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Automatic Priming Approaches in the Operation of Centrifugal Pumps

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Abstract— This In centrifugal pump, priming function plays a vital role. Priming means to remove the air from pump and its piping systems & to create vacuum so that pumping liquid will flood inside the pump. When water level is positive means above the center line of pump then priming is not required but in case of negative water level means water level is below the pump center line, priming is required. There are some conventional methods exist like use of foot valve, use of priming pots etc. which requires more time & human efforts during every start of pump which is not possible. To avoid the more initial time & efforts, some self-priming systems & mechanism

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I. INTRODUCTION

Comparator is a circuit that output is binary information depending upon the comparison of two input voltages here the comparison in

A centrifugal pump is a roto-dynamic pump (Refer Fig 1) that uses a rotating impeller to increase the velocity of a fluid. Centrifugal pumps used commonly to move liquids through a piping system. The fluid enters the pump impeller along or near to the rotating axis and accelerated by the impeller, flowing radially outward into a diffuser or volute chamber, from where it exits into the downstream piping system. Centrifugal pumps used for large discharge through smaller heads

Centrifugal pumps are pump that exploits the rotary motion of a bladed wheel (impeller) inserted in the pump casing itself. The impeller,

are developed by using vacuum pumps, floats, valves & piping. Generally,these mechanisms are fitted on same driver by which main centrifugal pump clocks hence additional cost of prime mover, foundation, installation & running cost are not required when using such mechanisms.These mechanisms can be useful in conducting automatic priming hence time & manual intervention required during every starting time is reduced completely but such mechanism required some initial costs.

Keywords: Priming, piping system, automatic priming, vacuum pump, priming pot,foot valves, floats, prime mover, human efforts, initial cost.

moving at high speed, projects the water previously sucked outwards in virtue of the centrifugal force developed, channeling the liquid in the fixed casing and then into the delivery piping.

Fig.1: Centrifugal pumps

Priming in centrifugal pumps:

In any centrifugal pumps, priming plays an important role, where liquid is to be sucked from

and which readily incorporated as a part of a new pumping system.

[2]

the bottom. It plays vital role when it need to

John Karassik [1989]

has described that

suck/lift the water from below the centerline of the pump suction. In that case, it needs to remove the air from the suction, to create the vacuum and suck the water up to the centrifugal pumps impeller eye. Starting of pump without priming will cause dry running of pump, which will damage the pump components. Without priming, liquid could not have sucked in the pump. Priming is as per shown in Fig. 2

Fig.2: Priming principle

Priming is nothing but filling of a pump or piping to displace the air within. It appears simple. Fill the pump with liquid, crack open the discharge valve and start the motor. Nevertheless, it is a little more complicated than that. To accomplish the priming function, there are some methodologies used. Some them are studied as below.

Nagla [1996][1]has developed priming device for pump. This invention is relating to provide a positive pressure priming, which is simple construction and fabricated at relatively low cost

priming of centrifugal pumps can be done by using priming chamber tank, in which opening is provided at the bottom and its connection is connected to the suction line of the centrifugal pump. It is described that priming can be done by using water-jet ejector or an air ejector.

Cartwright[1997] [3]has developed vacuum assisted priming system that includes the vacuum chamber communicating with a pump inlet via a transfer passage is used. A Valve assembly within the vacuum chamber controls the communication of the vacuum source with the chamber

Carnes[2007] [4]described the basic concept of vacuum technology along with its basic terms. It contains vacuum generation terminology and its different types in pumping system to generate vacuum. It gives vacuum measurement, monitoring, control and its regulation. He has explained about liquid ring vacuum pump principle and its schematic arrangements for its element.

Conventional methods of priming:

1) Priming with flooded suction: In this case, the suction, from which water is to suck in the pump, kept above the centerline of the pump (Refer Fig. 3). Due to which water will be readily available up to centerline of the pump.

Hence, there will be no air inside the piping. Hence, there is no need to do the priming.

2)A bypass around the discharge check valve: In this case, by-pass around the discharge valve provided (Refer Fig. 4). With this arrangement, some amount of liquid taken back in the casing. Due to which there will be always some amount of water in the casing even though pump stopped. Hence during starting the pump, there will some amount of water in the casing. Hence, no need to prime the pump again.

Fig. 4: Priming with bypass around the discharge check valve

3) The foot valve with auxiliary liquid supply: In this case, a foot valve provided at the end of suction piping (Refer Fig.5). Here to prime the pump/remove the air from the suction piping, auxiliary liquid supply provided. Which supply the water in the suction piping of the pump, due to which main pump gets primed. In this case, auxiliary liquid supply may be by using additional smaller size pump with separate prime mover or separate water tank is required.

Fig. 5: Priming by foot valve with auxiliary liquid supply

4) Priming by using foot valve: A foot valve installed in the suction piping to insure the liquid will not drain from the pump casing and suction piping when the pump stops (Refer Fig. 6).

These valves have a nasty habit of leaking. In this case priming funnel provided in the delivery pipeline or on the delivery casing. Water then filled through this funnel in to the suction pipeline. When water filled in the piping then priming of the main pump completes. Evacuate the air in the system with a positive displacement

priming pump operating between the pump and a closed discharge valve.

Fig. 6:Priming by foot valve

Limitations of Conventional Priming methods:

Limitations of conventional priming methods are as follows.

- Convention priming unit occupy more space
- Priming cannot be done without manual intervention in case of conventional priming method as those are not automatic
- Due to complicated pipe lines, more suction pipe lengths and long distance of separate priming pump, more time is required

- Additional prime mover is required when separate vacuum pump is used to draw the air from the suction pipe line
- Chances of de-priming due to non-full proof methods.
- Needs to re-prime in case of de-priming of centrifugal pump during working of the pump.

Auto priming in centrifugal pump:

To overcome above mentioned problems, there is a necessity of auto-priming system in the centrifugal pumps. In auto-priming system, unit is attached to the centrifugal pump. To run the priming unit, drive for same is taken from the driver of the centrifugal pump itself. Its suction is attached to the discharge casing of the centrifugal pump via flexible or rigid pipe so that air can be sucked from suction pipe line and discharge casing of the centrifugal pump. Drive for Auto-priming unit is given by belt and pulley arrangement. As it is attached to the main pump and is running continuously with the centrifugal pump, there will not be any chance of de- priming of the centrifugal pump. Some of methods of self-auto priming are studied as below.

1) Auto Priming by Vacuum Pump:

Vacuum pumps and compressors are machines designed for the compression of gases and vapours. Vacuum pumps and compressors compress the gases or gas vapour mixtures generated in various processes from the “suction pressure” to the “discharge pressure”. With vacuum pumps, the suction pressure is lower than atmospheric, whereas the discharge pressure with compressors is higher than atmospheric.

There are different types of vacuum pump technologies and there use in field like petroleum, sewage treatment, dental, ground water remediation and chemical industries. . Also A broad ranges of vacuum pump technologies are presently available and viable for many of the applications. These include water sealed liquid ring vacuum pumps, oil sealed liquid ring and rotary vane vacuum pumps, and a range of vacuum pump technologies that use no water for sealing. The liquid ring pump is the only one that uses water (and sometimes-other liquids) to seal the vacuum chamber inside the pump housing.

Fig. 7: Auto-Priming Unit by James Fryer

2) Auto Priming by using a solenoid valve and a float switch:

Nagle has developed priming device for pump

(Fig. 8). to provide a positive pressure priming, which is simple construction and fabricated at relatively low cost and which readily incorporated as a part of a new pumping system.

Fig. 8: Auto-Priming Unit by Nagle

The object of this invention is to provide a novel priming device for priming pumping system which is positive in its operation under all circumstances even though the entrance pipe so the pump is covered over with solid material.The invention further contemplates a priming device adapted for use in pumping system, which, by virtue of in incorporation of a solenoid valve and a float switch in the system, may made to operate entirely automatically. Fig 2.7 shows a view in side elevation of pumping system in which is incorporated a priming device made in accordance with the invention.

3) Auto Priming unit by McWilliams:

He has developed automatic priming system (Fig

9). This development relates to an automatic priming valve and system for making a pumping system fully automatic and more reliable in operation. Automatic priming system are known in the art and have been used, but without

altogether satisfactory results. Particularly because of recurrent faulty operation as well as expensive construction and maintenance of rather numerous and complicated parts usually required in known types of automatic priming system. A common method of priming a pump has been to exhaust the air from the pump by mean of vacuum pump. In this method, there is chance of leakage.

Fig. 9: Auto Priming Unit by McWilliams

4) Auto Priming byvacuum pump & float systems:

Carnes has designed vacuum assisted pump (Fig

2.4). In which a self-priming centrifugal pump including a supplementary vacuum pump and a float valve has developed.

Fig. 10: Auto-Priming Unit by Carnes

The vacuum pump serves to draw liquid to the pump for priming and the float valve shut of flow to the vacuum pump when liquid reaches a predetermined level to prevent entry of liquid into the vacuum pump. In some embodiments, the float valve includes an O-ring valve seal and the vacuum pump includes an oil delivery system to distribute oil from an oil reservoir to improve lubrication.

Advantages of Auto Priming systems:

There are many benefits that come with the priming system used by self-priming pumps.

- A well-designed vacuum priming system can prime multiple pumps, so installation costs are lower and the run-time is limited.
- It also ensures that all pumps are fully primed and lets you use the most efficient and reliable pumps at the lowest cost.
- Priming system is mostly a non-wetted component, it does not need expensive

construction materials, and ultimately reduces your construction and equipment expenses.

- Since we do not have to wait until a self- priming pump to finishes priming for it to be usable, you can maximize the efficiency of your pump at reduced power requirements.
- We can skip tedious and time- consuming start-up procedures for centrifugal pumps, and the glitches that come with it.
- By mixing air and water, a self-priming pump eliminates the need to fill it and the suction piping with water.
- There's no need for unreliable but expensive foot valves either.
- The most prominent advantage of a self- priming pump is its ability to handle solids. Some pumps can even handle solids up to 8 centimeters in diameter.
- Self-priming system reduces human efforts which required evert time of pump start in conventional methods.

II. CONCLUSION:

Auto priming systems are beneficial over conventional priming systems in terms of time, cost, maintenance & human efforts. Auto priming systems may require some initial cost investment for additional mechanism like vacuum pump, floats, piping's & valves etc. but it made pump operation automatic. It reduces human efforts that are required in conventional

priming methods during every time of pump start. As majority of priming systems operates on same prime mover by which main pump operated, no additional drivers & foundation are required for installation of self-priming units or systems.

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. The output waveform of comparator shown in Fig 8. Power waveform of the single tail comparator is shown in Fig 9.

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