Study on Electromagnetic-type Shock Wave Generation in Liquid

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Abstract

This study aims at the design and development of an electromagnetic shock wave generator based on repetitive trigger of finite amplitude shock pulse in liquids. This device of shock wave generation consists of six capacitors with a voltage of 6kV, which discharges a DC current to a flat coil. An insulated metal disk is placed in close proximity to the coil and is mounted in a liquid-filled tube. Lorentz force induced by an eddy current in the metal disk repulses the disk away from the coil. Disk’s repulsive acceleration produces a shock wave which is focused to a target by using an acoustic lens. The design tasks of the electrical and control circuits for intermittent shock wave generation have been carried out in detail. Meanwhile, the safety problem of the high-voltage DC power supply system is also considered except that it is used for shock wave generation. By increasing capacitor’s capacitance to enhance storage energy level, a higher focused pressure (peak pressure) of shock wave can be achieved. All the necessary control signals, acoustic field, peak pressure and shock intensity in FC-40 fluid and water have been measured in experiments. The developed shock wave generator can produce focused shock intensities of 0.06 to 0.104 mJ/mm². The shock intensity may have a potential medical application for extracorporeal shock wave therapy, messaging and other aesthetic applications.

Keywords: Shock wave focusing; Electromagnetic shock wave generation; high-voltage power system; acoustic lens

1. Introduction

In the past three decades, shock wave has been applied as non-invasive medical therapy such as extracorporeal shock wave lithotripsy (ESWL) which almost replaced the traditional surgery in clinical urology with minimal morbidity and side effects [1, 2]. Consequently in recent years shock waves were applied to treat musculoskeletal disorders such as tennis elbow, plantar fasciitis, heel spurs, etc. [3-7] Thus, extracorporeal shock wave therapy (ESWT) is referred to the treatment of musculoskeletal disorders. Very recently, ESWT was applied to treatment of ischemic heart