

AERODYNAMICALLY STREAMLINED ENCLOSURE FOR INPUT DEVICES OF A MEDICATION PREPARATION SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to United States Provisional Application Serial No. 62/047,325, filed September 8, 2014, entitled “Automated Visual Documentation Feature with Minimal User Input”, United States Provisional Application Serial No. 62/072,160, filed October 29, 2014, entitled “Enhanced Pharmacist Review Module for a System for Preparing a Pharmaceutical Compound”, United States Provisional Application Serial No. 62/072,054, filed October 29, 2014, entitled “Aerodynamically Streamlined Enclosure for Input Devices of a Medication Preparation System”, United States Provisional Application Serial No. 62/078,067, filed November 11, 2014, entitled “Aerodynamically Streamlined Enclosure for Input Devices of a Medication Preparation System”, and United States Provisional Application No. 62/077,968, filed November 11, 2014, entitled “Enhanced Platen for Pharmaceutical Compounding”, the entire disclosures of each of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention is generally directed to an aerodynamically streamlined enclosure for housing input devices, such as a scanner and/or camera, which are part of a medication preparation system. The streamlined enclosure may be placed within a flow hood and may be positioned in the upstream airflow vicinity of a scale.

Description of Related Art

[0003] The preparation of sterile pharmaceutical compounds typically takes place in a flow hood that provides an air stream to create a clean zone. During such preparations, cameras, scanners, and/or scales may be utilized to document the preparation. These devices are typically located in a flow hood and are positioned in the upstream air flow vicinity of a scale. However, any object will create an air flow disturbance that will affect the downstream air flow of the object. If this flow disturbance is present in the upstream vicinity of a scale, for instance, it can result in inconsistent pressure or turbulent flow conditions in the vicinity of the scale’s weighing surface. Depending on the level of flow disturbance, which is a function of multiple form parameters and location, this may result in the scale being unable to stabilize at all. A scale that cannot stabilize, may not be used to accurately prepare a medication, such as a sterile

compounded medication. In certain cases, the flow disturbance may result in accuracy tolerances that are beyond the acceptable limits of the system for medication preparation.

[0004] Accordingly, a need exists for a smaller and/or more streamlined device that will result in a smaller flow disturbance near a scale of the system to create a higher likelihood of meeting accuracy and stability requirements.

SUMMARY OF THE INVENTION

[0005] In accordance with an aspect of the invention, provided is a system for preparing a pharmaceutical compound. The system comprises: a scale having a platen configured for placement of an object thereon; a supporting arm comprising a first end coupled to a portion of the scale and a second end extending to a position above the platen of the scale; and an enclosure housing extending from the second end of the supporting arm and configured to house at least one input device. The enclosure housing has a curved front profile to minimize flow disturbance when the system is positioned within a flow hood.

[0006] The enclosure housing may be formed of an upper portion and a lower portion. In addition, the enclosure housing may comprise a first end coupled to the second end of the supporting arm and a second end extending over the platen of the scale. At least a portion of the second end of the enclosure housing may have a height that is greater than a height of at least a portion of the first end of the enclosure housing.

[0007] The at least one input device may include an image capture device, a barcode scanner, or both. If both an image capture device and a barcode scanner are provided within the enclosure housing, the barcode scanner may be angled, such as at a 45° angle with respect to a field of view of the image capture device, with respect to the image capture device within the enclosure housing.

[0008] In accordance with another aspect of the invention, provided is a system for preparing a pharmaceutical compound. The system comprises: a computing device comprising a processor and a user interface providing an operator with instructions for preparing the pharmaceutical compound; a scale operatively coupled to the processor of the computing device; and an enclosure housing comprising an image capture device and a barcode scanner. The enclosure housing is supported by a supporting arm and coupled to a portion of the scale. The image capture device is operatively connected to the processor of the computing device and has a field of view positioned to capture an object positioned on the scale. The barcode scanner has a sensor that is offset from the scale.

[0009] The barcode scanner may be angled with respect to the image capture device within the enclosure housing. For instance, the barcode scanner may be angled at a 45° angle with respect to the field of view of the image capture device. The enclosure housing may be supported by the supporting arm such that the enclosure housing is positioned above the scale. The enclosure housing may have a curved front profile to minimize flow disturbance within a flow hood.

[0010] In accordance with yet another aspect of the invention, provided is a system for preparing a pharmaceutical compound. The system comprises: a computing device comprising a user interface providing an operator with instructions for preparing the pharmaceutical compound; and a flow hood having positioned therein: a scale operatively connected to the user interface; and an enclosure housing comprising a camera positioned to capture an image of the scale during the preparation of the pharmaceutical compound.

[0011] The enclosure housing may be positioned above the scale. The enclosure housing may further comprise a barcode scanner. The enclosure housing may have a curved front profile to minimize flow disturbance within the flow hood.

[0012] These and other features and characteristics of the present invention, as well as the methods of operation and functions of the related elements of structures and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention. As used in the specification and the claims, the singular form of “a”, “an”, and “the” include plural referents unless the context clearly dictates otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] **FIG. 1** is a perspective view of an exemplary pharmacy preparation system for preparing a pharmaceutical compound in accordance with an embodiment of the present invention.

[0014] **FIG. 2** is a perspective view of the pharmacy preparation system of **FIG. 1** in a laminar flow hood having a user interface in accordance with an embodiment of the present invention.

[0015] FIG. 3 is an exploded perspective view of a portion of the pharmacy preparation system of FIG. 1 in accordance with an embodiment of the present invention.

[0016] FIG. 4 is a perspective view of a scale platen in accordance with an embodiment of the present invention.

[0017] FIG. 5 is a top view of the scale platen of FIG. 4 in accordance with an embodiment of the present invention.

[0018] FIG. 6 is a cross-sectional side view of a groove of the scale platen of FIG. 4 taken along line D-D of FIG. 5 in accordance with an embodiment of the present invention.

[0019] FIG. 7 is a perspective view of a flow hood system having an aerodynamically streamlined enclosure for input devices in accordance with an embodiment of the present invention.

[0020] FIG. 8A is a perspective visual representation of the air flow distribution within a flow hood having a scale and no enclosure.

[0021] FIG. 8B is a side view visual representation of the air flow distribution within a flow hood having a scale and no enclosure.

[0022] FIG. 9A is a perspective visual representation of the air flow distribution within a flow hood having a scale and a large blunt enclosure.

[0023] FIG. 9B is a side view visual representation of the air flow distribution within a flow hood having a scale and a large blunt enclosure.

[0024] FIG. 10A is a perspective visual representation of the air flow distribution within a flow hood having a scale and a medium sized blunt enclosure.

[0025] FIG. 10B is a side view visual representation of the air flow distribution within a flow hood having a scale and a medium sized blunt enclosure.

[0026] FIG. 11A is a perspective visual representation of the air flow distribution within a flow hood having a scale and a medium sized streamlined enclosure.

[0027] FIG. 11B is a side view visual representation of the air flow distribution within a flow hood having a scale and a medium sized streamlined enclosure.

[0028] FIG. 12A is a perspective visual representation of the air flow distribution within a flow hood having a scale and a small sized streamlined enclosure.

[0029] FIG. 12B is a side view visual representation of the air flow distribution within a flow hood having a scale and a small sized streamlined enclosure.

[0030] FIG. 13A is a perspective visual representation of the air flow distribution within a flow hood having a scale and a small sized shortened streamlined enclosure.

[0031] FIG. 13B is a side view visual representation of the air flow distribution within a flow hood having a scale and a small sized shortened streamlined enclosure.

[0032] FIG. 14 is a side view of a scale and a housing enclosure in accordance with an embodiment of the present invention.

[0033] FIG. 15 is a cross-sectional view of the housing enclosure of FIG. 14 taken along line A-A.

[0034] FIG. 16 is a cross-sectional view of the housing enclosure of FIG. 14 taken along line B-B.

DESCRIPTION OF THE INVENTION

[0035] For purposes of the description hereinafter, the terms “upper”, “lower”, “right”, “left”, “vertical”, “horizontal”, “top”, “bottom”, “lateral”, “longitudinal”, and derivatives thereof, shall relate to the invention as it is oriented in the drawing figures. However, it is to be understood that the invention may assume various alternative variations, except where expressly specified to the contrary. It is also to be understood that the specific devices illustrated in the attached drawings, and described in the following specification, are simply exemplary embodiments of the invention. Hence, specific dimensions and other physical characteristics related to the embodiments disclosed herein are not to be considered as limiting.

[0036] The invention is directed to an aerodynamically streamlined enclosure to house input devices, such as a scanner and/or a camera, that are part of a medication preparation system, such as a sterile drug compounding system. These devices are typically located in a flow hood and are positioned in the upstream air flow vicinity of a scale. The aerodynamically streamlined enclosure is designed in such a way to minimize the airflow disturbance that is created by having a device in a laminar airflow stream. This configuration allows the device to be placed in the upstream vicinity of a scale and still have an acceptable gravimetric accuracy (i.e. +/-0.05g) and stabilization time (i.e. no more than 2 additional seconds) for verifying medication preparation purposes.

[0037] Any object will create an air flow disturbance that will affect the downstream air flow of the object. If this flow disturbance is present in the upstream vicinity of a scale it can result in inconsistent pressure or turbulent flow conditions in the vicinity of the scale's weighing surface. Depending on the level of flow disturbance, which is a function of multiple form parameters and location, this may result in the scale being unable to stabilize at all. A scale that cannot stabilize, may not be used to accurately prepare a medication, such as a sterile

compounded medication. In certain cases, the flow disturbance may result in accuracy tolerances that are beyond the acceptable limits of the system for medication preparation.

[0038] A smaller and/or more streamlined device will result in a smaller flow disturbance and therefore a higher likelihood of meeting accuracy and stability requirements. The streamlined enclosure of the present invention has a form that minimizes flow disruption and drag, allowing for stable and accurate enough gravimetric readings that are required for medication preparation purposes. The streamlined enclosure of the present invention allows for required gravimetric scale accuracy and stability, while placing the input devices in the upstream airflow vicinity relative to the scale. Placing these objects (i.e. scanner and/or camera) within the scale vicinity is typically the ideal area for a number of reasons. A secondary advantage to the streamlined enclosure of the present invention is to provide and maintain a clean working environment for the sterile preparation of medications. In use, the purpose of the air stream in a flow hood is to create a clean zone for sanitary reasons. A turbulent zone created by objects near, or upstream, of the airflow may result in a potential contamination hazard during medication preparation. As a result, having an aerodynamically shaped enclosure housing for input devices minimizes the amount of laminar airflow disruption and decreases the chances of any type of contamination.

[0039] In accordance with one aspect of the present invention, a single enclosure houses at least one input device above the scale. The enclosure may house multiple input devices above the scale, such as a scanner and a camera. The enclosure is small and streamlined enough so that it has minimal effects on the stability and accuracy of the scale.

[0040] In certain cases, the input device enclosure may be positioned to the side or back of the scale and not directly provided in the upstream vicinity of the scale's weighing surface relative to airflow direction. This configuration may provide stable and accurate gravimetric scale readings since disturbed airflow would not reach the weighing surface vicinity of the scale, however, the input device would be provided in a less than ideal location. For example, if the input device is a camera, this side or back placement of the camera would most likely require photographs to be taken in a perspective view. If the input device is a scanner, this side or back placement would provide the scanner in a potentially less ergonomic location for use by a user.

[0041] In other cases, the input device may have a small enough footprint to be suitable for use without any enclosure. This configuration may provide efficient ergonomic scanning and the ability to have pictures taken from a direct top down view. This configuration may require that the housing of the device itself be optimized to provide little disruption to the air flow.

[0042] In still other cases, positioning an input device above the scale but in an orientation and/or with aid from additional air flow manipulating features could result in air that is sufficiently channeled away from the scale weighing surface so as to not have an appreciable effect on gravimetric readings of the scale. Similarly, additional airflow manipulating features could be designed to reorient disturbed air sufficiently such that when the air hits the scale weighing surface it is sufficiently deflected and/or dampened such that it does not adversely affect the stability and accuracy of the scale.

[0043] In another configuration, an enclosure may be provided around the scale so as to eliminate any type of potential airflow disturbance to gravimetric readings (i.e. a box housing used with high accuracy scales). A blunt, non-aerodynamic enclosure for the scale could fulfill gravimetric stability and accuracy requirements under a limited number of hoods since airflow patterns and flow rates vary between hoods.

[0044] In yet another configuration, a scale may be provided with high filtering for noisy environments or processing the gravimetric signal outside of the scale's logic system. This configuration could be used as a solution to achieving more accurate and stable results with blunt or non-streamlined objects.

[0045] In still another configuration, a platen of the scale may be provided in a way that minimizes the effects of airflow disturbances on the reading of the scale. Raising the device high enough above the scale could be a solution to achieving more accurate and stable results with blunt or non-streamlined objects.

[0046] The degree of sensitivity that a scale has under a typical hood used in sterile compounding is on the order of $(\pm 0.05\text{g})$ for a down flow rate of 55-80 cfm. To understand why this is the case, the pressure that is seen on the weighing surface of the scale and its relationship to the desired level of accuracy needs to be understood. According to simulations, the pressure that the platen (weighing surface of the scale) experiences ranges from -1.2Pa to 0.1Pa, with an average of approximately -0.07Pa. To gain an accuracy of $\pm 0.05\text{g}$ a deviation of no more than $\pm 0.0126\text{Pa}$ can be experienced by the scale due to airflow disturbances. This is extremely small compared to the overall range of pressure that the scale experiences. Qualitatively, this magnitude is so small that a user's hand moving in the vicinity of a surface can easily induce enough air movement to result in a much greater pressure disturbance. As a result, parameters such as form location within the hood (different flow patterns in different areas) and hood brands/models were realized to have a great enough influence on the performance of the scale's stability and accuracy.

[0047] With reference to **FIGS. 1-2**, a pharmacy preparation system, denoted generally as reference numeral **1**, assists pharmacists or non-pharmacist technicians in preparing a syringe, drug vial, or intravenous (IV) bag with one or more prescribed pharmaceutical compounds. The pharmacy preparation system is operatively connected to a user interface **3** including a computer having a processor and a stored memory, as well as a display **5** and a user input device **7**, such as a keyboard, mouse, etc. A scale **9** having a scale output interface **11** may be operatively connected to the processor of the user interface **3**. The scale **9** may be implemented as any suitable device for detecting a change in mass or weight when an object is placed thereon. Accordingly, the scale **9** may simply be configured as a device that sends a signal when the mass or weight of an object is greater or less than a predetermined threshold or a high-precision scale that provides an accurate reading of the weight of an object placed thereon.

[0048] In one embodiment, a barcode scanner **13** may be operatively connected to at least one of the processor of the user interface **3** and the scale **9**, such that the barcode scanner **13** may scan a medication vial having a barcode that is placed onto a portion of the scale **9**. In another embodiment, an image capture device **15** may be operatively connected to at least one of the user interface **3** and the scale **9**, such that the image capture device **15** may take a picture of an item, such as a medication vial, IV bag, or syringe placed onto a portion of the scale **9**. In one embodiment, the image capture device **15** may capture a plurality of still images or running video of items placed onto a portion of the scale **9** throughout the medication compounding process for documentation and/or subsequent review of the medication compounding process.

[0049] In still another embodiment, at least one of the barcode scanner **13** and the image capture device **15** may be at least partially enclosed within a housing **17**. In certain configurations, the housing **17** may fully enclose the barcode scanner **13** and the image capture device **15**. Optionally, the housing **17** may include only one of the barcode scanner **13** and the image capture device **15**. In one configuration, the barcode scanner **13** may be positioned within the housing **17** such that the barcode scanner **13** may easily scan a barcode of an item placed onto a portion of the scale **9** without further manipulation by the user. In another configuration, the image capture device **15** may be positioned within the housing **17** such that the image capture device may easily capture images of an item placed onto a portion of the scale **9** without further manipulation by the user.

[0050] With specific reference to **FIG. 3**, the housing **17** may be formed of an upper portion **17A** and a lower portion **17B** which are interfaced to provide minimal surface perturbations to minimize any surface adherence of contaminants such as microbes or other pathogens. In one

embodiment, the manufacturing of the housing **17** adheres to USP 797. Optical lenses **6, 8** may be fitted with the housing **17** to further ensure adherence to USP 797. In one configuration, optical lens **6** may be fitted with housing **17** in optical communication with image capture device **15**. In another configuration, optical lens **8** may be fitted with housing **17** in optical communication with barcode scanner **13**.

[0051] In one configuration, the barcode scanner **13** may be positioned within the housing **17** such that the barcode scanner **13** has a scanner that is offset from immediately scanning a barcode of an item placed onto a portion of the scale **9** without further manipulation by the user. In this configuration, accidental scanning is avoided. As shown in **FIG 3**, the barcode scanner **13** may be positioned such that the sensor is angled with respect to a platen **31** of the scale, such as at a 45° angle by a mounting bracket **18**. In this configuration, the user must actively place the objects to be scanned in range of the sensor of the barcode scanner **13**. In another configuration, the image capture device **15** may be positioned within the housing **17** such that the image capture device may easily capture images of an item placed onto a portion of the scale **9** without further manipulation by the user.

[0052] The housing **17** may be positioned above a portion of the scale **9**, such as supported by a supporting arm **19**. As shown in **FIG. 2**, the pharmacy preparation system **1** may be positioned within a laminar flow hood **25** having an inlet air source **23** and an outlet air port **27** for creating a laminar flow of air within an interior **29** of the laminar flow hood **25**. An exterior surface **21** of the housing **17** may have a curved front profile as shown in **FIGS. 1-3** to provide it with a streamlined shape and/or a profile which is optimized to reduce disruption of the flow of air within the laminar flow hood **25**.

[0053] Referring again to **FIGS. 1-3**, the scale **9** may include a base portion **43** which supports a platen **31** thereon. The base portion **43** houses a strain gauge load cell which measures the strain of an object placed on the platen **31**, and a force transducer, such as a load cell sensor, which converts the force applied to the platen **31** into an electrical signal which may be relayed to the scale output interface **11**. The base portion **43** supports the platen **31**, such as a portion of the weighing surface of the scale **9**, which may provide a visual indication, such as a cross recess **35**, to the technician of a center, or other desired portion, of an image to be captured by the image capture device **15**. This allows a technician to properly position drug compounding related medications **37** and related supplies within the field of view of the image capture device **15**, such as the image capture device enclosed within the housing **17** positioned above the platen **31** of the scale **9**. In one configuration, as shown in **FIGS. 4-6**, an upper surface **41** of the platen **31** may define a plurality of recessed grooves **39** and/or protrusions

extending from a surface of the platen 31 to frictionally restrain drug compounding related medications 37 and related supplies on the upper surface 41 of the platen 31. In another configuration, the upper surface 41 of the platen 31 may include a tackifier or other frictionally enhancing surface to similarly restrain drug compounding related medications 37 and related supplies on the upper surface 41 of the platen 31. The arrangement of grooves 39 and/or protrusions may easily indicate to a user the center of the platen 31 which may be arranged to coincide with the center of the field of view of the image capture device 15. The surface of the platen 31 may be coated with a durable composition that resists degradation caused by exposure to caustic agents, such as chemotherapy compounds and drugs, as well as cleaning agents, such as bleach, isopropyl alcohol, and the like. In certain configurations, the durable composition may be an epoxy or epoxy-based paint or coating.

[0054] The plurality of recessed grooves 39 and/or protrusions extending from a surface of the platen 31 may be configured to restrain any liquid material that is accidentally spilled on the upper surface 41 of the platen 31 during a compounding procedure. The plurality of recessed grooves 39 may define a receiving well 47 (shown in FIG. 1) which serves to collect and restrain accidentally spilled material in a confined area within the platen 31 until proper disposal techniques may be employed.

[0055] In another embodiment, the platen 31 may be removable from a base unit 43 of the scale 9. In this configuration, the platen 31 may be disposable and a technician may remove and dispose of the platen 31 after a single sterile drug compounding procedure. In this configuration, calibration of the scale 9 may be required for each individual platen 31 that is engaged with the base 43. In an alternative configuration, the platen 31 may include a disposable cover layer (not shown) which may be removed and disposed of after a sterile drug compounding procedure. The disposable aspect of the platen 31 ensures that prior to each compounding procedure, the platen 31 is clean and that no contaminants may transfer to a component of the drug compounding procedure. The platen 31 may be formed of a metal, composite, or polymeric material, as is conventionally known for scale weighing surfaces. In a further configuration, each platen 31 may include a unique individual identifier 45, embedded therein or attached to a surface thereof, which may be captured in an image captured by the image capture device 15. This allows for a technician and/or subsequent reviewer of the images captured by the image capture device 15 of the drug compounding procedure to verify that the platen 31 was changed between preparations. This may provide documented proof of a technician's compliance with institutional safety and sterility requirements. In certain configurations, the individual identifier 45 may be detected by the system software to

determine whether the platen **31** has been replaced at a specified interval, for example, at a specified point during a shift, a day, a preparation and/or after contamination is detected. In a further configuration, the need for a user to change the platen **31** may be shown through the user interface **3**, such as through a GUI. In a further configuration, the system may include safety features such that the user may be prevented from performing a compounding procedure until the platen **31** is replaced. A user may be prevented from preparing a sterile compounding procedure using the scale **9** and the platen **31** until the use duration of the platen **31** is confirmed to be within a compliance parameter.

[0056] In a further embodiment, the platen **31** may include an absorbent material which may absorb accidentally spilled material until proper disposal techniques may be employed. In a further configuration, at least one receiving well **47** of the platen **31** may include the absorbent material therein.

[0057] In certain situations, such as an aerosolation, it may be difficult for a technician to determine whether a cytotoxic material has been accidentally released from a container. Accordingly, the upper surface **41** of the platen **31** may include a coating layer which provides a visual indication, such as a color change, in response to fluid contacting the coating layer. In one configuration, the coating layer provides a visual indication in response to a leak or unintentional spill of material on the coating layer of the platen **31**. The coating layer may be configured to provide a color change upon contact with a cytotoxic material. The visual indication may be visually observable to a technician or user of the system. In other configurations, the visual indication may be observable by the image capture device **15**, or additional image capture device, such as an infrared camera.

[0058] In a further configuration, the platen **31** may be formed of a transparent and/or translucent material which permits passage of light therethrough. In this configuration, the base portion **43** of the scale **9** may also include a light source **49** for illuminating a portion of the platen **31**, such as by passing light through the platen **31** from a location underneath the platen **31**. This allows for enhanced visual inspection of drug compounding related medications **37** and related supplies to ensure they are free of defects. For example, the illuminated platen **31** may allow for a technician to visualize coring found in fluid filled IV bags. The light source **49** may be tuned to a certain wavelength appropriate to illuminate certain particles present within the drug compounding related medications **37**. In a certain configuration, the platen **31** may include regions that are opaque or substantially opaque and regions that are transparent, substantially transparent, translucent, and/or substantially translucent in order to selectively allow for illumination of certain portions of the platen **31**.

[0059] In another configuration, a scanner may be housed within the base portion **43** of the scale **9**. The scanner may be a barcode scanner optically configured to scan barcode labels present on drug compounding related medications **37** through the translucent and/or transparent portions of the platen **31**. The barcode scanner may be configured to obtain information from the barcodes to determine the contents of the vials placed on the platen **31**. In a further configuration, a barcode writer or an integrated label printer may be positioned within the base portion **43** of the scale **9** to write information to the label of a drug compounding related medication **37** placed on the platen **31**. In one configuration, the barcode writer may be configured to write information to the label of a drug compounding medication **37** pertaining to compounding results, date, time, lot numbers, and the like.

[0060] In yet a further configuration, the platen **31** may be in wireless communication with one or more system components. For example, a wireless interface may be provided in electrical communication with the platen **31** which may read and/or write data to a device provided on top of the platen **31**. The wireless interface may be a Bluetooth connection to a pump connected to a drug vessel provided on the platen **31**. Information transferred thereby may include pump operating parameters, such as patient specific flow rate and volumes. Accordingly, an automatically programmed device may be provided without requiring further user handling steps.

[0061] In yet a further configuration, the platen **31** may be configured to exhibit a visual indicator, such as a color change, when a weight measured by the scale **9** is within a specified tolerance. For example, the platen **31** may be equipped with an illuminated display which is activated once the scale **9** is stabilized and the unit measured is within a specified tolerance for a given drug compounding process.

[0062] In operation, the pharmacist/technician may be prompted through a series of display screens provided on the display of the user interface **3** to take the following steps. First, the operator may scan a first barcode with the barcode scanner **13** on a drug compounding related medication **37** including a drug to be reconstituted to prepare the prescribed pharmaceutical compound. The medication container may be placed on the scale **9** at the time of the scan, or a user may first scan the barcode and subsequently place the drug compounding related medication **37** on the platen **31** of the scale **9**. Once the weight stabilizes, the system verifies, using a mathematical algorithm, that the measured weight is meeting the weight target plus/minus a predetermined tolerance. In addition, the image capture device **15** takes an image of the drug compounding related medication **37** and displays it to the user on the display of the user interface **3**. The user then removes the drug compounding related medication **37** from the

platen **31** and the image is saved to the data record of the drug preparation. If the system cannot verify that the measured weight is within that target weight tolerance, the technician is required to re-perform this step until the correct weight is achieved.

[0063] Next, the technician scans a second barcode of a fluid container of fluid that is to be mixed with the drug to be reconstituted. As discussed above, the medication container containing the fluid may be placed on the scale **9** at the time of the scan, or a user may first scan the barcode and subsequently place the drug compounding related medication **37** on the platen **31** of the scale **9**. Once the weight stabilizes, the image capture device **15** takes an image of the drug compounding related medication **37** and displays it to the user on the display of the user interface **3**. The user then removes the drug compounding related medication **37** and the image is saved to the data record of the drug preparation. Again, if the system cannot verify that the measured weight is within that target weight tolerance, the technician is required to re-perform this step until the correct weight is achieved.

[0064] Thereafter, the user mixes the drug to be reconstituted with the fluid in the fluid container, both drug compounding related medications **37**, by injecting the fluid from the fluid container into the medication container. The medication container is then returned to the platen **31** of the scale **9** and the weight of the medication container is verified. Once the weight is stabilized and verified, the image capture device **15** automatically takes an image of the completed drug compounding related medication **37** based on a signal received from the scale and displays the image on the display of the user interface **3**. If the system cannot verify that the measured weight is within that target weight tolerance, the technician is required to re-perform this step until the correct weight is achieved.

[0065] If the technician decides that any of the above-described images are not meeting certain requirements, there is the option to request a new or additional image. Requesting another picture may automatically switch the image capture device **15** into a “live video mode” displayed at the user interface **3**. The technician can now move the medication container on the scale **9** to a preferred position and trigger the image capture through the user interface **3**. As before, the captured image will be shown at the user interface **3** and by removing the item from the scale **9**, the technician accepts the image and the system automatically moves to the next compounding step.

[0066] Once the drug preparation is complete, the system may optionally print a barcode label for placement on the completed drug preparation that includes encoded information representing the name of the pharmaceutical and patient information.

[0067] The pharmacy preparation system **1** may function in conjunction with several sequential computer-implemented modules for preparing and administering a prescribed fluidic compound, such as a chemotherapy compound. The modules each include code allowing for input from a user, generating output, and calculating and determining instructions for the preparation and administration of the pharmaceutical compound that may be implemented on one or more processors. More specifically, the modules may allow for a physician to enter a prescription for a patient that is subsequently verified for accuracy, prepared based on computer-aided instruction, verified based on a weight measurement, and administered to a patient. The modules may, during the drug preparation: (i) retrieve the prescription information data input by the physician in the CPOE module from the intra-hospital network; (ii) verify that the scanned barcode corresponds with the prescription information; (iii) determine if the weight of the syringe and/or IV bag is within a predetermined threshold accuracy level for the amount of the pharmaceutical to be administered; (iv) determine what adjustments must be made if the weight is not accurate; and (v) transmit data relating to the weight of the syringe and/or IV bag back to the intra-hospital network. These modules and processes may be implemented on several networked computing devices, or an independent computing device having its own processor where data and information is communicated between the computing devices using any suitable wired or wireless communication protocol, such as, but not limited to Ethernet, WiFi, cellular, Bluetooth, or the like.

[0068] Accordingly, the present invention guides a pharmacist or technician through the different compounding steps to prepare a medication order in a pharmacy by giving step-by-step instructions on a computer screen and verifying the different compounding steps by measuring the weight of the compounded liquids with a scale. The measured weight is then analyzed with a mathematical algorithm which checks if the necessary compounding accuracy has been accomplished. Every time an item is placed on the scale, a picture of the top of the scale is captured to create a visual documentation trail of the compounding process. The pictures are stored together with the recorded measurements from the scale and the algorithm results in a log file. If a measured weight of a drug is not in the predefined tolerance range of the expected weight, the software generates instructions to change the amount of the drug to bring it within the acceptable tolerance range. The software will not proceed to the next compounding step as long as the required tolerance of the present step has not been accomplished.

[0069] EXAMPLES

[0070] Referring specifically to **FIG. 7**, a flow hood is shown having an inlet laminar flow condition of 70 ft/min and an outlet flow condition of 533 ft/min. The flow hood includes an inlet environmental pressure condition of 0 pa. The flow hood also includes a weighing surface of a scale and an enclosure that is being assessed. For purposes of modeling, a simplified half model environment is shown.

[0071] Referring to **FIGS. 8A-13B**, a series of computational fluid dynamic simulations are reflected showing the difference in airflow disturbance between different enclosure forms. For each of these figures, the flow trajectories and velocity contours were used as outputs and the identical environment, grid, and boundary conditions were used in each simulation. For each testing run, a 3 minute stability test was employed in which any oscillations that would occur in three minutes without being touched were documented. For the testing runs, a 100g weight was used and 25 sample tests were run. The first stabilized value that the scale registered was recorded and two standard deviations were calculated and recorded as the accuracy.

[0072] **FIGS. 8A-8B** represent the air flow in a flow hood under idealized conditions with no enclosure present in the flow hood. The experimental assessment of the scale under these conditions was a stability of $\pm 0.00\text{g}$ and an accuracy of $\pm 0.0229\text{g}$. To understand the design variables that are critical to scale stability, the typical airflow within a compounding hood, as shown in **FIG. 8A**, must be understood. In **FIG. 8A**, flow is directed from the top of the hood to the bottom and air exists in the two areas (seen in red) at the front and back of the hood. Near the platen of the scale, the air splits into alternative paths. With reference to **FIG. 8B**, since the enclosure housing is located above the scale, the enclosure housing is prone to create an airflow disturbance downstream which may result in scale instability and inaccuracy. Certain enclosure housing designs may be optimized to reduce this downstream airflow disturbance.

[0073] **FIGS. 9A-9B** represent the air flow in a flow hood with a large relatively blunt enclosure head present in the flow hood positioned above the scale. The experimental assessment of the scale under these conditions was a stability of $\pm 0.06\text{g}$ and an unknown accuracy as the resulting scale readings were too unstable.

[0074] **FIGS. 10A-10B** represent the air flow in a flow hood with a medium sized relatively blunt enclosure head present in the flow hood positioned above the scale. The experimental assessment of the scale under these conditions was undetermined.

[0075] **FIGS. 11A-11B** represent the air flow in a flow hood with a medium sized relatively streamlined enclosure head present in the flow hood positioned above the scale. The

experimental assessment of the scale under these conditions was a stability of $\pm 0.02\text{g}$ and an accuracy of $\pm 0.0445\text{g}$.

[0076] **FIGS. 12A-12B** represent the air flow in a flow hood with a small sized very streamlined enclosure head present in the flow hood positioned above the scale. The experimental assessment of the scale under these conditions was a stability of $\pm 0.015\text{g}$ and an accuracy of $\pm 0.0297\text{g}$.

[0077] **FIGS. 13A-13B** represent the air flow in a flow hood with a medium sized but shortened relatively streamlined enclosure head present in the flow hood positioned above the scale. The experimental assessment of the scale under these conditions was a stability of $\pm 0.01\text{g}$ and an accuracy of $\pm 0.0153\text{g}$.

[0078] In each of **FIGS. 8A-13B**, the pressure and air speed of air within the flow hood is shown. The areas labeled **B** correspond to the smallest air speed and lowest pressure, corresponding to the least airflow disturbance. In contrast, the areas labeled **R** correspond to the greatest air speed and highest pressure, corresponding to the greatest airflow disturbance.

[0079] As shown in **FIGS. 14-16**, it is an objective of the present invention to minimize the quantity of turbulence that reaches the platen **31** of the scale **9**. Maximizing the distance “Z” between the housing **17** and the platen **31** aids in allowing any disturbance created by the housing **17** to be swept toward the back of the hood prior to reaching the surface of the platen **31**. Minimizing the distance “Y” aids in a similar fashion as this is directly related to the distance the disturbed air needs to travel prior to reaching the platen **31** of the scale **9**. Minimizing “Y” and cross-sectional diameter **a** results in the smallest orthogonal area to the flow stream, thereby minimizing airflow disturbance. Maximizing the **b/a** cross-sectional ratio in conjunction with smooth curving of the housing **17** creates a streamlined profile in the direction of the flow stream. This will minimize the amount of air that becomes turbulent by gradually splitting the laminar airflow stream and subsequently allowing it to reconnect.

[0080] While specific embodiments of the invention have been described in detail, it will be appreciated by those skilled in the art that various modifications and alternatives to those details could be developed in light of the overall teachings of the disclosure. Accordingly, the particular arrangements disclosed are meant to be illustrative only and not limiting as to the scope of invention which is to be given the full breadth of the claims appended and any and all equivalents thereof.

Claims

1. A system for preparing a pharmaceutical compound, comprising:
a computing device comprising a processor and a user interface providing an operator with instructions for preparing the pharmaceutical compound;
a scale operatively coupled to the processor of the computing device; and
an enclosure housing comprising an image capture device and a barcode scanner, the enclosure housing supported by a supporting arm and coupled to a portion of the scale, wherein the image capture device is operatively connected to the processor of the computing device and has a field of view positioned to capture an object positioned on the scale, and
wherein the barcode scanner has a sensor that is offset from the scale.
2. The system of claim 1, wherein the barcode scanner is angled with respect to the image capture device within the enclosure housing.
3. The system of claim 2, wherein the barcode scanner is angled at a 45° angle with respect to the field of view of the image capture device.
4. The system of claim 1, wherein the enclosure housing is supported by the supporting arm such that the enclosure housing is positioned above the scale.
5. The system of claim 1, wherein the enclosure housing has a curved front profile to minimize flow disturbance within a flow hood.
6. The system of claim 1, wherein the enclosure housing is formed of an upper portion and a lower portion.
7. A system for preparing a pharmaceutical compound, comprising:
a computing device comprising a user interface providing an operator with instructions for preparing the pharmaceutical compound; and
a flow hood having positioned therein:

a scale operatively connected to the user interface; and
an enclosure housing comprising a camera positioned to capture an image of the scale during the preparation of the pharmaceutical compound.

8. The system of claim 7, wherein the enclosure housing is positioned above the scale.

9. The system of claim 7, wherein the enclosure housing further comprises a barcode scanner.

10. The system of claim 9, wherein the barcode scanner is angled with respect to the camera within the enclosure housing.

11. The system of claim 10, wherein the barcode scanner is angled at a 45° angle with respect to a field of view of an image capture device.

12. The system of claim 7, wherein the enclosure housing has a curved front profile to minimize flow disturbance within the flow hood.