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Studyof Liquid Dispensingand Mixingin FluidHandling Systems -A Review Article

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ABSTRACT: Liquid dispenser machine is mostly found at different places for various application. Nowadays, automated liquid dispensers are used in many industrial applications eliminating manual tasks involved in it. In pharmaceutical industries, they are used widely for making medicinal solutions. In this review, liquid dispensing, metering and mixing methods are studied. The present limitation of these liquid dispensers in this industry is to meter or mix at one time only. The basic theme of this paper is to overcome this problem of metering and mixing separately. This review focuses on the methods of dispensing, metering and mixing which can be implemented for single device.

KEYWORDS: Fluid handling systems, Metering devices, Mixing, Dispensing, Peristaltic pump, Solenoid valve

I. INTRODUCTION

Nowadays, automation has become an important necessity in the industrial processes considering accuracy,time factor and less manual intervention. An automation in fluid handling which is widely acknowledged in precise metering of fluids and ensuring consistent mixing of the same.While dealing with microfluidics process automation assists in metering and proper dispensing of fluids from one place to another, this can be done with help of specific pumps/valves which acts like dispensers.In addition to dispensing of fluids,mixing is also one of the essential processes.Consistent mixing of fluids is important parameter that is expected when industrial processing of fluids is done with automation. To ensure the same specific blenders can be used according to the application. All these tasks can be achieved with the help of arduino, where it is interfaced with pumps/valves to ensure metering, mixing and dispensing of the fluids.

This paper gives brief information about each dispensing, metering and mixing. Various technological developments have been identified and simply brought together to achieve common goal of dispensing, metering and mixing. The distinctive solution to these problems would common tasks such as metering,dispensing and mixing all in one device.

II. FLUID DISPENSING SYSTEMS

The main aim is to study existing fluid management and handling system and to discover out the best system that is efficient, precise, less time consuming, flexible and less prone to variability in results and errors and suitable for desired application. The different fluid management and handling system studied in various paper are stated below:

[1]. Metering is the principal factor of any dispensing machine. For this reason, it is acceptable to utilize gadgets of top-notch like solenoid valves, programmable syringes, and so forth. A solenoid valve is an electromechanically operated valve. This valve is controlled by an electric flow through a solenoid. Solenoid valves are the most regularly utilized control components in liquids. Their tasks are to stop, discharge, meter, distribute, or blend liquids. They are found in numerous application zones. Solenoids offer quick and safe exchanging, high dependability, long help life, the great medium similarity of the materials utilized, low control force, and smaller plan. In this paper, the metering of the machine is finished by working three solenoid valves with the assistance of touch screen interfacing. The programmed dispensing machine is used over a manual working dispensing machine. This programmed machine

works with the assistance of a modified microcontroller. Microcontroller AT89C52 is used for this reason for vast scope. Programming of this microcontroller is finished with the assistance of VB.net or with the assistance of MATLAB language.

[2]. In this paper, S.S.Deshmukh et al. has discussed the use of a Microcontroller (89S52) for optimizing the mixing of multiple fluids and reducing idle time. The program for the microcontroller is developed with the help of Keil evaluation version IDE which is the most popular tool available for microcontrollers. The simulation of the system was done in a protest simulator which helped to debug logical errors. The other components such as dispensers, sensors, pumps, relays, dc motor, solenoid valves, stirrer operated by DC motor, and an input device are interfaced with the microcontroller. The main object of the paper is to propose a cheap, user-friendly, automated liquid mixing, and dispensing equipment with high accuracy and exactness.

[4]. Navoneel Banerjee and Et al. have designed an Arduino operated dispensing system, using a special pump, a peristaltic pump. [2]. Peristaltic pumps are a type of positive displacement pump used for pumping a variety of fluids. The fluid is contained within a flexible hose or tube fitted inside the pump casing. The actual pumping principle, called peristalsis, is based on alternating compression and relaxation of the hose or tube, drawing content in and propelling product away from the pump. A rotating shoe or roller passes along the length of the hose or tube creating a temporary seal between the suction and discharge sides of the pump. As the pump's rotor turns this sealing pressure moves along the tube or hose forcing the product to move away from the pump and into the discharge line. Where the pressure has been released, the hose or tube recovers creating a vacuum, which draws the product into the suction side of the pump, the priming mechanism. Combining these suction and discharge principles results in a powerful self-priming positive displacement action. [3]. The program was written using Arduino IDE software in the simulator, then fed into Arduino for the working of the prototype. The model was tested for mixing of two liquids and it gave satisfactory results.

[5]. In this paper, the model framework created can dispense changing amounts of liquids in millilitres (most extreme 1L) according to the request of the client. It utilizes the standard of time-based fluid dispensing accomplished through the inherent built-in-timer of the AT89C51 microcontroller. To fulfil the principle utilized and confirm the system's precision, liquids of changing viscosities were dispensed and observed. The trial results of the wireless liquid dispensing system when tested indicated direct relation between the dispensing time and desired volumes of liquids having varying viscosities.

[6]. William Gan Oliver&H˚Akansson have proposed a model of an automated liquid dispenser. The model is constructed using two ultrasonic sensors and a peristaltic pump. The main goal in the report is on dispensing a variety of both carbonated and non-carbonated drinks using an autonomous system that strives to have the same accuracy and skill as a dispenser operated by a human. The main expectation of this model is, it should be able to detect when a glass needs to be filled with liquid, decrease the foam by tilting the glass and replace it to its 3-original state. The system was evaluated using three different experiments, where two of them measured the accuracy of the construction. The results from the two experiments concluded that the constructed system is of high accuracy. The result from the third experiment tested the speed for one dispensation cycle and the conclusion was that improvements can be made.

[7]. A liquid dispenser is designed and constructed that works on self-dispensing. The paper has given an effective approach for creating this type of system. In the paper, all the components required are explained. Furthermore, the step-by-step design and the implementation of the system is done. The system has a controlling unit which comprises of microcontroller, sensor, operational amplifier, and electronic keypad. The code is developed in the notepad with assembly language which is later used in proteus 7.7 VSM professional for simulation of design. The self-dispensing is done through a sensor that detects the presence of a cup. If the cup is present then dispensing action takes place but if it is not present then no dispensing occurs. This system focuses on reducing manual work and to increase precision which may not be able to achieve with the manual intervention.

[8]. The patent discusses an automatic machine that is made for making various types of cocktails quickly and precisely. The common problem of manual work and precision is solved through this machine. This machine consists of a programmable control unit that has several different mixing methods stored in it also it helps in the mixing of cocktails. The time required to make a cocktail is only a few seconds, whereas manual operation needs some minutes. This machine replaces the electromagnetic valves which were

used in previous machines. There is a piston-type measuring pump that measures the fluid accurately and is also used in mixing. These are suitable for cocktail making in comparison to conventional measuring pumps. This new machine is cheap compared to others as its maintenance and production costs are low. The automated machine is more complicated as it has a frame, multi bodies, multichannel switching device, etc. All in all, it is a more intriguing product with a complex mechanism but it has several advantages.

[9]. The present application provides a beverage dispensing system. The beverage dispensing system may include a diluent line in communication with a diluent, a flow meter, and a variable flow control module positioned on the diluent line, several syrup lines in communication with some syrups, and a fixed flow control module positioned on the syrup lines. The variable flow control module controls the flow rate of the diluent through the diluent line based upon the flow rate of one of the syrups through one of the syrup lines. The positive displacement pump controls the flow rate of the micro-ingredients through the micro - ingredient lines (flow rate of the sweetener through the sweetener line) and the flow rate of the diluent through the diluent line as determined by the flow meter. The patent mainly focuses on the precise and accurate metering of micro-fluids, their mixing, and proper dispensing of accurate proportions.

[10].This patent introduces an automated fluid handling system comprising a housing and two or more fluid handling units arranged as interchangeable modular components with an external fluidics section and an internal non-fluidics section, and wherein the housing comprises a liquid handling panel with two or more of component positions for receiving said interchangeable modular components such that the external fluidics section is separated from the non-fluidics section by the liquid handling panel. The system consists of a pump module which is controlled by a microcontroller for pumping fluids. For, fluid control rotary valves are used. Such a motorized rotary valve may consist of a valve head with some defined bores with channels to the inlet and outlet ports of the valve. The Rotary disc, mounted on the motor, has several defined channels. The pattern of channels of the Rotary disc together with the pattern and location of the ports of the valve head, define the flow path and function of each type of valve. When the rotary disc turns then the flow path in the valve changes. The Quaternary valve is used for automatic mixing of four different solutions. The Quaternary valve opens one inlet port at a time, and the different solutions are mixed in a Mixer to form the desired buffer. The opening time in the switching valve is controlled by the system. The volume for each inlet port opening increases stepwise when the flow increases. To obtain a homogeneous buffer composition, one has to make sure to use a mixer chamber volume suitable for the flow rate of the method. The system used liquid chromatography for fluid handling.

[11]. This following patent uses, ultrasonic frequency to vibrate the fluid dispensing nozzle between successive dispensing cycles. The vibrations break a liquid string filament formed at a discharge end of the filling nozzle at the end of each cycle. Methods and a fluid filling nozzle for filling containers with a fluid are also provided in the patent.

III. DISCUSSION

The literature review conducted above, highlighted the advancements in the system integrating three processes metering, mixing and dispensing. These three basic processes are mainstay to many applications in industrial and medical area. So, it is significant to search cost effective and easy system for handling these processes.

For increasing the efficiency of the system, it is automated. As seen in the summary of the published papers, stated above in the body, microcontroller and Arduino are used widely to automate the system. Arduino, being a development board is very versatile, easier to use and has user friendly IDE. The Arduino can be easily programmed, on the other hand interfacing of microcontroller is cumbersome. Arduino is suitable for making this system automated, flexible to change the process in multiple ways by just changing the code and to reduce its chances to variability and errors.

The other main component that controls the metering of fluids is solenoid valve. Solenoid valves are widely used because of their precision and easy interfacing with Arduino. When using more than 2 ingredients using solenoid valves becomes costly. Thus, research should be carried on to find a cost effective alternative while using multiple ingredients. [10]. The use of quaternary valve is best suited in such situation. The quaternary valve along with metering controls the mixing process as well.

[8], [9], [10], For feeding and dispensing applications, we need a pump.[3]. For such applications, peristaltic pump should be used. This pump is suitable for pumping a wide range of viscous fluids very effectively and have a self-

priming feature thus reducing the effort of maintenance. This pump is also known as measuring pump due to its remarkable feature of controlling even low quantity of fluids being pumped. This pump can be effectively used for metering and dispensing of micro fluids. Thus, reducing the cost of using individual components for metering like flow sensors etc.

From the overall literature review conducted, it is clearly seen that there is a wide scope to research in the micro fluid management and handling system.[8]. The system used in cocktail mixer as in[9] Beverage dispensing system as in are very complex. There is also a need to develop a simple system for dealing with multiple fluids.

IV. CONCLUSION

Liquid dispensing is a device which is used in large number of industries for various applications. In pharmaceutical fields, as metering and mixing is not done simultaneously. Moreover, that metering is to be done with high precision. These are some of the points that came along while reading the literatures and research papers related to fluid handling systems.

1. The important characteristics of the liquid dispensers is metering. The precision and accuracy of metering devices is increased by microcontroller or arduino controlled syringes,solenoid valves are used.
2. To take the input from the users how much liquid should be dispensed from the machine touch screens are used which is interconnected with the arduino, naturally interfaced with the metering devices which makes a machine more user-friendly.
3. Different programmable devices such as microcontroller and arduino are interfaced with the metering devices, pumps, valves, syringes that needs to be controlled depending on theinput fed into it.Depending upon the application and programming lines (UNO/NANO/MEGA) arduino can be used. Nowadays, microcontroller AT89C52 is generally used for this purpose.
4. Different types of advance pumps are used in order to adapt to pumping of liquids with different viscosities.As discussed in one of the papers, the peristaltic pump is one of the pumps which is used in such cases which deals with dispensing of liquid with different viscosities.

The important feature of this paper is mixing and metering to be done simultaneously in a liquid dispenser and also increase in accuracy and precision of the metered liquid. While there is a scope of improvement in future in terms of pumping devices, metering devices and also programming devices. By reducing the losses in fluid properties such a viscosity, major and minor losses the machine can be made more efficient.

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