

**AUTOMATED PROCESS AND EQUIPMENT CAPABLE TO OPEN BAGS WITHOUT
DAMAGING ARTICLES ENCLOSED IN SUCH BAGS**

5 Field of the invention

The present invention relates to an equipment and related process for operating such an equipment for opening bags without damaging the articles, products, or goods contained in such a bag. A particular application may be for post-consumer recycling of articles, such as hygiene articles, whereby such articles may be delivered to a recycling unit in collection bags, where the bags
10 should be opened without damaging the articles so that these remain essentially intact for further processing.

Background

Often, products, materials, articles are delivered in a bag enveloping several thereof. Conventional automatic bag openers are broadly used for opening granular or powdery materials, such as by
15 feeding such bags along a conveyor and the cutting, slitting, or otherwise opening the bag whereby the opening tools penetrate into the inner of the bag. This requires that the materials inside the bags is unsusceptible to such a treatment.

However, certain products, materials, or articles that could be damaged by such a treatment, are packed in bags that are to be removed without damaging the articles.

20 A particular application relates to the post-use recycling of disposable articles, such as used hygiene articles. Such articles may be collected in bags for being delivered to a recycling plant. However, for certain processing steps, such as pre-washing of soiled articles for removing superficial soiling, such as faeces, the articles should be individualized out of the bag without damaging or opening the outer covers of the article, as this may lead to other materials of the
25 article, such as absorbent material from the inner of the article, be exposed to undesired effects in subsequent processing steps, such as being overly wetted by the cleaning fluid, or even prematurely removed.

Summary

To overcome these problems, the present invention is a bag opening unit for automatically
30 opening bags for removing articles contained in the bags, which comprises an actuator head and at least one vacuum source adapted to apply vacuum to a first and a second vacuum zone. The first vacuum zone is adjacent to a surface of the actuator head of the bag opening unit adapted to be contacted by the bags and is circumscribing a second vacuum zone, which is formed by a recession in the bag opening unit. The actuator head further comprises a bag opening device,
35 preferably selected from the group consisting of a cutting blade, a spine, a heating wire, and an

ultrasonic tool, whereby the bag opening device is stationary or movably connected to an axis, and adapted to be moved in the recession for contacting and opening the bag in the recession zone. In a second aspect, the invention is process for opening bags for removing articles contained in the bags, which is operated on a bag opening unit comprising an actuator head and at least one vacuum source, which is adapted to apply vacuum to a first and a second vacuum zone, wherein the first vacuum zone is adjacent to a surface of the actuator head adapted to be in contact with the bags and is circumscribing a second vacuum zone formed by a recession in the actuator head. The actuator head of the bag opening unit further comprises a bag opening device, preferably selected from the group consisting of a cutting blade, a spine, a heating wire, and an ultrasonic tool, whereby the bag opening device is stationary or movably connected to an axis, and adapted to be moved in the recession for contacting and opening the bag in the recession zone.

The process comprises the steps of

- positioning a bag comprising articles in the proximity of the recession;
- applying vacuum to the first and the second vacuum zone for attaching the bag in the first vacuum zone to the actuator head and pulling the bag into the second vacuum zone in the recession;
- activating the opening device so as to destruct the bag in the recession;
- reducing or releasing the vacuum such that the bag is released from the actuator head and the bag opening unit.

Brief description of the figures

Fig. 1 outlines a bag opening unit according to the present invention.

Fig. 2 outlines the same bag opening unit of Fig. 1 with a bag with articles in close proximity or contacting an actuator head of the bag opening unit.

Fig. 3 outlines the bag opening unit and the bag of Fig. 2, with vacuum being applied to the recession, which results in the bag being sucked into the recession with an opening device.

Fig. 4 outlines the bag unit and a bag as shown in Fig. 2, wherein further the opening device in the recession prior to being activated via an axis towards the bag in the recession.

Figures are schematic and not to scale. Same numerals refer to same or equivalent elements or features.

Detailed Description

The present invention can be applied to any automated system, where products, materials, or articles which are contained in bags, but should be removed therefrom without being damaged by the bag opening operation. Bags suitable to be used in the context of the present invention need to be air impermeable, or at least exhibit a resistance to air flow passing through that allows them to be pulled by vacuum. Typically, such bags are made of plastic film materials, such as – without

implying any limitation – polyethylene, that exhibit air impermeability, though other fully impermeable materials like paper function well. Other webs like non-woven or woven webs may function also, when exhibiting sufficiently low permeability. Further, the material should exhibit flexibility to be pulled away from the content of the bag or the bag should be filled such that there is sufficient slack in the material to allow such pull.

In order to further explain the present invention beyond the general description herein above, reference is made exemplarily to the recycling process for articles like absorbent hygiene products (AHP), e.g., baby diapers, adult incontinence articles and the like, upon being collected from users in collection bags containing a multiplicity of used products.

Such articles may contain exudates like faeces that may comprise matter which does not dissolve during the recycling process, also representing a contamination risk during and after processing. As the recycling process aims at separating plastic, fibers, or other absorbent material, especially superabsorbent polymers (SAP), into cleaned streams of recovered materials, non-dissolvable matter should be removed early in the recycling process, e.g., by exiting in a compost stream.

Thus, the soiled articles may be submitted to a pre-washing step for removing the coarse soiling, and this pre-washing step needs to be applied to individualized articles, which further should be folded open from the rolled-up state in which these are typically delivered.

Thus, the articles need to be removed from the bags. Opening each bag using manual labor would not be a cost-effective method for an on-going recycling operation. Methods are therefore needed to open the bags to remove the individual diapers.

Conventional technology of cutting the bags open or even shredding these altogether with their content is not desired as both the bag and diapers would be damaged. Any damage diaper would allow pulp and SAP to exit the diaper in a pre-washing process step and cause a wasteful loss of these materials.

Thus, the present invention aims at the automatic, or at least semi-automatic opening of the bags, like the diaper collection bags, without damaging the contained articles, like used diapers, within the bag.

The efficiency of AHP recycling operation (post-consumer) in terms of exiting material quality and purity is somewhat dependent on the quality of the content of incoming soiled articles. During the usage of the diaper, the diaper becomes loaded with exudates such as urine and faeces. During usage, the urine penetrates into the diaper and is absorbed, especially by the SAP, however the faeces typically does not penetrate into the diaper and remains on the surface. Such faecal matter does not only contain bacteria and other excretion materials coming from the user, but the faecal matter also contains materials such as non-digested fibers or seeds from the food eaten.

Any recycling AHP operation which is desiring to achieve pure exiting materials, such as plastic,

cellulose pulp fiber, and SAP needs to operate equipment and processes with a high separation efficiency. The failure or reduced performance of any separation process typically results in a reduction in purity reducing value and re-use potential of exiting materials.

5 Under the exemplary scenario for instance where seeds were eaten by the baby which pass through the baby directly exiting in the faecal matter, under the scenario of down-stream separation steps of the recycling process being based on relative density separators, these seeds could end up undesirably in the pulp material stream exiting the process. By default, removing such particles from the pulp stream is difficult and it is far better to remove the contamination risks earlier on in the process.

10 Thus, a pre-wash operation step prior to any process steps separating the article components, wherein the diapers remain un-damaged and where the faecal matter is removed, is highly preferred to improving enhanced down-stream purities of the materials.

During an effective pre-wash operation where solid matter is removed from the surface of the article, all elements within the faecal matter can be removed. If, however, the article is damaged
15 or breaks up in or prior to the pre-wash process step, large quantities of SAP and pulp can be released into the pre-washing tank, thus reducing the efficiency of the pre-wash process step and in some cases, cause the loss of the SAP and pulp.

It is therefore desirable for good performance of the recycling process that articles, such as diapers, entering a post-consumer recycling operation, especially when comprising a pre-wash
20 process step, are not damaged.

Typically, such articles arrive to the post-consumer recycling operation in bags. Opening the bags with a shredder or knife or similar would not only open the bag, but also damage the articles, and then cause SAP and pulp loss in the pre-washing process.

The following describes the process and equipment according to the present invention to open the incoming bags in an automatic and/or semi-automatic manner causing no or very limited damage
25 do the articles contained in such bags.

Optionally, the automatic or semi-automatic removal of the bag allows placing the diaper bag into a different recycling stream as the articles, as may be preferred as the bag choice ultimately being made by the consumer, bags may come in with different colours and materials which would have
30 the potential to contaminate the plastic stream of the down-stream recycling process.

Referring to the Figures 1 to 4, a bag opening unit 100 comprises an actuator head 101 and a bag 102 comprising articles 103, such as diapers.

In various system layouts, the actuator head 101 could be fixed, whilst a robot (not shown), of
35 one or more axes (not shown), moves the bag with articles towards the actuator head 101 of the

bag opening unit 100. Also, in other system layouts a robot of one or more axes (not shown), moves the bag opening unit 100 or at least the actuator head to the bag with the bag staying in a fixed position. Also, in other system layouts a robot of one or more axes (not shown), moves the bag opening unit 100 or at least the actuator head 101 to the bag whereby the bag is also being moved with a robot of one or more axes.

A bag opening system operates with a minimum of one bag opening unit 100, but may, to speed up bag emptying, be an equipment with multiple bag opening units 100, or one bag opening unit 100 may comprise multiple actuator heads 101. A bag opening unit 100 opens the bag at any location thereof. In an exemplary operation, two openings may be executed as two cuts, as may be horizontal cuts, may be made at the base of the bag and to ensure successful release of all articles additional five further cuts angled thereto, preferably perpendicularly thereto, can be made along the perimeter of the bag.

Further referring to Figure 1, an opening device 2, as may be stationary, such as a fixed knife as indicated in Fig. 3, or a moving opening device, such as when a knife not being in contact with the bag as indicated in Fig. 4, is moved by a driven axis 1 to open, e.g., by punching or cutting, the bag 102 in the recession 10.

When employing a moving opening device, this may be manually actuated by an operator, but preferably is an automatic translatory and/or rotational movement through axis 5 of the opening device.

A first vacuum zone 3 is depicted at the surface of the actuator head 101 between the actuator head 101 and the bag 102, and also a secondary vacuum zone 4 is shown within the actuator head 101 as also comprising the recession 10.

Depending on system set-up, the first (3) and the second (4) vacuum zones could be connected to the same vacuum system (not shown), however, it is more preferable to have the second vacuum zone 4 connected to a separate vacuum system different to the one for the first vacuum zone 3, thereby allowing different degrees of vacuum. Typically, the second vacuum zone 4 would be activated before the first vacuum zone 3, but could also be activated concurrently or later. If the second vacuum zone 4 is activated before the first vacuum zone 3, the diaper bag is pulled into the recession 10 which is a zone where opening of the bag 102 by the opening device 2, e.g., a spine or a cutting knife, can take place without damaging the articles 103 contained within the bag.

Optionally, the opening device may be a heated element such as a wire, or ultrasonic head instead of a spine or cutting blade or knife.

Optionally, a weight measuring device can be connected to the device holding the bag 103 in order to weigh the bag before, during, and after the cutting process. Via controlled feedback of

the weight measuring device, the system will detect if the bag has been emptied or not. The system will then be able to optionally repeat the opening action until the bag 103 is completely empty, as well as optionally shake the bag 103 until empty, as well as optionally place the incompletely emptied bag 103 in a holding location for manual inspection, as well as dispose of the bag 103.

Claims:

1. A bag opening unit (100) for automatically opening bags (102) for removing articles (103) contained in said bags (102),
5 said bag opening unit (100) comprising
 - an actuator head (101);
 - at least one vacuum source adapted to apply vacuum to a first (3) and a second (4) vacuum zone, wherein said first vacuum zone (3)
10 is adjacent to a surface of said actuator head (101), which is adapted to be contacted by said bags (102) and is circumscribing a second vacuum zone (4) formed by a recession (10) in said actuator head (101);
 - a bag opening device (2), preferably selected from the group consisting of a cutting
15 blade, a spine, a heating wire, and an ultrasonic tool, whereby said bag opening device (2) is stationary or movably connected to an axis (5), adapted to be moved in said recession (10) for contacting and opening said bag (102) in said opening zone (10).
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2. A process for opening bags (102) for removing articles (103) contained in said bags (102), operated on a bag opening unit (100) comprising
 - an actuator head (101);
 - at least one vacuum source
25 adapted to apply vacuum to a first (3) and a second (4) vacuum zone, wherein said first vacuum zone (3) is adjacent to a surface of said actuator head (101), which is adapted to be contacted by said bags (102) and is circumscribing a second vacuum zone (4) formed by a recession (10) in said
30 actuator head (101);
 - a bag opening device (2), preferably selected from the group consisting of a cutting blade, a spine, a heating wire, and an ultrasonic tool, whereby said bag opening device (2) is
 - stationary
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 - or movably connected to an axis (5), adapted to be moved in said recession (10) for

contacting and opening said bag (102) in said cutting zone (10),
said process comprising the steps of

- positioning a bag (102) comprising articles (103) in the proximity of said recession (10) of said actuator head (101);
- 5 - applying vacuum to said first (3) and said second (4) vacuum zones and attaching said bag (102) in said first vacuum (3) zone to said actuator head (101) of said bag opening unit (100) and pulling said bag (102) into said second vacuum zone (4) in said recession (10);
- 10 - opening said bag (102) by pulling it against said stationary opening device (2) or by moving said movable opening device (2) by said axis (5) towards said bag (102) in said recession;
- reducing or releasing said vacuum and releasing said bag (102) from said actuator head (101) and said bag opening unit (100).