A REVIEW ON APPLICATIONS OF SHOCK WAVE

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Abstract – *Shock waves are essentially non-linear waves that propagate at supersonic speeds. Such disturbances occur in* steady transonic or supersonic flows, during explosions, earthquakes, hydraulic jumps and lightning strokes. Rapid movement of piston in a tube filled with gas generates a shock wave. Any sudden release of energy (within few micro second) will invariably result in the formation of shock waves since they are one of the efficient mechanisms of energy dissipation observed in nature. The dissipation of mechanical, nuclear, chemical, and electrical energy in a limited space will usually result in the formation of a shock wave. When a shock wave is generated the pressure, temperature and density vary when the wave the gas molecules in its path can only move away from the front with the characteristic sound speed. Due to this effect the molecules will be carried along in the shock wave, and a flow in the direction of propagation results. A rapidly expanding gas, deriving its momentum from the release chemical energy as in a violent explosion, will generate shock waves. In a closed tube a shock wave may be generated by the sudden release of a gas at a high pressure into one at much lower pressure.

Key Words: Shock Wave, Supersonic, Hypersonic, Sound, Speed etc

1. INTRODUCTION

For designing aerospace vehicles flying at hypersonic speeds, it is very essential to have a proper understanding of the shock wave propagation and reflection dynamics. In the study of explosions, the blast wave signature is a very vital parameter, which dictates the strength of the explosions. Also shock waves are used for shockwave assisted gene transfer, preservative injection into wood slats, oil extraction, drug delivery, metal forming and reduction of bioburden in natural products. The typical signature of the overpressure in a biological medium comprising of bacterial cells and DNA, measured using a high sensitivity pressure transducer, we are discussing about the two main fields of shock wave applications, industrial and medical applications there are so many sub applications comes under these two major fields. Example for industrial applications such as aerospace industry, manufacturing industry etc... And the medical applications like shock wave therapy and kidney stone treatment etc[1-30].

2. INDUSTRIAL APPLICATIONS

The application of shock wave-assisted processes has gained considerable focus in recent years in industries. A variety of industrial processes use the property of shock waves to significantly change the thermodynamic state of a low pressure medium when they propagate through it. There are new developments not just in the applications of shock waves but also in the way they are produced[4].

The main fields that use the shock wave effectively are

- Explosive Welding
- Sandal Wood Oil Extraction
- Pencil Manufacturing Industry
- Metal Forming

2.1 Explosive Welding

Explosive welding method is well known as a technique to obtain clad materials with high bonding strength at the welded interface for the similar and dissimilar materials. Methods of explosive welding for a thin metal plate or foils using underwater shock wave have been developed by some of authors. In these methods' high explosive with 7 k/m detonation velocity is used to obtain the high underwater pressure to achieve good welding by the underwater shock wave. Therefore, geometric setup device such as the inclined reflector with a sheet-type high explosive is required to satisfy the weldable conditions, which the horizontal collision point velocity should be lower than the sound speed of the materials. In this study a new explosive welding technique using underwater shock wave generated by the detonation of the detonating code are proposed[4].

The underwater shock waves, generated by the explosive pack, should be controlled well so as to satisfy the conditions for explosive welding, and the details of this are discussed

2.2 Sandal Wood Oil Extraction

A new shock wave assisted oil extraction technique from sandalwood has been developed in the Shock Waves Lab, IISc, Bangalore. The fragrant oil extracted from sandalwood finds variety of applications in medicine and perfumery industries. In the present method sandal wood specimens (2.5mm diameter and 25mm in length) are subjected to shock wave loading (over pressure 15 bar) in a constant area shock tube, before extracting the sandal oil using non-destructive oil extraction technique[3,5].

In the present study, fresh samples of wood (referred as 'core samples') are drawn from standing trees using Pressler's increment borer. Core samples were drawn at breast height (1.37m above ground) from each of six different trees located in the Institute of Wood Science and Technology, Bangalore campus. The samples are further wrapped in blotting paper and kept in a desiccator till further experimentation to avoid absorption of moisture. During the present study two identical core samples are taken from each tree, exposing one of them shock waves while the other is used as a control specimen during the oil extraction studies[3,5].

2.3 Pencil Manufacturing Industry

Shock waves can also be used to push preservative solutions into wood samples like bamboo where conventional methods do not work. In IISc, shock wave assisted preservative injection system has also been developed for pencil manufacturing industry resulting in dramatic reductions in the process time. A new diaphragm less shock wave reactor has been developed for this application [1-7].

2.4 Metal Forming

The fabricated shock tube can be used for many industrial applications of shock waves. One such application is sheet metal forming. On the free metal forming using underwater shock wave by underwater detonation of explosive, we can make an experiment and the numerical simulation[1,6,8].

Underwater explosive metal forming is a type of metal forming technique that uses underwater shock wave from explosion of explosive in water to form the metal plate. The metal plate is accelerated to a high velocity after the action of the underwater shock wave, colliding with the die. During this process, the metal plate can obtain a great work-hardening effect. Based on this reason, the technique is superior to static forming techniques on the duplication of the shape of the die. die. Moreover, this technique can obtain appointed shape of materials using soft material dies, such as resins, plaster and paper. This technique profits to production of many kinds and quantity products[8-10].

3. MEDICAL APPLICATIONS

A shock wave is defined as an acoustic wave, at the front of which pressure rises from the ambient value to its maximum within a few nanoseconds.1, 2 Shock waves are characterized by high peak-pressure amplitudes (500 bar) with rise times of less than 10 nanoseconds, a short lifecycle (<10. MS), and a frequency spectrum ranging from 16 Hz to 20 MHz.3 After reaching the positive peak, the pressure rapidly drops to negative values within microseconds[7-8].

The main treatments that uses the shock wave effectively are

- Bile Duct Stone Treatment
- Cardiac Shock-Wave Therapy
- Extracorporeal Shockwave Therapy
- Treatment of upper urinary tract stones

3.1 Bile Duct Stone Treatment

Extracorporeal shock-wave lithotripsy (ESWL) is a successful method for the management of patients with bile duct stones when used in conjunction with other nonsurgical techniques. It was also the only treatment required in 56% of our patients [8].

Extracorporeal shock-wave lithotripsy is emerging as a new method in the nonsurgical treatment of choledocholithiasis. In the cases reported in the literature, ESWL was used almost exclusively when basket extraction (usually via an endoscopic approach) had failed[10].

3.2 Cardiac Shock-Wave Therapy

Clinical research in intriguing CSWT field continues since 1999, and several new trials are being published every year. The aim of this study was to summarize the results and also to evaluate the quality of currently accumulated evidence on the efficacy of CSWT on CAD treatment. This systematic review expands previously published analysis by including 23 recent studies, and confirms the beneficial effects of CSWT in a larger sample size of patients with stable CAD, an inclusion in meta-analysis studies with single clinical indication and a uniform treatment protocol, and assessment of bias risk in randomised trials.

3.3 Extracorporeal Shockwave Therapy

There is considerable controversy regarding the effectiveness of extracorporeal shock wave therapy in the management of plantar heel pain. Extracorporeal shock wave therapy (ESWT) was originally used for lithotripsy, but within the last 10 years has become increasingly used to treat musculoskeletal injuries including calcific tendinitis of the shoulder, lateral epicondylitis (tennis elbow), non-union or delayed osseous union and plantar heel pain[13].

In case of treatment of primary bone marrow enema syndrome of the knee the shock wave treatment was applied using an Electromagnetic Shock Wave Emitter (Dornier Compact DELTA II; Germany), with a penetration depth of between 0 and 150 mm and a focus diameter of 4 mm Shock waves were focused around (on the margins of) the femoral head under radiographic guidance. The treatment area was prepared with a coupling gel to minimize the loss of shock wave energy at the interface between the head of the device and the skin.

3.4 Treatment of upper urinary tract stones

Extracorporeal shock wave lithotripsy (ESWL) was introduced in clinical practice by Chaussee et al. in the 1980 s. Its usefulness is widely recognized, and it has become the most common treatment for upper urinary tract stones. ESWL has been performed more frequently than TUL for stone treatment in Japan compared with that in Europe and the United States (2008 General Meeting, Seminar of the Japanese Urological Association), which may be largely attributable to its simplicity and/or the National Health Insurance System in Japan.

4. CONCLUSION

The phenomenon of *shock waves* is commonly associated with aerospace engineering/astronautics and in particular with supersonic flight. Also, they have some of the recent emerging industrial and medical applications using artificially generated shockwaves in the laboratory.

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