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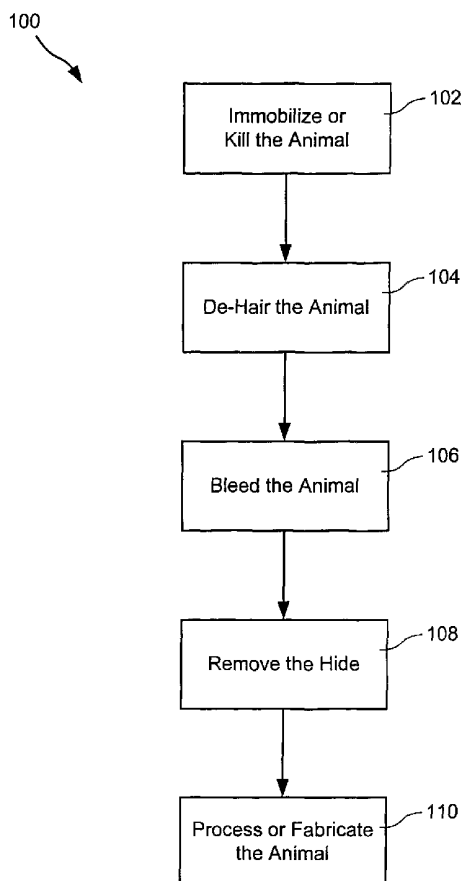
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(54) Title: METHODS FOR DE-HAIRING ANIMALS AND ANIMAL HIDES



(57) Abstract: In a method for slaughtering an animal, wherein the animal is immobilized, dispatched and fabricated, a method for removing hair from the animal prior to dispatching the animal. The method comprises the steps of contacting a depilatory substance to the animal's hair from a predetermined time, and removing the hair by directing pressurized depilatory substance at the animal. In accordance with one embodiment of the present invention, the depilatory substance is sodium sulfide. The present invention further comprises a system or apparatus for performing some or all of the steps of the method.



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Methods for De-Hairing Animals and Animal Hides

BACKGROUND OF THE INVENTION

The present invention relates generally to the removal of hair from animal carcasses and hides, and more particularly to methods and apparatus for applying a chemical to the animal carcasses and hides to remove the hair.

In the meat industry, and particularly in those areas devoted to the processing of beef and pork, meat packers slaughter animals in a process in which the animals are stunned, bled, skinned, eviscerated, and fabricated into meat sections which are marketable to the public or the restaurant trade. Animals enter a meat slaughter plant with various foreign materials present on their hair, including blood, dirt, manure, mud and vegetative material. An animal's hair is also contaminated with a multitude of microorganisms, some of which are pathenogenic to humans. Most bacteria present in a meat slaughter and processing facility are carried into the facility on the hides of animals to be slaughtered. During the slaughtering process, these microorganisms contact meat and other meat by-products, thereby contaminating such products, creating handling problems and reducing the shelf life and safety of meat products.

The control of contamination by microorganisms is a recognized problem in the meat packing industry. Many techniques have been employed in the past in an effort to destroy surface bacterial flora on meat, including de-hairing the animal prior to bleeding it. For example, U.S. Patent No. 5,149,295 issued to Bowling et al. discloses a method of de-hairing animals using a chemical solution to break-down protein bonds in the hair, so that the hair easily can be removed. However, the method disclosed in the Bowling et al. patent has several problems. First, the method for removing the hair from the animal disclosed in the Bowling et al. patent uses a pressurized water spray to spray off the hair after the chemical solution has reacted with the hair protein. The problem with this method is that it mixes the chemical solution with water, diluting the solution so that it cannot be reused. In addition, the diluted water-chemical effluent is toxic, and thus must be disposed of or treated properly. After treating thousands of animals a day, a very large amount of toxic waste is generated, without a good way to deal with it.

The Bowling et al. patent also discloses using pressurized air or a mechanical means to help remove the hair from the animal. However, pressurized air is not effective, and because of the size and shape of the animal carcasses, mechanical de-hairing means do not work.

5 In view of the above, a need exists for a new method for de-hairing an animal prior to the exsanguination of the animal.

SUMMARY OF THE INVENTION

10 In accordance with one embodiment of the present invention, in a method for slaughtering an animal, wherein the animal is immobilized, exsanguinated and fabricated, a method for removing hair from the animal's carcass prior to exsanguinating the animal. The method comprises the steps of contacting a depilatory substance to the animal's hair from a predetermined time, and removing the hair by directing pressurized depilatory substance at the animal. In accordance with one embodiment of the present invention, the depilatory
15 substance is sodium sulfide.

In accordance with another embodiment of the present invention, the step of contacting a depilatory substance to the animal's hair may comprise the steps of: applying a first dose of depilatory substance to the animal's hair for a first predetermined period of time; allowing the first dose of depilatory substance to dwell on the animal for a second
20 predetermined period of time; applying a second dose of depilatory substance to the animal's hair for a third predetermined period of time; and allowing the second dose of depilatory substance to dwell on the animal's hair for a fourth predetermined period of time. In accordance with one embodiment of the present invention, the combination of the first and the second periods of time is about 90 seconds, and the combination of the third and the
25 fourth periods of time is about 60 seconds.

In accordance with yet another embodiment of the present invention, the step of removing the hair comprises directing the pressurized depilatory substance at the animal for a period of time of about 30 seconds, or until the hair is removed. The pressure of the depilatory substance may be about 300 psi. Also, in accordance with another embodiment of
30 the invention, the depilatory substance used in the contracting step may be at a temperature of about 30 degrees Celsius, while the pressurized depilatory substance used in the removing step may be at a temperature of about 20 degrees Celsius.

In accordance with yet another embodiment of the present invention, the method may further include the step of capturing and reusing the depilatory substance for processing other animals.

5 In accordance with yet another embodiment of the present invention, the method may further include the step of applying an oxidizing agent to the animal's carcass after the hair has been removed. The oxidizing agent may be any suitable oxidizing agent, such as a peroxide, like hydrogen peroxide or sodium peroxide..

Finally, the present invention may comprise a system or apparatus for performing some or all of the steps of the method described herein.

10 A more complete understanding of the present invention may be derived by referring to the detailed description of preferred embodiments and claims when considered in connection with the figures, wherein like reference numbers refer to similar items throughout the figures.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is flow chart showing a process of slaughtering an animal;

Fig. 2 is a flow chart showing a process in accordance with one embodiment of the present invention for removing hair from an animal; and

20 Fig. 3 is a block diagram showing one embodiment of a system for removing hair from an animal.

DESCRIPTION OF THE SPECIFIC EMBODIMENTS

A. Introduction

25 The present invention relates generally to the removal of hair from animal carcasses and hides, and more particularly to methods and apparatus for applying a chemical to the animal carcasses and hides to remove the hair. In accordance with the embodiments described herein, a chemical or depilatory substance is applied to animal carcasses during the slaughter process in order to remove hair from the animal, thus reducing the chance of microbial contamination of meat and meat by-products. However, the present invention is
30 not limited to de-hairing animals during slaughter. One skilled in the art will appreciate, that the de-hairing methods and apparatus presented herein also may be used to process hides

after they have been removed from the animals. Thus, the present invention is not limited to the particular embodiments disclosed herein.

When animals enter the slaughtering process, they typically are carrying a large number of microorganism, for example, in the hair of the animal, as well as in other foreign matter stuck or attached to the hair. By removing the hair of an animal before the disassembly of the animal during slaughtering, substantially all foreign matter, including dirt, manure, blood, ingesta and most importantly, microorganisms, associated with animal hair is eliminated. Thus, the present invention drastically reduces the number of microorganisms from the onset of the slaughtering process, and increases the effectiveness of subsequent measures taken in the meat processing procedure to control the growth of spoilage and pathogenic microorganisms.

As used herein, the term microorganism refers to any microorganisms capable of contaminating meat products, thereby making such meat unsuitable or unhealthy for human or animal consumption. Such microorganisms include, but are not limited to, *E. Coli*, *Salmonella*, *F. Coliforms*, *Listeria*, *Staphylococcus*, *F. Streptococcus*, *Bacillus Anthracis*, *Balantidium Coil*, *Campylobacter Coli*, *Campylobacter Jejune*, *Francisella Tularensis*, *Sarcocystis*, *Taenia Saginata*, *Taenia Solium*, *Toxoplasma Gondil*, *Trichinella Spiralis*, *Yersinia Enterocolinea*, *Yersinia Pseudotuberculosis*, *Brucella*, *Chlamydia Petechia*, *Leptospira* and *Clostridium*.

As used herein, the term "animal" refers to mammal of the kingdom Animalia, which is consumed by humans or animals, including without limitation, bovine, ovine and porcine, and the term "hide" refers to the integument of an animal, such as a bovine hide, a porcine skin and an ovine pelt. The primary function of an animal hide while the animal is alive is to form a protective barrier to actively prevent the penetration of material through the animal's hair. Microorganisms are unable to penetrate an intact living animal hide, but can begin to enter the hide shortly after the death of the animal. For four to eight minutes after an animal is immobilized, its skin continues acting as an active barrier to microorganisms.

In a meat processing facility, the opportunity for microbial contamination of meat and meat by-products first presents itself upon the cutting open of an animal, exposing the animal's interior to microorganisms present in the ambient environment. The risk of microbial contamination extends throughout the entire slaughtering process, including final fabrication of the animal into various sections of meat for commercial sale. Typically, an

animal to be slaughtered is conveyed from an immobilization of killing station directly to a bleeding station. Bleeding of the animal is usually accomplished by severing the animal's carotid artery using a sharp knife. The severe wound made to the animal during the bleeding step allows microorganisms present on the animal's hide to enter the interior of the animal's body, thereby causing undesired bacterial contamination of meat and meat by-products to occur as well as infecting lost blood, thereby contaminating the general environment.

Referring now to flow chart 100 of Fig. 1, an animal slaughtering process in accordance with the present invention will be described. As one skilled in the art will appreciate, when an animal enters a slaughtering plant the animal typically is immobilized (step 102). Immobilization may include any means for precluding movement of the animal. In accordance with one embodiment of the present invention, immobilization comprises killing the animal, for example by sending one or more bolts into the animal's skull. In this particular embodiment, the animal's heart typically will stop. Other means also may be used to kill the animal.

In accordance with another embodiment of the present invention, immobilization comprises immobilizing an animal by impairing the animal's cerebellum. Impairment of an animal's cerebellum can, for example, be accomplished by using a stun gun device, which sends a bolt through the animal's skull in a particular location, thereby impairing its cerebellum and causing all voluntary muscle movements to cease. In this particular embodiment, the animal is brain dead, but involuntary muscle movements still may occur.

In accordance with yet other embodiments of the invention, animals may be immobilized by having them breathe immobilizing gases, by applying an electrical charge to an animal's head or spine, injecting an animal with immobilizing drugs or by striking an animal with a heavy instrument.

After the animal is immobilized, the animal is de-haired (step 104), for example by applying a depilatory substance to the animal hair. One embodiment of a de-hairing process in accordance with the present invention will be discussed in more detail below. After de-hairing (step 104), the animal is exsanguinated. Exsanguination of the animal may occur by severing of the animal's carotid artery while the animal is immobilized and suspended from a conveyor line.

After the animal is exsanguinated, the hide is removed (step 108) and the remainder of the animal is fabricated into meat products and by-products (step 110).

B. De-Hairing Process

As mentioned above, during the slaughtering process, the animal is de-haired prior to exsanguinating the animal. In accordance with one embodiment of the present invention, the de-hairing process comprises applying a depilatory substance to the hair of the animal. The step of applying the depilatory substance to an animal can involve any method, which sufficiently contacts a depilatory substance to an animal to allow the depilatory substance to react with the animal's hair. Such methods may include, but are not limited to, immersing, spraying, showering or dousing of the animal, or any other means known in the art for applying similar substances to an animal or animal hide.

The depilatory substance of the present invention may comprise any chemical compound known to remove or depilate hair from an animal's hide. While not intending to be bound by theory, it is believed that depilatory substances remove hair by breaking chemical bonds within individual hair fibers. Animal hair, and specifically cattle hair, is composed primarily of a single structural protein, keratin. Individual keratin molecules are held together to form hair fibers by covalent disulfide bridges between cystine amino acid residues. These bonds can be broken by reducing chemicals. Under strong reducing conditions, most of the disulfide bonds in a hair fiber will be broken and the hair will be cleaved into pieces less than a few millimeters in length. Other depilatory substances, such as strong oxidizing agents, act by oxidizing chemical bonds within hair fibers. An example of such an oxidizing agent would be an alkaline solution of hydrogen peroxide, as further described below. Therefore, according to this theory, the depilatory substances used in the present invention dissolve certain portions of an animal's hair and permit removal of the hair from the animal's hide. Moreover, upon contacting of a depilatory substance to an animal's hide, many microorganisms are initially killed by the strong reducing and oxidizing agents utilized.

In accordance with one embodiment of the present invention, the depilatory substance of the present invention is a sodium sulfide (Na_2S) solution. Care should be taken to use the depilatory substance in amounts, concentrations and contact times, which do not damage the animal hide. Thus, in accordance with this aspect of the present invention,

sodium sulfide is in a concentration from about 5% to about 15%, more preferably from about 8% to about 13%, and most preferably from about 9% to about 12%.

In addition to the foregoing specific formulations, other chemicals recognized in the art as effective to remove or dissolve hair from the hide of an animal, can be used as well.

The dwell time of any particular depilatory substance contacted with an animal's hide will vary depending upon the particular animal species, the type and concentration of depilatory substances used and the temperature at which such depilatory substances are applied, as well as other factors. In a preferred embodiment using sodium sulfide, the depilatory substance is effective at a temperature from about 10 degrees Celsius to about 40 degrees Celsius, more preferably from about 25 degrees Celsius to about 35 degrees Celsius, and most preferably from about 28 degrees Celsius to about 32 degrees Celsius.

In accordance with one embodiment of the present invention, it may be preferable to allow the depilatory substance to dwell on the animal hide until the protein bonds in the hair are sufficiently broken. However, because the grain portion of the hide is comprised of similar proteins as the hair, if the depilatory substance is left on the animal too long, the depilatory substance will begin to break-down protein bonds in the grain. As one skilled in the art will appreciate, this can cause damage to the grain. Thus, an appropriate dwell time is preferred. In an embodiment using sodium sulfide as the depilatory substance, the depilatory substance is sprayed onto the animal's hide for 1-60 seconds and left to dwell for an additional 1-180 seconds.

The step of removing hair in the present invention can be accomplished in any manner, which substantially eliminates the majority of hair on the animal. The de-hairing of animals preferably is performed relatively quickly to facilitate the timely conveyance of such animals along a meat processing line. As disclosed in U.S. Patent No. 5,149,295 issued to Bowling et al., hair is removed from an animal by directing pressurized water at the animal, which effectively strip the loosened hair from the animal's hide without damaging the hide. Other embodiments disclosed in the Bowling et al. patent include means for removal of hair using mechanical devices such as rigid blades, brushes or combs, or pressurized air sprays. However there are considerable problems with all of these methods. The problem with using a pressurized water spray to remove the hair is that the water mixes the depilatory substance,

diluting the substance so that it cannot be reused. In addition, the diluted water-chemical effluent is toxic, and thus must be disposed of or treated properly. After processing thousands of animals a day, a very large amount of toxic waste is generated, without a good way to deal with it. Also, pressurized air is not effective in removing the hair, and
5 mechanical means are ineffective because the size and shape of the animal carcasses make it difficult to remove hair evenly.

Thus, in accordance with one embodiment of the present invention, the hair is removed from the animal by directing a pressurized spray of a depilatory substance at the animal. Preferably, the same depilatory substance used to break protein bonds in the hair is
10 used. In this manner, the waste from the hair removal process comprises, the animal hair, other foreign matter attached to the animal hair and hide, and the depilatory substance. As discussed in more detail below, because the depilatory substance is not diluted, the depilatory substance can be captured and reused for processing other animals.

As mentioned above, it is important that the depilatory substance not be
15 exposed to the animal hide too long, or it can be harmful to the grain of the hide. In accordance with the present invention, using a depilatory substance to wash the hair off the animal also typically will expose the animal hide to the depilatory substance for a longer period of time. Depending on the dwell time of the first applied depilatory substance, it is possible that the washing procedure could damage the grain of the hide. Thus, in accordance
20 with one embodiment of the present invention, it may be preferable to select dwell and rinse times so the hide grain is not damaged.

Also, in accordance with another embodiment of the present invention, dropping the temperature of the depilatory substance used to rinse or wash the hair off the animal will slow or stop the reaction of the depilatory substance with the animal hide. That
25 is, at the lower temperature, the depilatory substance will not break-down protein bonds in the grain of the hide. Thus, in one embodiment of the invention, the depilatory substance used to rinse the hair from the animal is sodium sulfide at a temperature from about 5 degree Celsius to about 30 degrees Celsius, and more preferably from about 15 degrees Celsius to about 25 degrees Celsius, and most preferably from about 18 degrees Celsius to about 22
30 degrees Celsius.

As mentioned above, to remove the hair from the animal, a pressurized depilatory substance is used. In accordance with this aspect of the invention, a spray nozzle

or other suitable pressure spraying device is used to direct the pressurized depilatory substance at the animal. The spray may be directed at the animal at a pressure from about 200 psi to about 400 psi, and more preferably from about 250 psi to about 350 psi, and most preferably from about 285 psi to about 315 psi.

5 After the hair has been removed from the animal's hide, some of the depilatory substance still may exist on the hide. As mentioned above, the depilatory substance can be toxic, and in the case of sodium sulfide, the sulfide can evolve into hydrogen sulfide gas, which is toxic. If precautions are not taken, the toxins can contaminate the meat during exsanguination and fabrication. Thus, in order to remove the sodium sulfide
10 that still is remaining on the animal hide, the hide is sprayed with an oxidizing chemical, which oxidizes the sulfides. This oxidation process converts the sodium sulfide into oxygen and sodium sulfate, which is essentially a soap. As one skilled in the art will appreciate, sodium sulfate easily can be discarded without environmental issues. In addition to oxidizing the sulfides on the animal hide, the oxidizing agent also will act as a bactericide, further
15 reducing the potential for meat contamination by microorganisms present on the hide. Between the de-hairing process and the oxidation process, the animal carcass is very clean. In accordance with one embodiment of the present invention, the oxidizing chemical is a peroxide solution, such as a solution comprising hydrogen peroxide or sodium peroxide.

 The by-products produced by the de-hairing process, including hair sludge,
20 excess depilatory substances and other foreign matter found in the hair, can be collected for further processing. Recovery and recycling of the depilatory substance and various components of the sludge by-product may be desirable. For example, the hair and other foreign matter may be filter away from the depilatory substance, leaving a depilatory substance that can be reused in the de-hairing of other animals. Also, the hair sludge mixture,
25 which includes some depilatory substance can be further processed in order to regenerate usable depilatory substance. In one embodiment of the invention, a sludge mixture, comprised of hair removed from an animal mixed with a sodium sulfide depilatory solution, may be mixed with sulfuric acid to produce hydrogen sulfide (gas). The resulting hydrogen sulfide is mixed with sodium hydroxide to regenerate the sodium sulfide depilatory substance
30 and small quantities of sodium sulfate, which can be safely disposed of.

Hair recovered and separated from the sludge can be further processed for use as animal feed and for composing of fertilizer precursors, as well as other uses including recovery of specific amino acids.

Referring now to the flow chart 200 in Fig. 2, one embodiment of a method for de-hairing an animal will be described. After the animal is immobilized, a sodium sulfide solution is applied to the hair (and hide) of the animal. The sodium sulfide solution may be applied in one or multiple applications. In accordance with the illustrated embodiment, two applications of the sodium sulfide solution are applied. In accordance with this aspect of the invention, a first dose of the sodium sulfide solution is applied to the animal (step 202) and allowed to dwell on the animal for a period of time (step 204). The first dose of the sodium sulfide solution (step 202) may be applied in a time period from about 1 to about 45 seconds, and more preferably from about 10 to about 20 seconds, and most preferably from about 13 to about 17 seconds. The first dwell time (step 204) may be for a time period from about 1 to about 120 seconds, and more preferably from about 60 to about 90 seconds, and most preferably from about 70 to about 80 seconds. In one embodiment, the combined time to apply the first dose of the sodium sulfide solution (step 202) and allow the first dose of the solution to dwell on the animal (step 204) is about 90 seconds.

After the first application and dwell time, and second dose of the sodium sulfide solution is applied to the animal (step 206) and allowed to dwell (step 208). The second dose of the sodium sulfide solution (step 206) may be applied in a time period from about 1 to about 45 seconds, and more preferably from about 10 to about 20 seconds, and most preferably from about 13 to about 17 seconds. The second dwell time (step 208) may be for a time period from about 1 to about 90 seconds, and more preferably from about 30 to about 60 seconds, and most preferably from about 40 to about 50 seconds. In one embodiment, the combined time to apply the second dose of the sodium sulfide solution (step 206) and allow the second dose of the solution to dwell on the animal (step 208) is about 60 seconds.

In accordance with one embodiment of the invention, the temperature of the sodium sulfide solution applied in steps 202 and 206 is from about 20 to about 40 degrees Celsius, and more preferably from about 25 to about 35 degrees Celsius, and most preferably about 30 degrees Celsius.

After the second dwell time (step 208) a pressurized spray of the sodium sulfide solution is used to rinse the hair off the animal (step 210). In accordance with one embodiment of the invention, the rinse cycle occurs for a time period from about 1 to about 90 seconds, and more preferably from about 10 to about 40 seconds, and most preferably from about 25 to about 35 seconds. The pressurized sodium sulfide spray may be directed at the animal at a pressure from about 200 psi to about 400 psi, and more preferably from about 250 psi to about 350 psi, and most preferably from about 285 psi to about 315 psi. Also, in order to keep the sodium sulfide spray from degrading the grain of the hide, the temperature of the solution is dropped to a temperature lower than solution used in steps 202 and 206. In accordance with this aspect of the invention, the sodium sulfide solution used to rinse the hair from the animal is at a temperature from about 5 to about 30 degrees Celsius, and more preferably from about 15 to about 25 degrees Celsius, and most preferably at about 20 degrees Celsius.

After the hair has been rinsed off the hide (step 210), an oxidizing agent, such as a hydrogen peroxide solution, is sprayed on the carcass (step 212). As discussed above, the oxidizing agent oxidizes the sulfides, thus removing the toxic sodium sulfide from the carcass. The oxidizing agent also acts as a bactericide, killing any microorganisms that may be remaining on the carcass.

During the de-hairing process, the excess sodium sulfide solution from steps 202, 206 and 210 is captured for reuse. In addition, the hair and other foreign matter are captured, so that the sodium sulfide material can be removed from it (step 214).

The removal of the hair and microorganisms associated with such hair, achieves the objective of reducing microbial contamination of meat and meat by-products during the remainder of the slaughtering process. In addition, the removal of animal hair prior to the bleeding of the animal allows for the collection of blood significantly less contaminated by microorganisms than blood collected in traditional meat packing facilities. This relatively microorganism-free blood may be collected and further processed for use as feed supplements or used for extraction of pharmaceutical substances contained in the blood.

C. De-Hairing System

Referring now to Fig. 3, a system 300 for de-hairing animals in accordance with one embodiment of the present invention will be described. In particular, system 300

comprises a reservoir or tank 302, one or more hair removal stations 306, 308, a hair rinse station 310, and a sodium sulfide recovery and recycle system 312.

Reservoir 302 is for holding a depilatory substance, such as a sodium sulfide solution, and for supplying the depilatory substance to the hair removal stations. In the
5 illustrated embodiment, the solution in reservoir 302 may come from a source of fresh sodium sulfide 304, or from sodium sulfide recovery system 312.

Hair removal stations 306 and 308 are for applying the sodium sulfide solution to the animal, for example, in accordance with the methods described above. In accordance with the illustrated, two hair removal stations 306 and 308 are provided. However more or
10 less hair removal stations may be used as necessary. In addition, even if two or more doses of sodium sulfide solution are applied to the animal, the doses may be applied by a single station. Therefore, the present invention is not limited to the illustrated embodiment.

As discussed above hair removal stations 306, 308 may apply the sodium sulfide solution to the animals in any manner, which sufficiently contacts the solution to the
15 animals. Such methods may include, but are not limited to immersing, spraying, showering or dousing of the animal, or any other means known in the art for applying similar substances to an animal or animal hide.

After the sodium sulfide solution is applied to the animals and allowed to dwell for a predetermined period of time, the hair is rinsed or removed from the animals
20 using hair rinse station 310. In accordance with one embodiment of the invention, hair rinse station 310 comprises a spray device for directing pressurized sodium sulfide solution at the animal. As discussed above the pressurized spray will force the hair from the hide after the hair protein bonds are broken. Also, because the sodium sulfide solution used in hair rinse station 310 may be at a lower temperature than the sodium sulfide solution used in hair
25 removal stations 306, 308, hair rinse station 310 may comprise a cooling unit for cooling the sodium sulfide solution.

Because the sodium sulfide solution used by hair rinse station 310 is merely used to force the hair off the animal's hide, it probably is not imperative that super pure sodium sulfide solution be use. Accordingly, the sodium sulfide recovered by sulfide
30 recovery and recycle station 312 may be used by hair rinse station 310.

As the sodium sulfide solution is applied to the animal in stations 306-310, excess solution, as well as hair and other foreign matter, such as dirt, manure, ice, etc. will

fall off the animal carcasses. Because the sodium sulfide solution is toxic, it is important to dispose of these materials properly. In accordance with one embodiment of the present invention, system 300 includes a sodium sulfide recovery and recycling system 312 for dealing with the waste. In accordance with the illustrated embodiment, sodium sulfide recovery and recycling system 312 comprises a screen or filtering mechanism 314, a sodium sulfide collection reservoir 316, a solids collection reservoir 318 and a solids processing system 320.

Screen or filtering mechanism 314 is configured to capture the waste from stations 306-310 and separate the sodium sulfide solution from solids, such as hair, dirt, manure, etc. Once separated, the sodium sulfide solution passes to collection reservoir 316, while the solids pass to solids collection reservoir 318. Screen or filtering mechanism may comprise any suitable filtering device, however, in accordance with one embodiment of the present invention, screen or filtering mechanism 314 comprises a vibrating screen. The vibrations of the screen help separate the liquid from the solids.

As one skilled in the art will appreciate, when screens and some filter types are used, the liquid portion still may have some small particles of the solids mixed with it. Thus, the sodium sulfide solution in collection reservoir 316 may not be completely pure. In addition to particles of hair, manure, vegetable matter, etc., dissolved hair proteins also will be present. In accordance with one embodiment of the invention, about 5% of the recycled sodium sulfide solution in reservoir 316 will be continuously fed into the solids processing system 320 to prevent build-up of these materials. This level of recycle will permit almost indefinite reuse of the sodium sulfide solution within the de-hairing system. After recycle of the sodium sulfide solution, it can be reused, for example in hair rinse station 310, as discussed above. Also, in another embodiment of the invention, it is possible that the recycled sodium sulfide solution can be used in hair rinse stations 306, 308.

The solids (hair sludge) that are collected in solids collection reservoir 318 and that are separated from the composition in collection reservoir 316 pass to solids processing system 320 for further processing. Even though most of the sodium sulfide solution has been removed, traces of the solution still are present in hair sludge and should be removed for environmental purposes. Solids processing system 320 is configured to clean the toxins from the hair sludge mixture and regenerate usable sodium sulfide from the sludge.

In one embodiment of the invention, a sludge mixture, comprised of hair removed from an animal mixed with the sodium sulfide solution, may be mixed with sulfuric acid to produce hydrogen sulfide (gas). The resulting hydrogen sulfide is mixed with sodium hydroxide to regenerate sodium sulfide and small quantities of sodium sulfate, which can be safely disposed of. The sodium sulfide regenerated by solids processing system 320 is a pure sodium sulfide composition, so it can be added to fresh sulfide 304 in sulfide reservoir 302 and used by hair removal stations 306, 308. In addition, hair recovered and separated from the sludge can be processed further for use as animal feed, fertilizer precursors, as well as other uses including recovery of specific amino acids.

Also, after the hair has been removed from the hide of the animal, an oxidizing agent application unit (not shown) can be used to apply an oxidizing agent on the animal hide. As discussed above, the oxidizing agent will oxidize the sulfides on the hide, thus removing the toxicity from the hide, and killing additional microorganisms at the same time. The oxidizing agent application unit may comprise any suitable application means, which sufficiently contacts the oxidizing agent to the animals. Such means may include, but are not limited to mean for immersing, spraying, showering or dousing of the animal, or any other means known in the art for applying similar substances to an animal or animal hide.

D. Hide Processing

The present invention further includes a method for preparing hides for tanning. An industry intimately connected with the slaughter industry is the tanning industry. Current slaughtering methods largely dictate present tanning processes. Among the advantages of the present invention include benefits achieved by reducing the steps and costs of hide tanning procedures.

Animal hides, especially cattle hides, are one of the most valuable by-products of the cattle slaughtering process. Traditionally, an animal's hair has been removed from its hide only once the hide has been removed from the animal and fleshed. The hide tanning industry, rather than the meat processor, has traditionally utilized chemical compositions to depilate animal hides in preparation for subsequent treatment of such hides in the production of various leather goods. Traditional methods of slaughtering, however, damage a significant percentage of hides, making such hides less valuable to tanneries and precluding the use of such hides for marketable leather items.

Pursuant to conventional practices, a hide is removed from an animal with its hair intact. The hide is then put through a fleshing machine, which removes fatty tissue from the non-haired hide surface. The resulting hide is then cured, for example by salting the hide, and shipped to a tanner. Without de-hairing the hides, significant quantities of manure, hair, water and salt may be transported with the hides. The tanner then removes the hair present on the hide for further leather processing. The disadvantages of the above-described conventional procedure is that many hides are damaged during the fleshing process. There also are significant costs incurred by the tanner to de-salt the hides. Moreover, grading of the hides before removal of hair from the hides is a difficult task.

One embodiment of the present invention provides a method for preparing hides by applying a depilatory substance to an animal prior to fleshing of the animal's hide, and subsequently removing hair contacted by the depilatory substance. By removing hair from the animal prior to fleshing of the hide, significant advantages are achieved. A series of machines are used to pull the hides from animal carcasses. Mud, manure and wet hair cause the gripping device of the hide rollers to slip, which may stretch, tear or scar the hide. Moreover, a serious problem in hide preparation is that the machines utilized to clean, flesh and cure the hides often cause physical damage to the hides. Manure and mud balls attached to an animal's hair creates an uneven thickness which can cause tears or cuts in the hide when the hide is pressed between rollers and blades used in the fleshing process. Others have tried various methods to remove the mud and manure balls that form on cattle hides with little success. The present invention, by removing the hair from the animal's hide, effectively removes such manure and mud balls, thereby eliminating the ripping and tearing problems associated with traditional methods of hide processing. Damage caused to fleshing machines and hide pullers as a result of such manure and mud balls also is reduced.

Moreover, removal of bacteria from hides by the de-hairing method of the present invention, reduces the proteolytic degradation of such hides.

The tanning industry prefers cattle hides with no brands burned into the animal hide or scratches caused by horns, barbed wire or the slaughtering process itself. Ranchers unfortunately continue the practice of branding their cattle for identification purposes and the use of barbed wire is widespread. Meat processing facilities attempt to sort through cattle hides to separate branded and scratched hides from non-branded and non-scratched hides, the latter being separately shipped to tanners to be processed into high quality leather. It is often

impossible to discern whether a hide has been damaged with animal hair present on the hide. Thus, one benefit of the present invention is to remove hair from animal hides, facilitating the sorting and grading of hides and reducing improper shipments of damaged hides by meat processors to tanneries.

5

E. Conclusion

In conclusion, the present invention provides a novel system and method for de-hairing animals and animal hides that is economically and environmentally viable. While a detailed description of presently preferred embodiments of the invention has been given
10 above, various alternatives, modifications, and equivalents will be apparent to those skilled in the art. For example, while the present invention has been described in the context of de-hairing animals during the slaughtering process in order to reduce the exposure of meat to microorganisms, one skilled in the art will appreciate that the de-hairing process may be used on hides after slaughter without departing from the spirit of the invention. Therefore, the
15 above description should not be taken as limiting the scope of the invention, which is defined by the appended claims.

WHAT IS CLAIMED IS:

1 1. In a method for slaughtering an animal, wherein the animal is
2 immobilized, exsanguinated, and fabricated, a method for removing hair from the animal's
3 carcass prior to exsanguinating the animal, comprising the steps of:
4 contacting a depilatory substance to said animal's hair for a predetermined
5 period of time; and
6 removing the hair by directing pressurized depilatory substance at said animal.

1 2. The method as recited in claim 1, wherein said depilatory substance
2 comprises a sodium sulfide solution.

1 3. The method as recited in claim 1, wherein the step of contacting a
2 depilatory substance to said animal's hair comprises the steps of;
3 applying a first dose of depilatory substance to said animal's hair for a first
4 predetermined period of time;
5 allowing the first dose of depilatory substance to dwell on the animal's hair for
6 a second predetermined period of time;
7 applying a second dose of depilatory substance to said animal's hair for a third
8 predetermined period of time; and
9 allowing the second dose of depilatory substance to dwell on the animal's hair
10 for a fourth predetermined period of time.

1 4. The method as recited in claim 3, wherein said first and said third
2 periods of time are between 1 and 30 seconds, and said second and said fourth periods of time
3 are between 1 and 120 seconds.

1 5. The method as recited in claim 3, wherein said first period of time is
2 about 15 seconds, said second period of time is about 90 seconds, said third period of time is
3 about 15 seconds and said fourth period of time is about 60 seconds.

1 6. The method as recited in claim 3, wherein the combination of the first
2 period of time and the second period of time is about 90 seconds, and the combination of the
3 third period of time and the fourth period of time is about 60 seconds.

1 7. The method as recited in claim 1, wherein the step of removing the hair
2 by directing pressurized depilatory substance at said animal comprises the step of directing
3 the pressurized depilatory substance at said animal for a time period between 1 and 120
4 seconds.

1 8. The method as recited in claim 1, wherein the step of removing the hair
2 by directing pressurized depilatory substance at said animal comprises the step of directing
3 the pressurized depilatory substance at said animal for a time period of about 30 seconds.

1 9. The method as recited in claim 1, wherein the depilatory substance
2 used in the step of contacting a depilatory substance to said animal's hair comprises a sodium
3 sulfide solution at a temperature between 20 and 40 degrees Celsius, and wherein the
4 depilatory substance used in the step of removing the hair by directing pressurized depilatory
5 substance at said animal comprises a sodium sulfide solution at a temperature between 10 and
6 30 degrees Celsius.

1 10. The method as recited in claim 1, wherein the depilatory substance
2 used in the step of contacting a depilatory substance to said animal's hair comprises a sodium
3 sulfide solution at a temperature of about 30 degrees Celsius, and wherein the depilatory
4 substance used in the step of removing the hair by directing pressurized depilatory substance
5 at said animal comprises a sodium sulfide solution at a temperature of about 20 degrees
6 Celsius.

1 11. The method as recited in claim 1, wherein the depilatory substance
2 used in the step of removing the hair by directing pressurized depilatory substance at said
3 animal comprises a depilatory substance at a pressure of between 200 and 400 psi.

1 12. The method as recited in claim 1, wherein the depilatory substance
2 used in the step of removing the hair by directing pressurized depilatory substance at said
3 animal comprises a depilatory substance at a pressure of about 300 psi.

1 13. The method as recited in claim 1, wherein at least a portion of the
2 depilatory substance is captured and reused to remove hair from other animals.

1 14. The method as recited in claim 13, further comprising the step of
2 recovering the depilatory substance from the hair removed from the animal.

1 15. The method as recited in claim 1, wherein the animal comprises,
2 bovine, porcine or ovine.

1 16. The method as recited in claim 1, further comprising the step of
2 spraying an oxidizing agent on the animal's carcass after the step of removing the hair.

1 17. The method as recited in claim 16, wherein the oxidizing agent is
2 selected from the group of hydrogen peroxide and sodium peroxide.

1 18. A method for slaughtering an animal, comprising the steps of:
2 immobilizing the animal;
3 applying a first dose of depilatory substance to the animal's hair for a first
4 predetermined period of time;
5 allowing the first dose of depilatory substance to dwell on the animal's hair for
6 a second predetermined period of time;
7 applying a second dose of depilatory substance to the animal's hair for a third
8 predetermined period of time;
9 allowing the second dose of depilatory substance to dwell on the animal's hair
10 for a fourth predetermined period of time;
11 removing the hair from the animal carcass by directing pressurized depilatory
12 substance at said animal; and
13 exsanguinating said animal.

1 19. The method as recited in claim 18, wherein the depilatory substance
2 comprises a sodium sulfide solution.

1 20. The method as recited in claim 18, wherein said first and said third
2 periods of time are between 1 and 30 seconds, and said second and said fourth periods of time
3 are between 1 and 120 seconds.

1 21. The method as recited in claim 18, wherein said first period of time is
2 about 15 seconds, said second period of time is about 90 seconds, said third period of time is
3 about 15 seconds, and said fourth period of time is about 60 seconds.

1 22. The method as recited in claim 18, wherein the combination of the first
2 and the second periods of time is about 90 seconds, and the combination of the third and the
3 fourth periods of time is about 60 seconds.

1 23. The method as recited in claim 18, wherein the step of removing the
2 hair by directing pressurized depilatory substance at said animal comprises the step of
3 directing the pressurized depilatory substance at said animal for a time period between 1 and
4 120 seconds.

1 24. The method as recited in claim 18, wherein the step of removing the
2 hair by directing pressurized depilatory substance at said animal comprises the step of
3 directing the pressurized depilatory substance at said animal for a time period of about 30
4 seconds.

1 25. The method as recited in claim 18, wherein the depilatory substance
2 used in the steps of applying first and second doses of depilatory substance to said animal's
3 hair comprises a sodium sulfide solution at a temperature between 20 and 40 degrees Celsius,
4 and wherein the depilatory substance used in the step of removing the hair by directing
5 pressurized depilatory substance at said animal comprises a sodium sulfide solution at a
6 temperature between 10 and 30 degrees Celsius.

1 26. The method as recited in claim 18, wherein the depilatory substance
2 used in the steps of applying first and second doses of depilatory substance to said animal's
3 hair comprises a sodium sulfide solution at a temperature of about 30 degrees Celsius, and
4 wherein the depilatory substance used in the step of removing the hair by directing
5 pressurized depilatory substance at said animal comprises a sodium sulfide solution at a
6 temperature of about 20 degrees Celsius.

1 27. The method as recited in claim 18, wherein the depilatory substance
2 used in the step of removing the hair by directing pressurized depilatory substance at said
3 animal comprises a depilatory substance at a pressure of between 200 and 400 psi.

1 28. The method as recited in claim 18, wherein the depilatory substance
2 used in the step of removing the hair by directing pressurized depilatory substance at said
3 animal comprises a depilatory substance at a pressure of about 300 psi.

1 29. The method as recited in claim 18, wherein at least a portion of the
2 depilatory substance is captured and reused to remove hair from other animals.

1 30. The method as recited in claim 29 further comprising the step of
2 recovering the depilatory substance from the hair removed from the animal.

1 31. The method as recited in claim 18, wherein the animal comprises,
2 bovine, porcine or ovine.

1 32. The method as recited in claim 18, further comprising the step of
2 spraying an oxidizing agent on the animal's carcass after the step of removing the hair.

1 33. The method as recited in claim 32, wherein the oxidizing agent is
2 selected from the group of hydrogen peroxide and sodium peroxide.

1 34. In a method for slaughtering an animal, wherein said animal is
2 immobilized, exsanguinated and fabricated, an apparatus for removing hair from the animal's
3 carcass prior to dispatching the animal, comprising:

4 means for applying a depilatory substance to the animal's hair, said depilatory
5 substance for breaking bonds in the hair, so that the hair can be removed from the animal; and

6 means for directing a pressurized depilatory substance at the animal, said
7 pressurized depilatory substance for removing hair from the animal.

1 35. The apparatus as recited in claim 34, further comprising means for
2 capturing and reusing at least a portion of the depilatory substance and the pressurized
3 depilatory substance.

1 36. The apparatus as recited in claim 34, further comprising means for
2 capturing the hair removed from the animal, and a depilatory substance recovery system for
3 recovering the depilatory substance from the hair.

1 37. The apparatus as recited in claim 34, wherein the depilatory substance
2 is a sodium sulfide solution.

1 38. The apparatus as recited in claim 34, wherein said means for applying
2 a depilatory substance to an animal's hair comprises first application means for applying a
3 first dose of depilatory substance to the animal's hair and second application means for
4 applying a second dose of depilatory substance to the animal's hair.

1 39. The apparatus as recited in claim 38, wherein said first application
2 means and said second application means comprises a spraying system.

1 40. The apparatus as recited in claim 34, wherein said means for directing
2 a pressurized depilatory substance comprises a pressurized spray system.

1 41. The apparatus as recited in claim 35, wherein said means for directing
2 a pressurized depilatory substance comprises a pressurized spray system which uses the
3 depilatory substance and the pressurized depilatory substance captured by said means for
4 capturing and reusing.

1 42. The apparatus as recited in claim 35, wherein said means for capturing
2 and reusing comprises a screen for filtering the depilatory substance from the animal hair,
3 and a reservoir for catching the filtered depilatory substance.

1 43. The apparatus as recited in claim 34, further comprising means for
2 applying an oxidizing agent on the animal carcass.

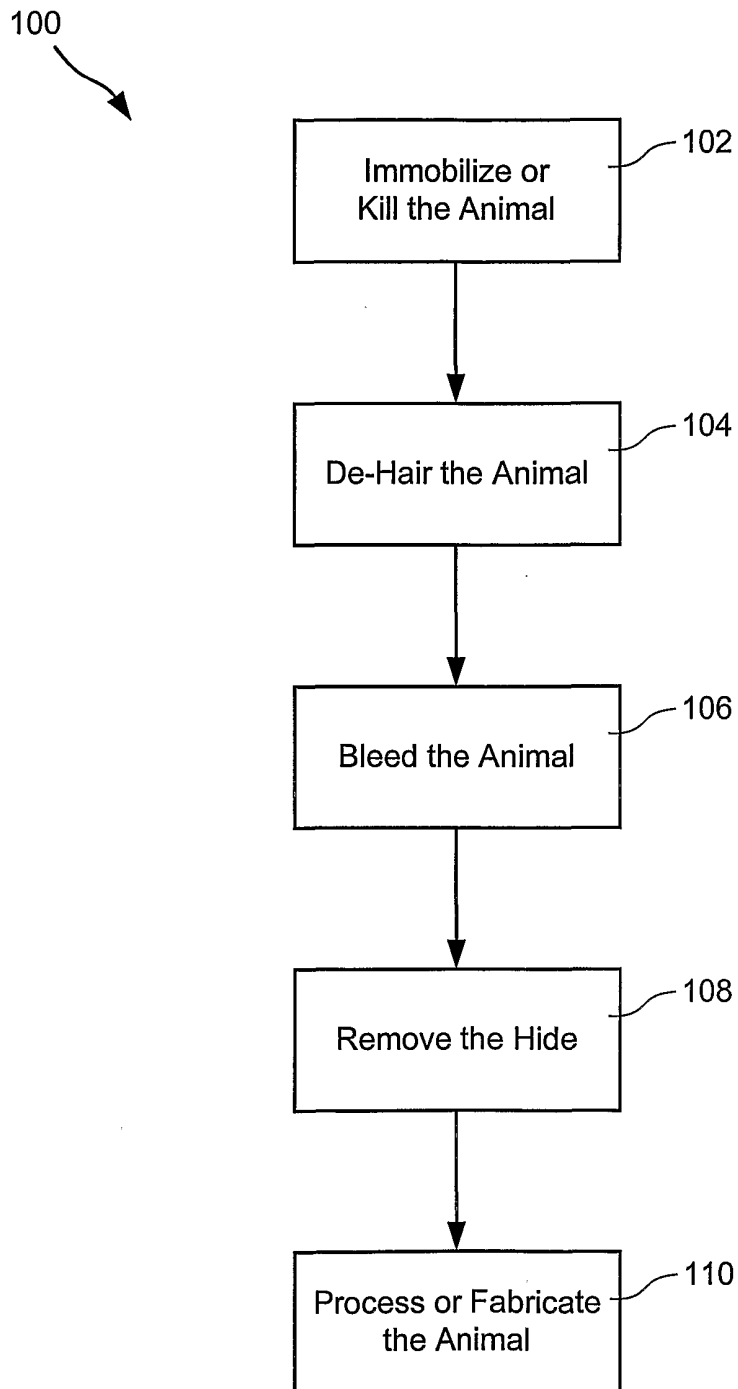


FIG. 1

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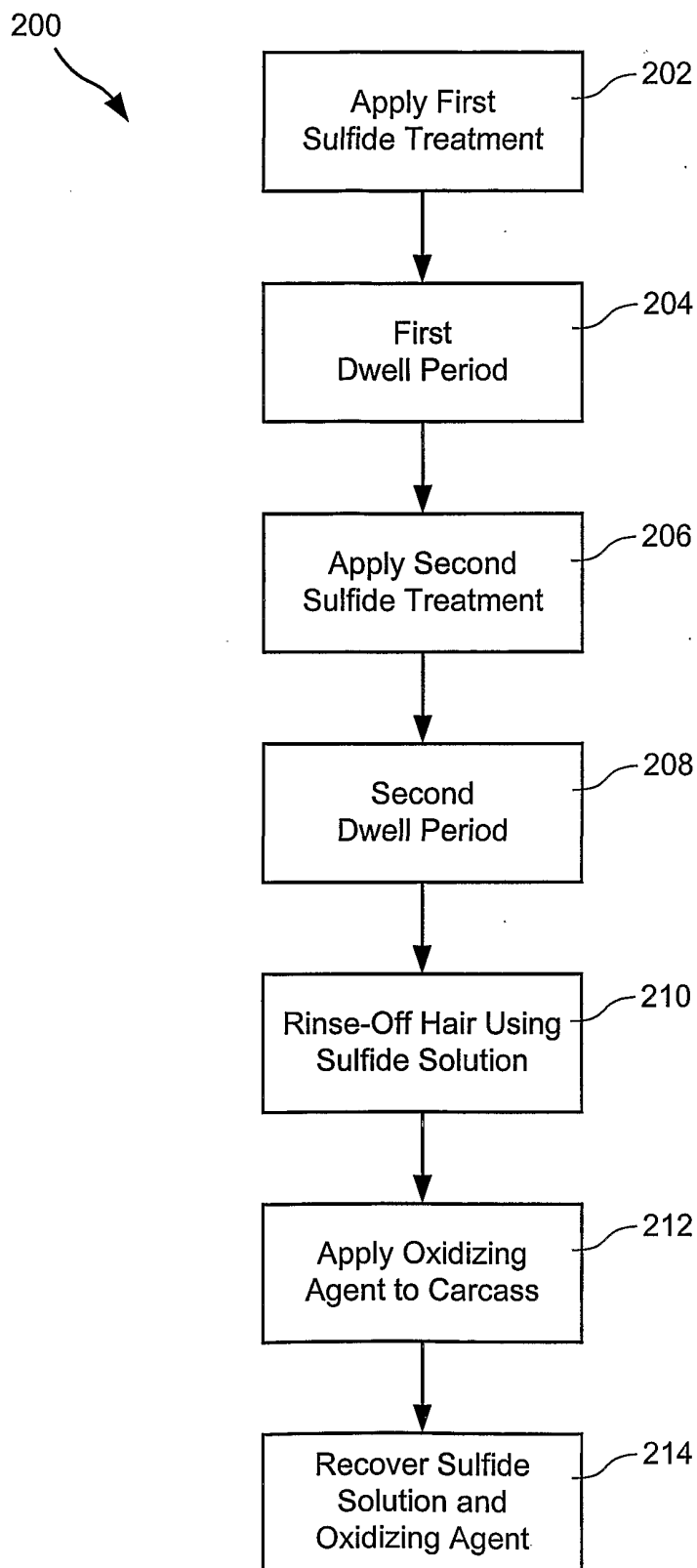


FIG. 2

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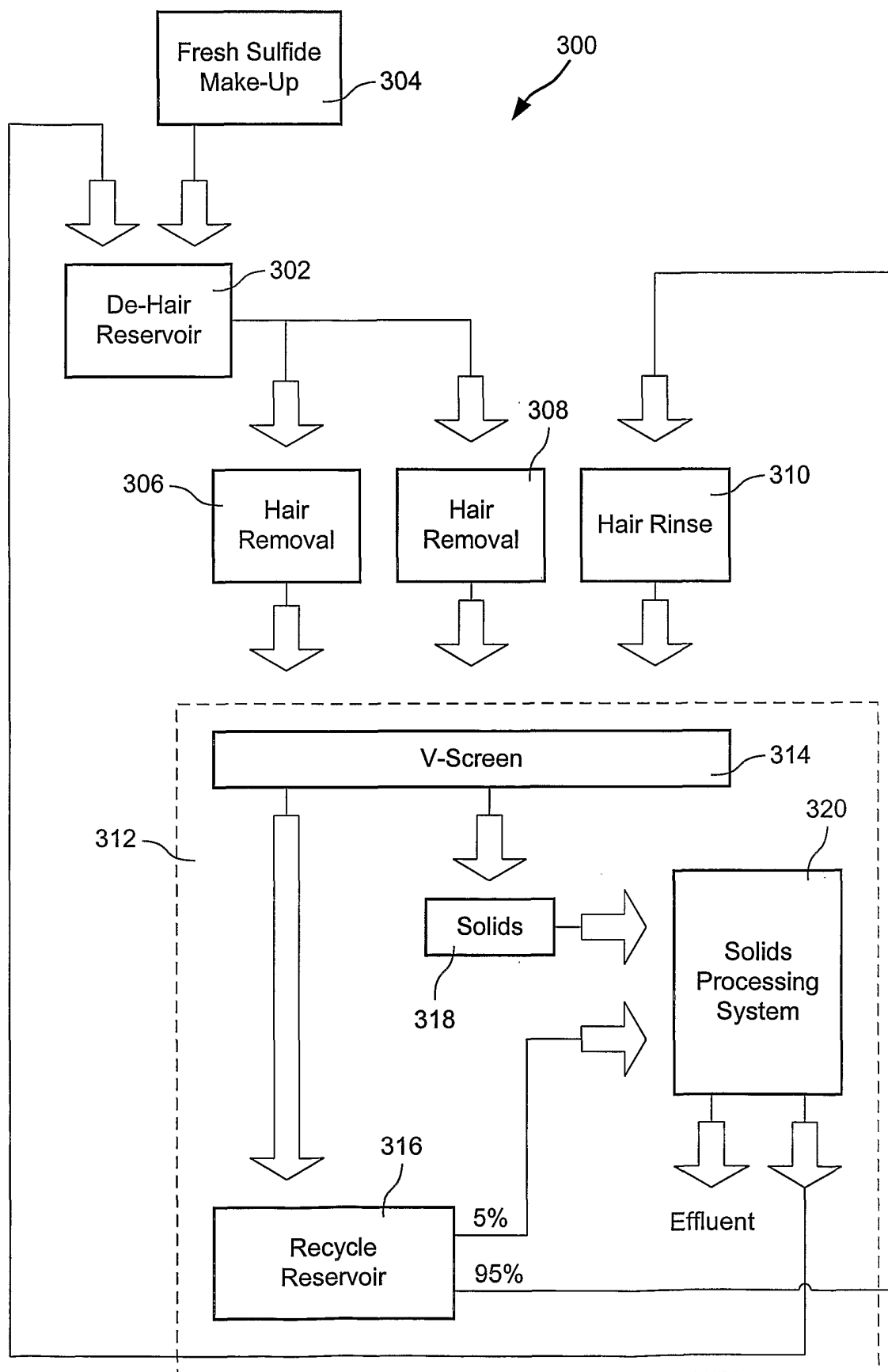


FIG. 3