

The structural design of composite flywheel

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Background

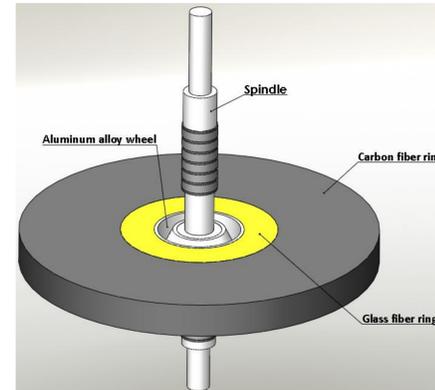
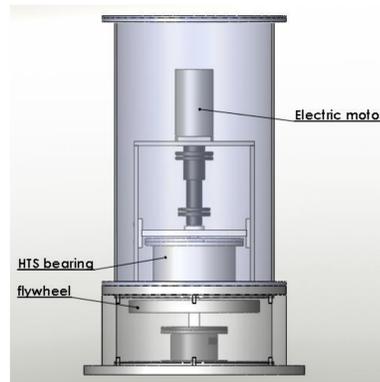
Composite flywheel is a novel energy storage device which can realize energy conversion between mechanical energy and electric energy. It has many advantages including high energy storage, high power, no pollution, high storage efficiency, noise free , wide application , long cycle life, and so on. The subject studied in this paper is a 0.5MJ/10000r/min superconducting composite flywheel energy storage system. Use the ANSYS finite element analysis software to set up the composite flywheel rotor model, extract the radial stress along the radius direction, circumferential stress and shear stress under the condition in maximum rotation rate. The results show that composite material can be well used for the high-speed flywheel structural design

Objectives

- ❖ 0.5MJ/10000r/min superconducting composite flywheel energy storage system.

Structural

Composite flywheel energy storage system. It is made by HTS bearing , electric motor and flywheel



The flywheel is made by composite material flange and aluminum alloy wheel

The composite material flange is composed by two parts; the inner edge is glass fiber ring and the out edge is carbon fiber ring.

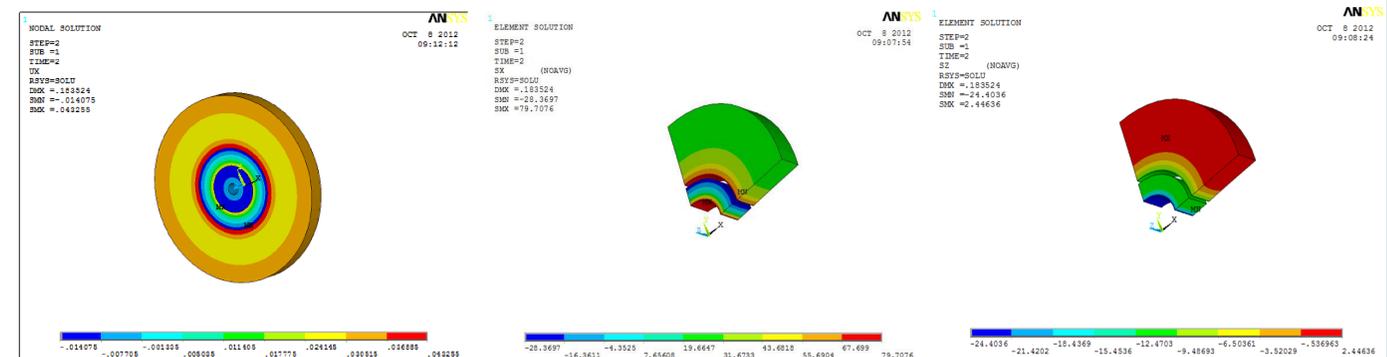
Conclusion

- ❖ Composite material such as glass fiber and carbon fiber has characteristics of low density and high strength. Currently it is the first choice for the manufacture of the flywheel.
- ❖ Composite material is twined along the circumferential direction, so the circumferential modulus and circumferential allowable stress are high, but the radial modulus and radial allowable stress are low. Using multilayer composite material concentric rings assembly methods could improve the distribution of the radial stress.
- ❖ Composite flywheel has large margin in strength distribution and stress distribution under the highest rotor speed.

the mechanical properties of the composite material

Property	Units	Carbon fiber	Glass fiber
Radial modulus	Gpa	120	40
Circumferential modulus	Gpa	9	9
Shear modulus	Gpa	4.8	4
Poisson's ratio		0.3	0.3
Radial tensile strength	Mpa	1600	1200
Radial compression strength	Mpa	900	900
Circumferential tensile strength	Mpa	19	19
Circumferential compression strength	Mpa	80	80
Shear strength	Mpa	50	50

The strength and stress conditions under the highest rotor speed



Radial displacement(The maximum is 0.31mm)

Circumferential tensile strength and compression strength(The Maximum tensile strength is 79Mpa and strength and the Maximum compression strength is 28Mpa)

Radial tensile strength and compression strength (The Maximum tensile strength is 2.4Mpa and strength and the Maximum compression strength is 24Mpa)

Results