Flywheel Energy Storage

An Opportunity for the Automotive Industry and Beyond
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Properties of Flywheel Energy Storage Systems (FESS)

Advantages:
- High power density
- High cycle life
- Uncritical deep discharge
- Precise SoC determination
- Easy SoH determination
- Good recyclability

Disadvantages:
- High self-discharge
- Low energy density
- High costs

System Analysis

Components and Auxiliaries of FESS

Identification of Critical Components

Component | Current Problems | Development Targets |
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1. Bearings | Magnetic bearings result in high costs and control system complexity. Rolling element bearings are an economic alternative, but represent the only part subject to mechanical wear, which also defines self-discharge. | Reduction of torque loss while improving service- and lubrication life time. |
2. Rotor | In order to reach the desired threshold energy density higher rotational speeds are required. This results in high costs caused by intricate manufacturing methods and materials (fiber composites). Rotor burst poses a safety risk. | Cost reduction and increased rotor speeds. Optimized inherent safety and improved burst/crash behavior. |
3. Housing | The housing contributes the largest share to the FESS’s weight of all components and hence reduces the specific energy of the system. Furthermore, it is a safety-critical component, relevant for approval of the technology in the automotive industry. | Weight reduction while maximizing safety in the case of rotor burst or vehicle crash. |

1. FESS Bearing Design

Mass imbalance forces can be mitigated by a resilient bearing mount and super-critical rotor operation:

Rotor and Bearing
- Ceramic hybrid bearing
- Rotor end-plates
- Threads for balancing
- Axial bolts
- Metal sheet stack

Resilient Bearing Seat
- Temperature leads
- Coolant port
- Seals for axial pre-stress springs
- Bearing seat
- Silicone ring

Values determined for a representative case (rotor with 11 kg mass, balancing quality class G=2.5 and max. speed 60,000 rpm).