COMPARISON OF QUAD ACTING WITH DOUBLE ACTING RECIPROCATING PUMP USING CFD ANALYSIS

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ABSTRACT

Reciprocating pumps are pumps in which the reciprocating motion of pistons, plungers or membranes causes a fluid to move. The discharge of a single-acting reciprocating pump is low compared with a double-acting one for the same input power. In this respect an attempt has been made to increase the discharge by making some modifications in the double-acting pump with the same input power. Two additional pistons have been placed vertically and adjacently to the main cylinder. The fluid flow analyses of quad-acting reciprocating pump and double acting reciprocating pump have been performed in ANSYS CFX. The various parameters such as discharge of the fluid, velocity of fluid flow and pressure of fluid flow have been presented.

Keyword: - *Reciprocating pump, Double acting, Quad acting, Discharge, Velocity, Pressure.*

1. INTRODUCTION

Generally, the reciprocating pump is a positive displacement pump. It creates the required lift and pressure by displacing liquid with a moving member called plunger housed inside a cylinder. Most of the reciprocating pumps have one or more cylinders which are alternately filled with liquid from the sump and then displaced and allowed to flow to the delivery tank.

The reciprocating pump consists primarily of a piston or plunger that moves backward and forward in a close fitting cylinder. Suction and delivery pipes are connected to the cylinder to transmit the required fluid to the tank. The pipes are provided with non-return valves; a suction valve in the suction line and a delivery valve in delivery line. The forward and backward motion to the piston is imparted by a crank and connecting rod mechanism operated by a power source which may be an electric motor.

2. DESIGN CALCULATION:

2.1 DIMENSION:

Description	Length of main cylinder (mm)	Diameter of main cylinder (mm)	Length of vertical cylinder (mm)	Diameter of vertical cycle (mm)	Diameter of delivery pipe (mm)
Double acting reciprocating pump	**400**	**50**	**No vertical cylinder**	**No vertical cylinder**	**10**
Quad acting reciprocating pump	**400**	**50**	**80**	**30**	**10**

The above table shows the dimensions of the double acting reciprocating pump and quad acting reciprocating pump.

2.2 FORMULA:

Discharge of pump = Area of delivery pipe× velocity at outlet.

$$Q = A * v$$

Where,

Q - Discharge m^3/s

A - Area of delivery pipe m^2

v - Velocity m/s.

3. EXPERIMENTAL DESIGN:

The construction of double acting and quad acting reciprocating pumps are constructed based on design shown above in fig 3.1 and 3.2 and further analyses are done with the help of Ansys CFX.

3.1 DOUBLE ACTING RECIPROCATING PUMP

A double acting pump is one which has two suction valves, delivery valves and two suction and delivery pipes. In double acting reciprocating pump suction and delivery strokes occur together. When the plunger moves forward, it makes the water to move out from the cylinder through the discharge valve at right side and the adjacent suction valve is closed in position. At this moment, the suction will be created inside the cylinder which draws the water into the cylinder through left side suction valve whereas the adjacent delivery valve is closed. During the reverse stroke, the water moves out from the cylinder through the delivery valve at left side, and the adjacent suction valve is closed in position.

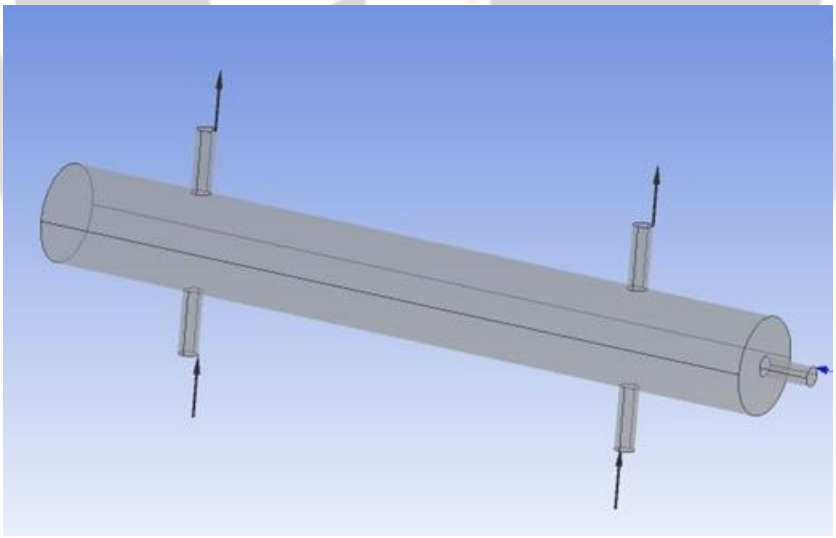

Fig 3.1: Double acting reciprocating pump

3.2 QUAD ACTING RECIPROCATING PUMP

In addition to the main cylinder, quad acting reciprocating pump consists of two vertical cylinders and it is acting by a spring force and the piston of the main cylinder. Double action pumping will be taken place in main cylinder similar to double acting reciprocating pump and the combination of piston of the main cylinder and spring force will active the pumping action in the two vertical cylinders.

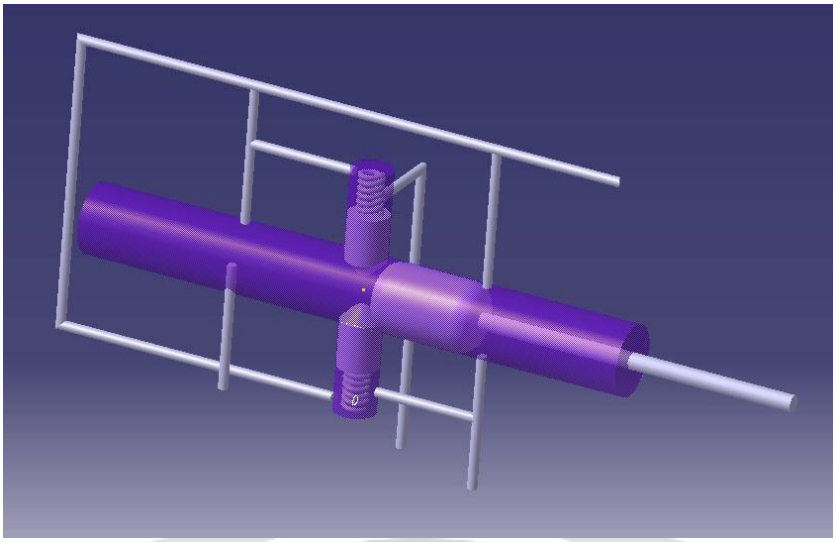

Fig 3.2: Quad acting reciprocating pump

4. FEATURES OF ANSYS CFX:

CFX is fully integrated into the ANSYS Workbench environment, a platform designed for efficient and flexible workflows, CAD associatively and powerful capabilities in geometry modeling and meshing. The built-in parameter manager makes it easy to conduct design exploration.

ANSYS CFX can model your most difficult fluid flow-related physics phenomena and solve sophisticated models for multiphase flows, chemical reaction and combustion. Even complicated viscous and turbulent, internal and external flows, flow-induced noise predictions, heat transfer with and without radiation can be modeled with ease.

ANSYS CFX provides complete mesh flexibility, including the ability to solve flow problems using unstructured meshes that can be generated about complex geometries with ease. Supported mesh types include triangular, quadrilateral, tetrahedral, hexahedral, pyramid, and prism (wedge). ANSYS Workbench allows you to import your CAD geometry, prepare it for CFD use in ANSYS Design modeler and mesh it automatically or manually with the ANSYS Mesh component.

CFX models the effects of solid motion on fluid flow by coupling with ANSYS structural mechanics solutions through the Workbench unified user environment. ANSYS CFX provides robust and accurate two-way FSI without the need to purchase, administer or configure third-party coupling and pre- and post-processing software.

5. ANALYSIS REPORT:

5.1. DOUBLE ACTING RECIPROCATING PUMP:

5.1.1. MESHING OF DOUBLE ACTING RECIPROCATING PUMP

Figure 5.1.1.shows the optimal surface mesh for cylinder and piston for obtaining the best possible results of fluid flow analysis. The number of static nodes is 12564and the number of elements is 59944.

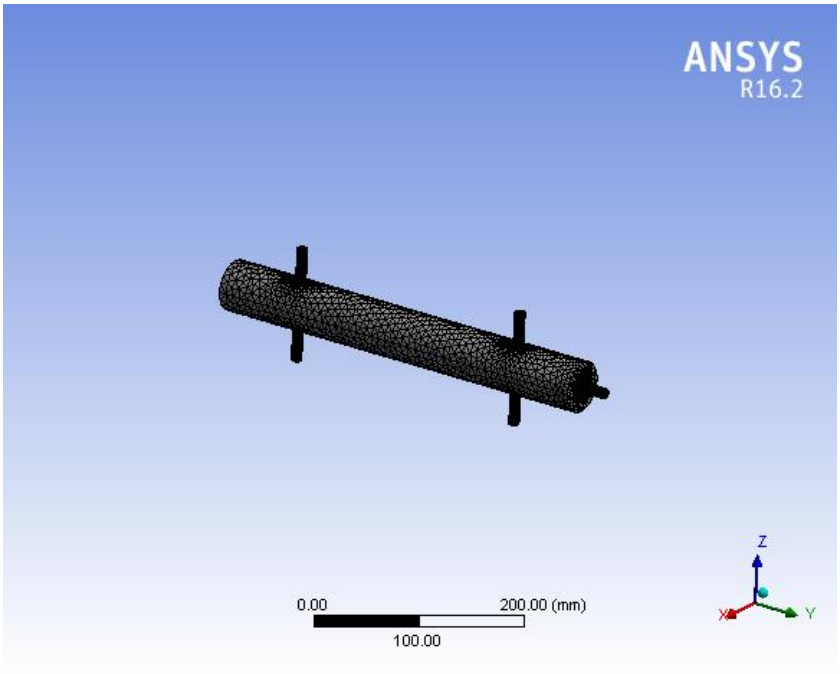

Fig 5.1.1: Meshing of double acting reciprocating pump

5.1.2. VELOCITY ANALYSIS OF DOUBLE ACTING RECIPROCATING PUMP

Figure 5.1.2.shows The fluid flow analysis has been carried out in the double-acting cylinder model. The velocity of fluid flow has been analyzed in the main cylinder. The maximum velocity of fluid is 1.09 m/s.

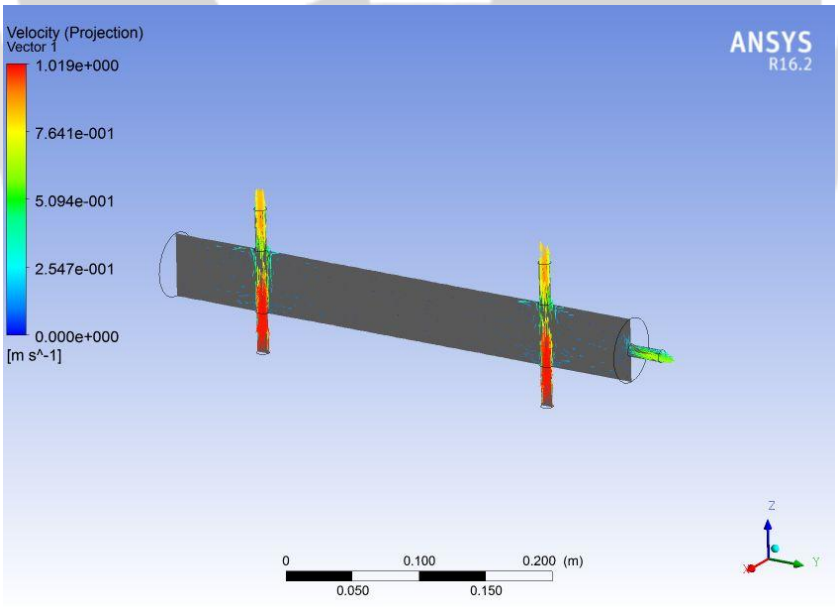

Fig 5.1.2: Velocity analysis of double acting reciprocating pump

5.1.3. PRESSURE ANALYSIS OF DOUBLE ACTING RECIPROCATING PUMP

Figure 5.1.3.shows The fluid flow analysis has been carried out in the double-acting cylinder model. The pressure of fluid flow has been analyzed in the main cylinder. The maximum pressure of fluid is 3.28Pa.

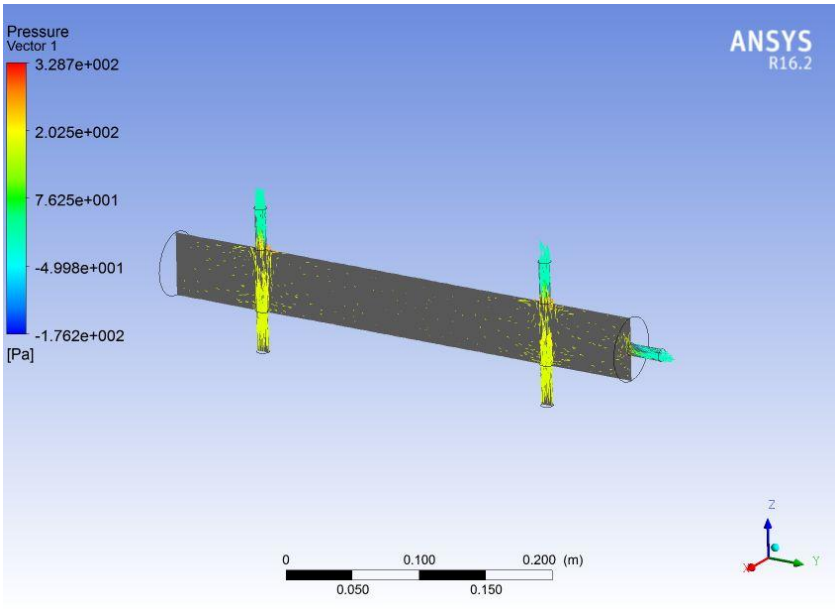

Fig 5.1.3: Pressure analysis of double acting reciprocating pump

5.2. QUAD ACTING RECIPROCATING PUMP:

5.2.1. MESHING OF QUAD ACTING RECIPROCATING PUMP

Figure 5.2.1.shows the optimal surface mesh for cylinder and piston for obtaining the best possible results of fluid flow analysis. The number of static nodes is 86470and the number of elements is 401227.

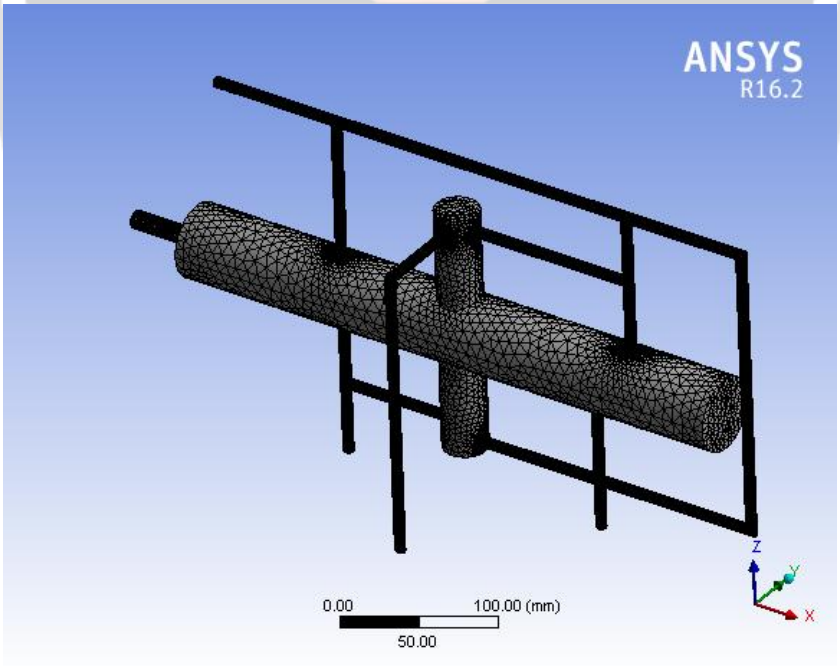

Fig 5.2.1: Meshing of quad acting reciprocating pump

5.2.2. VELOCITY ANALYSIS OF QUAD ACTING RECIPROCATING PUMP

Figure 5.2.2.shows The fluid flow analysis has been carried out in the quad-acting cylinder model. The velocity of fluid flow has been analyzed in the main cylinder. The maximum velocity of fluid is 3.157 m/s.

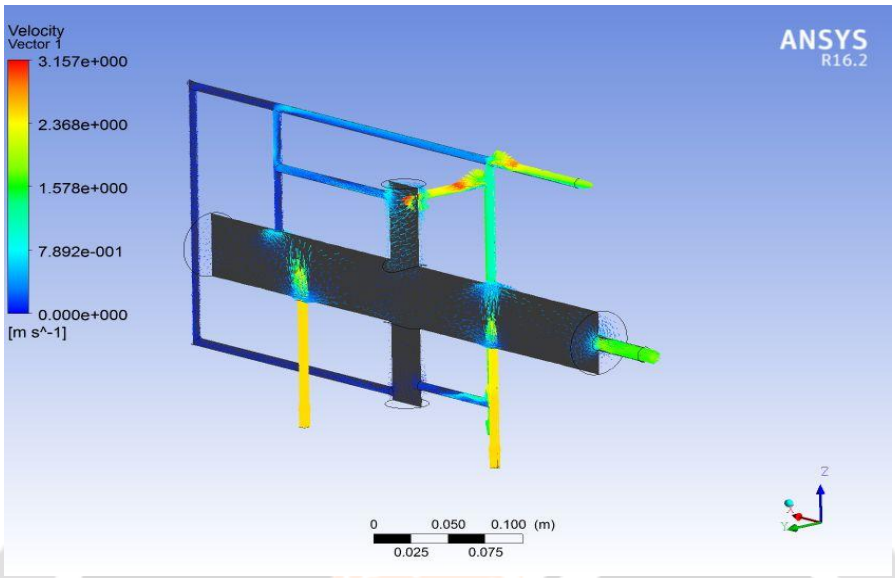

Fig 5.2.2: Velocity analysis of quad acting reciprocating pump

5.2.3. PRESSURE ANALYSIS OF QUAD ACTING RECIPROCATING PUMP

Fig 5.2.3 shows The fluid flow analysis has been carried out in the quad-acting cylinder model. The pressure of fluid flow has been analyzed in the main cylinder. The maximum pressure of fluid is 6.73e+3Pa.

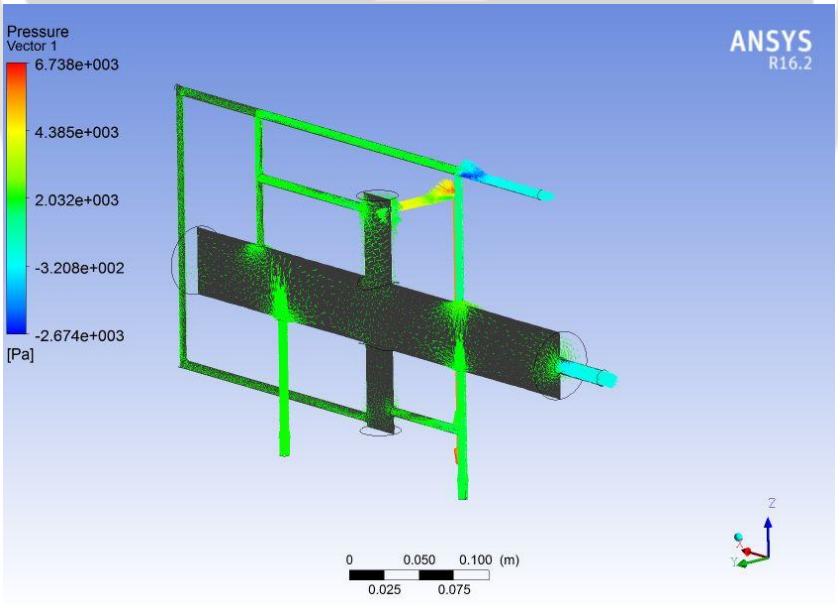

Fig 5.2.3: Pressure analysis of quad acting reciprocating pump

6. RESULT AND DISCUSSION

The data from Ansys CFX analyses report is taken into consideration and calculation is done on discharge of double acting reciprocating pump and quad acting reciprocating pump. The Fig 6.1 shows that quad acting reciprocating pump has more discharge than double acting reciprocating pump. It is due to higher velocity of the quad acting reciprocating pump than double acting reciprocating pump.

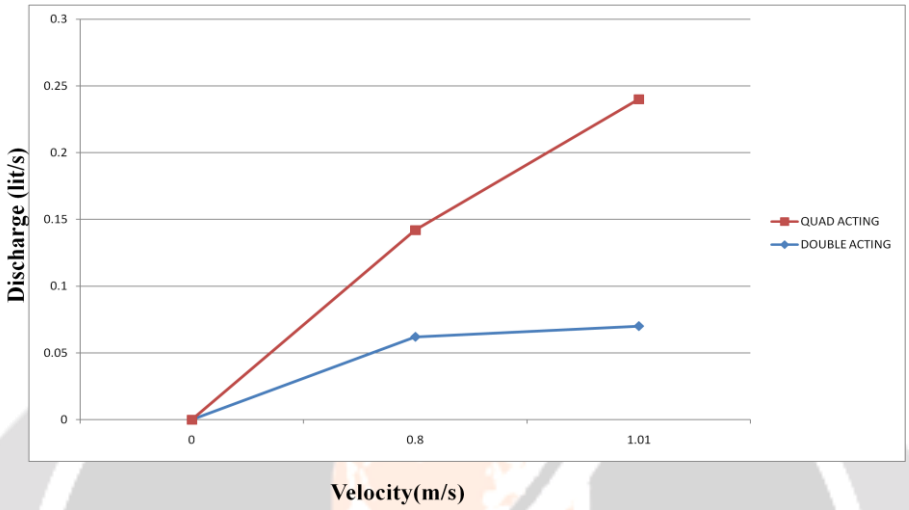

Fig 6.1: Comparison results of double and quad acting reciprocating pump

7. CONCLUSION

This paper presents the comparison of discharge between double acting and quad acting reciprocating pump using Ansys CFX for same input value. It is concluded that the quad acting reciprocating pump is more efficient that double acting reciprocating pump for the same input parameters.

8. REFERENCE

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