M10 AN IMPACTING ENERGY HARVESTER THROUGH PIEZOELECTRIC DEVICE FOR VELOCITY WATER FLOW

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Abstract
In this paper a new idea is proposed and studied to supply deep sea low-consumption devices using low-cost disk piezoelectric elements. The system scavenges energy from a water flow using piezoelectric materials and the characteristic undulating movement of bodies with pozitive buoyancy that are attached to the seabed with flexible cords, similat to an inverted pendulum. The piezoelectric components, together with the movement of the inverted pendulum, create an electrical power generator that harvests the mechanical energy brought by the sea movements. In addition, is studied to maximize the pendulums undulating motion by means of vortices produced by a cylindre situated upsetream. A prototype with the proposed electronic harvesting system is built and tested. The evaluation consist on testing the performance of the piezoelectric device and observe the electrical power generated.

Keywords— Energy harvesting, piezoelectric, sea currents, marine sensors networks, impacts.

I. INTRODUCTION

The increase of sea electronic instrumentation, system and sensor deployments to study the maritime medium has led to an era where powering these devices is a key point in order to minimize wiring or maintenance costs. Sea water motion provides big amounts of kinetic and potential energy that can be converted into electrical power. This conversion can be accomplished, between others, using piezoelectric elements, which deliver electrical charge from an applied deformation in their molecular structure. Because of the low frequency of the sea motion, usual bending piezo elements are not really convenient [1] and low-cost disk piezoelectric units are used instead in this work, together with a new impacting method. These piezoelectric devices produce electrical energy when a mass impacts them, providing higher power levels for low-frequency mechanical harvesting environments [2]. This is possible due to the resonance achieved in each impact if the element has the possibility to move freely at its center, where the impact occurs.

II. IMPACT PENDULUM-BASED ENERGY GENERATOR DESCRIPTION

As it was described before, the obtaining of energy in the proposed system comes from the deformation suffered by the piezoelectric disks due to the impacts of the physical pendulum. The energy harvesting device is placed inside a cylindrical body attached to the seabed with a flexible cord and oscilates in a curent flow as shown in Figure 1a.
The flow downstream of an object placed perpendicularly to a uniform current is characterized by the alternated and periodic detachment of vortexes (Kármán vortex street), as shown in Figure 1b.

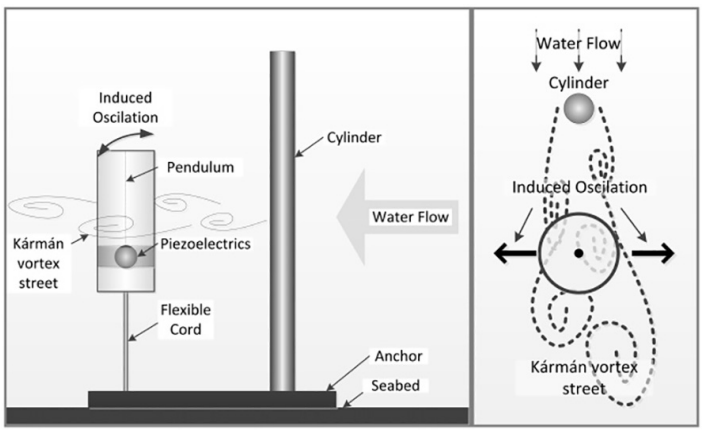

Figure Energy harvesting system. (a) Side view. (b) Top view.

n order to characterize the piezoelectric elements, a test-bench is built to control the mechanical energy provided by a free-falling ball which impacts a disk piezo element. This energy is calculated using the initial height, ball mass and final measured deformation, as well as subtracting the loss of energy due to the rebounds presented in the impact. Table 1 shows some results obtained from testing the impacts of different round bodies to the piezoelectric elements in a free-fall, using a 100MΩ probe.

Height [cm]	Weight [gr]	Voltage [Vpeak]	Rebound [ms]	Deform [um]
6	3.2	63.8	53.36	17.5
6	4.63	77	72.63	23.8
6	12.539	128	93.35	60
8	3.2	55.6	60.72	21.7
8	4.63	84	84.92	27.6
8	12.539	155	115.75	49.7
10	3.2	70	75.6	26.9
10	4.63	106	95.47	38.6
10	12.539	169	119.5	84.8

Table 1 is used to find the relationship between the output voltage and the applied force, calculated with the weight, height and deformation, where finally a mean value of V/F=754.4mV/N is obtained.

III. CONCLUSIONS

A new idea about harvesting energy from the ocean is proposed and evaluated, featuring the uncommonly used disk piezoelectric elements to obtain electrical energy from the sea motion using an impact-based system. Different tests are worked out to evaluate the impacts and piezoelectric elements. A prototype is built and tested in water tank, and the obtained results give hope to think that this system can be implemented and applied to power small nets of underwater sensors.

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