ABSTRACT

All processing operations generate waste, and the percentage of waste generated varies considerably. The reclamation processes, as used in Polymeric Industries, will be dealt with here. Unit process of Size Reduction, which is the first step in a reclaim system, will be emphasized. Staged size reduction (cutting as opposed to breaking and tearing) will be dealt with in more detail. The performance and economics of Size Reduction and Reclamation System will also be outlined.

INTRODUCTION

In the last 2-3 years we have become very aware of the environmental crisis facing the nation. There is an increased awareness about Recycling and Resource Recovery. “Reclamation” is not only becoming ecologically popular and necessary, but may be the only means of solving the huge solid waste problem. Unfortunately, neither the problem or its solution is simple and despite all the attention that recycling has received in recent years, we keep on generating more waste and recycle a very low percentage of the resources than before.

In the past recycling was thwarted by a network of circumstances. The United States, during its growth period, passed some tax laws and regulations that were designed to encourage and exploit the plentiful natural resources. Very little attention was paid to the environment itself, and also to the method of processing the raw materials. Now the technology of processing the virgin materials has advanced to such a stage that nobody even wants to consider processing of the waste materials to produce good acceptable products. There is evidence though that we are beginning to understand that our concept of cost has been narrow. Information is emerging to show that recovering the resources is indeed economical if we put a price on other factors such as protecting the environment, conserving energy, and other natural resources.

The economics, the technology, and lately social and political pressures dictate our actions. Up to now it was not always practical to reclaim the wastes generated, but due to the shortage of raw materials and soaring labor costs, there is more incentive to recycle and reclaim. Substantial efforts are being made and research at all levels is being conducted to make reclamation processes economical and practical. The raw material producer, the processor and the machinery manufacturers are trying to coordinate research effort to shorten the time period of research and remove the formidable technical barriers which are there to true recycling of polymeric materials. Major contributions in solving this problem are being made because self interest has become the prime motive in the use of waste materials by all parties.
All processing operations generate waste and it could be in many forms including the natural wastage from the process. In conformity with the theme of this conference, I will try to deal with a few facets of reclamation as practiced in polymeric industry.

The emphasis will be on the type of waste generated, size reduction systems, and the reclamation processes used in textile fiber and polymeric film industry. I will attempt to present some solutions as to how one small segment of the industrial waste generated during the processing of polymeric materials can be tackled, how a solution has been evolved, and how the reclamation process can be effectively utilized economically and profitably to produce raw materials for further usage. All of it would be with particular reference to that segment of waste where the scrap can be kept fairly clean and homogeneous.

Four practical reasons cited for the increased interest in the recycling of polymeric materials are: (1) high cost of virgin resin, (2) concern for ecology, (3) uncertain long term availability, and (4) availability of technology to recompound scrap into engineered compounds.

**RECOVERY METHODS**

Utilization consists of resource recovery and recycling. Resource recovery techniques include pyrolysis, hydrolysis, chemical processing, biochemical conversion process, etc. Recycling is involved with the regeneration of material so that it could be used back into the system of process.

Many techniques are under study and several methods are currently being employed for utilizing polymeric waste materials. The three major waste recovery systems applicable to film and fiber reclamation are:

1) Material regeneration — Regenerating the film-fiber material into a form similar to the raw material. Regenerated material may not be of prime quality; it is often necessary to blend it with virgin material.

2) Chemical depolymerization — By this method the waste is converted to pure basic raw materials and monomers.

3) Compaction — This involves compaction of fibers or film into a granular or pellet form capable of being extruded or injection molded.

All of the methods outlined above for film and fiber reclamation rely on the unit process of size reduction as a first step where the waste material is channelled through a series of cutters and/or granulators for introduction into the waste recovery system. This unit process of size reduction, nature of waste, and the effect of recycling will be explored in more detail.

Size reduction is defined as a mechanical separation process where bodies of material are reduced into smaller pieces by the application of forces. Size reduction yields a smaller range of particle sizes and thoroughly mixes the waste. The uniform density and homogeneous mixture allows efficient handling of the waste material for feeding at a uniform rate into the regenerative or reprocessing system. The amount of reduction required depends upon the feed material and the final process of reclamation.

**NATURE OF WASTE**

At an estimated average of 7 percent of total output, about 650 million pounds of man-made fiber waste, both cellulosic and noncellulosic, was produced in 1973 by fiber producers and textile mills in the U.S. Polyester, nylon, and polyolefins are the major textile materials produced for consumption by the synthetic fiber industry. Various forms of waste produced in the textile industry include undrawn and semi-drawn fiber, spool cuttings, spun staple or filament tangled fibers, solid purgings, bird nests, spinnerette purgings, slit film yarn, high strength stretched tape, etc., etc. This waste may be produced at almost any stage in the process. The major use of these synthetic waste fibers so far has been to produce specialty or lower grade textile product. Major portion of the waste fibers produced is still being sold to the garnetting industry. The garnetters process the waste into fibers for yarn spinning, weaving, or knitting.

Of the 26 billion pounds of plastic materials produced in 1973 in the U.S., a fair percentage was used to make films and sheets. Consumption of plastic films in the U.S. has increased more than 12 percent per year since 1961 reaching nearly 4.6 billion pounds in 1973. By 1985, it is estimated that 11.6 billion pounds of film will be used. Apart from the continued growth of polyolefins and PVC, polyester films have also enjoyed a compounded growth rate of about 13 percent since 1968. 5 percent to 7 percent of the total output as waste is not
uncommon for the film processing industry. The scrap generated could be in the form of edge trim, damaged, start-up off-spec rolls, or the extruder purgings, etc.

RECYCLING AND SIZE REDUCTION SYSTEMS

There is nothing new in recycling polymeric materials. Injection molding people have been doing it for a long time; but there is a growing awareness of the need to recycle all forms of polymeric waste materials. Some textile and film manufacturers and other processors have captive waste reprocessing systems to produce speciality or low grade products. Few companies recycle or reprocess the waste generated on a large scale. There is an increasing interest in the in-plant processing of waste materials, and this is particularly suitable for companies making film and film-like products where the amount of waste material is significant and where, with good housekeeping, the scrap can be graded and kept clean and will not leave their point of origin. Almost all the waste salvaged today comes from manufacturers and businesses where large amounts of relatively clean and homogeneous wastes accumulate. They are collected and sometimes processed by the secondary materials industry. This industry is well established with over 80,000 employee and an annual sale of approximately $8 billion. The waste after sorting and reprocessing is sold to the manufacturers for reuse (mostly for secondary use). Until recently, the question of reclaiming textile waste did not arise. Flow of textile fibers in process and waste textile utilization flow is illustrated in Figures 1 & 2. For regeneration purposes in textile industry, we are considering the waste before it has been formed into a cloth or a fabric, because by then it may be composed of different blends, dyes, luster, etc., which would have to be separated into the individual fibers of the same characteristics. The size reduction systems for material handling and reprocessing is dealt with in greater detail below. Tangled film-fiber wastes are accumulated in containers, bales or boxes for storage or shipment, and bound with ropes, bands, or wires. Figs. 3, 4, 5, 6, 7, & 8 show the typical nature of waste under consideration. Figs. 3 & 4 show bales of slit film. Fig. 5 shows a compacted bale of film and Fig. 6 shows a roll of waste film with a cardboard core. Fig. 7 shows fiber waste in cardboard boxes and Fig. 8 shows a compacted bale of fiber packed in cardboard and wrapped in metal strapping. These waste packages usually vary in weight between 400 and 1,000 pounds, and are oftentimes much heavier because of the bulk density of the packed material. For example, a fine denier fiber with a high bulk density will occupy the same space as undrawn fiber, but will weigh considerably more. The rolls of film could vary in diameter, length, and weight depending upon the source where the scrap was generated.

Opening of these compacted packages for reprocessing and recycling is a very time consuming job. The material, if pulled manually, presents a difficult handling problem. Fig. 9 shows the tangled nature of textile fibers. An automatic size reduction system, shown in Fig. 10, handles these bales and prepares material for reclamation. Economics of primary size reduction system is also dealt with separately.

Compact material in bales or boxes, when introduced into this system capable of handling 1,000 to 4,000 pounds per hour, is upended onto an oscillating feed conveyor. Wires, strappings, ropes, and packaging materials are removed in the upender. Once separated from the packaging materials, waste film or fibers are conveyed to a guillotine cutter by means of a finger conveying system for initial size reduction.

Guillotine cutters are shears with one fixed blade and a powered blade having an up-and-down movement. A guillotine cutter is a comparatively slow process machine which operates in the two to eight stroke per minute range. Guillotine not only cuts the material, but also acts as a metering device. Fig. 11 shows a bale of textile fibers in the guillotine chamber.

Compacted material is automatically cut into slabs of predetermined length and conveyed to a rotary cutter for precise second stage reduction. The rotary cutter also operates at a relatively slow rate of speed, usually under 200 rpm in waste handling systems. Fig. 12 shows the basic principles of a rotary cutter. Fig. 13 shows the slit film on the feed conveyor of the cutter after being cut on the guillotine. Fig. 14 shows the short fiber length obtained after the tangled fibers have been cut on a rotary cutter. A granulator, rotary cutter with a screen for size control, performs the third and last step in the reduction operation. However, it is possible to replace the granulator with another heavy
FIG. 1 WASTE TEXTILE UTILIZATION FLOWS
FIG. 2 TYPICAL FLOW OF TEXTILE FIBERS AND THE RESULTING GENERATION OF TEXTILE WASTE
duty cutter for further reduction. Fig. 15 shows the basic principle of a granulator.

The film waste recovery system utilizing a heavy duty cutter and a conveyor has been designed to overcome some of the problems encountered previously in the feeding and handling of the materials. This film scrap reclamation system handles any type of film in haystack, sheet, or roll form regardless of the thickness. Fig. 16 shows the size reduction part of the film waste recovery system in which tough bulky film is fed into an overriding conveyor (Fig. 17) which compresses the material and feeds it to the heavy duty cutter. After precutting the material, the cutter feeds the film to a granulator and then the material is picked up by a blower. The granulated material and the air are separated by a cyclone collector. It is then fed to an extruder (mostly blended with virgin pellets).

Fig. 18 shows the material obtained after two stages of size reduction. It shows the film before and after being cut on the rotary cutter and granulator.

When the film to be recycled is available in rolls but is wound on a cardboard or other material which cannot be recycled with the base film, another circuit (Fig. 19) is utilized. The film roll is first cut by the guillotine, and then by the rotary cutter and the granulator.

Staged size reduction is used in the systems mentioned above. Pre-cutting of the material helps in uniform feeding to the granulator where controlled particle size is obtained. It also eliminates surge loads and increases the output rate from the size reduction system.

After size reduction, controlled particle size materials with a uniform bulk density are normally fed into an extruder. Because of low bulk density, difficulty to feed contaminated materials, presence of moisture, and coatings, some modifications in the standard extrusion equipment have been introduced. Some of these are automatic screen changers, double venting, vertical extruders with a ram feed, stuffer ram or auger fed hopper above the extruder, or an agitated hopper which not only serves a densifying unit, but is also being used for preblending waste with pigments and other additives, etc., etc.

Sometimes granulated material is compacted in a pellet mill, before fed into an extruder, to increase the bulk density of the material. In one compaction process, sintering by means of heat and pressure produces nonuniform sized pellets. However, if the bulk density of the compacted material is similar to that of the virgin pellets, there is no problem involved in blending these two materials.

New developments in extrusion equipment will eventually permit the use of low bulk density
FIG. 10 VIBRATING CONVEYOR, GUILLOTINE, ROTARY CUTTER, GRANULATOR, AND A CYCLONE COLLECTOR
FIG. 11

FIG. 12 SHOWS THE BASIC PRINCIPLE OF A ROTARY CUTTER WITH 4 FLY KNIVES ON THE ROTOR AND 1 BED KNIFE USED FOR CUTTING BULKY WASTE MATERIALS. ONE LARGE DIAMETER FLUTED FEED ROLL HOLDS THE MATERIAL AT THE TIME OF CUTTING BY THE FLY KNIVES AGAINST THE BED KNIFE.
SCHEMATIC DIAGRAM OF A GRANULATOR

FIG. 15 THE BASIC PRINCIPLE OF A GRANULATOR WITH THREE FLY KNIVES CUTTING AGAINST TWO FIXED KNIVES. THE SCREEN IS LOCATED IN THE LOWER HALF OF THE CUTTING CHAMBER FOR SIZE CLASSIFICATION

FIG. 16 THE BASIC SIZE REDUCTION SYSTEM FOR PLASTIC FILM WASTE RECOVERY
materials (2 to 3 pounds per cubic foot) without a need for pelletizing or compaction.

Quite a large quantity of film-fiber is still being dumped or not being effectively utilized due to the presence of coatings, finishes, lubricants, etc. Though attractive economics exist for reprocessing clean waste material, but the presence of coatings and finishes, etc., has caused substantial problems in the reextrusion process by blocking screen packs due to gelation or in the blowing out of material through the vents. New processes are being explored to wash and dry this waste prior to extrusion. Washing and drying of the soiled polyolefin waste (containing dust, quartz, metals, and water soluble salts) is already being promoted in Europe. The centrifuging of fibrous waste after washing does present some problems due to the matting of long fibers, but if granulated to a very short fiber length (0.030 m), washing - centrifuging and drying problems could be solved. Despite the fact that the addition of these unit operations to the complete reclamation system further adds to the processing cost, yet going this route would be more economical than throwing away the precious raw material. Emphasis, of course, is in the use of scrap material so that the film-fiber waste can be regenerated into the same form from which it came without going through the pelletizing route or an additional heat cycle.

Some extruder manufacturers claim that their systems will accept a range of thermoplastics in an uncut soft form (film, tape, and fiber) for the production of dense granulate and subsequent reuse. Screw design plays an important role in the ability of these machines to accept film, sheet, bundles of tape, rolls of fiber, etc., and also convey the material consistently to insure a reasonable output. Another essential factor in this design is the need to apply early heat into the voluminous materials.

**SELECTION OF EQUIPMENT**

Selection of proper size reduction and downstream processing equipment is very important to guard against deterioration of property characteristics in the reclamation system.

We are trying to reclaim a more homogeneous mass of feed as far as the material properties are concerned. As enumerated above, the shape may vary. Though the material properties are homogeneous, size reduction is a complex operation and can cause serious problems to the cutting equipment and flow of material through various constituents. The size reduction system should be considered in terms of cutting equipment, effect of cutting parameters on the performance, the nature of feed material, size distribution, material handling, the extrusion equipment with which it is to be used, and the economics. A brief discussion of some of the parameters is as follows:

There is no all encompassing theory yet available which can relate to the breaking up of polymeric materials, but one thing is clear — the internal structure of polymeric materials, lend them easily to being sheared or cut. Though size reduction can be affected by the application of one or several mechanisms, namely shearing, abrasion, impact, or crushing which impart either one or a combination of tensile, compressive or shear forces to the material, but the use of shearing machines for size reduction of polymeric materials is most efficient. The rotary cutter, the guillotine, and the granulator used in the size reduction systems mentioned above, all use the principle of shear cutting.

The machine size and the power required for a solid waste system are determined by the nature of the input material, the processing rate (in pounds per hour) and the output particle size required. The power requirements increase exponentially as the particle size decreases. It is for this reason that staged size reduction is recommended to handle bulky unmanageable waste. Another example of staged size reduction in addition to the systems mentioned above is illustrated in Figs. 20, 21 & 22. The block of high density polyethylene would best be handled by reducing it in a guillotine, cutter, granulator system rather than dumping it in one huge machine for reduction.

There are a lot of variables that affect cutting and in ultimately obtaining the required particle size and through-put rate. The type of finish on waste fibers often impedes the cutting operation and may even cause fiber fusion. Undrawn material — unoriented and noncrystalline — are easy to cut. However, fine denier fibers and thinner gauge film require machines with close tolerances and sharp cutting edges. Blade edges must be kept sharp and be continually adjusted to avoid fusion. Purgings are comparatively brittle and tend to shatter in rotary cutting equipment.

As mentioned above, the thickness of the film affects cutting. It is difficult to granulate one mil thick film as compared to seven mil. Not only is the output rate reduced for the same conditions,
but the bulk density of the material also is reduced. All of these factors should be considered beforehand.

Material handling is the next important part of a waste reclamation system. Effort should be made to adequately size the various components and avoid any jam ups in the system. Anticipating some of the material handling problems, the guillotine cutter system for baled or voluminous material and the overriding conveyor system for the film were designed. Jam ups can occur in any part of the system due to the heterogeneous and stringy nature of the material. The guillotine cutter not only provides an initial cut, but also facilitates in making the feed more uniform for conveying it to the cutter.

When using a granulator as the third cutting stage, air circulation (blower) is essential for correct operation, especially when reprocessing heat-sensitive materials. An air circulation system not only helps dissipate the heat generated by the mechanical action of the cutting blades, but also removes heat caused by material attrition. However, one disadvantage of a granulation system is the removal of air from the reprocessed material. Fiber fluffing and filament separation reduces the bulk density of the material. Although small fiber lengths are obtained by using a granulator, this may not always be ideal, since materials have a tendency to wrap around holes and plug up screen openings. If this is the case, it is often better to substitute a second rotary cutter for the granulator or use very small screen openings in the machine.

There is an increasing interest in the inplant reprocessing of material. A new trend is developing to reclaim the waste generated in a process on line rather than to collect it and reprocess at some other location. This would require a different approach of size reduction and material handling.

ECONOMIC ANALYSIS

In the present state of affairs, the overabundance days are over. We have to look back and forward and evaluate where we are heading. Nobody's going to tell us that the resources are limited and we must constrain ourself in utilizing these. The unrestrained and haphazard technical development is no longer the answer. If we consider
the present state of material supply and demand we would find that refuse generated at very stage of processing should be recycled and that segment of waste which cannot be recycled be burned as fuel. Fortunately the polymeric materials present the best opportunity both for recycling and as a fuel alternately. Unfortunately, money is still the problem to undertake some resource recovery and recycling projects. Resource recovery is still viewed as a risky business. Not many people are willing to take these chances in the present recessionary economy. If we analyze all the technology available to us, one would find that the resource recovery and recycling is almost as inexpensive as some of the techniques that are used for disposal. A number of factors that are already at work are really encouraging and these are tending to encourage recycling by narrowing the price differentials of the recycled and virgin materials. As new and more stringent pollution control laws are enforced industry’s cost for processing raw material would increase and this may direct attention to the opportunities for the increased use and reclamation of process waste. Rapidly rising energy costs would also favor use of waste materials since their processing generally consumes less energy than processing the raw materials.

The economics, the costs involved and the gains from a Reclamation System (Fig. 23) are discussed in the following paragraphs where a typical example is considered showing how a potential user of a recycling plant can make money and can recover all the invested costs within a short period.

In todays economy, the money market is very tight. In the final analysis, the customer is interested in cost per pound of material and the cost savings in dollars/lb. of processed material. I have tried to analyze the processing cost analysis of a typical size reduction package and also for a complete fiber-film reclaim system. Some assumptions have been made in the presentation of this simplified analysis. (e.g., maintenance cost as 10% of equipment cost.) Each user of the reclaim system would have to generate his own set of figures and find out the cost and return on investment. The cost analysis is based upon processing 2000 lbs./hr for 1600 hr./year and the differential price between the scrap film-fiber and the virgin pellets has been taken as 15¢/lb. for the calculations.

One would notice that the power consumed in the waste reclamation system is not the only cost. (It is a major cost.) The wear of knives and the extruder screw, the cost of labor and material for general maintenance, and the downtime all contribute to the economics of the system. In the primary size reduction system, it costs only 1.8¢/lb. to prepare material, and the processing cost through the complete extrusion system to produce pellets from the waste was only 5.5¢/lb.

**Example No. 1:**

*Primary Size Reduction System*

A. Equipment

- Upsender
- Oscillating Conveyor
- Guillotine Cutter
- Metal Detector
- Rotary Cutter with Feed and Discharge Conveyor

B. Process Factors

1. Material  · Fiber waste
2. Capacity  · 2000 lbs./hr.
3. Operating Hrs.  · 1600 hrs./yr.
4. Direct Labor Operations  · 1-1/2 man hours/hour

C. Machine Factors

1. Estimated Power Number  · 0.625 HP hrs./lb.
2. Horsepower  · 125 HP

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D. Costs

1. Equipment Cost - 125,000 dollars
2. Auxiliaries Cost - 25,000 dollars
3. Installation Cost - 60,000 dollars
4. Total Cost - 210,000 dollars

E. Economic Factors

1. Maintenance Cost - 15,000 dollars/yr
2. Power Cost - 0.02 dollars/HP hr.
3. Amortization Period - 10 years
4. Labor Rate - 6 dollars/man hour
5. Rent (1000 ft.² @ $3/ft.² hr.) - 3000 dollars/yr.

F. Cost Calculations

1. Power Cost - 125 x 0.02 = 2.5 dollars/hr.
2. Equipment Cost - (210,000) (10x1600) = 13.12 dollars/hr.
3. Direct Labor Cost - 6 x 1.5 = 9.00 dollars/hr.
4. Maintenance Cost (10% of Equipment Cost) - 15,000 / 1,600 = 9.37 dollars/hr.
5. Rent Cost - 3,000 / 1,600 = 1.88 dollars/hr.
6. Total Cost - 35.87 dollars/hr.

Rate - 2000 lbs./hr.

Total processing cost - \( \frac{35.87 \times 2}{2000} = 0.0179 \$/lb. \)

Cost of processing Material in Primary Size Reduction System: 0.0179$/lb. or 1.86/lb.

Example No. 2:

_Fiber Reclaim System (2,000 lbs.hr.basic) to regenerate Film-Fiber to Pellets._

A. Equipment

- Upender
- Oscillating Conveyor
- Guillotine Cutter
- Metal Detector
- Rotary Cutter with Feed and Discharge Conveyor
- Granulator(s)
- Live Storage Bin(s)
- Air Conveying
- Screw Feeder
- Vented Extruder
- Screen Changer
- Strand Die

Primary Size Reduction - $125,000.00
Secondary Size Reduction - $125,000.00
Feeding, Melting and Extrusion - $150,000.00
EFFECT OF RECYCLING ON MATERIALS

Reclamation and recycling of film and fiber waste is being practiced on a large scale in applications where the scrap can be kept fairly clean and homogeneous, or where slightly sub-standard material is acceptable. However, problems such as low bulk density and lack of fluidity of the granulated product, as well as the toughness of some products such as polyester, in addition to lack of technical knowhow, have kept the process from becoming very popular.

Reuse of plastic and textile waste materials is ultimately governed by the effects of successive heat cycles, and whether the material is reconstituted by the reprocessor or by the manufacturer who is generating the waste. The effect of moisture, the change of intrinsic viscosity (a function of molecular chain length), melt flow index, the loss of physical properties, discoloration of material when exposed
FIG. 23 FILM-FIBER RECLAMATION SYSTEM SHOWING THE PRIMARY SIZE REDUCTION - SECONDARY SIZE REDUCTION, FEEDING, EXTRUSION AND PELLETIZING EQUIPMENT
to successive heat histories over extended periods of time all affect in the final analysis.

OTHER RECLAMATION METHODS

Most of the discussion and efforts so far and also emphasized in this paper have been in the direction to regenerate the waste material where it has been clean and homogeneous. Technological development is not only taking place in this direction, but some unorthodox applications are also being explored, particularly as far as the use of mixed waste is concerned. A degradation of physical properties has been noticed in the mixed plastic waste when recycled, but by the use of “compatabilizer”, it is claimed the properties of the mixed polymeric waste can be improved significantly. The economics of using chlorinated polyethylene as a compatabilizer are being explored and tested. Some very diverse applications where mixed plastics have found a use are as a sand substitute in concrete, as mulch or soil conditioner, as a substitute of wood by producing molded foam products out of mixed plastics waste, or for producing particle board, sub-flooring and sub-roofing when mixed with available fibrous material such as wood chips or asbestos, and for many other uses. The fibrous components in the mixed refuse act as reinforcements for the other constituents of the mixture resulting in good quality product.

One of the large chemical companies has formed a material recycling group whose function is to reclaim all types of waste materials generated in their various plants. The approach taken by this group to upgrade one of the products is relevant to our subject. One particular grade of fiber is being recovered from scraps of blended fiber yarns. These scrap fibers are dissolved in a special solution and filtered. The resulting pure polymer is extracted in flake form and can be extruded into pellets as a finished product. Another development that has come on the horizon in the last 2-3 years is the use of secondary fibers in the nonwoven industry. The chopped-up synthetic waste fibers can be very effectively used in the dry or wet laid processes for producing nonwoven products.

CONCLUSIONS

Recycling and reclamation of the waste has offered processors and material users an attractive method to alleviate material supply problems and has also presented an additional source of raw material. It is now accepted as a means of conserving our resources and at the same time improve our standard of living by fighting pollution and combating inflation. Size reduction is only a part of complete solid waste management system. Before it can be designed, it is necessary to know the characteristics of the waste and what basic function the system is to perform. There is no accumulated body of formal knowledge which can be tapped. New installations are drawing heavily on the test work. Size reduction in solid waste field is an emerging technology. The operating data and the economics of the complete reclamation systems is either nonexisting or is a proprietary information. There is no set standard or a rating system existing in the polymeric industry which would help in evaluating and selecting the proper equipment for a specific problem. A numerical rating procedure for reclamation systems would have to be developed.

At the outset, I would like to add that due to the variety of shapes and sizes of all the materials that have to be reclaimed, extensive test work should be conducted and results evaluated prior to any commitment for one particular system. It is here that the three arms of industry — material producer, the processor and the machinery builder — can really contribute.

The interest in resource recovery which was so publicized in 1973 and 1974 slowed down slightly in 1975. I sincerely hope that proven technologies for reclamation and reuse would foster increased interest by all parties. We need to work not only on the development of profitable reclamation systems, but also on processes so that we generate less waste during processing and use our virgin materials more effectively and efficiently.