PERFORMANCE CHARACTERISTICS OF A VERTICAL HAMMERMILL SHREDDER

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This is a well written and comprehensive shredder performance paper. It is presented in a methodical manner and much of its data is developed from mathematical analysis. In short, it is a professional paper.

To my knowledge there is no other report published, like this, with important shredder operational data derived from full scale processing operations. The data was collected from operations conducted over a significant number of consecutive operating days, during which time a considerable amount of refuse was processed. These values came from actual operating conditions, not laboratory or simulated situations. Furthermore, the data is not distorted. I know, because this report comes as a result of an acceptance test, written as part of a “turnkey” equipment contract between Waste Management, Inc. (WMI) and The Heil Company. I wrote the bulk of that contract, and was deeply involved in the planning and the execution of the acceptance test. A report of this nature was overdue for the resource recovery industry. Now those involved with planning vertical shredding installations can draw upon useful and meaningful figures for throughput, particle size, energy cost/ton, and hammer cost/ton.

While the authors deserve credit for professionally developing and presenting data, credit should also be given to the plant operator whose equipment, site, and personnel were involved and whose operating data was made public knowledge; that is Waste Management, Incorporated.

There are some additions, clarifications, and corrections. For kWh/ton, I recommend the use of the term energy cost/ton, not power cost/ton. Power is the rate of doing work (kW), while kWh is a measure of work or energy. Such change would be in keeping with engineering definitions and, hence, more professional.

The authors noted their inability to test for particle size variability versus throughput. I can offer the operating observation that, given a constant hammer configuration, vertical shredder throughput at low rates result in larger particle size. This indicates material interaction contributes to particle size reduction.

For the majority of time during the acceptance test, 26 sets of hammers and arms were attached to the rotor. The 1000 hp electric motor spun the rotor at 582 rpm. Hammers, made of water quenched alloy steel, can not be retipped during their useful life. Hammer and arm assemblies are removed from the shredder to facilitate hammer change. Assemblies of new hammers and original arms go back into the shredder.

Not clear to me is whether the work index $E_i$ is used to compare shredder efficiencies or shredding system efficiencies. After deliberation, I believe this value would be valid only for system comparisons. I reason that plant layout and plant
operating personnel impact greatly upon the work index and all these factors are involved as a system.

There are two errors in the paper as it elaborates on plant throughput. Though shown correctly elsewhere in the report, minimum contractual requirements for shredder throughput are listed as 50 tons/hr (45 t/h). They were always 60 tons/hr (54 t/h). The second error concerns plant processing results. Plant average daily throughput was 39 percent above design capacity, not 80 percent as listed. This is checked by

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\frac{1178 \text{ ton/day (1052 t)}}{850 \text{ ton/day (759 t)}} = 1.39
\]

Corrections which do not detract from the data of the report but which should be listed for those readers who are operationally orientated are:

1. Shredded refuse entering RefCOM must always be scalped of at least 70 percent of ferrous metals. Therefore, if the magnetic belt separator does not work, another magnet would be temporarily erected and used.

2. Transfer trailers have live bottoms, consisting of conveyor chains with cross flights. These trailers unload the shredded refuse on the landfill; they do not "dump" the refuse.

In summary, the paper, professionally presented, has significant performance data for a vertical shaft hammermill shredder. It should be useful reference material for the planners within the resource recovery industry.

Discussion by

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The data and information presented in this paper is very interesting and will be helpful to those that must conduct shredder performance tests in the future. The method of taking shredder discharge material samples is well conceived and certainly would provide a good representative sample.

The fact that the moisture content of the refuse had no appreciable effect on the particle size analysis is noteworthy.

The performance specification for the shredder required that the throughput must be a minimum of 60 tons/hr for twelve consecutive days with an average minimum daily throughput of 850 tons (770 tons). While the performance specification for shredded material size indicates that the particle distribution must be on the basis of dry weight, throughput is determined on an "as received" basis for moisture content. Since the moisture content of most typical municipal refuse varies considerably, would it not be more logical to measure the throughput on a dry basis? Since the moisture content of the shredded material had to be determined anyway, it would have been interesting to see what the effect of moisture has on the capacity of the machine. Perhaps the authors could go back to the data gathered and see what the effect would be. If the refuse averaged 25 percent moisture, then, on a dry basis, the shredder may only be capable of 60 tons/hr (54 t/h) throughput.

AUTHORS’ RESPONSE

The authors appreciate the comments and corrections offered by the discussers.

Mr. Handler’s suggestions are well taken. There is, however, a misunderstanding of the shredder throughput. It is stated in the paper that the shredder processed 80 percent more refuse than required in the performance guarantee, and Mr. Handler calculates this as 39 percent. The 80 percent figure was calculated using the actual refuse processed per "shredder on time", as shown in Table 1. The shredder throughput is thus not penalized for time it was not actually processing refuse. In all, the shredder was operating 127 hours, and processed 14,133 tons of refuse, for an average throughput of 111 tons/hour. When compared to the required throughput of 60 tons/hour, the shredder exceeded the requirement by over 80 percent.

Mr. Sanneman’s suggestion of measuring throughput using dry weights is well taken. In the case of this study, the throughput was to be measured on an “as received” basis, but certainly a dry analysis would have been more meaningful. Unfortunately, the sampling requirements for this study prevented an analysis of moisture vs. particle size. Some of this work has been conducted in a pioneering study by Trezek and Diaz, with the results published in an EPA document as well as several journals.