The invention relates to a system and method for processing of fibres and particulates such as wool, wherein material is placed within a receptacle configured to allow the ingress and egress of treatment fluid, conveyed to a treatment fluid application area, treated with a treatment fluid, and conveyed from the treatment fluid application area.
FIBRE AND PARTICULATE PROCESSING

TECHNICAL FIELD

[0001] This invention relates to fibre and particulate processing.

[0002] More specifically, this invention relates to a system for the treatment of fibres including wool and feathers in both their natural and particulate forms.

BACKGROUND ART

[0003] Wool scouring is the practice of treating raw wool using various solutions in order to remove impurities such as wool grease, suint and dirt. A typical scouring process involves the wool undergoing a series of washes in various cleaning solutions, culminating in the drying of the wool in preparation for further processing.

[0004] The design of wool scouring machinery has increasingly focused on the processing of bulk amounts of wool—typically 5,000 kg/hr. Subsequently, the complexity and sheer size of the typical plant has advanced such that it has substantial housing, monitoring and maintenance requirements.

[0005] This requires a significant investment in capital, land, staff, maintenance and energy.

[0006] Further, the scale of these projects is such that only a few are in a geographical region, leading to additional transportation costs.

[0007] A typical modern plant features a continuous feed system by which the raw wool is fed across and through a series of “bowls” containing various cleaning products. Machinery is configured to distribute the wool evenly across each bowl, and submerse it in the cleaning product. The wool is squeezed through a roller system in order to remove the cleaning product before the next stage.

[0008] In the event of malfunction or an incorrect concentration of cleaning fluid being applied, these systems suffer the downfall of requiring the entire stream of wool to be processed through the line before it can be cleaned and retreated. Recovering the wool from the line mid-process is a cumbersome procedure and can be very wasteful given the bulk quantities of the wool.

[0009] Additionally, the use of a continuous feed system means that in order to process wools with different treatment requirements, either multiple lines are required, or a reconfiguration of the line between each lot is necessary. The typical wool scouring plant is too large to rearrange the system—adding or removing stages would require the recommissioning of the plant, an expensive, complex, time consuming and uneconomic act.

[0010] Additionally, the traceability of individual, small lots of fibres in such a large scale continuous scouring process is difficult, if not impossible. Traceability of small fibre lots is an increasing necessity for high value products such as those produced by applying special chemical treatments for wool fibres.

[0011] It would be advantageous to allow for the scouring of wool or other fibres or particulates in individual lots, so that such lots may be treated according to individual requirements, without the difficulties of resetting and rearranging the system. This would allow traceability of individual lots, for which there is increasing need.

[0012] Merely scaling down the typical wool scouring plant would not address the issues discussed here. The complexity of machinery in the feeding, distribution, immersion and subsequent dewatering via squeeze rollers of the wool is such that the cost of purchasing and maintaining such equipment (even in miniature form) exceeds the value added when smaller amounts of wool are processed. In addition, miniature equipment would not be suitable, as the wool fibre length remains constant and can wrap around such small scale equipment.

[0013] This is particularly true of situations where a producer has a variety of breeds, or small scale farmers whose production does not warrant shipping costs to a large scale wool processing facility. Such situations require the capability of processing small quantities of fibre, in separate batches which may have individual processing requirements.

[0014] The same difficulties are faced in other situations where a relatively delicate material requires processing in small or discrete quantities.

[0015] It is an object of the present invention to address the foregoing problems or at least to provide the public with a useful choice.

[0016] All references, including any patents or patent applications cited in this specification are hereby incorporated by reference. No admission is made that any reference constitutes prior art. The discussion of the references states what their authors assert, and the applicants reserve the right to challenge the accuracy and pertinence of the cited documents. It will be clearly understood that, although a number of prior art publications are referred to herein, this reference does not constitute an admission that any of these documents form part of the common general knowledge in the art, in New Zealand or in any other country.

[0017] It is acknowledged that the term ‘comprise’ may, under varying jurisdictions, be attributed with either an exclusive or an inclusive meaning. For the purpose of this specification, and unless otherwise noted, the term ‘comprise’ shall have an inclusive meaning—i.e. that it will be taken to mean an inclusion of not only the listed components but also other non-specified components or elements. This rationale will also be used when the term ‘comprised’ or ‘comprising’ is used in relation to one or more steps in a method or process.

[0018] Further aspects and advantages of the present invention will become apparent from the ensuing description which is given by way of example only.

DISCLOSURE OF INVENTION

[0019] According to one aspect of the present invention there is provided a method of material treatment, including the steps of:

[0020] a) placing the material within a receptacle configured to allow the ingress and egress of treatment fluid;

[0021] b) conveying the receptacle to a treatment fluid application area;

[0022] c) treating the material with a treatment fluid; and

[0023] d) conveying the receptacle from the treatment fluid application area.

[0024] According to a further aspect of the present invention there is provided a material treatment apparatus, including:
a receptacle configured to contain material to be treated, and allow the ingress and egress of treatment fluid; and

b) convey the receptacle to a treatment fluid application area;

c) hold the receptacle in position while the material is treated by a treatment fluid; and

c) convey the receptacle from the treatment fluid application area.

Reference to material throughout this specification should be understood to mean any material suitable for treatment in accordance with the present invention. This may include threadlike or filamentous components or particulates of those fibres.

The preferred embodiment of material in the present invention is in the form of filamentous or particulate components including, but not limited to, wool, fur, flax, or feathers.

Reference shall now be made to the materials as being fibres throughout the specification, but this should not be seen as limiting.

Reference to treatment throughout this specification should be understood to mean any operation or procedure which alters the condition of fibres.

The preferred embodiment of treatment in the current invention is the scouring, compaction, drying, heat treatment, dyeing, chemical treatment or extraction of fibres.

Reference to treatment fluid throughout this specification should be understood to mean any fluid that can alter the condition of the material such as fibres.

Thus the treatment fluid in the current invention can include air, water, detergent, acid, alkali, dyeing agents, bleaching agents, sand or micronised particles.

Where the present invention is used to treat animal fibres, preferred fluids can include air, water, detergent solutions, acid solutions, alkali solutions, dyeing solutions, chemical solutions and bleaching agents. With particular reference to wool scouring, the treatment fluid may be a lye solution.

It should be noted that the fluids may have varied temperatures, pressures and concentrations.

Reference to containment throughout this specification should be understood to refer to holding the fibres in such a way that treatment may occur and the fibres be kept together.

Reference to ingress throughout this specification should be understood to refer to the passage of fluid such that the treatment fluid can reach the fibre.

Reference to egress throughout this specification should be understood to refer to the passage of the treatment fluid away from the fibres.

Reference to a receptacle throughout this specification should be understood to refer to a means of containing fibres.

The preferred embodiment of a receptacle in the current invention is in the form of a rigid sided container, although possible embodiments include a basket or bag.

In a preferred embodiment the receptacle is an open topped container with rigid mesh sides. Preferably the mesh size is sufficiently small that fibres are unlikely to escape through the mesh—yet sufficiently large to allow ready ingress and egress of the fluid with respect to the fibres.

In a preferred embodiment the receptacle may include a means by which it is attached to and supported by the conveyor. To this end, the receptacle may include handles.

The size of the receptacle may be such that it may substantially fit within the treatment fluid application area. Reference to a treatment fluid application area should be understood to mean the position within the apparatus at which the fibres located in the receptacle are brought into contact with the means of treatment.

The preferred embodiment of a treatment fluid application area is in the form of a rigid sided container such as a bath which has been subdivided into a number of open-topped compartments.

In another embodiment, the treatment fluid application area may comprise two or more rigid sided compartmentalised containers.

It is envisaged that the treatment fluid may be circulated within the container, and that the container may allow for the replacement or alteration of the treatment fluid.

Where the treatment process includes exposing the material to a series of cleaning cycles, the treatment fluid from later stages may be reused in an earlier sequence of the process for the next batch of material.

For example, in wool scouring the water used in the later stages of the cycle may be reused for the initial stages of scouring the next batch of wool. At early stages in the cycle, the high level of contaminants in the wool may mean that high levels of purity of the water used as treatment fluid is not essential. Water from the later stages (in which the wool has been cleaned) may therefore be used without a significant reduction in effectiveness. This may serve to improve cost efficiency—both in terms of reducing total usage and the waste disposal of same, and also associated costs such as heating the treatment fluid.

When also envisaged that a continuous or regular flow of clean treatment fluid may be introduced into the treatment fluid application area, with the most used, or contaminated, treatment fluid drained in order to maintain consistent fluid levels.

The treatment fluid area may therefore include channels, or valves, between compartments or baths which facilitate the transfer of treatment fluid.

In another embodiment, a treatment fluid application area may be configured for the specific purpose of carrying out a chemical treatment or modification of the fibres other than by way of submersion.

For example, the treatment fluid application area may include a spraying or jetting apparatus.

In one embodiment a treatment fluid application area may be configured for the specific purpose of drying the fibres. Drying may occur by convection drying, conduction drying, vacuum drying, application of centrifugal force, dehumidification or radio frequency drying.

Reference to conveying throughout this specification should be understood to mean the causation of contact between the receptacle in which the fibres are located, and the means of treatment.

In most cases there is a conveyor that carries the receptacle and fibres to the treatment fluid application area. However in other embodiments the treatment fluid application area could be moved to the receptacle:
The conveyor can be driven by an actuator and reference to an actuator throughout this specification should be understood to be any means by which action or motion is achieved or initiated.

Thus, an actuator in the present invention could take the form of a hydraulically or pneumatically driven piston, a chain or gear or screw drive, a pulley-based drive system or winch.

The preferred embodiment of conveying in the present invention is composed of a cradle which supports the receptacle and can lift or lower the receptacle relative to the treatment fluid application area.

It is preferable that the conveying system is capable of supporting and conveying more than one receptacle at a time.

Reference to a cradle throughout this specification should be understood to mean a frame intended to support a piece of equipment.

In a preferred embodiment, the cradle is configured to adjust the elevation of a receptacle or receptacles.

The preferred embodiment of the cradle in the present invention is in the form of parallel rails by which a receptacle may be supported, and a plurality of actuators to allow for a change in elevation of the rails. Preferably the actuators are of a linear configuration and powered by pneumatic or hydraulic pistons, rams or motors or electro-mechanically such as an electric motor coupled to a screw.

It should be appreciated that the receptacles may be manually positioned over the treatment fluid application area, before the conveyor adjusts the elevation of the receptacle.

In preferred embodiments the treatment fluid is squeezed from the fibres in the receptacle during or after the application of fluid.

Reference to a plunger throughout this specification should be understood to refer to a means of pressing against the fibres so as to facilitate in the egress of treatment fluid.

In one preferred embodiment of the present invention, the plunger is in the form of a plate of sufficient shape and surface area so as to fit within an opening in the receptacle, while the surface area covers a significant portion of the opening. For example, the plunger base may be slightly smaller than the open aperture of the receptacle.

The plunger may be driven by any number of actuators, but preferably the drive means is a pneumatic or hydraulic piston.

In one preferred embodiment the plunger may be in the form of a plate that allows the ingress and egress of fluid while preventing the fibres from escaping in the same direction.

In some embodiments the action of the plunger may be assisted by the resting of the receptacle against a drain plate. Reference to a drain plate throughout this specification should be understood to refer to a means of allowing fluid to pass through a surface, while preventing the passage of extraneous material.

Preferably the receptacle includes a perforated base which may function as a drain plate. However, it is anticipated that additional support may be required when a high pressure plunger is applied to the receptacle, and an additional drain plate in the form of a rigid, perforated flat surface with a surface area equal to or greater than the base of the receptacle may be utilized.

Preferably the drain plate has perforations or slots of sufficient size as to prevent the passage of fibres that have inadvertently escaped the receptacle. The drain plate is intended to be able to withstand forces applied to it by a plunger.

In another embodiment the plunger may be in the form of a perforated plate that allows the fluid to pass through the plate surface while preventing the fibres from escaping in the same direction.

It should be appreciated that automation may be achieved by way of a central controller configured to interface with the various components to carry out pre-programmed sequences according to the material being treated, or the nature of treatment required. For example, some batches may only go through a limited number of treatment cycles, or forgo a drying stage.

The present invention provides the advantages of:

- Continuous batch operation, able to process multiple lots simultaneously but separately;
- Processing batches according to individual requirements on a single line without extensive reconfiguration;
- Ability to readily remove batch or treatment fluid from process should need arise;
- Portability;
- Minimal moving parts;
- Low cost;
- Minimal labour to operate;
- No special housing required; and
- Traceability of individual lots.

**BRIEF DESCRIPTION OF DRAWINGS**

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

**FIG. 1** shows a perspective view of the present invention configured in accordance with a preferred embodiment of the invention; and

**FIG. 2A** shows a cross sectional view of the conveyance means configured in accordance with a preferred embodiment of the present invention in a first stage of operation;

**FIG. 2B** shows a cross sectional view of the conveyance means configured in accordance with a preferred embodiment of the present invention in a second stage of operation;

**FIG. 2C** shows a cross sectional view of the conveyance means configured in accordance with a preferred embodiment of the present invention in a third stage of operation; and

**FIG. 2D** shows a cross sectional view of the conveyance means configured in accordance with a preferred embodiment of the present invention in a fourth stage of operation.

**BEST MODES FOR CARRYING OUT THE INVENTION**

With reference to the drawings there is provided in **FIG. 1**, a fibre processing system generally indicated by arrow (13).

Fibres (not shown in **FIG. 1**) are loaded—manually or automatically into a receptacle.
[0095] The receptacle (1) is then connected to a conveying system (14) which includes a common lifting cradle (2) configured to raise and lower the receptacle (1) using rams.

[0096] The common lifting cradle (2) then lifts the receptacle (1) above a treatment fluid application area (3).

[0097] An actuator (4) which forms part of the conveying system (14) conveys the receptacle (1) to be positioned above the first of the treatment fluid application areas (3). Alternatively, the receptacle (1) may be manually positioned in the cradle (2) above the treatment fluid application area (3).

[0098] Operation of the cradle (2) is shown in more detail in FIG. 2A to FIG. 2D.

[0099] FIG. 2A shows the receptacle (1) containing fibres (5) positioned above the treatment fluid application area (3).

[0100] In FIG. 2B, the receptacle (1) is lowered into the treatment fluid application area (3) by the lifting cradle (2).

[0101] A plunger (6) is mounted above each treatment fluid application area (3).

[0102] The plunger (6) mildly agitates the fibres (5) by one or more compression/release cycles against the base of the receptacle (1) while submerged in the treatment fluid (7), as depicted in FIG. 2C.

[0103] The receptacle (1) and plunger (6) are then returned to the position depicted by FIG. 2A.

[0104] In order to egress the treatment fluid (7) retained by the fibres (5), the plunger (6) presses the fibres against the base of the receptacle (1) as shown in FIG. 2D.

[0105] The expressed fluid is captured by the treatment fluid application area (3). This may be repeated more than once in order to express as much of the fluid as possible.

[0106] Returning to FIG. 1, the receptacle (1) is moved into position above the next treatment fluid application area (3), and the process as previously described is repeated.

[0107] Once the desired series of treatments have been conducted, the receptacle (1) is conveyed to a position below a high pressure plunger (8).

[0108] The high pressure plunger (8) presses the fibres (5) against a reinforced drain plate (9).

[0109] The fluid expressed from the fibres (5) drains either directly into the fluid application area or into a containment area (10) capable of holding an amount of fluid equal to that of one treatment fluid containment area (3).

[0110] The receptacle is then conveyed through a drying area (11) where the fibres (5) are dried, typically using hot air. The fibres (5) are retained in the receptacles (1) through the drying area (11).

[0111] The dried fibres (5) are removed from the receptacles (1) and the empty receptacles (12) are returned to the start of the fibre processing system (13) to be reloaded with fibres (5).

[0112] Transport of the empty receptacles (12) from exit to entry of the fibre processing system (13) is either manual or automated.

[0113] The present invention provides for individual lots of fibres (5) to be processed through the fibre processing system (13) without mixing between lots.

[0114] Aspects of the present invention have been described by way of example only and it should be appreciated that modifications and additions may be made thereto without departing from the scope thereof as defined in the appended claims.

1. A method of material treatment, comprising the steps of:

   placing the material within a receptacle configured to allow the ingress and egress of treatment fluid;
   conveying the receptacle to a treatment fluid application area;
   treating the material with a treatment fluid, comprising lowering the receptacle into at least one container containing the treatment fluid and agitating the material by compressing and releasing the material with a plunger; and
   conveying the receptacle from the treatment fluid application area.

2. The method as claimed in claim 1, comprising the further step of raising the receptacle above the container containing the treatment fluid and expressing treatment fluid from the material by compressing and releasing the material with the plunger.

3. The method as claimed in claim 2, wherein treating the material comprises conveying the receptacle to a container containing fresh treatment fluid.

4. The method as claimed in claim 1, comprising expressing treatment fluid from the material by positioning the receptacle against a drain plate and compressing the material with a high pressure plunger.

5. The method as claimed in claim 1, comprising drying the material by conveying the receptacle to a drying area and exposing the material to hot air.

6. The method as claimed in claim 1, wherein the receptacle is an open topped container with at least one mesh side.

7. The method as claimed in claim 1, wherein the material to be treated is wool.

8. The method as claimed in claim 1, wherein the treatment fluid is a lye solution.

9. A material treatment apparatus, comprising:

   a receptacle configured to contain material to be treated, and allow the ingress and egress of treatment fluid; a plunger configured to extend into the receptacle; and a conveyor, comprising a lifting cradle configured to adjust elevation of the receptacle, the conveyor configured to:
   convey the receptacle to a treatment fluid application area, wherein the treatment fluid application area comprises a container containing the treatment fluid, and the lifting cradle is configured to lower the receptacle into the container, and hold the receptacle in position while the material is treated by a treatment fluid, and convey the receptacle from the treatment fluid application area.

10. The apparatus as claimed in claim 9, wherein the plunger is configured to agitate the material by compressing and releasing the material.

11. The apparatus as claimed in claim 9, wherein the lifting cradle is configured to raise the receptacle above the container containing the treatment fluid, and the plunger is configured to express treatment fluid from the material by compressing and releasing the material.

12. The apparatus as claimed in claim 9, wherein the treatment fluid application area comprises a plurality of containers, and the conveyor is configured to convey the receptacle between the containers.
13. The apparatus as claimed in claim 9, wherein the receptacle is an open topped container with at least one mesh side.
14-15. (canceled)