International Journal of Engineering Research and Development
e-ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 9, Issue 11 (February 2014), PP. 24-30

High Pressure Silent Screw Pump With Zero Maintenance

Samip. P. Trivedi[1], Sunil. M. Mahajan[2]
[1]*Mechanical, Sandip institute of technology & research center/ University of pune, India*
[2]*Mechanical, Sandip institute of technology & research center / University of pune , India*

Abstract:- Some fluid solutions utilized throuout the world have proven to be dificult to move using conventional pump. These type of fluids includes Newtonian & non - Newtonian fluids. So, screw pumps were developed to successfully pump many of this mixtures . Screwpump has on inherent slow pressure build up and low pollution output, but in vacant times newer version have been developed with high performance which can deliver liquids to pressure above 300 bar and flow rate about 750 m^3/h with long term reliability excellent efficiency.
Keywords:- Newtonian Fluid , Non – Newtonian Fluid, Inhevent , Vecent Time

I. INTRODUCTION

1.1 Pump

A pump is a device in whit it moves a liquid or gas or some Newtonian& non-Newtonian fluids under the mechanical action.

1.2 Classification of Pump

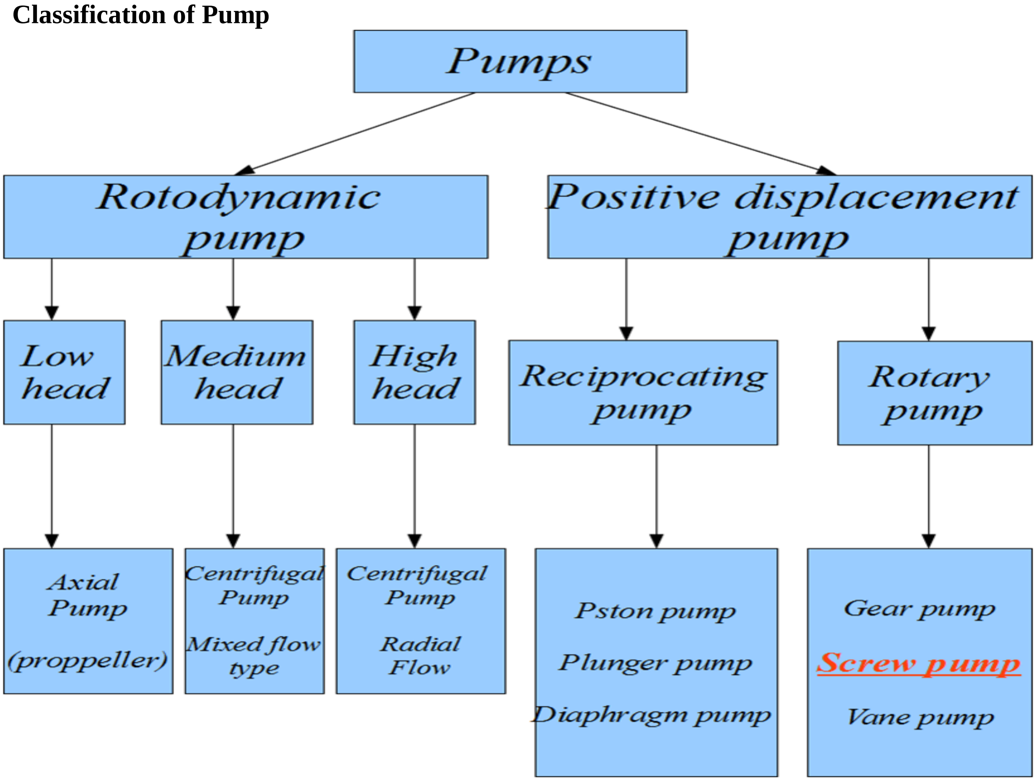

Fig. no. 1:- Classification of pumps

1.3Screw Pump

Screw pump is the screw conveyor with its typical axial direction of discharge. Among the advantages of this delivery principle are the relative insensitivity to dirt, insensitivity to viscosity, low-turbulence delivery of the fluid, and largely pulsation-free and thus low-noise delivery. It has also one screw, tow screw and three screw pump. Three screw pump is also called as high pressure screw pump. A three screw pump operates on the same principle of intermeshing screws as the two screw pump, and can be configured as a double suction pump (technically, a six screw pump). The three screw design utilizes a centrally-located primary screw, or power rotor, which intermeshes with two secondary screws, or idler rotors. The idler rotors are located 180 degrees from each other, are suspended within the pump and do not penetrate the housing. The power rotor penetrates the housing and requires one bearing and one seal; there may be bushings or sleeve bearings that are exposed to the pumped fluid. During operation of a three screw pump, the rotor turns and allows the pumping element to create a thin film of fluid around it. The force of this fluid film acting on the rotor supports the pumping element within the housing. The method of supporting the rotor limits the possible materials of construction to mnon-galling combinations and the fluids that can be handled to typically non-aggressive fluids. Screws can be hardened, but stainless steels cannot be used due to the galling characteristics. Disrupting the fluid film around the rotor can cause the rotor to lose support and potentially contact the rotor housing or the adjacent screws.

Disruption of the fluid film can result from solid particles, gas bubbles, low viscosity (slugs of water or solvents) or other variable and/or process upset conditions. If the screws come in contact with one another, they potentially lock together causing the pump to stop moving fluid and potentially damaging the internals. These three rotors have accurately machined precisely intermeshing threads which enfold the liquid being pumped and act as seals in relation to each other and to the pump body or sleeve in which they rotate. Designed for pumping oils the triror (three) screw pump has an axial pulse free flow an silent operation for sensitive forced lubrication, seal oil circulation and oil firing systems. Pumps are available in 17 frame sizes with various pitch angles and lengths offering a wide flow and pressure range.

II. CONSTRUCTION

The trior (three) screw pump of the positive displacement axial flow screw type with only three moving parts. A power rotor or a driven screw and other two are idler or driver rotors. These three screws are accurately machined precisely intermeshing threads which enfold the liquid being pumped and act as seals in relation to each other and to the pump body or sleeve in which they rotate.

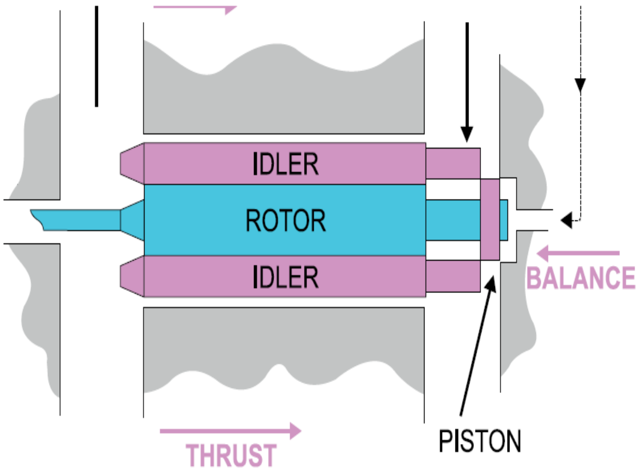

Fig. no. 2:- Construction

The screw pump includes the low pulsation, low noise, and slow pressure build up. Theoretically, screw pumps are pulsation free since they deliver the same volumetric flow for any angel of rotation. In practice however slight pulsation rangingin magnitude from 1 to 2.5 percent of the discharge pressure will be produce. Two occurrence are responsible for this the changing quality or effectiveness of sealing between the delivery and suction chambers as the screw rotates and the compressibility of the fluid pumped. Fluids are compressed by an amount where the compressibility of the air free hydraulic oil is $6.7(10^{-5})cm^2/kp$, for water $4.5(10^{-5})cm^2/kp$, and synthetic not easily flammable, fluids such as phosphate ester, $3.7(10^{-5})cm^2/kp$. The positive displacement pump is commonly used to feed chemicals into the water or to move heavy suspension, such as sludge. One type of positive displacement pump consists of a piston that moves in a back and forth motion within a cylinder. It is used primarily to move material that has large amounts of suspended material, such as sludge. The cylinder will have check valves that operate opposite to each other, depending on the motion of the piston. One check will be located on the suction side of the piston and will open as the piston moves back, creating a larger cylinder area. After the piston has reached the longest stroke position, the motion of the piston will reverse. This action will open the discharge check valve and close the suction check. The contents of the piston are then discharged to discharge piping. After the discharge, the motion of the piston will reverse and the suction stroke will begin. This action will take place as long as power is applied to the pump.Screw pumps are generally made of normal mild steel with a special epoxy coating. A suitable coating system will be selected for each specific application.

2.1 Components

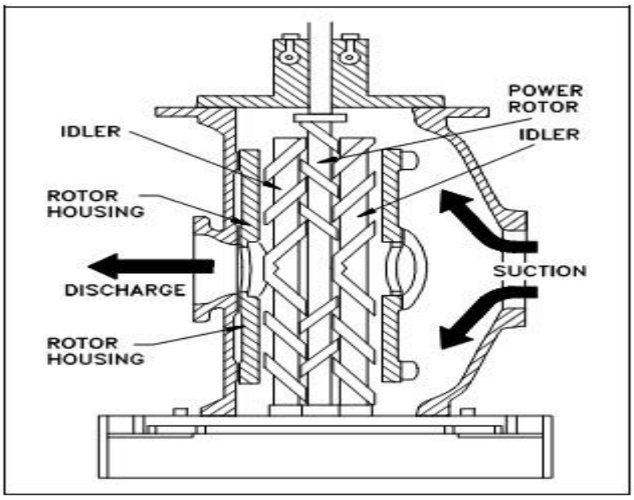

Figure 18 Three-Screw, High-Pitch, Screw Pump

Fig. no. 3:- Components of screw pump

(a) Guard

The only manufacturer that gives the screw pump and lower bearing maximal protection by using guards / shrouds around the lower bearing. By using this cover the possibility of items such as rags, ropes, cables and other debris wrapping around the bearing will be eliminated. Originally this cover was made of cast iron (and often too heavy to handle) but the new guard, made of strong industrial compound plastic, is not heavier than 25 kg whilst having the same or even better characteristics than cast iron.

(b) Flexible coupling

To absorb shock-load and torque during startup and operation, a heavy duty flexible coupling is used between the drive shaft of the screw pump and the output shaft of the gearbox. Selection of the type and size of coupling is done by experienced engineers.

(c) Drive units

A range of drive unit arrangements for all type of screw pumps and all sizes. Although there are many different arrangements, they all consist at least of motor (mostly electric motors however diesel motors are also possible). The drive units come pre-assembled on a steel support frame for easy installation and simple alignment.

(i) gearbox (to reduce the speed of the driving motor)
(ii) base plates & support frame
(iii) connection between motor and gearbox (see below)

The screw pump is suspended from the upper bearing. This means that almost all the load is hanging from the top. The upper bearings therefore are specially designed to take up both the axial force as well as the radial force. The Spaans Babcock standard upper bearings are pedestal mounted because installation and pre-alignment are much easier than with the wall-mounted upper bearings.

(e) Lower bearings

The lower bearing of a screw pump is a very important component. Its role is to keep the pump aligned and to maintain the accurate gap between screw and trough. Although it carries only a small portion of the load of a screw pump, it has to do its duty under harsh conditions: submergewater. Spaans Babcock has developed during the last 50 years a large range of lower bearings; the most used types are shown below:

(f) Conventional lower bearing

The traditional lower bearing is based on a non-rotating stub shaft that is rigidly mounted to the bottom of the inlet and a bronze bush sleeve bearing, mounted to the lower end of the screw pump, that is rotating around the stub shaft to ensure that eventual wear will occur evenly distributed. A very small amount of grease is constantly pumped into the bearing by a grease pump that is installed at the top.

(g) Totally enclosed lower bearing

A totally enclosed lower bearing that is based on roller bearings. This bearing does not need any external lubrication and can be operated without grease pump. The calculated operational lifetime of this bearing is in excess of 100,000

III. WORKING

3.1 Working principle

The basic principle of all screw pump is the screw conveyor or with its typical axial direction of discharge. Advantage of this delivery principle is the relative insensitivity to dirt, insensitivity to viscosity, low-turbulence delivery of the fluid, and largely pulsation and thus low-noise delivery.

3.2 Constructional working

The trior (three) screw pump is of the positive displacement axial flow screw type with only three moving parts, a power rotor and two idler rotors. These three rotors have accurately machined precisely intermeshing threads which enfold the liquid being pumped and act as seals in relation to each other and to the pump body or sleeve in which they rotate.

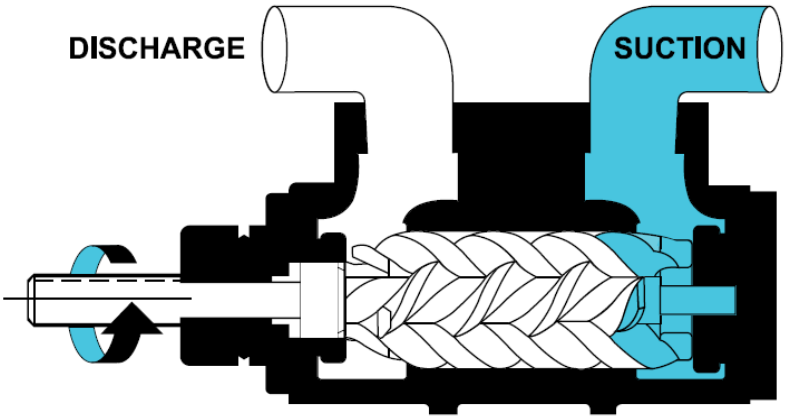

Fig. no. 4:- Suction of fluid

The power rotor is connected directly to the prime mover (electric motor, diesel engine, steam turbine etc) and as it rotates, the idlers turn due to the action of the pumped liquid. This action is in effect, that of a piston moving continuously in one direction, producing a smooth uniform flow without pulsations. As the idlers perform no work, no gears are required to transmit power between the screws. As radial forces on the idlers are taken up by the surrounding cylindrical surfaces, no other bearings are required. Axial forces on the screw set caused by the pressure differential between inlet and outlet are balanced hydraulically within the pump.

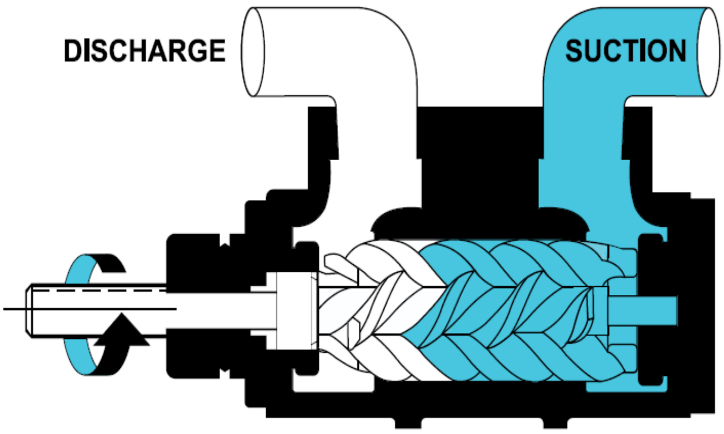

Fig. no. 5:- Arising pressure of fluid

The chamber formed between two adjacent threads and the bore is known as a 'closure'. It is the closure which contains the liquid as it moves through the pump. As the screw set rotates, the unfolding closures in the suction chamber creates a low pressure (partial vacuum) area into which liquid is forced to flow by the pressure differential between this low pressure area and the absolute pressure on the liquid at the pump inlet. At the discharge end, the folding closures force the liquid into the discharge pipe against the natural resistance (known as discharge pressure) created by the static head and discharge pipe system frictional losses. The discharge, or back pressure forces a certain portion of liquid to pass back along the internal clearances from discharge to suction. This is a characteristic of all rotary positive displacement pumps. The very fine working clearances of a triror pump reduces this 'leakage' or 'slip' to a minimum, thus maximizing volumetric efficiency.

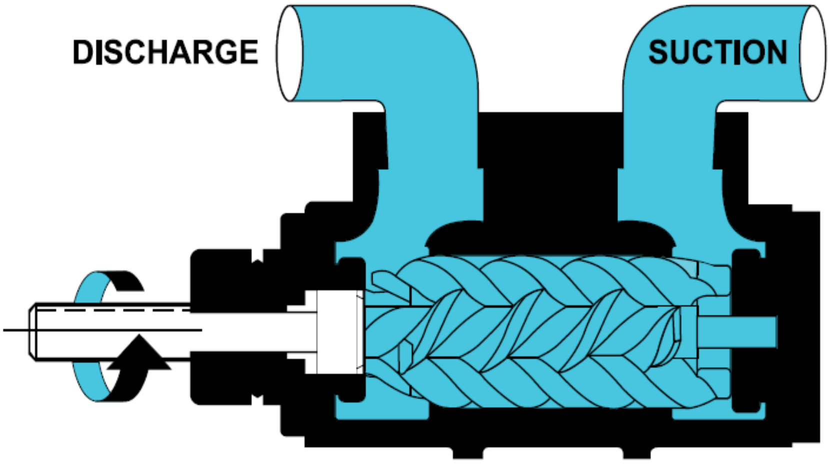

Fig no. 6:- Discharge of fluid

Three screw pumps are manufactured in two basic styles, single suction and double suction. The single suction design is used for low to medium flow rates and low to very high pressure. The double suction design is really two pumps in parallel in one casing. They are used for medium to high flow rates at low to medium pressure. Three screw pumps will generally have only one mechanical shaft seal and one, or perhaps two, bearings that locate the shaft axially. Internal hydraulic balance is such that axial and radial hydraulic forces are opposed and cancel each other. Bearing loads are thus very low. Another common characteristic of three screw pumps is all but the smallest, low pressure designs incorporate replaceable liners in which the pumping screws rotate. Thus, field repair is a simple matter. The center screw, called the power rotor, performs all the pumping. The meshed outside screws, called idler rotors, cause each liquid-holding chamber to be separated from the adjacent one except for running clearances. This effectively allows staging of the pump pressure rise. High pressure pumps may have as many as 12 stages while low pressure pumps may have only two or three. Because the center screw is performing all the pumping work, the drive torque transferred to the idler rotors is only that necessary to overcome viscous drag of the cylindrical rotor spinning within its liner clearance.

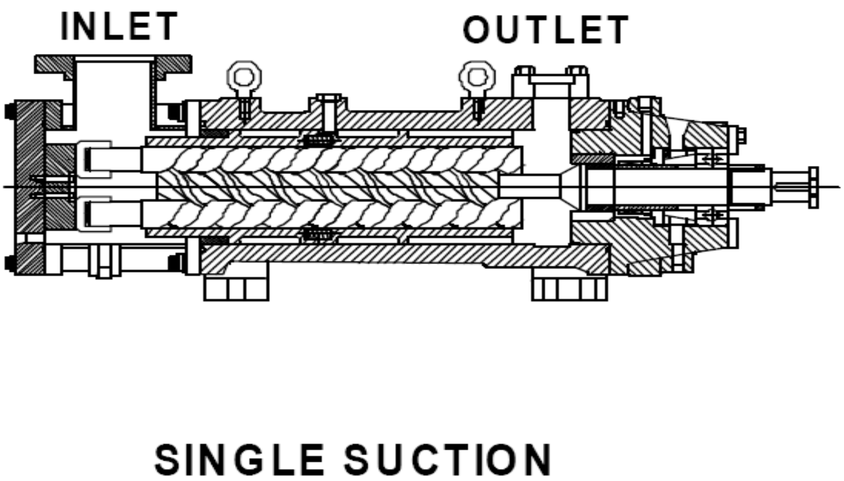

Fig no. 7:- Single suction screw pump

The theoretical flow rate of these pumps is a function of speed, screw set diameter and the lead angle of the threads. Basically, flow rate is a function of the cube of the center screw diameter. Slip flow, the volumetric inefficiency due to clearances, differential pressure and viscosity, is a function of the square of the power rotor diameter. This results in larger pumps being inherently more efficient than smaller pumps, a fact that applies to most rotating machinery. Speed is ultimately limited by the applications capability to deliver flow to the pump inlet at a sufficient pressure to avoid cavitations. This is true of all pumps. Three screw pumps tend to be high speed pumps, not unlike centrifugal pumps. Two pole and four pole motors are the most common used. When large flows, very high viscosities or low available inlet pressures dictate, slower speed may be necessary. For example, some polymer services handle liquid at 50,000 centistokes or more. Three screw pumps on such service would typically be operated in the 50 to 150 rpm. Gas turbine fuel injection service would more commonly be in the 3000 to 3600 rpm range since the fuels tend to be low in viscosity, 1 to 20 centistokes, and the pump inlet is normally boosted to a positive pressure from a fuel treatment skid pump. The high speed operation is desirable when handling low viscosity liquids since the idler rotors generate a hydrodynamic liquid film in their load zones that resists radial hydraulic loads, very similar to hydrodynamic sleeve bearings found in turbo machinery. In order to achieve the highest pressure capability from three screw pumps, it is necessary to control the shape of the screws while under hydraulic load. This is best achieved by the use of five axis NC profile grinding which allows complete dimensional control and a high degree of repeatability. Opposed loading of the idler rotor outside diameters on the power rotor root diameter dictate that these surfaces be heat treated to withstand the cyclic stress. Again, profile thread grinding allows the final screw contour to be produced while leaving the rotors quite hard, in the order of 58R (58 on the Rockwell C scale). This hard surface better resists abrasive wear from contaminants, typical of crude oil transport.

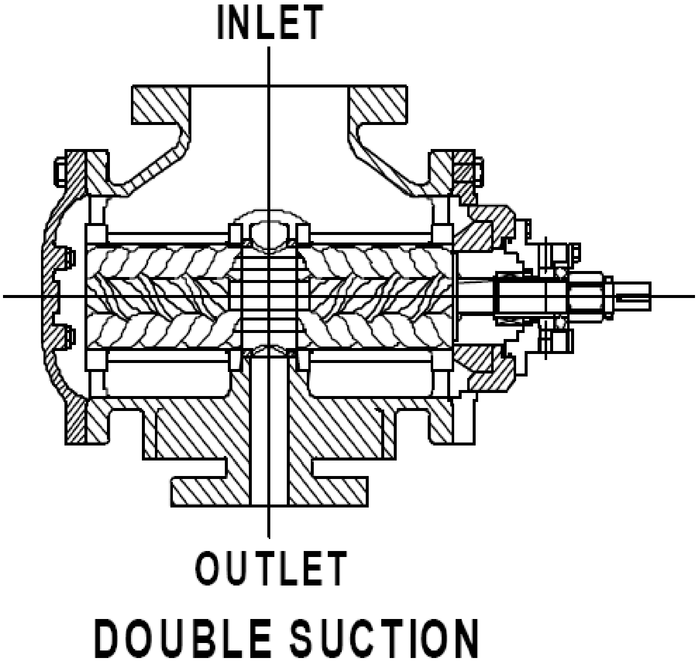

Fig no. 8:- Double suction screw pump

As versatile as three screw pumps are, there are some applications for which they are not suitable. While many advances in materials engineering are taking place, the state of the art for three screw pumps is such that very corrosion resistant materials such as high nickel steels have too great a galling tendency. The rotors of three screw pumps touch and thus any materials that tend to gall are unsuitable. Unfortunately, this includes many corrosion resistant materials. Viscosities too low to allow hydrodynamic film support generations are also application areas for which the three screw pump is not optimal.

IV. ADVANTAGES

a) As compare to other pumps in this pump we can also displace the non-Newtonian fluids.
b) Pump age rate over 70,000 gpm and discharge rate in excess of 3000 psi are obtainable with suction head of about 25 in hg.
c) Today's three screw high performance pump can deliver liquid pressure above 300 bar and flows upto 750 m^3/h with long term reliability and excellent efficiency.
d) There is no noise even though running at high pressure and high speed.

e) It has a no need of scheduled inspection.
f) It has no need of guide vaines, slide valves, xand shaft seals.

V. DISADVANTAGE

a) It has a very high cost.

VI. APPLICATIONS

a) Three screw pumps can be used on any clean lubricating liquid chemically compatible with the materials of construction. e.g. lubricating oil, hydraulic oil, residual fuel oil
b) It is widely used in marines, industrial, mobile applications, and environmental industries.
c) They are commonly used for machinery lubrication, hydraulic elevators, and fuel oil transport and burner service.
d) It can also used in refinery processes for high temperature viscous product such as asphalt, and vacuum tower bottom.
e) Three screw pumps are also used for polymer pumping in the manufacturing of synthetic fibers such as Nylon and Lycra

VII. CONCLUSIONS

By studying on this topic in conclusion, using the generic terminology 'screw pump' fails to recognize the key mechanical design and performance differences that each screw pump type offers. However, once they are understood, engineers will find a proven technology suitable for a wide range of applications in multiple industries. It can also performed on various viscosities and for the various fluids such as a Newtonian and non-Newtonian fluid at a desired pressure.

ACKNOWLEDGEMENTS

The seminar report on "**High Pressure Silent Screw Pump With Zero Maintenance**" is outcome of guidance, moral support and devotion bestowed on me throughout my work. For this I acknowledge and express my profound sense of gratitude and thanks to everybody who have been a source of inspiration during the seminar preparation.

First and foremost I offer my sincere phrases of thanks with innate humility to **Prof.P.R.Hatte ,** (H.O.D) Mechanical Engg Department, SITRC, Nashik for providing help whenever needed.

The consistent guidance and support provided by **Prof.S.M.Mahajan** is very thankfully acknowledged and appreciated for the key role played by him in providing me with his precious ideas, suggestions, help and moral support that enabled me in shaping the seminar work. **Samip Pankajkumar Trivedi.**

REFERENCES

[1]. Screw Pump of one, two, and three screw design by Joachim Wegener (Department head of screw pump development) and Walter E. Cozza (manager project department).
[2]. High performance rotary screw pumps by James R.Brennan, Imo Industries Inc. , Monroe, NC, USA.
[3]. Understanding the unique characteristic and operating principle of one ,two ,and there screw pump by Rob Jordan, Colfax fluid Handling.
[4]. Pumps & Systems, for further information log on to www.pump-zone.com
[5]. Handbook of pump for some content, selection of pump, positive displacement of pump.