

# Densification

In 2011, the NDCEE evaluated four densification technologies for the Army. Waste streams generated at a military installation typically include one or more of the following: (1) canteen waste (food residues, liquids, paper and plastic items), (2) plastics (beverage bottles and containers, other service containers, packaging materials), (3) classified and unclassified paper documents, (4) other paper products, (5) waxed and unwaxed cardboard boxes, (6) classified and unclassified magnetic and optical media, and (7) wood pallets. The technology evaluation focused on two applications: (1) classified and sensitive waste such as those found at United States Army facilities and (2) typical municipal solid waste (MSW) found at combat outposts. The demonstrations used simulated examples.

## Problem Statement

Because the generation and disposal of solid waste consumes valuable time and resources that can negatively affect personnel safety and operational readiness, the DoD has aggressively explored and implemented many solid waste reduction solutions. While the DoD has successfully reduced the amount of solid waste that is being generated and sent to landfills or incinerated, no installation has a 100% diversion rate and no deployed forces have a zero solid waste footprint. In addition to addressing solid waste reduction requirements, densification technology could help contingency operations lower their fuel logistical burden, which in turn reduces the potential for insurgency attacks on fuel convoys.

## Technology Description

Densifiers are standard pieces of equipment in the recycling and waste management industries, increasing mass per unit of volume of the waste stream. Densification processes include shredding/grinding/particle reduction, compression, pelletizing, and briquetting.

In pelletizing, ground material is forced through a cylindrical die by rollers. In a flat die pelletizer, the die is stationary while the rollers push the material through; a ring die machine allows the rollers to stay stationary while the die spins, pushing the material through the rollers. The final product is a cylinder with a diameter between 6 and 8 millimeters and no longer than 38 millimeters.

Briquetting is a molding process that allows dried material to be compressed into a flammable block, which can be used as a source of energy or heat. A briquette machine works by applying pressure to the feedstock. The pressure generates some heat; with some machines additional heat is added from hydraulics and/or heaters. During compression, raw material in the feedstock liberates adhesives that allow the briquette to form. A briquette is at least 25 millimeters (approximately 1 inch or more) in diameter. Like pellets, briquettes are extremely compacted, making it easier to transport and store than loose raw material. A significant advantage of a briquette is its higher fixed carbon and calorific value.

Refuse-derived fuel (RDF) from the densification of waste materials can be used in many types of energy systems including coal/biomass boilers and some waste-to-energy (WTE) systems based on gasification or pyrolysis. Some WTE systems incorporate densification as part of the feedstock preparation process.

## Environmental, Safety, Occupational Health, and Energy (ESOHE) and Cost Benefits

**ESOHE Benefit.** Densification reduces waste volume and allows waste to be used as a resource, eliminating the environmental liabilities and risks of landfills and open burning. Using RDF supports energy conservation and energy security.



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**Cost Benefit.** The NDCEE conducted a cost-benefit analysis (CBA) evaluating two alternate scenarios using the four briquetter technologies. The four systems vary in cost from \$40,000 to \$400,000. Baseline costs were obtained or derived mostly from data provided by U.S. Army Garrison, Aberdeen Proving Ground, MD; alternative data were obtained or derived mostly from the equipment vendors. From a cost perspective, three of the four densifiers were shown to have a positive payback period ranging from 0.5 – 5.5 years. However, recovery costs from use of the energy value of the briquettes were not computed and, depending on the scenario, could impact the financial finding. Coupled with the non-quantifiable benefits of reducing landfill waste and realizing the energy value of the briquette waste to reduce fossil fuel usage, implementing any of the four briquetting technologies could prove to be a responsible and economically sound decision.

## Technology Benefits

- Makes waste easier to handle
- Optimizes transport logistics
- Reduces landfill costs
- Creates a RDF that can be used in some gasifiers and biomass boilers
- Is commercially available
- Has long life expectancies (some systems reportedly have been in operation for over 40 years)
- Is available in a range of configurations and sizes
- Is relatively simple and easy to operate
- Is compatible with existing Army infrastructure and systems and DoD/federal emission guidelines

## Technology Limitations

- Should be housed in a building or other shelter (e.g., ISO container)
- Cannot process glass and metals; a magnetic separator is used to remove metal
- Is usually coupled with a shredder, which can be noisy and generate dust depending on waste composition
- Limited ability to handle feedstock with high moisture levels (i.e., >30%)

## Accomplishments

- Conducted a feasibility study and worked with 11 DoD stakeholder organizations to better understand Army needs and identify general technology requirements for solid waste reduction
- Identified 15 vendors and 3 distributors with a densification technology potentially applicable to military requirements
- Between June and September 2011, demonstrated four densification technologies and two gasification systems, which used densification products
- Produced a Demonstration and Validation Test Report that documented test activities and findings as well as results from a CBA

## Technology Transition Opportunities

Major advancements in densification technology can help the military to meet its twin objectives of reduced MSW generation and decreased use of fossil fuel. Furthermore, the NDCEE demonstrations revealed that in the near future the military may have several mobile WTE options that meet both its technical and cost requirements.

## Points of Contact

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*The NDCEE tested four densification systems. As evident by these photos, briquette manufacturing differs per system. While product length and diameter varies per system, all of the systems meet Army technical requirements for processing solid waste.*



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