Steps in the Evolution of a 60-mm Cutting System

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The Waterjet system has been developed to fit between two steps in the Demilitarization By Inductive Heating Meltout (DIHME) system.

- Disassembly of round and cartridge
- WJ Disassembly
- Induction heating to remove charge
Abrasive waterjets have been found to be effective in cutting munitions. But need to be cut underwater if we are to avoid the noise and spread of abrasive and debris around the area.
Nozzle performance testing

By determining the time that it takes to sever the fuze end from the round, it is possible to optimize cutting performance.

Several slices were made on each shell
A full factorial experiment was carried out. Only 2 first order results are shown.

The experiment varies jet pressure, abrasive feed and rpm. Note that as pressure goes up, curve fitting shows the optimal rpm decreases from 18 to 15 rpm, though in all cases 18 rpm gives the shortest time for cutting.

At 1 lb/min and $3.00 a lb, a saving of 4 sec is $0.20 per shell.
Cost evaluation steps

• Abrasive cost - $0.60/lb (to buy)
• Abrasive disposal - $2.40/lb (flash, landfill)
• Water cost - $1.80/kgal
• Water disposal - $0.04/gal (carbon treatment)
• Energy cost - $0.20/kWhr.

a) Dan Burch, John Griggs, Mike Johnson, Greg Olson, David Summers “Abra
sive Waterjet Cutting Demilitarization of 40MM Projectiles” 1999 Global Demilita
rization Symposium & Exhibition, Tulsa, OK, May 20, 1999
b) Dan Burch, John Griggs, Mike Johnson Greg Olson, “Abra
sive Waterjet Cutting Demilitarization of 40MM Projectiles”, 2000 Global Demilitarization Symposium & Exhibition Coeur d’Alene, ID, May 18, 2000
Effect of abrasive concentration

Note that there is no change in the optimal concentration, when the pressure changes, (at 20% by weight ratio of abrasive to water). However this does mean that the abrasive feed rate should change with pressure to ensure the same concentration.
UMR designed and build a prototype fixture to:

- Section 4 x 40mm rounds simultaneously
- Develop a concept that can work for rounds in the size range from 20mm to 120mm.
- Rotate the rounds during cutting
- Make 2 cuts, to remove fuze and tracer ends
- Trim the ends to remove protruding TNT.
- Separate the cut parts to remove loose material
- Place the parts so that they can be picked up.
Must be able to rotate the rounds in the range from 1 - 25 rpm.

- Moving the rotating mechanism forward to grip and rotate the round requires a complex sealing structure.
- The rotation must take place with the presence of abrasive and high pressure water during cutting.
- Any gripping mechanism must also cope with the presence of abrasive in the surrounding water.
- The cutting will take place under water.
To control noise, and collect the abrasive, the shell is submerged, for cutting.

Note
Raising the water level is a standard procedure in cutting tanks and requires an air inflated bladder in a protected position in the tank.
The initial system used 2 diaphragm chucks to grip and a drive that rotated the shells from both ends.
Requirements

- The four 40 mm rounds must be on a 5 inch centerline to centerline distance.
- The longitudinal centerline axis of the four 40mm rounds must be located at 36” above the floor.
- The waterjet nozzles need to be 1” below the waterline during the cutting operations.
- Must have sensors that indicate when cuts have completed for each fuse/tracer on each round.
- Must interface with the waterjet robot end of arm tooling and hardware.
The initial holding and rotation fixture was changed

Figure 1

Figure 2

The fuse end chuck was replaced with an idling chuck.

The concept of maintaining the fuse end chuck as an idling component, significantly simplifies the mechanism.
The fixture that was built is meant to hold four rounds, and to rotate them under the nozzles. Drives are located in the end wells, and the rounds in the center well.
The original configuration, showing motors

Motors     grippers     rounds

TRACER END ASSEMBLY

FUSE END

CONTROLs*

TANK
The Holding & Rotation Fixture has been built
A set of drive motors is located at the end of the frame
The target rounds were then changed to 60-mm mortar rounds, which could be held from a single end.
Sensing the cut completion

By rotating from just one end, one can sense when the separation cuts are made, by noting when the rotation of the body of the round stops, and the fuze drops away.
Each individual nozzle has its own control valve

So that flow can be stopped as cutting is complete
And each also has a controlled abrasive hopper feed

This allows overall control of abrasive use for each nozzle
The cutting heads are mounted on an arm

The assembly on the arm is mounted on a post, and driven by a confined hydraulic system.

Arm in the open position

The fan jets (not shown in real pictures as they block the view) clean the area as the arm moves after cuts.
Hydraulic arm controls
Conclusions:

- A rotational speed of 18 rpm is recommended for process optimization.

- To simplify selection of an abrasive feed rate, an AFR of 20% abrasive, by weight, is recommended.

- The economics of operating pressure vs operating cost is a function of nozzle lifetime at different pressures. This is being investigated.

- At this AFR the cutting head position does not influence the cutting time.
Thank You for your kind attention