Since the stated objective of the paper is the development of a test program with the objective of employing a common basis for the evaluation of air classifiers, it would appear that some initial strides have been made in that direction.

The reduction of the main parameters to dimensionless ratios allows you to normalize the differences due to size and geometry found in various types of air classifiers installed in plants with varying feed rates.

When the light fraction quality and the combustible yield are plotted against this critical air to solids ratio, it will allow you to evaluate a given installation and establish its most efficient feed rate at a given air flow, or inversely, the air flow that will result in the highest light fraction quality and combustible yield at a known or constant feed rate.

Thus, the evaluation of the performance of the classifier can be made independent of the composition of the waste stream. However, since the numbers reflect only the percentages of combustibles and non-combustibles lifted, you cannot predict the resultant fuel quality since that quality is subject to the variations of the infeed.

It might appear that as far as overall plant operations are concerned, these variations, over which the air classifier has no control, will become far more significant than those which it can address itself to.

From that, it could be concluded that if exacting fuel specifications, or allowable percentages of organics residual in the heavies are key factors in a plant or process, then the air classifier cannot be expected to control those factors. It points out that although the performance of classifiers can be evaluated and compared under varying sets of conditions, it does not necessarily establish a method of determining fuel quality on a quantitative basis.

Floyd Hasselriis  
Combustion Equipment Associates  
New York, New York

The authors are to be congratulated on their efforts to make sense out of the highly variable data obtained from tests of three entirely different air classifiers in three locations, and of their practical decision to evaluate them in terms of their ability to produce a low-ash product suitable for use as a fuel.

Considering the variability of the RDF being handled, both as to composition and flow rate, and the few data points from which they constructed their graphs, it is gratifying that meaningful trends could be obtained and many important conclusions drawn. The reader should be warned,
however, that not all of the conclusions will stand up to a stronger data base. It should also be pointed out that the term effectiveness would be a better term than efficiency, leaving efficiency to be used solely for “what was achieved compared to what possibly could be achieved”.

By ignoring the many components in the light fraction and calling it the Paper-Plastic fraction, and further, by treating this fraction as an entity determined by the ability of the air classifier to lift it, we find that the performance of all three air classifiers becomes similar. The relationship between the light fraction which was lifted and the total amount which could have been lifted is properly called the classifier efficiency. The data shows that the amount of material lifted by a fixed air current depends upon the ratio between the air flow and the solids flow: more air lifts more solids up to the point where there are no more solids to be lifted, given the conditions in the classifier.

The behavior of air and solids flowing in ducts has long been known to those active in the solids-conveying field. It is strange that this knowledge has not been translated into the Resource Recovery field. Perhaps the preoccupation with the components of refuse is analogous to the tree/forest problem: instead of looking at the trees as fuel we were led to look at the bark. The air classifier cannot distinguish between similar materials, and in fact, cannot classify out materials unless they are substantially different aerodynamically.

The graphs in Fig. 6 show clearly that non-ferrous metals (aluminum) could not be dropped unless a large fraction of the light fraction was dropped. They also show that the fines, defined as minus-14 mesh, behaved essentially the same as the paper and plastic: Why shouldn’t they? They were classified by the same classifier, and minus-14 mesh glass has the same lifting velocity as the light paper. The plus-14 mesh noncombustibles reported to the heavies, in accordance with our wishes.

In retrospect we can see that the resource recovery industry bought the classifier as a device for separating paper from heavies, based on tests run with very light solids loadings, hence giving high separation efficiencies. Operation with heavy loadings was undertaken without an appreciation of the full consequences, based on A/S ratios of 2 to 3, and air velocities appropriate for the relatively dry material which results when MSW is allowed to lie around. Against this background it comes as a shock to many that normal MSW moisture levels require higher A/S ratios and higher column velocities if high separation efficiencies are to be achieved.

The trends in Fig. 10, showing the percent lifted falling off at high A/S ratios are not positively established with the few points of data presented. While it seems unlikely that as the particle concentration becomes lighter the percent lifted is reduced, it is also understandable that as the stream becomes denser, more material which could fall is entrained, including combustible heavies as well as non-combustibles.

This paper does not mention the moisture content of the RDF, or the particle size. The average column velocity, which can be calculated from the data presented, is a major factor in classifier behavior.

The amount of combustibles dropped with the heavies is crucial to the overall fuel yield. Low specific energies can be achieved at the expense of fuel recovery by the classifier. This loss can be compensated for by performing another classification step on the heavies in order to recover these combustibles. On the other hand, the lights of a classifier which has a high percentage of heavies will tend to be very low in ash content, since low lifting velocities do not entrain as much fine glass.

Discussion by

Roger DeCesare
U.S. Bureau of Mines
Avondale, Maryland

The authors are to be congratulated for this fine, original work. There is a real need for basic air classification data as presented in this paper. Although the final report to EPA will undoubtedly contain considerably more detail, I would like to see additional clarifying statements addressing the following items:

1. The rationale for using only paper and plastics for LFQ should be more fully explained. Are corrugated and paperboard products considered paper? After removing the fines from the air classifier light product on a 14-mesh screen, why not simply pick out the metals and evaluate total combustibles including fabric, wood products and other organics? What effect would this change in definition for LFQ have on your overall evaluation of an air classifier?

2. I would like to see a paragraph addressing the relevance of combustible yield in relation to
the wide variation in refuse composition, size and moisture content. The Bureau of Mines characterized refuse from different municipalities and on selected samples determined that the combustible content of air classifier lights ranged from 80-90 percent while the paper and plastic content on the same material ranged from 60-90 percent. In the Bureau’s pilot plant, one of the air classifiers processes minus 2-in. material and refuse processed from one community had 25 percent shredded cloth report with the light fraction. Using LFQ as a parameter overlooks the value of this portion of the classifier lights. I look forward to reading the results of the fuel evaluations made on your products and to reading the final report to EPA.

Discussion by
Russell J. Galgana
Smith and Mahoney
Albany, New York

The paper appears to be well written and organized. The information contained in it should provide a useful starting point for the designer interested in sizing or selecting such equipment. The strong apparent correlation between air to solids ratio and light-heavy material split was especially impressive.

Although it may have been beyond the scope of this paper, I could not help wondering about the fate of the combustible materials that would be expected to report to the heavy fraction of the air classifier output. It would seem logical to expect that in a Resource Recovery facility designed to produce fuel from refuse, that suitable means would be employed to recover as much combustible material as practical. Doing so would maximize the waste energy recovered and minimize the amount of residue requiring disposal by landfilng.

From the standpoint of producing a relatively uniform fuel product, air classification appears to be a viable, if somewhat energy intensive (generally high fan horsepower) approach. However, it appears that such suitability may be limited to instances where it is necessary to fit the fuel to the boiler (as with existing boiler plant with fixed fuel requirements) rather than fit the boiler to the fuel (as has been done in Hamilton, Ontario and Albany, New York).

The refuse to energy concept has two objectives, elimination of refuse and conservation of fossil fuels; it will be interesting to see how these needs are met by the emerging technologies in the Solid Waste Processing Field.

AUTHORS’ REPLY

I would like to take this opportunity to comment upon points raised by discussion submitted in response to the presentation of the paper. First, let me point out that although I am well aware of the audience’s interest in acquiring performance and design data for air classifiers, the purpose of the paper was not to supply detailed test data for specific sites or air classifiers. The detailed data for seven air classifiers will be available as part of the final report on the air classifier project when it is completed and the information undoubtedly will be presented at technical meetings at some time in the future. The explicit purpose of the paper was to describe procedures and methods for testing and characterizing air classifier performance. The test data which was presented was intended solely to substantiate the testing methodology and the methods used for interpreting and evaluating air classifier performance.

There were some questions raised by the discussers to which I can supply some brief answers. The range of average air dry moisture content and characteristic particle size (63.2 percent cumulative percent passing) were 14 to 27 percent and 1.7 to 2.8 cm, respectively. The rationale for using paper and plastic as a measure of light fraction quality (LFQ) is that they can be sorted relatively quickly. Given the size and complexity of the EPA program, it would be prohibitively expensive to sort every combustible component in the samples of light and heavy fractions. As a means of further explanation, sorted paper included all paper wastes (e.g. corrugated, newsprint, ledger, computer cards, etc.). Data on combustible yield was presented mainly to show that it is not a basic parameter for indicating air classifier performance. Other parameters (described in the paper) inherently describe air classifier performance at a more fundamental level.

Finally, I might add that based upon the audience’s comments at the ASME Conference and those of the discussers, there is a keen interest in the subject of air classification and hopefully the final report covering the air classifier project will provide the detailed test information being sought by the resource recovery industry.