



# The Effect of Ultrasound in Dislodging Radioactive Waste from DOE Pipelines



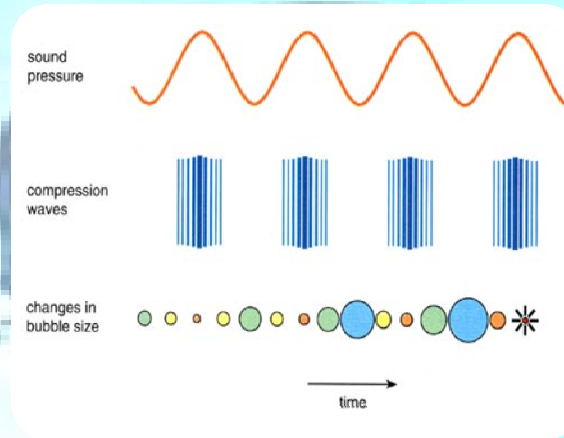
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## Purpose

To investigate the feasibility of a pulsed hydraulic system specifically designed to unblock plugged pipelines used by the Department of Energy to transfer radioactive waste.

## Method of Solution

Intense ultrasonic waves traveling through liquids generate small air cavitations that enlarge and implode, creating tremendous localized heat as well as a powerful jet stream. These conditions may provide a solution for clogged pipelines.



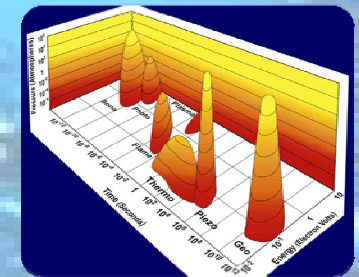
## Implosion

The implosion of an air cavitation occurs violently and in less than a microsecond. The gasses inside the bubble are compressed and generate intense heat, heating its contents to 5,500° C – near the temperature of the surface of the sun.

## Solid Surface in Liquid



The presence of the solid surface distorts the pressure from the ultrasound field so that a cavity implosion near the surface is asymmetric. This distortion generates a jet of liquid directed at the surface with a speed near 400 km/hr.



<sup>3</sup>Chemistry: the interaction of energy and matter. (<http://www.science.gov>)

## Acknowledgements

I would like to thank the Department of Energy Fellowship Program, Dr. Leonel Lagos, and my mentor Dwayne McDaniel.

## Overcoming Liquids Tensile Strength

Tensile Strength is the maximum stress that a material can withstand from a stretching load without failing. A liquid is held together by attractive forces, which determine its tensile strength. A cavitation or bubble occurs when a sufficiently large negative pressure associated with the expansion cycle overcomes the liquids tensile strength.

## Cavity Growth and Critical Size

When a bubble is irradiated with ultrasound wave, it absorbs energy from alternating compression and expansion waves and grows in size. The cavitations will oscillate in sync with the rhythm of the sound waves. Since the amount of gas that diffuses in or out of the cavity depends on the surface area, diffusion into the cavity during expansion will be greater than diffusion out of the cavity during compression. Critical size is when the bubble can no longer absorb energy and then implodes.

## Sonochemistry of Cavitations

Cavitations are the phenomenon of the formation of vapor bubbles of a flowing liquid in a region where the pressure of the liquid falls below its vapor pressure.

## Inducing Cavitations Through Ultrasound

Cavitation inception occurs when the local pressure falls sufficiently below the saturated vapor pressure, a value given by the tensile strength of the liquid. Ultrasound waves consists of compression and expansion cycles.

➤ Compression Cycle – Exert a positive pressure on the liquid by pushing the molecules together.

➤ Expansion Cycle – Exerts a negative pressure on the liquid by pulling the molecules away from one another. Cavitations occur in this cycle.