Control the Output of an HTS Dynamo with a DC Background Field

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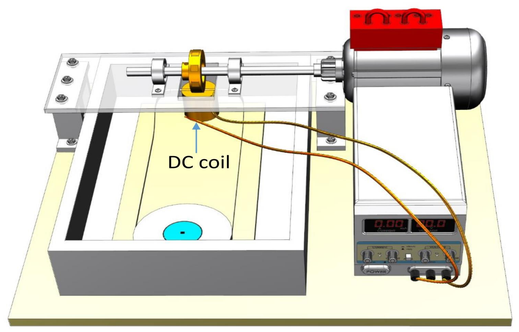
Corresponding author：wei wang
weiwangca283@gmail.com

Hang Xu ， Wei Wang ， Chao Yang ， Hong Li， Chenghuai Wu， Run Long， Zhengxuan Yang， Chenlin Xiong
College of Electrical Engineering, Sichuan University, Chengdu china 610065

1.Introduction of key contents of the paper



- There are two key points in this paper:

1. The influence of AC traveling wave DC bias on superconducting coil charging experiment;
2. Accurate control of HTS current based on background magnetic field.

- Main content of the article:

Main contents: This paper presents a feedback control method of HTS motor based on background field, The main theoretical basis of this article [Wang et al. PHYS. REV. APPLIED 9, 044022 (2018)],which can control the current in superconductor flexibly and accurately.

2. Introduction of experimental device

Introduction to key devices and principles:

- Introduction to fixed structure of disk, stator and DC coil

Disk:8 permanent magnets with N poles outward; Place in the air.

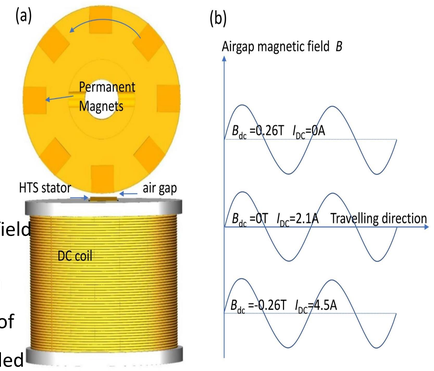
HTS stator: the criticalcurrent IC of the stator superconducting is 325 A in liquid nitrogen.

Hall sensor: measuring air gap magnetic field

DC coil: there is a rectangular iron core in the middle of the DC coil, which is made of electrical pure iron. 3500 turns of enameled wire were spared outside. It can provide a local and stable DC magnetic field. Placed in liquid nitrogen.

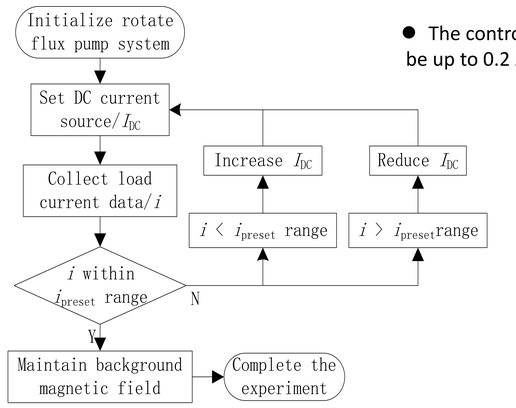
- The influence of background magnetic field on traveling wave DC bias is introduced

$$B_y(x,t) = B_a sin(kx - \omega t) + B_{dc}$$



3. Introduction to control methods

Superconducting coil current control flow chart



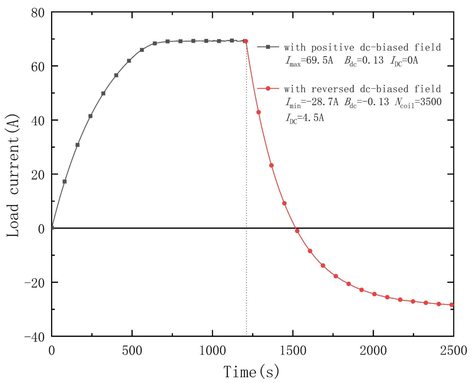
- The control accuracy can be up to 0.2 A

I_{DC}: DC power output value / A;

i: Real time current of superconducting double cake coil / A;

i preset range: preset range of superconductor current, including the maximum value and the minimum value;

4.Charging experiment under background magnetic field



Forward charging:

DC coil current = 0 A

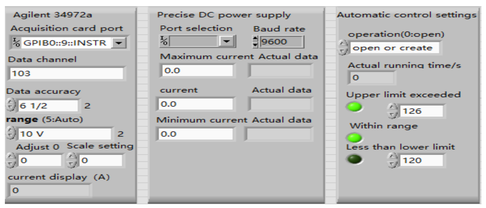
Reverse charging:

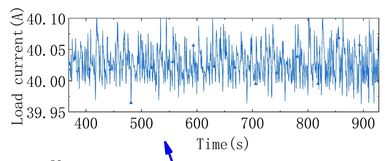
DC coil current = 4.5 A

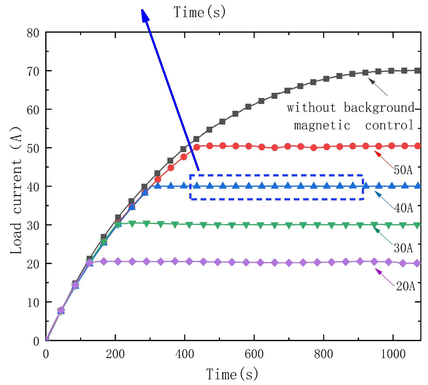
- The change of charging experiment of superconductor coil in background magnetic field;

1. The background magnetic field can change the current of superconducting coil
2. The background magnetic field can change the direction of superconducting coil current
3. The background magnetic field is provided by DC coil with iron core

5. Precise control of HTS current







- LabVIEW Program

1. Data acquisition and storage of data acquisition card.
2. DC current source control and program-controlled output.
3. Control algorithm setting

HTS current control is shown in the left figure:

1. Any current value can be controlled by the background magnetic field
2. The maximum control accuracy can reach about 0.2 A
3. The control method is very simple
4. This control method can not change the original inherent device

6. Conclusion

Experimental conclusion:

- We change the DC bias of the AC traveling wave through the background magnetic field. The experimental results clearly show that the AC current magnetic wave can only pump the magnetic flux into the superconducting closed loop with the help of the DC bias field.Advantages: simple structure, no need to change the original device structure, suitable for all traveling wave flux pumps.

- We designed an adaptive control system based on background field for the rotary flux pump device developed in the early stage. Without changing the working state of the flux pump system, the closed-loop current in the superconductor can be accurately controlled without contact by controlling the background magnetic field.Advantages: high accuracy (up to 0.2A), and the accuracy can be further improved through algorithm improvement in the later stage.

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