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MYUNG et al.(10) **Pub. No.: US 2011/0083282 A1**(43) **Pub. Date: Apr. 14, 2011**(54) **OZONE PROCESS FOR DENIM**(76) Inventors: **JASON MYUNG**, Paramount, CA
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D06L 3/04 (2006.01)(52) **U.S. Cl. 8/111; 68/5 R**(57) **ABSTRACT**

An apparatus and a method for decolorizing a denim fabric with an oxidizing gas is disclosed. The process is initiated by producing compressed air which is processed to generate dry air. The air pressure of dry air is reduced to maintain at 10 psig and thereby generates ozone gas. A negative pressure is maintained to ensure no ozone leak out to ambient from a washer. The denim fabric may be exposed to a controlled amount of ozone gas for a predetermined time such as a process time. Whenever the process time expires, the amount of ozone gas is converted back to oxygen by running a variable speed motor at high speed to create a negative pressure within the processing unit and released to atmosphere. The method also incorporates a means for monitoring the level of ozone concentration in ambient for the safety of operators.

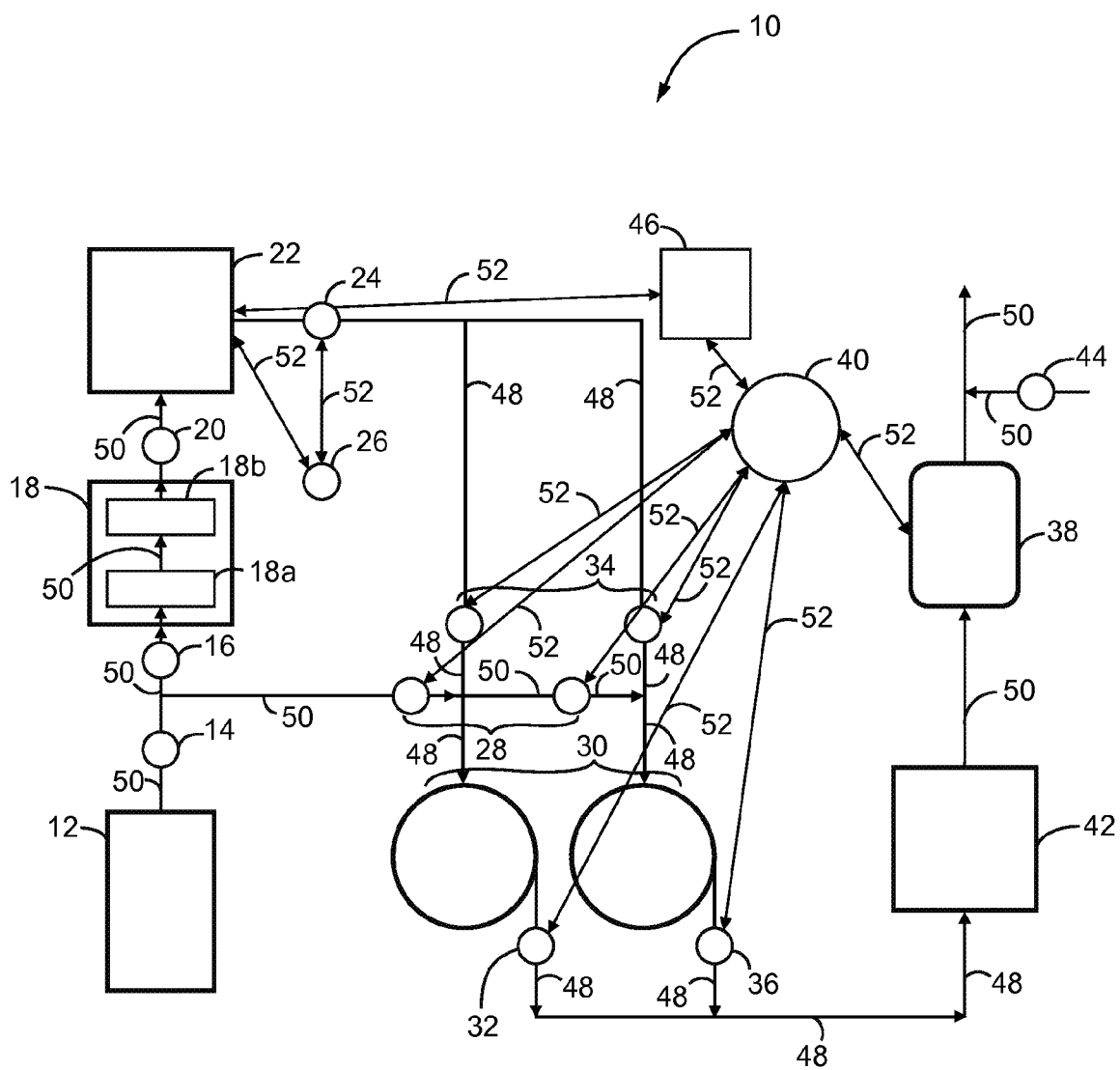


FIG. 1

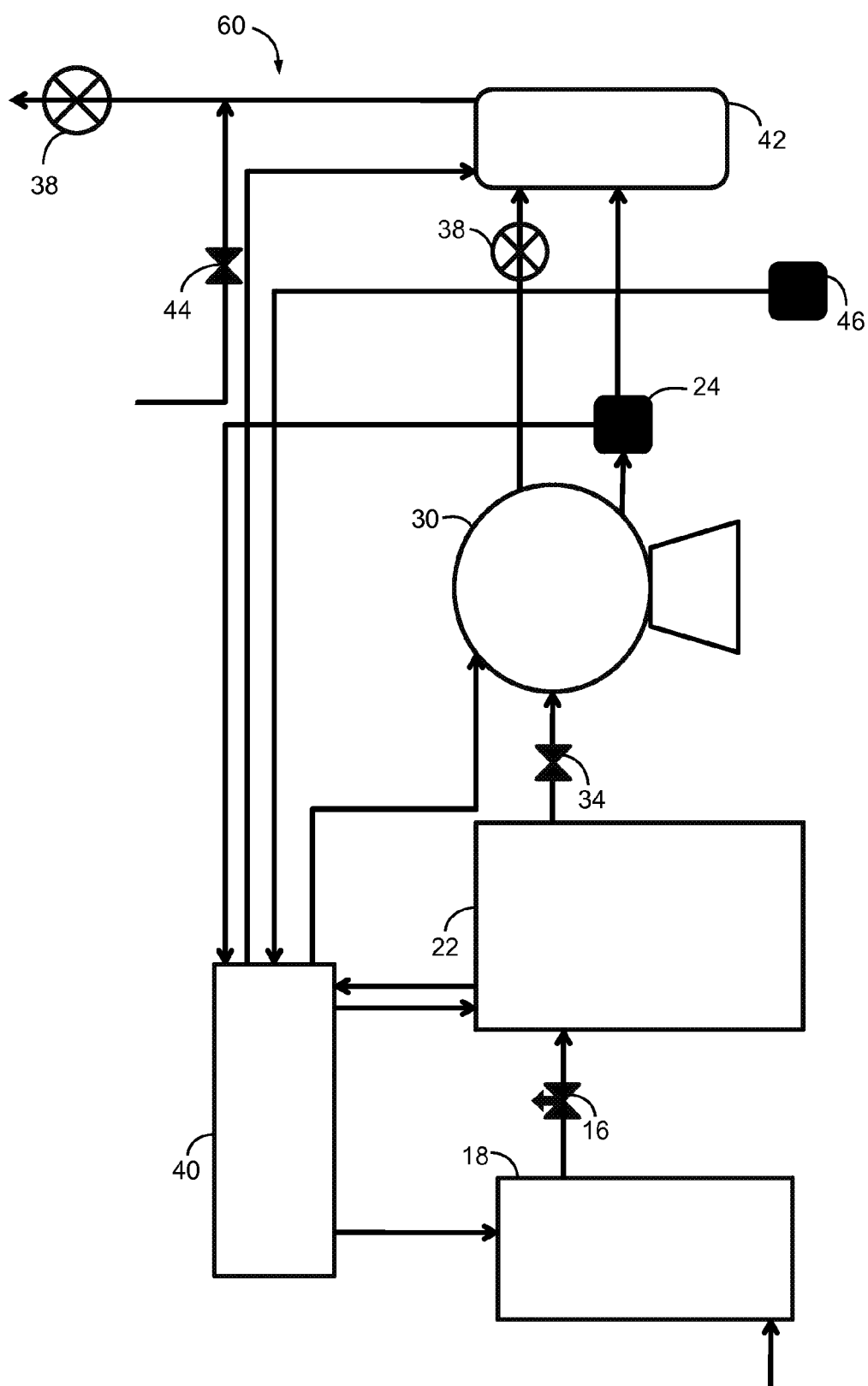


FIG. 2

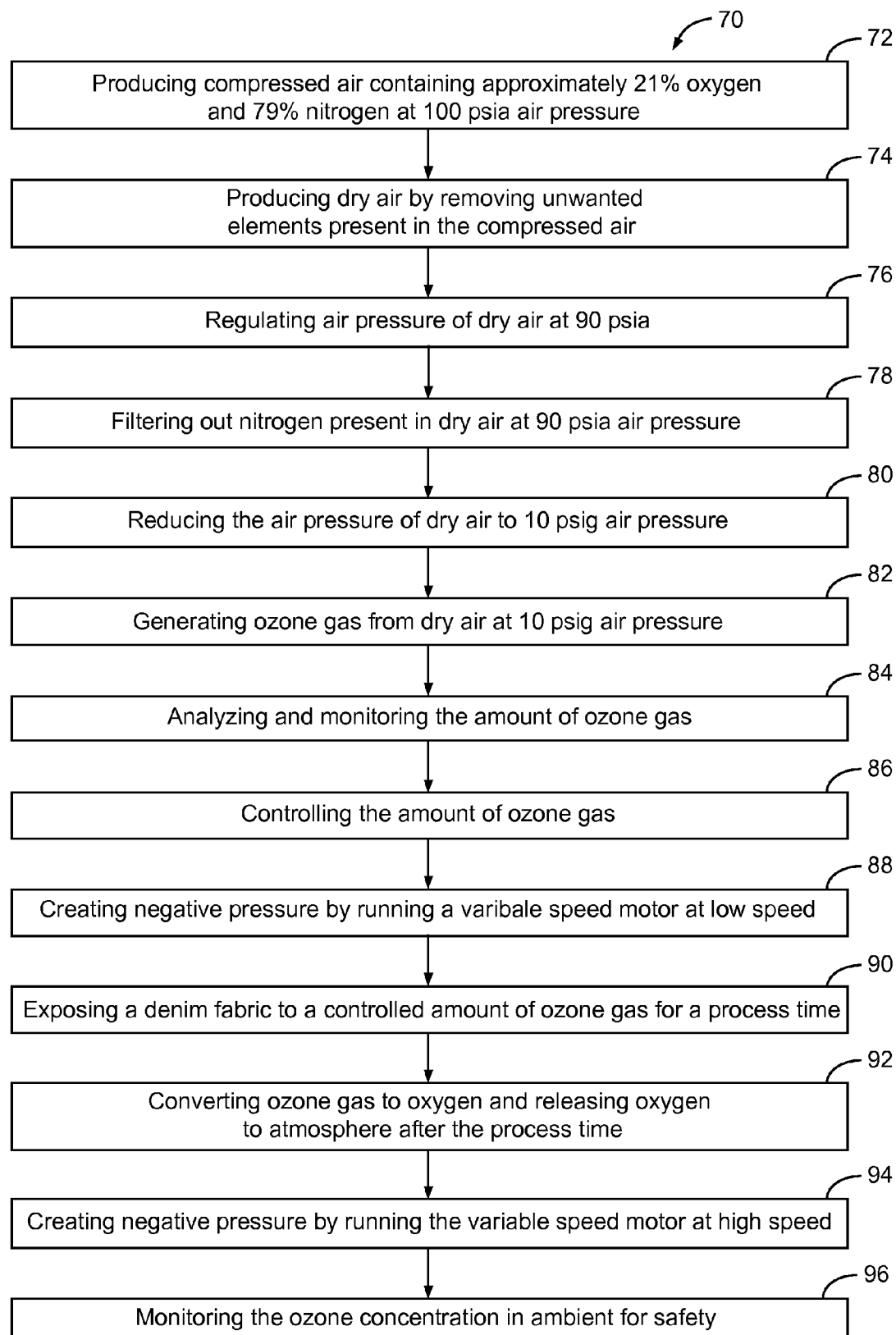


FIG. 3

OZONE PROCESS FOR DENIM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not Applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH AND DEVELOPMENT

[0002] Not Applicable.

FIELD OF THE INVENTION

[0003] This invention relates to an apparatus for the treatment of a denim fabric with an oxidizing gas. More particularly, an apparatus for treating the dry denim fabric with ozone gas for decolorizing dyes, coloring agents on the fabric.

DISCUSSION OF RELATED ART

[0004] Denim is considered to be world's one of the oldest fabric. The popularity of denim fabrics is high in almost every age group. Denim fabrics provide comfort, durability, versatility and glamour. The decolorization of denim fabrics are done by processes such as stone washing, ice washing, sand blasting, rubbing with sand paper or pumice stone etc. Neutralization process using hot water and chemicals, and processes utilizing potassium permanganate spray are also used to provide the desired fading effect.

[0005] U.S. Pat. No. 7,252,688 to Tashiro on Aug. 7, 2007 teaches an apparatus for decolorizing a textile product using ozone. The apparatus enables the decolorization rate to be adjusted by adjusting the water content of the textile product and controlling the ozone concentration to achieve uniform decolorization. The decolorization apparatus includes an airtight container, a rotary drum which rotates in the airtight container, an ozone generator connected with the airtight container through an automatic valve, a water supply unit, and a blower unit which includes an air heater and supplies hot air and cool air to the airtight container. The ozone concentration inside the airtight container is maintained at a desired level by measuring the ozone concentration using an ozone analyzer and controlling the ozone generator. While the particular invention fulfills their respective objectives, the device lacks an ozone monitoring unit for monitoring the concentration of ozone in ambient for providing safety of operation.

[0006] U.S. Pat. No. 6,024,766 to Wasinger on Feb. 15, 2000 discloses a process of desizing textiles with enzymes together with a subsequent step of deactivating any residual enzymes to prevent degradation of the textiles. There is further provided a step or removal of any residual sizing and/or decolorizing dyed garments with ozone. However, in this process costly enzymes are utilized for decolorizing the fabrics. Moreover, this process also requires chemicals that have high cost and unfriendly to the environment.

[0007] U.S. Pat. No. 5,313,811 to Wasinger on May 24, 1994 discloses an apparatus for laundering and treating garments or fabrics with an oxidizing agent. The apparatus includes a housing having a chamber containing a barrel mounted for rotation. A door is provided for placing the garments or fabrics into the chamber. Associated with the housing is a venturi mixer for introducing an oxidizing gas and a liquid into the chamber and a valve for removing liquid from the chamber. Controls are provided to selectively permit a washing, extracting and abrading cycle. However, this

device utilizes hot steam for treating the garments thereby wasting a considerable amount of energy.

[0008] Therefore there is a need for an improved apparatus for decolorizing a denim fabric with an oxidizing gas that would have an ozone monitoring unit for monitoring the concentration of ozone in ambient for providing safety of operation. Such an apparatus would be free from costly enzymes and chemicals that would have high cost and unfriendly to the environment. Moreover, such an apparatus would eliminate the usage of hot steam thereby saving energy. The present invention accomplishes these objectives.

SUMMARY OF THE INVENTION

[0009] The present invention is an apparatus for decolorizing at least one denim fabric with an oxidizing gas comprising at least one air compressor for producing compressed air, at least one air separator for producing dry air, and at least one pressure regulator for regulating the air pressure of dry air at an air pressure of about 90 psia. The at least one air compressor produces compressed air containing approximately of about 21% oxygen and approximately of about 79% nitrogen at an air pressure of about 100 psia (pounds per square inch absolute). The separator removes the unwanted elements from the compressed air. The apparatus further includes at least one oxygen generator that filters out nitrogen present in the dry air at the air pressure of about 90 psia for producing dry air containing approximately of about 95% pure oxygen. The oxygen generator further includes at least one absorber vessel and at least one oxygen receiver. The pressure regulator reduces the air pressure of dry air containing approximately 95% of pure is oxygen to about 10 psig.

[0010] At least one ozone generator is utilized for generating ozone gas from dry air containing approximately 95% pure oxygen at an air pressure of about 10 psig. At least one ozone analyzer is provided for monitoring and analyzing the amount of ozone gas generated in the ozone generator. At least one proportional integral derivative (PID) control unit is designed for controlling the amount of ozone gas for decolorizing the at least one denim fabric. The PID control unit is in communication with the at least one ozone analyzer for controlling the amount of ozone generated in the ozone generator. The apparatus also includes a plurality of inlet air solenoid valves provided in connection with at least one washer. A plurality of outlet solenoid valves are provided in connection with at least one washer. A plurality of inlet ozone solenoid valves are provided in connection with at least one washer. A plurality of outlet ozone solenoid valves are provided in connection with at least one washer.

[0011] The washer may be selected to expose the at least one denim fabric therein. At least one variable speed motor is utilized for creating a negative pressure in the washer. The variable speed motor is adapted to rotate at high speed and/or low speed for creating the negative pressure in the washer. At least one master control unit is designed for setting a regulated periods of time. The regulated period of time may be a process time, a purge time or the like. The master control unit may be provided in combination with at least one computer. At least one ozone destruction unit converts ozone gas to oxygen and releases is oxygen to the atmosphere. At least one manual air valve controls the rate of flow of oxygen released to the atmosphere. At least one ambient ozone monitor monitors the ozone concentration in ambient for the safety of

operators. The ambient ozone monitor may further include at least one ozone sensor for detecting the ozone concentration in ambient.

[0012] The communication between a plurality of units herein is achieved through different communication lines. An ozone sensor may be utilized for shutting down the ozone generator when the ozone concentration in ambient exceeds 0.01 PPM. The air compressor produces compressed air containing approximately of about 21% of oxygen and approximately of about 79% of nitrogen at an air pressure of about 100 psia (pounds per square inch absolute). The compressed air is then passed through the at least one air separator to produce the dry air used in the process. The dry air then allowed to pass through the at least one pressure regulator, which regulates the air pressure to about 90 psia, and the air is fed to the at least one oxygen generator. The oxygen generator filters out most of the nitrogen in the air and produces approximately of about 95% pure oxygen, which is fed into the at least one pressure regulator that reduces the pressure down to about 10 psig. The pressure regulated oxygen at 10 psig is fed to the ozone generator.

[0013] Controlled amount of ozone passes through the at least one inlet ozone solenoid valves. The washer may be represented as washer A or washer B, as in this instance. The washer, is preferably washer A or washer B is where the dry denim jean is exposed to ozone gas and the oxidation on the fabric occurs. The desired effect on the at least one dry denim fabric can be controlled by duration of oxidation, concentration of ozone, and combination of both. The duration of oxidation may be known as process time. The process time is set on the at least one master control unit. At the process time, the at least one variable speed motor is run at low speed to create the negative pressure in the at least one washer. The negative pressure prevents ozone leak out to ambient from the at least one washer.

[0014] When the process time expires, remaining ozone pass through the at least one outlet solenoid valves, and is fed to the at least one ozone destruction unit, which converts ozone to oxygen and releases to atmosphere. The time of destruction of remaining ozone in the at least one washer after the process may be known as purge time. The purge time is also set on the at least one master control unit. At the purge time, the plurality of inlet ozone solenoid valves are opened and/or closed, and the at least one variable speed motor is run on high speed to create the negative pressure in the at least one washer so as to destruct the remaining ozone in the at least one washer.

[0015] The present invention is an improved apparatus for decolorizing a denim fabric with an oxidizing gas having an ozone monitoring unit for monitoring the concentration of ozone in ambient for providing safety of operation. Such an apparatus is free from costly enzymes and chemicals that have high cost and unfriendly to the environment. Moreover, such an apparatus eliminates the usage of hot steam thereby saving energy. Other features and advantages of the present invention will become apparent from the following more detailed description, taken in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of the invention.

DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a schematic diagram of the present invention, illustrating an apparatus for decolorizing a desirable portion of at least one denim fabric with an oxidizing gas;

[0017] FIG. 2 is a process flow diagram of the present invention, illustrating a method for decolorizing at least one denim fabric with an oxidizing gas; and

[0018] FIG. 3 is a operational flowchart, illustrating a method of operation in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] FIG. 1 illustrates an apparatus for decolorizing at least one denim fabric **10** with an oxidizing gas comprising at least one air compressor **12** for producing compressed air, at least one air separator **14** for producing dry air, and at least one pressure regulator **16** for regulating the air pressure of dry air at an air pressure of about 90 psia. The at least one air compressor **12** produces compressed air containing approximately of about 21% oxygen and approximately of about 79% nitrogen at an air pressure of about 100 psia (pounds per square inch absolute). The at least one air separator **14** removes the unwanted elements from the compressed air. The unwanted particles in the compressed air may include oil, moisture or the like.

[0020] The apparatus **10** further includes at least one oxygen generator **18** that filters out nitrogen present in the dry air at the air pressure of about 90 psia for producing dry air containing approximately of about 95% pure oxygen. The at least one oxygen generator **18** further includes at least one absorber vessel **18a** and at least one oxygen receiver **18b**. An at least one pressure regulator **20** reduces the air pressure of dry air containing approximately 95% of pure oxygen to about 10 psig (pounds per square inch gauge). At least one ozone generator **22** is utilized for generating ozone gas from dry air containing approximately 95% pure oxygen at an air pressure of about 10 psig. At least one ozone analyzer **24** is provides for monitoring and analyzing the amount of ozone gas generated in the ozone generator **22**.

[0021] At least one proportional integral derivative (PID) control unit **26** is designed for controlling the amount of ozone gas for decolorizing the at least one denim fabric. The at least one PID control unit **26** is in communication with the at least one ozone analyzer **24** for controlling the amount of ozone generated in the at least one ozone generator **22**. The apparatus also includes a plurality of inlet air solenoid valves **28** provided in connection with at least one washer **30**. A plurality of outlet solenoid valves **32** are provided in connection with at least one washer. A plurality of inlet ozone solenoid valves **34** are provided in connection with at least one washer **30**. A plurality of outlet ozone solenoid valves **36** are provided in connection with at least one washer **30**. The at least one washer **30** may be selected to expose the at least one denim fabric therein. At least one variable speed motor **38** is utilized for creating a negative pressure in the at least one washer **30**. The at least one variable speed motor **38** may be a low speed fan, an exhaust fan or the like. The at least one variable speed motor **38** is adapted to rotate at high speed and/or low speed for creating the negative pressure in the at least one washer **30**. At least one master control unit **40** is designed for setting a regulated periods of time. The regulated period of time may be a process time, a purge time or the like. The at least one master control unit **40** may be provided in combination with at least one computer. At least one ozone destruction unit **42** converts ozone gas to oxygen and releases oxygen to the atmosphere. At least one manual air valve **44** controls the rate of flow of oxygen released to the atmosphere. At least one ambient ozone monitor **46** monitors the ozone

concentration in ambient for the safety of operators. The at least one ambient ozone monitor **46** may further include at least one ozone sensor for detecting the ozone is concentration in ambient. The communication between a plurality of units herein is achieved through different communication lines, generally indicated as **48**, **50** and **52**; wherein the line **48** indicates flow of ozone, **50** flow of oxygen and **52** indicates the flow of communication between the plurality of units. An ozone sensor (not shown) may be utilized for shutting down the ozone generator when the ozone concentration in ambient exceeds 0.01 PPM.

[0022] Now, referring to FIG. 2, a process flow diagram for a method for decolorizing at least one denim fabric with an oxidizing gas **60** is illustrated. The at least one air compressor **12** produces compressed air containing approximately of about 21% of oxygen and approximately of about 79% of nitrogen at an air pressure of about 100 psia (pounds per square inch absolute). The compressed air is then passed through the at least one air separator **14**, which separates unwanted particles like oil, moisture or the like suspended in the compressed air for making the dry air used in the process. The dry air then allowed to pass through the at least one pressure regulator **16**, which regulates the air pressure to about 90 psia, and the air is fed to the at least one oxygen generator **18**. The at least one oxygen generator **18** filters out most of the nitrogen in the air and produces approximately of about 95% pure oxygen, which is fed into an at least one pressure regulator **20** that reduces the pressure down to about 10 psig (pounds per square inch gauge).

[0023] The pressure regulated oxygen at 10 psig is fed to the at least one ozone generator. The at least one oxygen generator **18** includes the at least one absorber vessel **18a** and the at least one oxygen receiver **18b**. The ozone gas generated in the at least one ozone generator **22** is constantly analyzed and monitored by the at least one ozone analyzer **24**. The at least one ozone analyzer **24** and the at least one proportional integral derivative (PID) control unit **26** communicates together to control the amount of ozone generated by the at least one ozone generator **22**. The desirable amount of ozone is set on the at least one PID control unit **26**. Controlled amount of ozone passes through the at least one inlet ozone solenoid valves **34**. The at least one washer **30** may be represented as washer A or washer B, as in this instance. The washer **30**, preferably washer A or washer B is where the dry denim jean is exposed to ozone gas and the oxidation on the fabric occurs. The desired effect on the at least one dry denim fabric can be controlled by duration of oxidation, concentration of ozone, and combination of both. The duration of oxidation may be known as process time. The process time is set on the at least one master control unit.

[0024] At the process time, the at least one variable speed motor **38** is run at low speed to create the negative pressure in the at least one washer **30**. The negative pressure prevents ozone leak out to ambient from the at least one washer **30**. When the process time expires, remaining ozone pass through the at least one outlet solenoid valves **32**, and is fed to the at least one ozone destruction unit **42**, which converts ozone to oxygen and releases to atmosphere. The time for destruction of remaining ozone in the at least one washer **30** after the process may be known as purge time. The purge time is also set on the at least is one master control unit **40**.

[0025] At the purge time, the plurality of inlet ozone solenoid valves **34** are opened and/or closed, and the at least one variable speed motor **38** is run on high speed to create the

negative pressure in the at least one washer **30** so as to destruct the remaining ozone in the at least one washer **30**. The variable speed motor **38** may be facilitated as a low speed fan, an exhaust, or the like. The at least one ambient ozone monitor **46** is utilized for monitoring the ozone concentration in ambient for the safety of operators. The at least one ambient ozone monitor **46** communicates with the at least one master control unit **40** for shutting down the ozone generator **22** when the ozone concentration in ambient exceeds 0.01 PPM.

[0026] FIG. 3 is a flowchart illustrating a method of operation of an apparatus **70** for decolorizing at least one denim fabric with an oxidizing gas. The process may be initiated as indicated at block **72** by way of producing compressed air, generally containing approximately 21% oxygen and approximately 79% nitrogen at 100 psia air pressure. The compressed air is processed so as to produce dry air as in block **74** by removing undesirable components in the compressed air such as oil, moisture or the like. The dry air pressure is regulated at 90 psia and nitrogen contained therein is filtered out to produce dry air containing 95% pure oxygen as shown at block **78**. As indicated at block **80**, the air pressure of dry air is reduced to maintain at 10 psig and thereby generates ozone gas as at block **82**. The amount of ozone gas generated from the dry air is being analyzed, is monitored and controlled as shown at blocks **84**, **86**. A negative pressure is generated as shown at block **88** to ensure no ozone leak out to ambient from the process unit, the washer here for example. The at least one denim fabric may be exposed to a controlled amount of ozone gas for a predetermined time such as a process time as indicated at block **90**. Whenever the process time expires, the amount of ozone gas is converted back to oxygen by running a variable speed motor at high speed to create a negative pressure within the processing unit and released to atmosphere as depicted at blocks **92**, **94**. The method also incorporates a means for monitoring the level of ozone concentration in ambient for the safety of operators as shown at block **96**.

[0027] While a particular form of the invention has been illustrated and described, it will be apparent that various modifications can be made without departing from the spirit and scope of the invention. For example, the duration of oxidation, concentration of ozone or the like may be contemplated to achieve desirable effect on a desirable portion of the at least one denim fabric. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

What is claimed is:

1. An apparatus for decolorizing at least one denim fabric with an oxidizing gas comprising:

at least one air compressor for producing compressed air containing approximately of about 21% oxygen and approximately of about 79% nitrogen at an air pressure of about 100 psia;

at least one air separator for producing dry air by removing unwanted elements therefrom;

at least one pressure regulator for regulating the air pressure of dry air at an air pressure of about 90 psia;

at least one oxygen generator for filtering out nitrogen present in the dry air at the air pressure of about 90 psia for producing dry air containing approximately of is about 95% pure oxygen;

at least one pressure regulator for reducing the air pressure of dry air containing approximately 95% of pure oxygen to about 10 psig;

at least one ozone generator for generating ozone gas from dry air containing approximately 95% pure oxygen at an air pressure of about 10 psig;
 at least one ozone analyzer for monitoring and analyzing the amount of ozone gas generated in the ozone generator;
 at least one proportional integral derivative (PID) control unit designed for controlling the amount of ozone gas for decolorizing the at least one denim fabric;
 a plurality of inlet air solenoid valves arranged in connection with at least one washer;
 a plurality of outlet solenoid valves being in connection with at least one washer;
 a plurality of inlet ozone solenoid valves being in connection with at least one washer;
 a plurality of outlet ozone solenoid valves provided in connection with at least one washer;
 at least one variable speed motor for creating a negative pressure in the at least one washer;
 at least one master control unit designed for setting a regulated period of time;
 at least one ozone destruction unit for converting ozone gas to oxygen and releasing oxygen to the atmosphere;
 at least one manual air valve for controlling the rate of flow of oxygen released to the atmosphere; and
 is at least one ambient ozone monitor for monitoring the ozone concentration in ambient for the safety of operators;
 whereby the decolorization rate of the at least one denim fabric can be adjusted by controlling the amount of ozone gas, the duration of the regulated periods of time and thereby applying more abrasiveness on the denim fabric.

2. The apparatus of claim 1 wherein the at least one oxygen generator further comprises at least one absorber vessel and at least one oxygen receiver.

3. The apparatus of claim 1 wherein the at least one ambient ozone monitor may include at least one ozone sensor for detecting the ozone concentration in ambient.

4. The apparatus of claim 3 wherein the at least one ozone sensor may be utilized for shutting down the ozone generator when the ozone concentration in ambient exceeds 0.01 PPM.

5. The apparatus of claim 1 wherein the unwanted particles in the compressed air may include oil, moisture or the like.

6. The apparatus of claim 1 wherein the at least one PID control unit is in communication with the at least one ozone analyzer for controlling the amount of ozone generated in the at least one ozone generator.

7. The apparatus of claim 1 wherein the at least one variable speed motor may be a low speed fan, an exhaust fan or the like.

8. The apparatus of claim 1 wherein the at least one variable speed motor is adapted to rotate at high speed and/or low speed for creating the negative pressure in the at least one washer.

9. The apparatus of claim 1 wherein the at least one washer may be selected to expose the at least one denim fabric therein.

10. The apparatus of claim 1 wherein the apparatus may be utilized for decolorizing a desirable portion of the at least one denim fabric.

11. The apparatus of claim 1 wherein the at least one master control unit may be provided in combination with at least one computer.

12. A method for decolorizing at least one denim fabric with an oxidizing gas comprising:

- a) producing compressed air containing approximately of about 21% oxygen and approximately of about 79% of nitrogen at an air pressure of about 100 psia;
- b) producing dry air by removing unwanted elements from the compressed air;
- c) regulating the air pressure of dry air at an air pressure of about 90 psia;
- d) filtering out nitrogen present in the dry air at an air pressure of about 90 psia for producing dry air with approximately of about 95% of pure oxygen;
- e) reducing the air pressure of dry air containing approximately of about 95% of pure oxygen to an air pressure of about 10 psig;
- f) generating ozone gas from dry air containing approximately of about 95% of pure oxygen at an air pressure of about 10 psig;
- g) analyzing and monitoring the amount of ozone gas;
- h) controlling the amount of ozone gas for decolorizing the at least one denim fabric;
- i) exposing the at least one denim fabric to a controlled amount of ozone gas for a regulated period of time;
- j) creating negative pressure for avoiding the leakage of ozone gas;
- k) converting ozone gas to oxygen and releasing oxygen to atmosphere after the completion of the regulated period of time;
- l) creating negative pressure to destruct the remaining amount of ozone gas for a regulated period of time; and
- m) monitoring the ozone concentration in ambient for the safety of operators.

13. The method of claim 12 wherein the method is employed for desirably achieving oxidation of the at least one denim fabric within a predetermined duration of processing.

14. The method of claim 12 wherein the method may be utilized in a final stage of laundering operation with oxidizing gases for decolorizing dyes, coloring agents or the like on the at least one denim fabric.

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