Report on

Mechanical Bag Breakers

October, 2005

Prepared For:

The Region of Peel
and
Stewardship Ontario

Prepared By:

Entec Consulting Ltd.

TABLE OF CONTENTS

LIST OF TABLES

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Executive Summary

This report presents a technical review of commercially available bag breakers used in municipal Material Recycling Facilities (MRFs), namely, the following:

North America:
- Bulk Handling Systems (BHS)
- Machinex Industries (Machinex)

Europe:
- Boa Systems BV (Boa)
- BRT Recycling Technologie Gmbh (BRT)
- Mattiessen Lagertechnik Gmbh (Mattiessen)
- Vauché S. A. (Vauché)

In addition to obtaining technical data from the equipment manufacturers, experiences of MRF operators where the equipment is operated were documented and three MRF visits were conducted to view the breakers in operation.

The following table summarizes salient technical data for the breakers as well as approximate capital costs and examples of MRFs where each breaker is operating:

Manufacturer	Model	Throughput	Cost (2005)	Sample MRFs
BHS	BB – 60 BB – 72 BB - 90	45 bags/min 50-60 bags/min 70 bags/min	$87,100 U.S. $97,200-$105,300 U.S. $125,500 U.S.	▪ City of Guelph, On - single stream recyclables ▪ BFI, Milpitas Ca.- fibre and containers ▪ Miller Waste Systems, Halifax NS – containers only ▪ City of St. Peters, Mo – all recyclables
Machinex		15 – 20 tonnes/hr	$56,000 Cdn.	▪ Colchester N.S. – containers only
BRT	N XL	6 tonnes/hr 10 tonnes/hr	68,500 € 97,200 €	▪ City of Edmonton – single stream recyclables ▪ Cleanaway – Rainham (UK) – single stream recyclables ▪ Cleanaway – Greenwich UK – single stream recyclables
Mattiessen		8-10 tonnes/hr	£68,000 (Viridor 2004)	▪ Viridor - Ipswich MRF (UK) - single stream recyclables ▪ Sita - Sinn ▪ Cleanaway – Flensburg (Germany)
Vauché		4 to 8 tonnes/hr	70,000 €	▪ Lille MRF (France) ▪ Charleroi MRF (Belgium) ▪ Milan (Italy)

The report also documents operating characteristics and the costs related to manually sorting plastic film following the use of the bag breaking technologies investigated. The following table summarizes these findings:

Location	Throughput (tonnes/yr)	Days/ yr	Tonnes/d ay	Operating hrs/day	No. of FTE Sorters	Tonnes/ operating hr	Tonnes/ sorter hr	Cost/ tonne
Edmonton	30,558	250	122	9.5	12	12.9	1.07	$9.90
Northumberland	13,000	250	52	7.6	2	6.9	3.43	$6.48
Colchester	4,550	260	18	7.5	3	2.3	0.78	$23.25
Guelph	10,895	250	44	7.0	2	6.2	3.11	$8.63
Ipswich	44,200	260	170	14	2	12.1	6.07	£5.43

In general, with the exception of the Colchester MRF operation, the cost of removing film plastic (including the cost of the breaker) varies between about $6 and $10 per tonne processed through the breaker.

Only two bag breakers are manufactured and readily available in North America: BHS and Machinex. The availability of the other three European bag breakers in the North American market is not clear. Although Edmonton's experience with the BRT breaker has been positive, potential difficulties with supply of spare parts, maintenance, etc. would also be items that customers should consider in purchasing one of these breakers.

1.0 INTRODUCTION

In July, 2005, Stewardship Ontario engaged Entec Consulting Ltd. (Entec) to undertake a review of plastic sorting options at the Region of Peel's new Material Recovery Facility and also to provide an up to date review of mechanical bag breaking technologies and costs. This report presents the findings of the bag breaking project. The review of plastics sorting options will be presented under separate cover.

Entec completed a review of bag breaking technologies for The Clorox Company of Canada in 2003[1] to assess the incremental cost of mechanically breaking and removing film plastic recycling bags at Materials Recovery Facilities (MRFs). This project updates technical details of commercially available mechanical bag breakers and provides an assessment of the bag removal process at operating MRFs.

In broad terms, the scope of work for this study involved:

- identifying commercially available mechanical bag breakers;
- compiling technical data for each of the breakers;
- identifying MRFs where these breakers are presently operating;
- discussing with MRF operators details of their bag breaking and removal system to determine such items as technical reliability, throughput capacity, mechanical reliability, operational constraints, etc.;
- visiting several MRFs to view the breakers in operation; and
- preparing a report to summarize the findings of the investigations.

[1] The Cost of Breaking and Sorting Plastic Bags at MRFs; for The Clorox Company of Canada; May 2003

2.0 COMMERCIALLY AVAILABLE BAG BREAKERS

2.1 General

In addition to contacting major equipment suppliers and MRF operators, an internet search was conducted to identify manufacturers of mechanical bag openers. A number of bag openers were identified for processing of bagged Municipal Solid Waste (MSW) and leaf and yard waste. Since this study focused on the processing of dry recyclables in MRFs, only those breakers with a MRF track record were reviewed in detail.

This search included not only breakers available for use in North America, but also those used in the United Kingdom, Europe and Australia. A listing of breakers included in this study follows:

North America:

- Bulk Handling Systems (BHS)
- Machinex Industries (Machinex)

Europe:

- Boa Systems BV (Boa)
- BRT Recycling Technologie Gmbh (BRT)
- Mattiessen Lagertechnik Gmbh (Mattiessen)
- Vauché S. A. (Vauché)

Two breakers that were previously manufactured and operating in MRFs are no longer manufactured. One, a slitter-type breaker, was designed and manufactured by Muma Manufacturing Inc. (St. Thomas) and installed in the Guelph wet/dry MRF in 1997. This has since been replaced. The other was the Jones Auger Bag Burster, manufactured by Karl W. Schmidt. This operated for a number of years in the Colchester MRF in Nova Scotia.

Most bag breakers now on the market rely on rotating slitting knives to cut or shred the plastic film and to release the enclosed material. Although early designs had varying degrees of success in handling the variety of sizes and strengths of plastic film bags arriving at a MRF, today's models are much more successful at breaking bags of all sizes. Some are more successful than others at removing the contents of the bag and all still require some degree of downstream manual separation of the plastic film. Previous auger designs of bag openers had very slow throughputs and because of their design, produced a very "mangled" mixture of recyclables, with severe glass breakage. These types of breakers are no longer popular for recyclables, and are more popular for use with bagged organics (e.g. as in the Guelph wet composting plant).

Trommels are often used in MRFs in Europe and the UK to open film bags. Trommels were not included in this study as dedicated bag openers.

Details of the openers investigated are presented in the following section, with drawings and specifications sheets presented in the Appendices. In addition to obtaining technical data from each manufacturer, data were obtained where possible from MRF operators to quantify and cost the extent of breaking bags and removing film plastic. Three site visits (Colchester, NS; Guelph, ON; and Ipswich, UK) were also conducted as part of this study to view the breakers in operation.

2.2 North American Manufacturers

Bulk Handling Systems (BHS)

General

Bulk Handling Systems (BHS) is the largest North American manufacturer of bag breakers. BHS breakers are now in place in over 50 MRFs.

Concept

Bagged recyclables are gravity fed into the Bag Breaker® via an infeed conveyor to achieve an evenly metered flow rate. Large, counter-rotating drums stretch the incoming bags to an extreme, causing the plastic film to break and release the contents. The empty bags and recyclables are discharged from the bottom of the machine. The Bag Breaker® was designed to process the recyclables without marring or damaging the commodities. Each empty bag is typically released in 1-3 large, elongated strips to reduce plastic contamination and facilitate easy removal. A conveyor is required to collect and transport the processed material out from under the Bag Breaker®.

BHS claims a processing efficiency of 90% (90% of the bags will be opened and 90% of the material will be released from the bag).

A PLC control panel programmed with anti-jam mechanism and pass through action monitors the unit in the event a large, foreign object enters the machine. The Bag Breaker® will attempt to pass the item(s) several times. If unsuccessful, the unit will stop itself and any upstream equipment, preventing damage to the machine.

Throughput and Costs

Several models are available based on throughput volume and material composition. These range in price from about $90,000 to $126,000 (U.S).

Sample MRF Installations

The BHS bag breaker is in operation in Canada at the Halifax Regional MRF (operated by Miller Waste Systems), the City of Guelph MRF and the Northumberland County MRF as well as numerous other MRFs throughout the world.

Operating experience with these breakers is that they generally perform without problems except for the need for periodic maintenance and cleaning. A site visit was conducted at the Guelph MRF to observe the breaker in operation and to gather operating data listed below. In addition, a telephone interview was conducted to verify operational data of the Northumberland County MRF breaker.

The BB-90 model breaker in Guelph typically operates at between 9-15 tonnes/hr and both the Guelph and Northumberland breakers are operating without major problems. The Northumberland process design has a return chute system to recirculate bags of recyclables to the breaker during peak periods when film sorters are not able to cope with the volume of film to be removed at the initial sorting station.

Estimated Annual Cost for Blue Bag Removal at the Guelph MRF

Annual Blue Bag Tonnes Processed (2004) = 10,895

Operating:		**Cost/tonne**
Equivalent of 2 FTE staff dedicated to blue bag removal		
Sorters – 2 FTE sorters, 7 hrs/day, 250 days/yr @ approx $16/hr =	$56,000	
estimated 30% benefits =	$16,800	
Maintenance – 4 hrs, 12 months @ $18/hr =	$864	
Power consumption (estimated)	$1,000	
Sub Total =	$74,664	$6.85
Capital:		
Approximate capital costs (2003) = $150,000 Cdn		
Interest rate = 5%		
Anticipated life (yrs) = 10		
Amortized annual cost =	$19,426	$1.78
Total Annual Cost =	**$94,090**	**$8.63**

Estimated Annual Cost for Blue Bag Removal at the Northumberland MRF

Annual MRF Tonnes Processed (2004) = 13,000 (residential line only)

Operating:		**Cost/tonne**
Equivalent of 2 MRF staff dedicated to blue bag removal		
Sorters – 2 sorters, 7.58 hrs/day, 250 days/yr @ approx $13/hr =	$49,270	
estimated 30% benefits =	$14,781	
Maintenance - cleaning - 30 min/day x 250 @ $17/hr =	$2,125	
- maintenance – 30 min x 26 wks @ $17/hr =	$221	
Power consumption (estimated) =	$1,000	
Sub Total =	$67,397	$5.18
Capital:		
1999 capital costs (breaker, hopper, return feed conveyor) = $130,000		
Interest rate = 5%		
Anticipated life (yrs) = 10		
Amortized annual cost =	$16,836	$1.30
Total Annual Cost =	$84,233	$6.48

Contact:

Bulk Handling Systems
1040 Arrowsmith
Eugene, OR 97402
(541) 485-0999
sales@bhsequip.com
www.bulkhandlingsystems.com

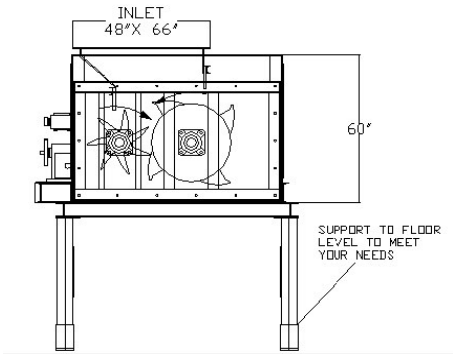
Machinex Industries (Machinex)

General

Machinex have one breaker operating in a recyclables MRF (Colchester N.S.) and one processing mixed waste (C.E.S.M.; Montreal P.Q.).

Concept

The Machinex breaker is almost identical in design and operation to that of the BHS breaker. Bagged material falls from a conveyor feed above between two drums with rotating blades that slice the bags. The manufacturer also claims an anti-blocking mechanism. A schematic of the breaker is shown below:



Throughput and Costs

Machinex claim a maximum throughput rate of 29 tonnes/hr for MSW and yard waste and from 15 to 20 tonnes/hr for bagged recyclables. The cost of the unit was quoted as $56,000 Cdn.

Colchester, Nova Scotia MRF

The author visited the Colchester Nova Scotia MRF to see the Machinex breaker in operation. The MRF processed approximately 13,000 tonnes of 2 stream bagged recyclables (bagged fibres and bagged containers) in 2004. The Machinex bag breaker replaced the previous auger bag breaker in 2003 and has been operating without a major problem over the past two years processing the bagged container stream. Bagged fibres are manually debagged on the tipping floor prior to the in-floor feed conveyor.

After debagging, 2 dedicated film sorters remove film and 2 other container sorters (@ 50% FTE) also remove film. Approximately 416 tonnes of film was recovered in 2004 (95% of the film was low density polyethylene). On the container sorting conveyor, approximately 4,550 tonnes/yr of containers were processed in 2004, or about 2.33 tonnes/hr. The equivalent of 3 sorters remove film plastic in the MRF.

Estimated Annual Cost for Bag Removal at Colchester MRF

Annual MRF Tonnes Processed (2004) = 13,000
Annual Breaker Tonnes Processed (2004) = 4,550

Operating:			**Cost/tonne**
Equivalent of 3 MRF staff dedicated to blue bag removal after breaker			
Sorters – 3 sorters, 8 hrs/day, 260 days/yr @ approx $12/hr (estimated 30% benefits) =		$97,344	
Maintenance –		$1,000	
Power consumption (estimated) =		$1,000	
	Sub Total =	$99,344	$21.83
Capital:			
Approximate capital costs (2003) = $50,000			
Interest rate = 5%			
Anticipated life (yrs) = 10			
Amortized annual cost =		$6,475	$1.42
Total Annual Cost =		**$105,819**	**$23.25**

Contact:

Machinex
2121 Oliver St.
Plessisville, Quebec
G6L 3G9
(819) 362-3281
info@machinex.ca
www.machinex.ca

2.3 European Manufacturers

Boa Systems BV (Boa)

The information presented here is a condensed version of information from the BOA website. Despite repeated requested, no further detail of the breaker was supplied by BOA.

General

BOA has been active for more than 45 years in the waste and recycling industry and has evolved from a baler manufacturer to a full service supplier of waste processing installations. BOA Systems B.V. since 1 March 2003 forms part of the Synmet International Group.

Concept

The BOA breaker can be loaded with plastic bags by crane or from a conveyor. The bags are fed to a channel where an oscillating mechanism, with a pull and tear movement, rips the bags apart. The mechanism has teeth and is powered hydraulically. All bags are therefore opened and fed in a constant stream to the output conveyor. The machine adapts itself to the amount of inflow material, and regulates a constant stream of output material, the opened bags. Characteristics of this machine is that it does not contaminate itself with difficult to handle waste. This is achieved because the machine does not have rotating parts or axles.

Throughput and Costs - NA

Sample MRF Installations - NA

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BRT Recycling Technologie Gmbh (BRT)

General

BRT manufacturers the SCHLITZ-O-MAT Bag Opener. Although its main market is Europe, approximately 250 machines have been supplied around the globe. In North America, one machine operates in the Edmonton MRF on blue bag recyclables and the other operates in Cleveland Ohio on MSW. In Germany BRT Bag Openers are mainly used for opening and emptying of yellow DSD bags. The opener in the City of Edmonton MRF was installed in 1999 and has operated reliably since that time.

Concept

The SCHLITZ-O-MAT systems open the bags utilizing wear-resistant non-cutting indexing drums operating at a high torque, low RPM. The unique design protects against blockage and clogs due to large, bulky items, plastic netting and films, and is resistant to impurities and other non-recyclable materials.

The system is configured to work with existing feed conveyors, or can be set up to work with a feed hopper. A second conveyor, located under the opener, transports material to the sorting stations.

An integrated PLC controls mechanical functions and allows for speed and volume adjustment, plus provides system monitoring while operational data and diagnostic messages are presented via an LCD text display unit. In addition, the units feature a design that minimizes moving parts to reduce wear, leading to a significant reduction in repairs and maintenance. The systems operate at a low noise rating of 75-76 decibels, creating a very user friendly environment which means the systems can used in open spaces, or, for even quieter operation, may be installed within enclosures.

Throughput and Costs

Designed for recycling, including glass and ONP, two models are available with handling capacities to 10 tons per hour. There are also two models available for handling solid wastes and yard wastes (compost) with capacities of up to 30 tons per hour.

For recyclables, the following models are available:

Model	Cost
SCHLITZ-O-MAT N basic version: Working width: 1.300 mm; 6 t/h at 100 kg/m^3	68,500 €
As above with 6m hopper:	109,600 €
SCHLITZ-O-MAT XL basic version: Working width: 1.700 mm; 10 t/h at 100 kg/m^3	97,200 €
As above with 6m hopper:	136,800 €

The above prices (in Euros) refer to the European machine design, in particular, the electrical equipment according to EU standards. The adaptations to North American standards would need to be defined and would change the prices accordingly. The reported capital cost of the Edmonton breaker was $72,000 Cdn in 1999.

City of Edmonton MRF

The City of Edmonton MRF was visited in the spring of 2003 as part of another study to observe the bag breaker and to identify costs associated with breaking bags and removing film plastic after the bags were broken. The City collects all curbside recyclables in translucent blue bags. Once on the conveyor in-feed system, the bags travel past a pre-sort station where 4 sorters positively sort any loose cardboard, non-recyclables and large items[2]. All material then travels through the bag breaker and then to a film sorting conveyor where 8 staff positively sort film plastic. An additional 4 full time equivalent staff sort film at various other sorting stations throughout the MRF. Much of the sorting effort on the film removal line is spent shaking recyclables from the torn blue bags.

As part of this study, the operator confirmed that the bag breaker was still operating with no major problem and that the operation had not changed since last visited in 2003. The following summarizes the estimated cost of breaking and removing plastic bags at the Edmonton MRF.

Estimated Annual Cost for Blue Bag Removal at the Edmonton MRF

Annual MRF Tonnes Processed (2002) = 30,558

Operating:		**Cost/tonne**
Equivalent of 12 MRF staff dedicated to blue bag removal		
Sorters – 12 sorters, 9.5 hrs/day, 250 days/yr @ approx $10/hr = (estimated 30% benefits)	$285,000	
Maintenance – 16 hrs, 12 months @ $18/hr =	$3,456	
- welding rods - $200 x 12 months =	$2,400	
Power consumption =	$2,140	
Sub Total =	$292,996	$9.59
Capital:		
Estimated capital costs (Apr/99) = $72,000 Cdn		
Interest rate = 5%		
Anticipated life (yrs) = 10		
Amortized annual cost =	$9,324	$0.31
Total Annual Cost =	**$302,320**	**$9.90**

Contact:

BRT Recycling Technologie GmbH
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49545 Tecklenburg
T: +49 5482 9384 0
F: +49 5482 9384 84
email: hallo@brt.info

[2] Some of the material is loose on the tipping floor due to bags breaking in the collection vehicle and through movement by the front-end loader.

Mattiessen Lagertechnik Gmbh (Mattiessen)

General

The Mattiessen breaker is used throughout Europe and in the UK. To date, no machine is operating in North America.

Concept

Bags are fed into a feed hopper (up to 30 m^3 capacity) either by front end loader or feed conveyor. A conveyor in the bottom of the feed hopper moves the bags up to a rotating drum. The drum has steel blades that lift the material over the drum in the direction of the drum rotation. As the material reaches the top level of the drum, it is forced through an opening created by a hydraulic ripper curtain. The bags are ripped open, they continue over the drum past the curtain as the drum continues to rotate. At his point, the blades retract into the drum so that the material falls over the drum onto an in-floor conveyor beneath the machine.

The use of retracting blades means there is no material that wraps around the blades – they are virtually self-cleaning. The blades extend out of the drum as the rotation again approaches the bottom of the feed hopper, as shown in the photograph below.

The manufacturer claims "*almost 100% emptying of the sacks, including sacks in sacks*". The drum has an automatic reverse operation and as a result of the self cleaning blades, is insensitive to large hard materials, nets, chains, wires, etc.

Throughput and Costs

The manufacturer claims a throughput rate ranging from 8 to 10 t/h, depending on the bulk density of the material (up to 120 kg/m^3). This throughput was verified and often exceeded during a field visit to the Ipswich MRF in the UK.

Ipswich MRF Installation (UK)

The Mattiessen opener was installed April 2005 as part of a renovation at the original MRF by Viridor Waste. The MRF now consistently processes 10 t/h and has operated as high as 15 t/h, but at the higher throughput, the blades tend to produce smaller paper sizes which then become more difficult to manually sort. The breaker produces a good separation of film and bag contents. Two sorters currently remove film plastic. The machine has operated virtually maintenance free over the first 4 months despite many non-recyclables (toasters, metal equipment parts, etc.) passing through the breaker before they reach the pre-sort area.

Estimated Annual Cost for Bag Removal at the Viridor Ipswich MRF (UK)

Annual MRF Tonnes Processed (2004) = 44,200

Operating:		**Cost/tonne**
Equivalent of 2 MRF staff dedicated to film removal after breaker		
Sorters – 4 sorters, 14 hrs/day, 260 days/yr @ approx £12/hr =	£174,720	
estimated 30% benefits =	£52,416	
Maintenance – (estimated) =	£2,000	
Power consumption (estimated) =	£2,000	
Sub Total =	£231,136	£5.23
Capital:		
Estimated capital costs (2004) = £68,000		
Interest rate = 5%		
Anticipated life (yrs) = 10		
Amortized annual cost =	£8,806	£0.20
Total Annual Cost =	**£235,942**	**£5.43**

Contact:

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D-25361 Krempe

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F: +49 8424 483 2701
info@mattiessen-technik.de
www.matthiessen-technik.de

Vauché S. A. (Vauché)

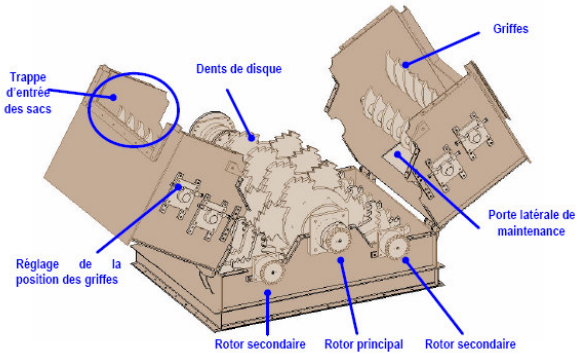
General

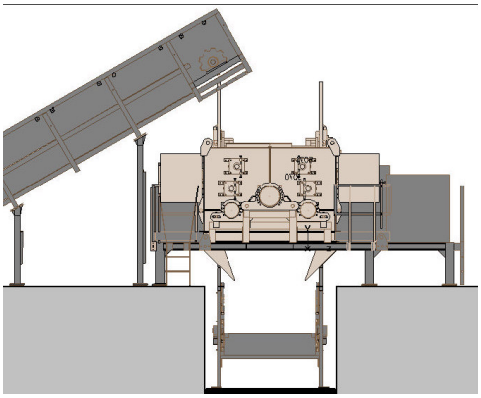
Vauché, a French company, manufacturers a bag breaker that is used extensively throughout Europe.

Concept

The Vauché breaker has 3 rotors with 4 blades on each rotor as shown below. The larger central rotor slowly spins in a clockwise direction while the two small rotors on either side spin in the opposite direction at a faster speed. In this manner, the bags are ripped into one or two pieces and the contents spill out through the openings between the rotating blades.

The blades have no sharp edges and are coated with a wear-resistant coating so that the film and contents don't stick to the metal. The design, configuration and motion of the rotating of the discs help prevent coiling and don't shred the contents of the bag.





The machine has a complete electronic overload and anti-block control system. The rotors are self-reversing and if there is a constriction, the rotors reverse up to three times to try to free the material. If this fails, a signal is sent to the controller so that the material can be dislodged manually.

The manufacturer quotes a 90-95% efficiency rating for opening sacks when handling recyclables and although this breaker was not observed as part of this study, reports are that it produces an excellent separation of film and bag contents.

Throughput and Costs

A throughput ranging from 4 to 8 tonnes/hr is claimed for material densities from 70 to 120 kg/m^3 (recyclables) and from 10 to 15 tonnes/hr for materials with a density between 300-500 kg/m^3 (MSW). Costs are quoted in Euros, assuming French installation as of the first quarter of 2005.

Model	Cost
Electro-mechanical version	70,000 €
Hydraulic version	90,000 €
Shipping, installation (in France)	3,700 €

Sample MRF Installations
Lille MRF (France)
Charleroi MRF (Belgium)
Milan (Italy)

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3.0 SUMMARY

A summary of basic bag breaker characteristics is shown in Table 3.1. The costs shown in the table are those provided by the manufacturer at the time of this study, except as otherwise noted.

Table 3.1: Bag Breaker Data

Manufacturer	Model	Throughput	Cost (2005)	Sample MRFs
BHS	BB – 60 BB – 72 BB - 90	45 bags/min 50-60 bags/min 70 bags/min	$87,100 U.S. $97,200-$105,300 U.S. $125,500 U.S.	▪ City of Guelph, On - single stream recyclables ▪ BFI, Milpitas Ca.- fibre and containers ▪ Miller Waste Systems, Halifax NS – containers only ▪ City of St. Peters, Mo – all recyclables
Machinex		15 – 20 tonnes/hr	$56,000 Cdn.	▪ Colchester N.S. – containers only
BRT	N XL	6 tonnes/hr 10 tonnes/hr	68,500 € 97,200 €	▪ City of Edmonton – single stream recyclables ▪ Cleanaway – Rainham (UK) – single stream recyclables ▪ Cleanaway – Greenwich UK – single stream recyclables
Mattiessen		8-10 tonnes/hr	£68,000 (Viridor 2004)	▪ Viridor - Ipswich MRF (UK) - single stream recyclables ▪ Sita - Sinn ▪ Cleanaway – Flensburg (Germany)
Vauché		4 to 8 tonnes/hr	70,000 €	▪ Lille MRF (France) ▪ Charleroi MRF (Belgium) ▪ Milan (Italy)

Table 3.2 presents a summary of operating characteristics for a number of MRFs where plastic film is sorted following the use of a bag breaker. In all but one locations listed (Colchester), all recyclables are collected curbside in plastic bags. Readers should be aware that there are a number of factors, in addition to the type of bag breaker used, that contribute to the variations in productivities and costs exhibited in the table. These include:

- The incoming material (e.g. Colchester sends only bagged containers through the bag breaker)
- The process design (e.g. Northumberland has a return chute that film sorters can use to re-circulate bags to the bag breaker during peak periods)
- Individual sorter productivities (e.g. private sector versus municipal employees, the presence of incentive pay for productivity thresholds, etc.).

Table 3.2: Film Sorting Data

Location	Throughput (tonnes/yr)	Days/ yr	Tonnes/d ay	Operating hrs/day	No. of FTE Sorters	Tonnes/ operating hr	Tonnes/ sorter hr	Cost/ tonne
Edmonton	30,558	250	122	9.5	12	12.9	1.07	$9.90
Northumberland	13,000	250	52	7.6	2	6.9	3.43	$6.48
Colchester	4,550	260	18	7.5	3	2.3	0.78	$23.25
Guelph	10,895	250	44	7.0	2	6.2	3.11	$8.63
Ipswich	44,200	260	170	14	2	12.1	6.07	£5.43

Based on a visual inspection of the breakers reviewed in this study (with the exception of the Vauche breaker, which is based on reports from other industry personnel who have seen the breaker in operation), the breakers are rated below from 1 (low) to 5 (high) as to how well they open bags and separate film from bag contents:

Manufacturer	Rating
BHS	3
Machinex	3
BRT	3
Mattiessen	4
Vauché	5

In general, with the exception of the Colchester MRF operation, the cost of removing film plastic (including the cost of the breaker) varies between about $6 and $10 per tonne processed through the breaker.

For Ontario applications, there are only two bag breakers that are manufactured and readily available in North America: BHS and Machinex. BHS has a longer track record, has proven reliability and is in operation in numerous MRFs throughout five continents. Machinex is operating in only one MRF (Colchester NS) although it also has proved reliable over the past two years.

The availability of the other three European bag breakers in the North American market is not clear. Each is currently designed to meet EU specifications and modifications would be needed to meet local electrical codes. Although Edmonton's experience with the BRT breaker has been positive, potential difficulties with supply of spare parts, maintenance, etc. would also be items that customers would need to consider in purchasing one of these breakers.

APPENDIX A

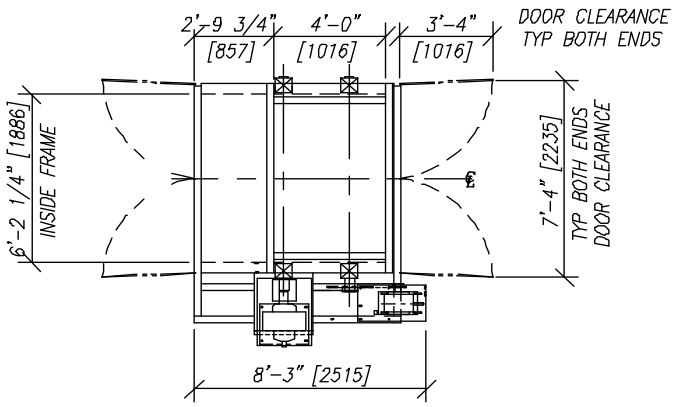
Manufacturer's Data

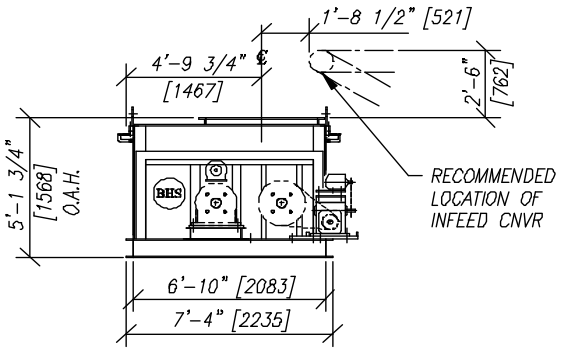
BHS

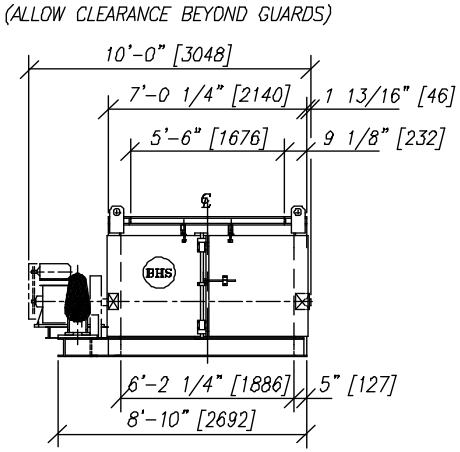
Operating Requirements: A staffed pre-sort conveyor is required if any large items, such as paint buckets, lawn chairs, larger cardboard etc, will be present in the incoming material stream. If these items are not removed, the Anti-Jam Mechanism will frequently be initiated, resulting in belt stoppage and reduced production rates.

Item 1: One (1) BHS Bag Breaker – Model BB-72
- Sized to process up to 10 TPH of Single Stream material.
- Material to be conveyor fed.
- Motors: One (1) 20 HP and one (1) 2 HP motor with Class II reducers.
- Control panel in NEMA 12 enclosure

Item 1: One (1) BHS Bag Breaker – Model BB-90
- Sized to process up to 25 TPH of mixed recyclables.
- Material to be conveyor fed.
- Motors: One (1) 20 HP and one (1) 2 HP motor with Class II reducers.
- Control panel in NEMA 12 enclosure
- Electrical: 380/3 phase/60 Hz.







THIS DWG AND ITS ASSOCIATED 'CADD' FILE ARE FOR REFERENCE ONLY. YOU SHOULD REQUEST A 'ISSUED FOR CONSTRUCTION' DWG FROM THE BHS PROJECT MANAGER AT THE TIME OF ORDER.

BULK HANDLING SYSTEMS, INC.
1040 ARROWSMITH · EUGENE, OREGON 97402
PHONE (541) 485-0999

PRODUCT:

BHS BAG BREAKER® PATENTED

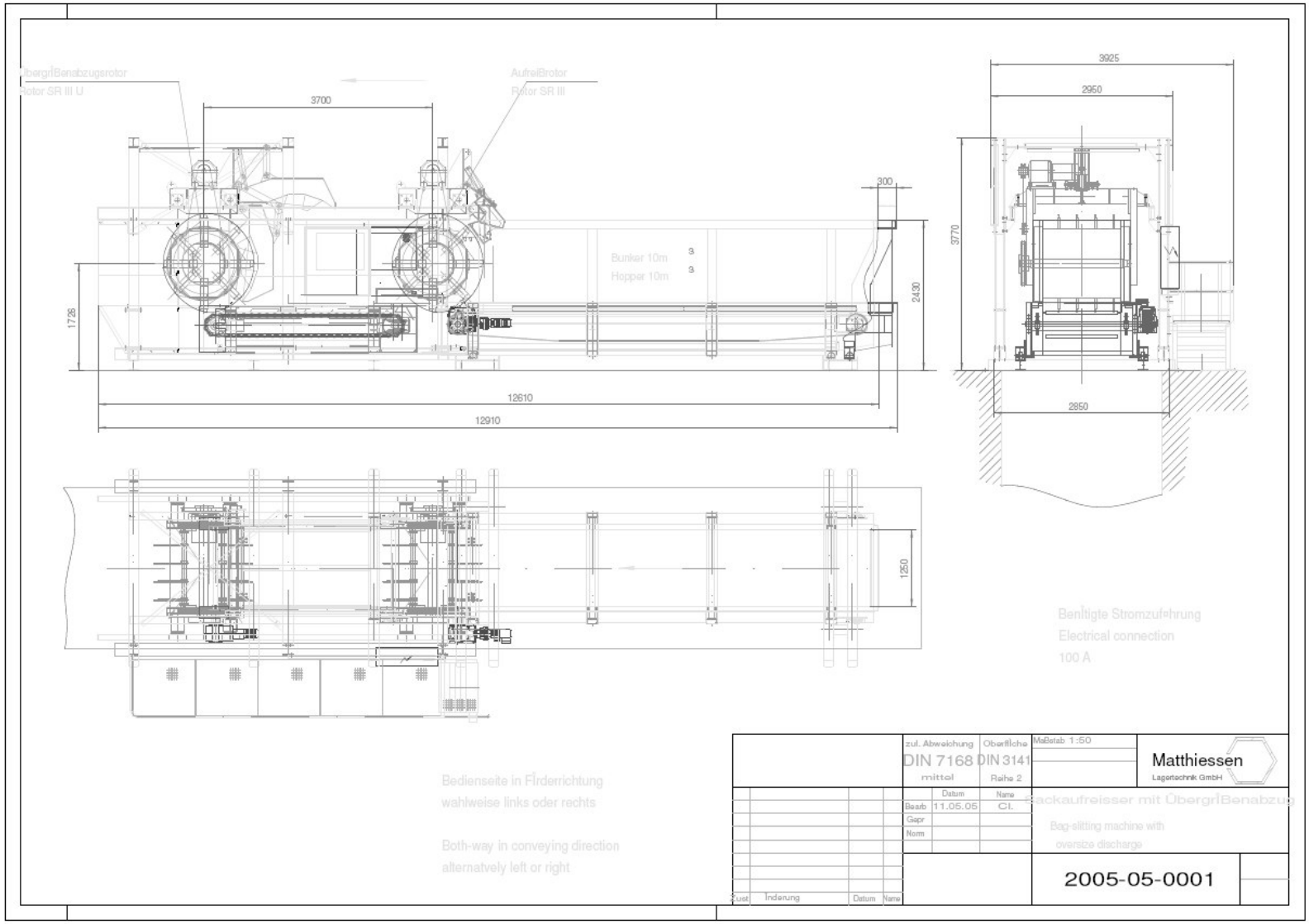
MOD. # BB-72L

CAD FILE: MARK\M-118

REV: 1

SCALE: 3/16"=1'

Matthiessen



The right technological answers to the sorting of recyclable materials

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are in demand - we are the specialists!

The change in sorting techniques

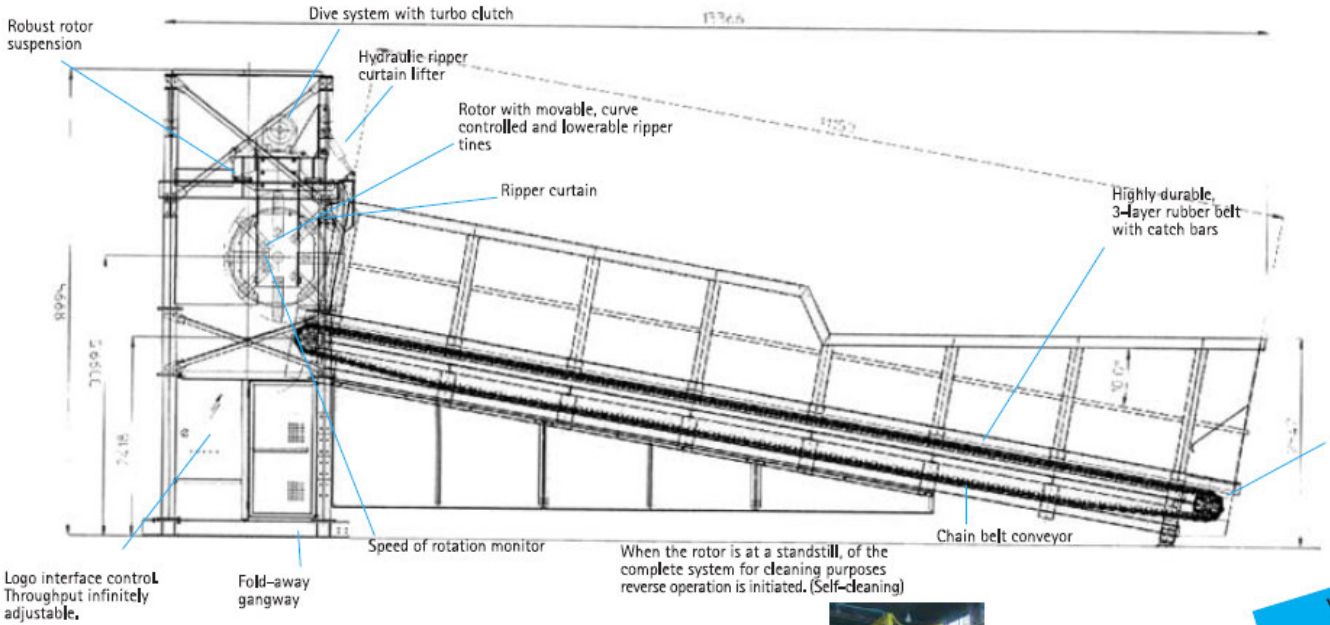
Trailor-made technology catering for all sorting tasks.

Intelligent technology keeps costs down

The modular design of the Matthiessen systems ensures efficient and economic operation at the user's plant, thus making sure that costs are kept to a minimum. An important aspect for all companies engaged in the sorting of light weight-packaging.

Safeguarding the enviroment

Equipped with the most modern control systems, this machine not only simplifies work enormously, but also contributes to reducing energy costs in the plant. This means that a favourable cost structure is guaranteed.



When the rotor is at a standstill, of the complete system for cleaning purposes reverse operation is initiated. (Self-cleaning)

Technology for sorting recyclable materials

High-tech sorting of recyclable materials
for the successful solution to the job

Up to 10 tons per hour

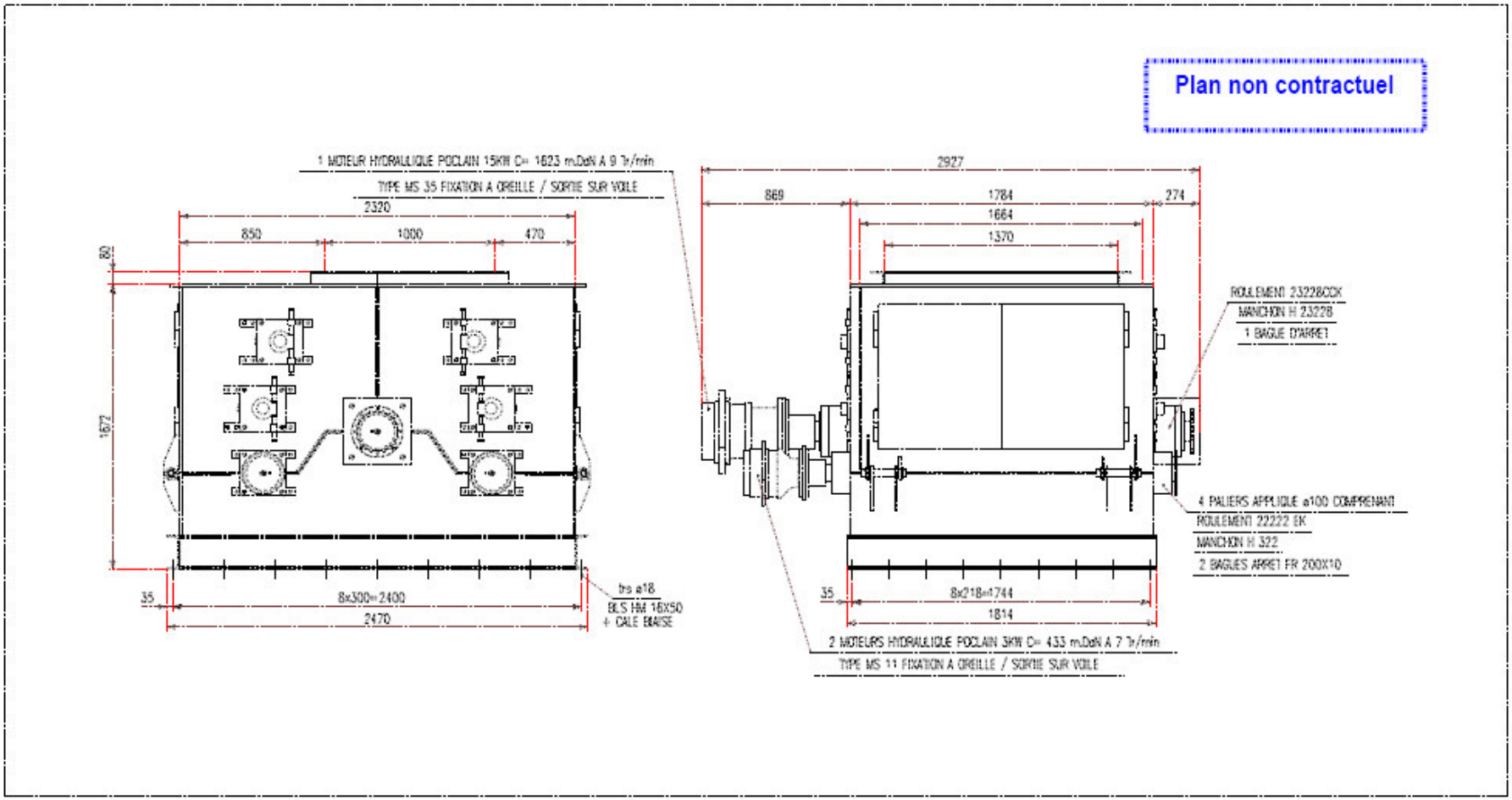
The machine for ripping open and emptying the sacks, and for metering, can achieve an output of up to 10 tons per hour, corresponding to roughly 2.500 - 5.000 yellow sacks. Additionally, throughput can be in finitely adjusted. Apart from the savings in costs for the waste disposal company, work for the sorter is greatly simplified: Metal objects such as cans are now sorted easier and better using magnets in follow-on systems.

The machine complies with EU guidelines!

Warranty: 2 Years! on single-shift operation

Matthiessen Lagertechnik

Vauché


Plan non contractuel
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470
80
1672
35
8x300=2400
2470
trs a18
BLS HM 16X50
+ CALE BIAISE
2927
869
1784
274
1664
1370
ROULEMENT 23228CCK
MANCHON H 23228
1 BAGUE D'ARRET
4 PALIERS APPUYE a100 COMPRENANT
ROULEMENT 22222 EK
MANCHON H 322
2 BAGUES ARRET FR 200X10
35
8x218=1744
1814
2 MOTEURS HYDRAULIQUE POCLAIN 3KW C= 433 mDaN A 7 Tr/min
TYPE MS 11 FIXATION A OREILLE / SORTIE SUR VOILE