Hong Kong Student Science Project Competition 2022

Team Number: SAPE265

Project Title: regenerative friction brake

Project Type: Invention

To our best knowledge and after thorough literature research, as at 4/7/2022 , there are / ~~are no~~ similar works. If there are, the reference links are as below:

- **https://ieeexplore.ieee.org/abstract/document/5686984**
- **https://www.sciencedirect.com/science/article/abs/pii/S0378775319313618**
- https://www.sciencedirect.com/science/article/abs/pii/S0196890419300470

The enhancement our project has made for the existing related products or research is summarized as below:

Our product is more durable than existing regenerative braking systems. Traditional regenerative braking systems can only be applied on hybrid and electric vehicles but our product can be applied on any combustion type vehicles, including gasoline cars and trains, making it more applicable.

I. Background

Regenerative braking systems can recycle wasted thermal energy from braking. However, traditional regenerative braking systems are restricted to hybrid and electric vehicles. Our product is made to break those limitations and is designed to be also applied on combustion vehicles, and even trains. Our product aims to address all car owners of combustion type vehicles, allowing them to conserve some of the energy they waste every day. Aside from making pre-existing technology more applicable, we aim to make the product more durable than previous technology to make it more cost efficient.

From our literary research we discovered the blend braking control strategy of the braking & heating system is established.

Moreover ,the performance of the system is tested by the simulation platform and vehicle tests.

Furthermore,the proposed system can offer higher regeneration efficiency.

In addition, we also discovered an electric KERS which makes use of a supercapacitor bank as an energy storage element for internal combustion engine vehicles .

The recovery efficiency of braking energy of the system increases from 23.8% to 65.3%, and the improvement rate of driving range reaches 81.4%.

Finally, regenerative braking systems can also save energy and provide higher efficiency for a car.

II. Objectives

To recycle wasted energy from traditional braking in vehicles and to allow it to be also applied on combustion vehicles, instead of only being restricted to hybrid and electric vehicles, unlike pre-existing regenerative braking systems.

III. Methodology

The product is made by melting the individual metals of each of the alloys within the thermocouple individually in the absence of oxygen, in order to prevent the metals from oxidizing during the process. It is then kept heated for an extended period of time to allow the liquid current to stir and mix the content. Next, the contents of the crucibles are poured onto 2 separate molds 15 minutes

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apart. The liquid metals are finally allowed to cool back down to room temperature. One of the metal plates cools down first, and is taken to one side to slightly polish, then pressed onto the still half-liquid other metal plate to allow them to fuse. After the entire thing is cooled down, the metal plate is taken to polish slightly.

IV. Design of Invention

Layers of different thermocouple anodes are stacked upon each other longitudinally, while the same happens with the respective cathodes for the types of thermocouples. Each layer is no thicker than 1mm. By doing so, the heat capacity difference of different thermocouple materials and their thermal conductivity difference allows for slightly higher energy generation than normal TEGs at an only slightly elevated cost. The invention works upon the Seeback effect(also called the thermoelectric effect), which allows certain metals to generate an electrical potential difference when their temperature change, creating a current based on the temperature difference within the metal. This is amplified by using two metals with different heat capacities, Seeback's coefficient and thermal conductivity, to generate more current flow with less temperature difference. By stacking different types of thermocouple anodes next to each other(as well as cathodes next to each other), the thermal conductivity difference, heat capacity difference and difference in material not only allow an increased resistance to the environment but as well as the power generation efficiency.

V. Application / Market Need

The product can be applied on any automobile that utilizes the traditional braking method, including combustion vehicles, trains, as well as mountain bikes, the application process is also relatively cheap and easy, making it more convenient for the user to apply on their vehicles. Moreover about 80% of vehicle sales in China are still combustion vehicles. Considering that a majority of vehicles in China are still combustion type, there is a large market need for the product. The large market need can also increase the impact of invention as the large number of users make it conserve more energy combined.

Besides from wear and corrosion due to acid rain, we can find no other limitations in our product based on our experiments.

VI. Conclusion

Based on our experiments, we have found out that the product has an energy efficiency of about 25.8%, allowing it to properly recycle the wasted energy during braking. We have also tested our product on multiple combustion vehicles, and the results show that it is also easily applicable to non-hybrid, non-electric vehicles. On the other hand, we believe that we should continue testing different types of thermal couples and try to make our product more efficient and as cost effective as possible. which shows that the proposed project has met the objectives. This shows that our objectives for the project have been completed but have yet to be perfected, and has lots of room for improvement.