

# Metering Pump System a Solution for Repetitive Accuracy: A Review

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**ABSTRACT:** A meter mixing machine is a machine used to mix different components with a specific ratio. The metering pump moves a precise volume of liquid in a specified time with accurate flow rate. There are various pumps used for this application. A piston pump is one of the useful metering pump because it gives comparatively steady flow rate. Metering pump feature a high level of repetitive accuracy. Also they are capable of pumping a wide range of chemicals such as acids, bases, corrosives, or viscous liquids and slurries. Flow rates for metering pumps are usually quite low due to the nature of the application. Metering pumps are used wherever the flow rate of a liquid needs to be regularly measured and adjusted to precise level. They're most commonly used to pump treatment chemicals in industries.

**KEYWORDS:** metering, mixing, piston, flow rate.

## I. INTRODUCTION

Metering pumps are positive displacement pumps designed to dispense precise amounts of fluids and measured flow control. Metering pumps move precise volumes of liquids in a required time period and gives accurate flow rates. This class of pumps moves liquids in two stages, the suction stroke and the discharge stroke. During the suction stroke, liquid is pulled into the pump cavity past the inlet check valve. During the discharge stroke, the inlet valve closes; the outlet valve opens, and the liquid is pushed out. The most common types are diaphragm pumps, piston pumps, peristaltic pumps, plunger pumps, rotary pump. Wherever the flow rate of a liquid needs to be measured regularly and need to be adjusted to precise levels, Metering pumps are used. Pump is designed for low cost metering or transfer applications, involving corrosive and abrasive products. The pumped media is contained within a tube from source to delivery and ensuring capability with arduous flows in the chemical or medical fields.

## II. REVIEW OF METERING PUMP

World pumps volume 2005, Issue 461, Feb 2005 [7] proposed that, where the required level of accuracy is of a high order, the metering pump concept comes into its own. A metering pump is a reciprocating volumetric pump that has by design a swept volume adjustment function. The flow delivered is, therefore, a function of both the pump flow adjustment and pump speed.

N. D. Manring et al. [9] states that the dynamic of the variable-displacement pump influence the overall dynamics of the hydraulic system, these pumps have been the object of considerable research.

Herbert H. Tackett et al. [8] proposed that Metering pump is a positive displacement chemical dosing device with the ability to vary capacity manually or automatically as process conditions require.

The pumping action is developed by a reciprocating piston which is either in direct contact with the process fluid, or is shielded from the fluid by a diaphragm. Diaphragms are actuated by hydraulic fluid between the piston and the diaphragm.

Metering pumps are positive displacement pumps designed to dispense precise amounts of fluids and measured flow control. They feature a high level of repetitive accuracy and are capable of pumping a wide range of chemicals including acids, bases, corrosives, or viscous liquids and slurries.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 6, June 2016

Maxroy B, issue 5/92 [12], A reciprocating pump is any machine using reciprocating motion to cause fluid to be moved from one location to another.

Piston pumps consist of a plunger that moves in a tightly fitting cylinder to displace the fluid in the liquid end, which is equipped with inlet and outlet non-return valves. Metered volume is controlled by adjusting the stroke length and frequency [6].

Liu Yajun et al. [1] proposed in his paper the wear behavior of piston seal. The dispenser is fuel pumping and measurement device in gas station. Flow meter in dispenser is piston type. A seal on each piston prevents leakages between opposite chamber.

World pump, volume 2000, issue 407, Aug 2000, [2] states the choice of pump for particular application is based on number of factors, dosing rate, accuracy of dosing, liquid to be pump, cost.

The metering pump is positive displacement chemical dosing device [10]. The pumping action is developed by reciprocating pump.

## III.METERING PUMP

Metering pumps feature a high level of repetitive accuracy and are capable of pumping a wide range of chemicals including acids, bases, corrosives, or viscous liquids and slurries.

There are two main types, both of which may adjust the flow rate by any number of different pumping mechanisms:

1. Variable displacement pumps adjust the flow by changing the amount of fluid that enters the pump, while the motor always runs at a constant speed. They often do this by adjusting the stroke length, or in some cases the amount of hydraulic fluid that is bypassed.
2. Fixed displacement pumps adjust the flow by changing the speed of the motor, while the same amount of fluid is displaced with each revolution.

### 1. Operation

Metering pumps are positive displacement pumps, meaning they use expanding and contracting cavities to move fluids. This method of operation provides the steady flow and consistent volume characteristics of metering pumps, and also makes it more apt to handling viscous liquids and slurries which generate more resistance. Metering pumps transfer media in two stages: the intake stroke and the output stroke. During the intake stroke, liquid is pulled into the pump cavity past the inlet check valve. During the output stroke, the inlet valve closes, the outlet valve opens, and the fluid is forced out. [2]The flow may be varied by changing the stroke length or by adjusting the cycle frequency.

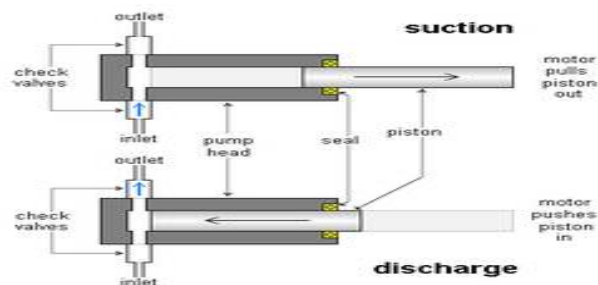


Fig 1 suction and discharge of piston pump

Metering pumps are usually driven by a constant speed AC motor, although different drive mechanisms may be used depending upon the application at hand. Some of these include fixed speed, variable speed, electric drive, solenoid drive, and magnetic drive. The drive mechanism translates the rotary motion of the driver into reciprocating movement. Industrial duty metering pumps will submerge this portion of the pump in an oil bath to assure sufficient lubrication and reliability during continuous operation.

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## 2. Pump Types

There are a number of different pump types that can be configured for metering applications. The different types are listed below.

-Bellows pumps use a compressible container with an outlet nozzle (called a bellows device) to move fluid through a piping system. They have the ability to pump both liquids and gases and do not require seals.

-Diaphragm pumps use the reciprocating action of a flexible membrane (diaphragm) to move fluid in and out of the pumping chamber. These pumps require no seals.

-Peristaltic pumps (also called hose pumps) use a roller device to move fluid through a tube or hose. Because the fluid is contained in the tube, it does not come in contact with the pump or outside environment

-Piston pumps move fluid using one or more reciprocating pistons inside a cylinder (chamber), normally driven through the use of a crankshaft and connecting rod. These pumps require a seal to prevent leaks and should not handle abrasive media.

-Syringe pumps deliver small amounts of fluid through a syringe using a pusher block connected to a plunger. Flow is managed through a screw attached to the pusher block, typically operated by a corresponding controller.

Almost all metering pumps are of the positive displacement type. Many metering pumps demonstrate a pulsation due to the action/mechanism involved

•Pumps with pulsation effects:

–Piston Pumps

–Peristaltic Pumps

–Diaphragm Pumps

–Gear pumps (to a lesser degree) [13]

•Pumps without (or minimal) pulsation:

–Rotary lobe Pumps

–Progressing Cavity Pumps

## 3. Specifications

The primary specifications to consider when selecting metering pumps are flow rate, pump head, pressure, horsepower, power rating, outlet diameter, and operating temperature [2].

## 4. Sizing and selecting of metering pump

Following points should be considered

1. Identify the required capacity in terms of flow rate and discharge pressure.

2. Do not oversize the pump. A metering pump should be sized to maximum expected flow rate is 85% to 90% of the pump capacity. This leaves the additional capacity if needed. The minimum capacity should never be less than 10% of the pump capacity to maintain accuracy.

3. Material selection for metering pump must take into consideration corrosion, erosion, and solvent action. Solvent based chemicals may dissolve plastic heated pump. Acids and caustics may require stainless steel or alloy liquid ends. Consider the effect of erosion when handling abrasive slurries.

4. Select driver machining the available utilities which may include electric, air, gas or other means of driving the pump. Identify hazardous area of requirements when selecting the driver.

## 5. Metering pump basic components

1. Driver- pump is usually driven by an AC constant speed motor. Variable speed, pneumatic, hydraulic also utilized.

2. Driver mechanism- the drive mechanism translate the rotary motion of driver into reciprocating movement.

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Vol. 5, Issue 6, June 2016

3. Flow adjustment- pump flow rate is adjusted by varying stroke length, effective stroke length, stroking speed.
4. Liquid end- the liquid end design and material of construction are determined by the service condition and the nature of the fluid to be handled temperature, flow rate, fluid viscosity, corrosiveness and other factors are considered.

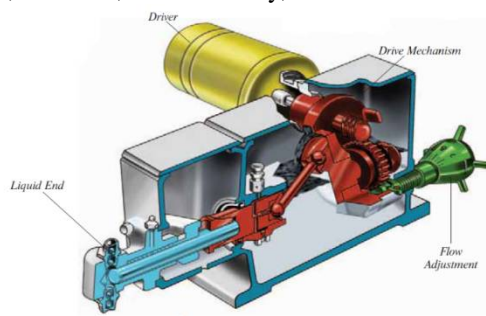


Fig 2 components of metering pump

### IV. APPLICATIONS

1. For dosing of drinking water with sodium hypochloride.
2. In brewing industry, to disinfect of fruits and vegetables with water.
3. In maintaining the quality of swimming pool.
4. In chemical, oil and gas production industry.

### V. CONCLUSION

The metering pump system operates with high accuracy and precision. Where the repetitive accuracy and flow requirement is the main factor the metering pump is used. The paper illustrates review of metering pump system, its working and applications.

### VI. ACKNOWLEDGMENT

I expressed my sincere thanks to my guide **Dr. Mrs. R. S. Bindu** for kindly assisting me and helping me to prepare a paper work.

I wish to express my thanks to respected coordinator **Prof. N. I. Jamadar**, HOD of Mechanical Department **Dr. K. K. Dhande**, and our Principal **Dr. R. K. Jain** for their support and motivation.

Last but not the least, I am very thankful to my friends for encouragement.

### REFERENCES

- [1] Liu Yajun, Tang Dian, Liu Jun, "Wear behavior of piston seals in flow meter of fuel dispenser under different pressure conditions", Journal of Flow measurement and Instrumentations, volume 28, issue 45-49, 2012.
- [2] "Metering pumps accuracy and applicability", Journal of WORLD PUMPS, volume 2000, issue 407, August 2000.
- [3] George M. Low, "Firefly pump metering system", United states patent, 1971.
- [4] L. craft, "metering and dispensing system", united states patent 2946,488, 1960.
- [5] Harry Pinkerton, "positive displacements piston pump", cl-103-157, 1965.
- [6] Ilya Larchikov, Andrey Yurov, Sergey Stazhkov, " Power analysis of an axial piston Hydraulic Machine of power intensive hydraulic drive system", science direct, volume 69, issue 512-517, 2013.
- [7] "Metering and dosing", Journal of world pump, volume 2005, issue 461, February 2005.
- [8] Harbert tackett, "Positive displacement reciprocating pump fundamentals" international pump users symposium, 2008.
- [9] N. D. Manring, R. E. Johnson, "Modeling and Designing a Variable-Displacement Open-Loop Pump", journal of dynamic systems, measurements, and control, volume 118/267, June 1996.
- [10] Milton Roy manual issued by 5/92.
- [11] "Sizing and selecting metering pumps", metering pump standard, ANSI, 2010.
- [12] "Metering pump technology", Milton Roy, revision B, 2005.

# International Journal of Innovative Research in Science, Engineering and Technology

*(An ISO 3297: 2007 Certified Organization)*

Vol. 5, Issue 6, June 2016

## BIOGRAPHY



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