Balloon - a reservoir of energy

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1 Introduction

Humanity is continuously searching for alternative sources of energy. However using wind or sunlight do not currently supply us with a sufficient amount of energy. Moreover, usage of energy in cities is also increasing. Energy use is different during days and nights, as well as dropping during weekends. That is why storing energy is inevitable. Today there are different ways of storing energy, however, they are ineffective or very expensive. The aim of my research is to find an effective and cheap way of storing energy.

$$F_{jet} = 2S(p - p_0)$$

2 Balloon – a reservoir of energy

In my research I wanted to determine whether it is possible to store energy in a balloon. I compared two methods of collecting energy – energy of compressed air in the balloon, and the elastic energy of a twisted balloon.

2.1 Energy of compressed air

When we put some air into the balloon, the volume of it increases. Air pressure inside the balloon is changing. First it is increasing very fast, then it is slowly decreasing to increase again in the end. We can approximately divide this process into three shorter processes: isochoric, adiabatic and again isochoric. After that simplification we can calculate the change of enthalpy of the air, which equals the gathered energy inside the balloon, as shown in Eq. (1).

I concluded that a balloon has some advantages, thus it might be a future alternative method of energy storage.

2.2 Elastic energy of a twisted balloon

In order to see whether the previous method is effective, I decided to compare it with another method, outlined in this section. I found out that twisting a balloon obeys Hook's law, as dependence between the force and number of twists is almost linear. In this case I also determined energy gathered [1] in a balloon – Eq. (2).

$$E = \pi r F n \quad [2]$$

3 Using gathered energy

In order to determine whether energy gathered in a balloon could be easily used, I built two vehicles.

Energy gathered in balloons made these vehicles move, so I could determine their effectiveness.

3.1 First vehicle

The first vehicle is using energy of compressed air in a balloon. Through a nozzle, some air escapes. Due to the principle of conservation of momentum, the vehicle starts moving. Jet force depends on the cross section of the nozzle and the difference of air pressure inside and outside the balloon (Eq. (3)) – it is changing all the time.

Surprisingly, a new balloon appeared to be [3] less effective than one that was already used a few times. After optimizing the relevant parameters, I measured the distance travelled by the vehicle and calculated its efficiency. The outcome was about 5.8%.

3.2 Second vehicle

The second vehicle looks extraordinary, but the way it works is simple. After twisting the balloon, it starts to untwist, causing the arm to rotate. However, ground makes a full rotation of the arm impossible, so the big tube starts to roll, moving the vehicle. In this case, after optimizing parameters, I estimated that the efficiency of this method for storing energy is approximately 25.9%.

4 Conclusion

A balloon is a toy everyone knows and has played with. The phenomena occurring as balloons store and release energy are

$$\Delta H = |\Delta W| + \Delta U$$

very sophisticated and interesting. It is possible to collect energy in a balloon through different ways, which are quite effective and cheap. The next step is to do the same in a macro state, so that balloons (special one's) could collect energy for a whole city.

References

[1] Joachim Gmyrek "Zbiór zadań z fizyki z rozwiązaniami", Politechnika Śląska, Gliwice 1995

[2] Jadwiga Salach "Termodynamika", Zamkor, Kraków 2004

[3] http://www.grc.nasa.gov