Contactless energy transfer systems

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1 Introduction

Energy management is one of the main concerns in modern devices and vehicles as we are aiming to optimize its consumption. For now, the main technology used to transfer electrical energy is by cable, but it has some limitations, as it adds a significant weight,is a huge waste of space, and it can be a big source of maintenance issues. Therefore, Contactless Energy Transfer Systems (CETS) have been studied and developed in a wide variety of industrial sectors.

2 Principle of CET

This technology is so far one of the main trend in electronic and electrical research fields and a lot of dif ferent tracks have been studied different results. We first have to know that managing electrical energy is noth ing more than just moving energy from a starting point to an other through a medium. In common systems, the medium is copper but air, water, body tissue, light waves or inductive fields can also be suitable [1]. To de cide which CETS to use, it may be useful to think in the application that the device is going to have, and the condition in which it will work as those are parameters that can influence its efficiency.

3 Types of CETS

There are four main types of CET, acoustic waves, light waves (also known as "optical waves"), inductive coupling and capacitive coupling.

3.1 Acoustic CETS

This technology uses sound waves as its main medium for transmitting energy. For this, instead of a plug-cage to insert a cable and transmit electricity, this technology uses a power circuit to transform the electrical energy into a pressure wave, which is "a wave in which the propagated disturbance is a variation of pressure in a mate rial medium"[1]. Then, a transducer receives this pressure wave, transforming the energy of the disturbance into electricity. For this, piezoelectric materials are usually used, since one of their main characteristics is to generate voltage out of pressure.

3.2 Light CETS

Light wave CETS use certain wavelengths to trans mit energy. This wavelength are usually in or near the visible spectrum [2]. A known system that uses this is a photovoltaic diode (PVD) paired up with an optical power beam. The beam is directed into the PVD and then transformed back into electric energy.

3.3 Inductive Coupling CETS

Inductive coupling CETS consist on a DC/AC resonant converter, the air gap in the transformer and the AC/DC converter. The DC is converted into high fre quency AC, then it varies with the "K" factor[2], and then converted back to DC. There are four types of induc tive CETS, depending on the way the transformers are used; cascade transformer, multiple secondary winding and sliding.

3.4 Capacitive CETS

Capacitive CETS consist on two primary and two secondary metal plates, and a high frequency resonant power electronic converter. The resonant converted gives energy to the primary plates, which are placed with the secondary plates near them, the secondary plates are isolated. An electric field is created, allowing a dis placement current to pass on from primary to secondary plates. An electric inductor may be added to in series with the secondary plates to increase the output power [2].

4 Comparison

The four types of CETS previously mentioned have advantages and drawbacks. The acoustic CETS can be more reliable than the others when certain frequency and size of transmitter and receiver are used, it can also be

[1] *pressure wave*. 2011. In *Merriam-Webster.com*. Retrieved October 8, 2018, from `https://www.merriam-webster.com/dictionary/pressurewave`.

[2] Coupling factor.

used where electromagnetic fields are not allowed, also it can be more efficient if the distance from the transmitter to the receiver is much larger than its the radio of each, whereas if the distance is smaller, they are less efficient. For light CETS, one disadvantage is that increasing the distance of transmission will increase losses because of diffraction. An advantage is that it can deliver huge amounts of energy over short distances. For the capacitive CETS, the plates act as an isolating barrier, making surroundings less of an issue. The constrained electric field also helps to redue electromagnetic interference.

5 Future use

CETS will imply a huge gain of weight and space in our vehicles and especially in aircraft. The only physical transfer systems left will be flow pipes like for example fuel pipes between the inner, outer and central tank of an airplane. These deletions may open up new horizons in design, aerodynamics studies or accommodations in our vehicles and lead us to a knew era with more efficient planes and vehicules.

The most concrete example is the Solar Impulse project launched in 2003, it was intended to create a plane which would be able to fly only with electrical engines days and nights. By adding photo voltaic cells on each wings (empennage included) they used a contactless energy (solar to electric) to supply the engine.

6 Conclusion

CETS are an upcoming technology that will reduce maintenance costs and increase reliability due to the removal of cables. It will also give more freedom of movement as it will help to reduce weight and space loss. Depending on the desired use, it is convenient to check each of the CETS advantages and disadvantages over the rest, to be sure that it will perform at its best. For vehicles, like planes, CETS will translate into a reduction of weight and wings might get a thickness reduction, as connection equipment will not be required, and also the drive range can increase thanks to the previously mentioned photo voltaic cells.

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