speed Blower** – 70K RPM
- **Micro-Turbines** – 35KW – 500KW at various speeds
- **Compressor**: 200 kW @ 21K RPM



Permanent Magnet Synchronous Motor Elements: Rotor and Stator



Schematic Cutaway of Permanent Magnet Rotor and Stator Showing Carbon Fiber Wrapped Rotor, Stator Windings, Shaft and ALKA ™ Sleeve over End Windings.

The design of the complete system is the customer's responsibility, but e+a provides advice and support in most aspects of permanent magnet synchronous and induction machine design, including the following areas:

- Parameter settings for frequency converters
- Calculation of interference fits
- Test of a prototype on an e+a test bed (additional cost)
- Mechanical installation of a shaft on a PM rotor
- Guidelines for machining motor elements
- Aligning a PM rotor inside a stator
- Typical water jacket designs
- Machining rotors and stators
- Thermal issues

Type	Stator OD [mm]	Stator Total Length [mm]	Power [KW]	Speed [RPM]	Efficiency %
mSpW24/24-4	240	342	500	24,000	97.6
mSpW20/30-4	200	386	400	30,000	97.5
mSpW20/22-4	200	306	320	28,000	98.1
mSpW17/25-4	170	333	300	35,000	97.4
mSpW17/25-2	170	333	200	45,000	96.9
mSpW20/22-4	200	306	200	21,000	97.6
mSpW13.5/15-2	135	235	100	60,000	96.4

Examples of PM Motor/Generators in Production

Carbon Fiber Rotors for PM Machines

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