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# An Overview of Peristaltic Pump Suitable For Handling of Various Slurries and Liquids

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**Abstract** – *A peristaltic pump is a type of positive displacement pump used for pumping a variety of fluids. The fluid is contained within a flexible tube fitted inside a circular pump casing. A rotor with a number of "rollers", "shoes" or "wipers" attached to the external circumference compresses the flexible tube. As the rotor turns, the part of the tube under compression closes (or "occludes") thus forcing the fluid to be pumped to move through the tube. Additionally, as the tube opens to its natural state after the passing of the cam ("restitution") fluid flow is induced to the pump. In this paper construction, basic principle of working and pump design specification has been discussed. The advantages and critical applications have been presented.*

**Keywords –** *Occludes, PD pumps, Peristalsis, Restitution, Rollers, Tubes.*

## 1. INTRODUCTION

A lot of equipment around us uses the mechanisms of pump, from the smallest Pump used in the house to the biggest scales and specification pump used in industries. A peristaltic pump is a type of positive displacement pump used for pumping a variety of fluids. Peristaltic pumps are typically used to pump clean or sterile fluids. Because the pump cannot contaminate the fluid, or to pump aggressive fluids because the Fluid cannot contaminate the pump. Some common applications include pumping Aggressive chemicals, high solids slurries and other materials where isolation of the Product from the environment, and the environment from the product, are critical.

Viktor Shkolnikova, John Ramunash, Junan G. Santigoa, [1] makes a miniature peristaltic pump which uses a single reciprocatory actuator motion to produce pumping. Pumping is achieved the upstream valve and then compresses the section of the tube. In this the delivery of pump is not continues i.e. only in compression stroke delivery of pump happened.

Marion H. Bobo, Michael M Brown [2] addresses housing is adopted to receive a flexible tube. The housing has curved wall & clamp. The roller assembly includes at least to a compression roller assembly includes at least one guide roller. The guide rollers are peripherally spaced between compression rollers whose race of them comes into contact with the flexible tube during rotation of the roller assembly. They use the gear system for rotating the roller from the above we can understand the operation of roller and tube. Theirs Scope to redefine the number or roller etc.

Robert B. Clay and William A. Dorering [3] design the pump by squeezing the roller pressing and elastic tube supported by side a semi cylindrical chamber. The collapsed tube responded by travelling side roller which press the tube transversely. This expedites refilling and increases the pump capacity. A surge chamber consisting of an elastic hollow cylinder housed inside chamber housing provided with inwardly projecting annular ribs smoothen out both minor and major surges inflow of the viscous material.

Corey Koch, Vicent Remcho, James Ingle [4] presents the design and characterization of novel PDMS (Polydimethylsiloxane) and tubing-based micro pumps based on direct actuation. A simple PDMS microchip consisting of a micro channel formed around a circular hole in the center of the microchip was pumped peristatically. The center hole housed a miniature-motor driven, roller type actuator, analogous to that used in bench-top peristaltic pumps. The roller type actuator compressed the channel walls together as it rotated, thereby invoking peristalsis. A miniaturized tube based micro pump was designed to utilize the same actuator by employing a polycarbonate housing fabricated to hold commercial peristaltic pump tubing.

## 2. NEED OF PERISTALTIC PUMP

Various devices haves been proposed in the past for pumping viscous fluids and slurries. Such slurries are frequently very corrosive and abrasive to machinery and pumping operations involving them have presented serious problems in many instances because of the nature of the suspended solids they contain. The slurry commonly comprises a gelled liquid media in which solid particles are suspended. These viscous materials have corrosive and abrasive action on the pump parts, hence it is necessary to separate pump moving parts from the slurry to avoid blockage and corrosion and wear of the parts.

At pump seminars and conferences the problems that operators continually bring up typically include:

• Pump loss as a result of leaks from oil seals
• Deficits in the monitoring and diagnosis of the operating status of an industrial pump
• Service times and maintenance intervals *[5]*.

David B. Parker illustrates the importance of the positive displacement (PD) pump over the centrifugal pump. In this they present how the system response of the PD pumps. PD pumps are capable of moving a wide range of fluids. Entrained gasses, solids, low viscosity to high viscosity and low net positive inlet pressure available can all be designed for. The flow is nearly constant, without pulsation and does not impart high shear to the fluid. The high mechanical efficiency offers energy savings. PD pumps come in many designs and operating ranges, but they all work on the same principle. An increasing volume is opened to suction, filled, closed, moved to discharge, and displaced. The delivered capacity is nearly constant throughout the discharge pressure range. This constant capacity will intersect a system curve at a defined point, allowing a high degree of system control *[6]*.

## 3. ROTARY PERISTALTIC PUMP

### 3.1: Rotary peristaltic pump

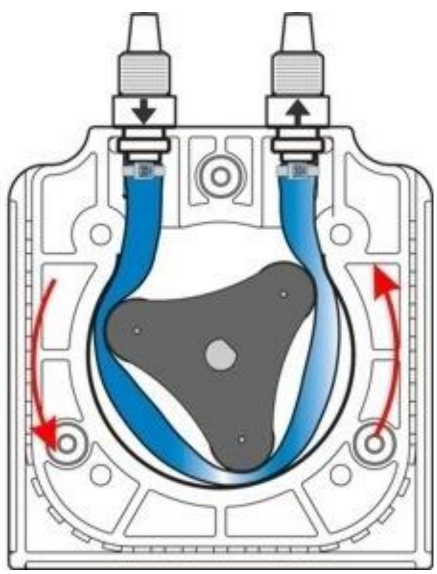

Figure 3.1.1: Basic Shape for rotary peristaltic pump

Rotary peristaltic pump have pump case, hose, rotor, shoe and motor. The Pump case has rotor that lay down at shaft that support by it bearing. Normally two shoes will put at rotor Rotary peristaltic pump have two flange. This flange will be connecting input fluid and output. Hoses are pump element that be found at peristaltic pump, which rotor and shoe is use to pressed hose and will be have vacuum to pulling fluid to enter the hose.

Rotary peristaltic pump is different from the linear type where the rotary type used motor to rotate the shaft linear type used cam to control the motion of shaft. The rotor is attached to the shaft that connected to the motor. End of strip rotor was pressed the hose and the vacuum is form to produce attraction force.

**3.2: Basic Operation of Peristaltic Pump**

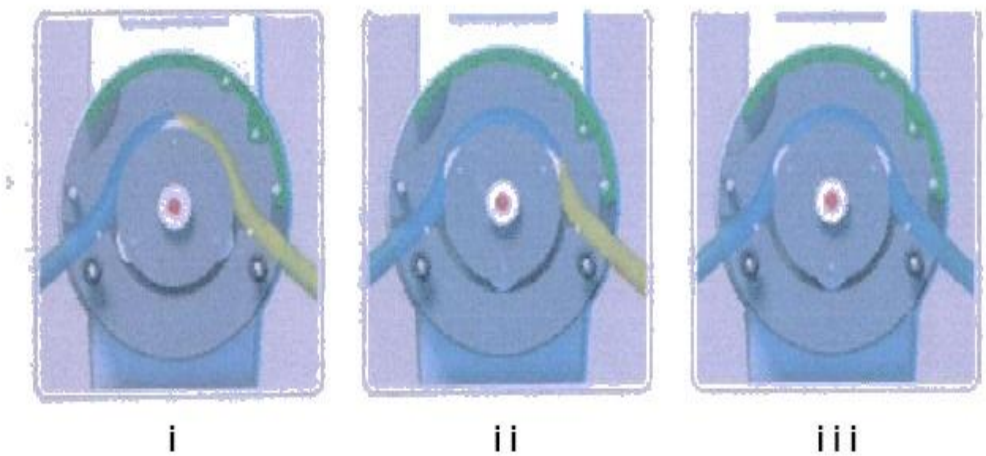


Figure 3.2.1: Principle of peristaltic pump

Above figure shows that basic operation for rotary peristaltic pump. Principle of operating is very easy. Figure 3.2.1 (i), shown that when rotor is rotate, fluid is enter the hose because of attraction force from vacuum produce after hose push by rotor. Figure 3.2.1 (ii) shown that hose are fully pressed by rotor along the hose and then fluid is push and flow to the output. Figure 3.2.1 (iii) shown that fluid is shift to output and the other place which operator wish. Parts of shoe were form vacuum and attract the fluid that want to pump. This operation stay repeatedly until the power of motor is off.

**3.3: Main types of peristaltic pump**

**3.3.1: Hose pumps**

Higher pressure peristaltic hose pumps which can typically operate against up to 16 bar in continue service, use shoes (rollers only used on low pressure types) and have casings filled with lubricant to prevent abrasion of the exterior of the pump tube and to aid in the dissipation of heat, and use reinforced tubes, often called "hoses". This class of pump is often called a "hose pump".

The hoses in a hose pump are typically reinforced, resulting in a very thick wall. For a given ID the hoses have much bigger OD than tubing for the roller pump. This thicker wall, combined with a stiffer material typically used in the hoses make the forces necessary to occlude the hose much greater than for the tubing. This results in a bigger and slower pump (up to 50/60 RPM) and motor for a given flow rate with the hose pump than the roller pump, consuming more energy to run.

The biggest advantage with the hose pumps over the roller pumps is the high operating pressure of up to 16 bars. With rollers max pressure can arrive up to 12 Bar without any problem. If the high operating pressure is not required, a tubing pump is a better option than a hose pump if the pumped media is not abrasive. With recent advances made in the tubing technology for pressure, life and chemical compatibility, as well as the higher flow rate ranges, the advantages that hose pumps had over roller pumps continues to erode.

### 3.3.2: Tube pumps

Lower pressure peristaltic pumps typically have dry casings and use rollers along with non-reinforced, extruded tubing. This class of pump is sometimes called a "tube pump" or "tubing pump". These pumps employ rollers to squeeze the tube. Except for the 360 degree eccentric pump design as described below, these pumps have a minimum of 2 rollers 180 degrees apart, and may have as many as 8, or even 12 rollers. Increasing the number of rollers increase the frequency of the pumped fluid at the outlet, thereby decreasing the amplitude of pulsing. The downside to increasing number of rollers it that it proportionately increases number of squeezes, or occlusions, on the tubing for a given cumulative flow through that tube, thereby reducing the tubing life.

### 3.4: Two kinds of roller design in peristaltic pumps:

**3.4.1 Fixed occlusion --** the rollers have a fixed locus as it turns, keeping the occlusion constant as it squeezes the tube. This is a simple, yet effective design. The only downside to this design is that the occlusion as a percent on the tube varies with the variation of the tube wall thickness. Typically the wall thickness of the extruded tubes varies enough that the % occlusion can vary with the wall thickness (see above). Therefore, a section of tube with greater wall thickness, but within the accepted tolerance, will have higher percent occlusion, which increases the wear on the tubing, thereby decreasing the tube life. Tube wall thickness tolerances today are generally kept tight enough that this issue is not of much practical concern. For those mechanically inclined, this may be the constant strain operation.

**3.4.2 Spring-loaded rollers --** As the name indicates, the rollers are mounted on a spring. This design is a bit more elaborate than the fixed occlusion, but helps overcome the variations in the tube wall thickness over a broader range. Irrespective of the variations, the roller imparts the same amount of stress on the tubing that is proportional to the spring constant, making this a constant stress operation. The spring is selected to overcome not only the hoop strength of the tubing, but also the pressure of the pumped fluid. *[7]*

## 4. PERISTALTIC PUMP SPECIFICATIONS

The most specifications provided by a manufacturer for a peristaltic pump are either related to design or performance.

### 4.1: Design Specifications

A number of design parameters should be considered when selecting peristaltic pumps.

**Tubing size -** the diameter and wall thickness of the casing used to house the media, typically given in inches (in) or millimetres (mm). It affects the discharge and the size of tubing needed for replacement. Pumps may be designed to allow multiple sizes of tubing.

**Number of rollers -** the number of rollers or shoes used in the drive mechanism. More rollers reduce pulsation and provide a smoother flow.

**Number of channels -** the number of separate tubes in the pump which operate simultaneously.

### 4.2: Performance Specifications

The primary specifications to consider when selecting peristaltic pumps are flowrate, pressure, horsepower, power rating, outlet diameter, and operating temperature.

**Flow rate** describes the rate of volume discharge through the pump, usually given in gallons per minute (gpm) for industrial applications and gallons per hour (gph) or millilitres per minute (ml/min) for low-flow applications.
**Pressure** is the force per unit area handled by the pump. It is usually given in pounds per square inch (psi) or bar.
**Horsepower** indicates the output power of the pump, measured in units of horsepower (hp). This determines the type of motor or power source needed to operate the pump.
**Power rating** indicates the power required to operate the pump, measured in Watts (W) or horsepower (hp).
**Outlet diameter** is the size of the discharge or outlet connection of the pump. It determines the size of connections made between the pump and the system.
**Operating temperature** defines the range of temperatures at which the pump can operate or the temperature limit of the tubing within the pump.

**4.3: Peristaltic Pump Tubing**

The compatibility of a peristaltic pump with a certain type of fluid is almost completely dependent on the design of the tubing. This is why, when selecting a peristaltic pump, it is important not to overlook the selection of the pump tubing. There are many factors that should be considered in this selection process.

**Chemical compatibility -** the tubing material must be chemically compatible with the pumped fluid. Engineers should use a chemical compatibility chart designed specifically for pump tubing (not a general use chart) to aid in this decision. When a chart is not sufficient, immersion tests may be used to determine its compatibility or resistance to corrosion. For some applications, it is better to line the inner part of the tubing with a chemically inert material to maintain both structural and chemical compatibility.
**Pressure -** the tubing material must be able to withstand the system pressure without leakage or failure. It must also be able to adequately handle abrasive media and suspended solids.
**Temperature -** the tubing material must be able to operate within the temperature range of the system. Users should identify the minimum and maximum temperatures reached in the system and select a material with an appropriate corresponding temperature range.
**Size -** the tubing must be correctly sized in order to fit within the pump head and operate effectively. Closer dimensional tolerances will result in more consistent and repeatable performance.
**Life expectancy -** the tubing material must have a tolerable rated life expectancy to reduce downtime and costs associated with replacement.
**Transparency -** if the media needs to be viewed during pumping, the tubing material should be transparent.
**Gas permeability -** for application where the media must be isolated from gases in the environment, the tubing material must have an acceptably low gas permeability rating.
**Regulatory approval -** for certain industries, such in pharmaceuticals, the tubing material must meet and conform to certain standards and certifications.
**Cost -** The cost of the tubing material must be acceptable in conjunction with its intended life expectancy, since it must be routinely replaced.

**4.4 A few tube materials include:**

**Silicone -** A translucent medical/food grade tubing which is odourless, non-toxic, and has FDA and USP Class Vl approvals. It is auto cleavable and has a temperature range up to 220°C. Used in most general applications.
**Autoprene -** This is an opaque thermo-plastic rubber with unmatched wear resistance when long tube life is required. This material has FDA food grade approval, and has been further enhanced to meet the requirements and approval standards of USP Class VI criteria for medical bio-compatibility.

**Viton -** A black, shiny, synthetic rubber with resistance to concentrated acids, solvents, ozone, radiation and temperatures up to 200o C. Viton is expensive, and while it has excellent chemical compatibility, Viton is not renowned for durability and will have a limited service life.
**Tygon -** This tube has excellent chemical resistance, handles virtually any inorganic chemical, and is one of the families of non-toxic tubes. Tygon has a clear finish and is available in a limited size range.
**Prothane II -** A transparent blue polyester polyurethane tubing which is resistant to ozone, diesel fuel, kerosene, motor oil, mild solvents, aromatic hydrocarbons, petrol and concentrated acid and alkaline solutions.
**Vinyl -** The least expensive of any pump tubing type, but is not widely chemically compatible and has a below average service life. It cannot be autoclaved and cannot handle temperatures above 80°C.
**Fluor polymer -**The most chemically inert tubing material, but with an extremely short service life. It is auto clavable. *[8]*

## 5. CONCLUSION

This paper presents the brief idea of the peristaltic pump such as basic principle, construction and working, literature survey gives idea of present status of work and challenges in design and developments of peristaltic pumps. Also other advantages are cleared from above stated constructions. That are,
Seal-less design: The main feature of the peristaltic pump is the tube/hose: because this is the only part of the pump to come in contact with the product it means the pump avoids corrosion and is leak-free.
Dry running: Many pump users face difficulties when the pump runs dry, peristaltic pumps are able to do this without any lubrication from outside.
Self priming: The pumps are capable of self-priming and can handle products that are likely to "air" or "gas".
Gentle pumping action: In addition, because of the tube/hose and the pumps gentle action, the product being pumped is not damaged in the process thus making peristaltic pumps ideal for shear sensitive products.
High suction lift: The pumps also have high suction capabilities and can provide high discharge pressures meaning they are suitable for use where the product being pumped needs to be moved away from the area of the pump.
Reversible: Due to the action of the pump it can be used to empty lines or clear blockages by reversible rotation.
Non slip pumping: The pumps have no internal backflow giving accurate dosing without slip
Accurate dosing: The pumps are accurate in dosing, with repeatability and metering capabilities.
Enhanced Hose Life - Abrasion resistant: Tube/Hose life is not related to products abrasive qualities. The tube/hose only fails due to fatigue or chemical action.
Low Life Cycle Costs: When the tube/hose does need replacing the cost is minimal compared to other pumps maintenance costs, in addition the time needed to replace the tube/hose is much less then that needed to repair other pump types.

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