Linear Direct Current Electromagnetic Motor with Liquid Eutectic Gallium-Indium Alloy Coil

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Abstract

Abstract placeholder

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Contents

1 Introduction

Background

Soft robots important

Methods of locomotion all new, each with different advantages and drawbacks

Lack of traditional locomotion options

Liquid metal wired electromagnetic motors presents a possible solution

Transferral of existing robotics locomotion corpus to soft robots

Also presents a possible advantage re: cooling by circulating the wires

Question Statement

Is it feasible to build an electromagnetic motor using liquid metal for wiring that can also be cooled via circulating metal in the wiring?

Aims

Design, build and characterise an electromagnetic motor with liquid metal coils

2 Design, Manufacturing and Assembly

2.1 Mathematical Modelling

2.1.1 Motor Force

$$\mathcal{F} = \mathcal{R}\Phi \tag{1}$$

$$\Phi_0 = \int B \; dA \tag{2}$$

Under the assumption B is uniform, equation 2 becomes

$$\Phi_0 = BA \tag{3}$$

$$\begin{aligned} \mathcal{F} &= R_m \Phi_0 \\ &= \frac{l_m}{A_m} B_r A_m \\ &= l_m B_r \end{aligned} \tag{4}$$

A_m cancels out demonstrated in 4

$$\mathcal{F} = R_g \Phi \tag{5}$$

$$\begin{aligned} l_m B_r &= \frac{\ln \frac{r_{out}}{r_{in}}}{2\pi l_c} \Phi \\ \frac{2\pi l_m l_c B_r}{\ln \frac{r_{out}}{r_{in}}} &= \Phi \end{aligned} \tag{6}$$

$$\Phi = BA \tag{7}$$

Subbing equation 7 into 6 gives

$$\frac{2\pi l_m l_c B_r}{\ln \frac{r_{out}}{r_{in}}} = B_a ctive A_a ctive \tag{8}$$

$$A_a ctive = 2\pi l_c (r_{core} - r_{wireout} + 2r_{wireout} \frac{(layer+1)layer}{2}) \tag{9}$$

l_c cancels out

$$B = \frac{l_m B_r}{\ln \frac{r_{out}}{r_{in}} (r_{core} - rwireout + r_{wireout}(layer+1)layer)} \tag{10}$$

2.1.2 Heat and Temperature

2.2 Optimisation Algorithm

2.3 Physical Design and Manufacturing

wires
magnet

2.3.1 Shell

2.3.2 Core

2.3.3 Wire Bobbin

2.4 Assembly

2.4.1 Shell and Magnet Assembly

2.4.2 Wire Assembly

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3 Experiment Designs and Results

3.1 Experiment 1: Force Characterisation

3.1.1 Method

3.1.2 Results

3.2 Experiment 2: Circulation Thermoregulation

3.2.1 Method

3.2.2 Results

4 Discussion

application to the original physical situation

comparison with related problems and other solutions

Critical assessment of significance

difficulty of the problem and how well it has been tackled

[1]

5 Conclusion

6 Appendicies

References to previous works should be made in a consistent way. Specific references should be itemised in the Reference list, with any other more general material listed in a Bibliography. Only those books and papers actually consulted should be included. There are several variations on layout of reference lists; obtain advice from your supervisor and the library staff.

References

[1] J. Liu, "Liquid metal machine is evolving to soft robotics", *Science China Technological Sciences*, vol. 59, no. 11, pp. 1793–1794, Nov. 1, 2016, ISSN: 1869-1900. DOI: `10.1007/s11431-016-0696-7`. [Online]. Available: `https://doi.org/10.1007/s11431-016-0696-7` (visited on 05/02/2019).