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Cavitation and Study of its Effect and Remedies– A Review

Sonti Chouhan[1], Pradeep Nagoriya[2], Puneet Kumar Nema[3]

[1,2]B.E Students, Department of Mechanical Engineering, Madhav Institute of technology and Science, Gwalior, Madhya Pradesh, India
[3]Professor, Department of Mechanical Engineering, Madhav Institute of technology and Science, Gwalior, Madhya Pradesh, India

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Abstract - *Cavitation remained one of the few problems in modern technology and science which do not have any feasible solution. Cavitation causes rise of many problems in operation of pumps, decrease in efficiency, erosion, high operational cost etc are some of them. However, there are some techniques developed through which cavitation phenomena can be identified and also can reduce it to some extent. In this paper some technologies and researches are discussed and also the abstract of controlling cavitation in different circumstances are discussed.*

Key Words: Cavitation, Npsh, Centrifugal pump.

1. INTRODUCTION

Cavitation is the phenomena which occurs mainly due to the pressure difference. If some liquid, consider it is water, flowing through a pipe which is convergent followed by a divergent section. When water passes through a convergent section then due to continuously reducing cross section area of pipe and incompressibility of water its velocity increases, so therefore to maintain its energy level (according to bernoulli law) pressure decreases, but afterwards when water passes through divergent section its velocity decreases and pressure increases. If in convergent section pressure drops below the vapour pressure of water then it forms vapour bubbles which when enters into divergent section pressure again changes rapidly, these bubbles burst on the surface of metal which causes damage. It can be seen that vaporization itself does not do the damage, but after evaporation, when velocity decreases and pressure increases it collapses. In many or it would not be wrong to say that in most of the application cavitation is an undesirable effect. Hence every system wants for its better operation that phenomena of cavitation does not occur. But still completely annihilation of cavitation could not be made possible in other words it is inevitable phenomena. Cavitation causes many problems like it damages the impeller, deteriorates the material of pipes, produces noise and vibration which further causes loss of energy and reduced efficiency. These things make it very important to control the happening of cavitation or atleast to reduce it to some extent. See fig.1 which shows the cavitation phenomena in a general centrifugal pump. These collapsing bubbles on the surface erode the material from the surface and once it starts it almost becomes uncontrollable.

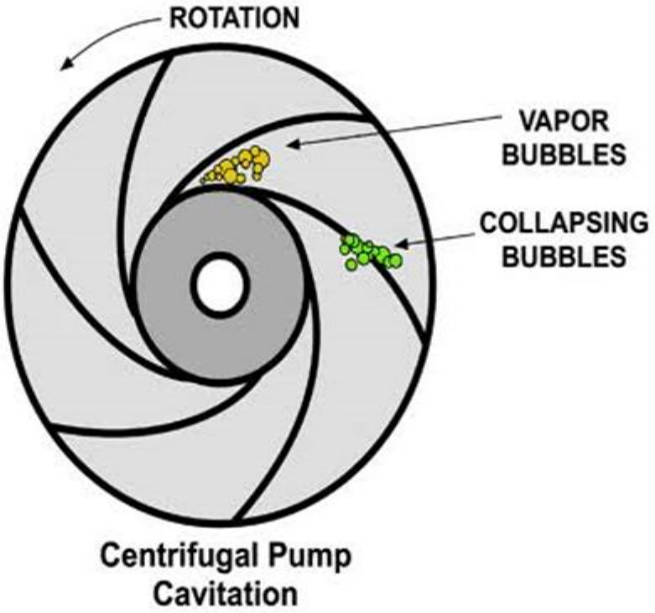

Fig.1 Cavitation in centrifugal pump

1.1 NPSH

NPSH is a term used to eliminate the risk of cavitation in pumps. It is a pressure difference of fluid at inlet of pumps and vapour pressure of fluids. It can be defined as-

N-: net
P-: positive
S-: suction
H-: head

Hence in net amount suction head should be positive in order to avoid cavitation.

$$(NPSH)net = (NPSH)a - (NPSH)r$$

NPSHa= net positive suction head available
NPSHr= net positive suction head required

To avoid cavitation-:

$$(NPSH)net > 0$$

It means (NPSH)r should be greater than (NPSH)a to avoid cavitation.

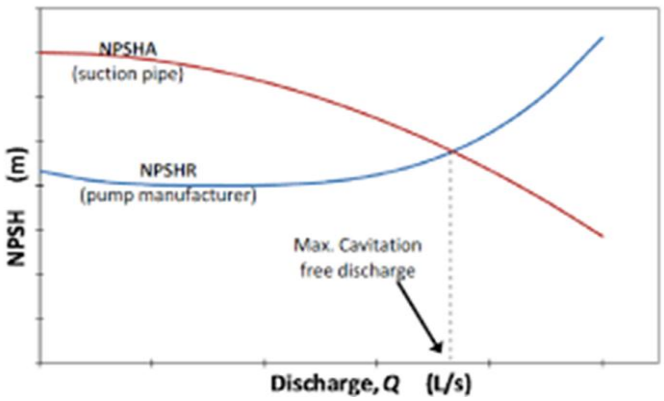

Fig.2 Npsha and Npshr

2. CAVITATION RESEARCH STUDIES:

There is various research that has been done in various circumstances to understand the effect of cavitation and to overcome this problem. These researches are summarized here to have a better understanding of cavitation and its control processes. And then there is a case study of our one particular use of pumps in farms.

2.1Cavitation In Pressure Controlling valves:

A research has been done to identify the occurrence of cavitation in pressure controlling valves. For cities or for factories a huge piping system is implanted to control the water distribution management. And along with these pipes used controlling valves to control flow rates. These valves are continually subjected to different water pressure, due to which they are at high risk of forming a cavitation zone around them. but it is difficult to tell whether cavitation has started yet or not. So in order to comment about the inception of cavitation a research has been conducted which proposes a method to tell that in pressure controlling valves if cavitation is started or not. In this there are four sensors used around valves, which records the data about change in frequency, noise, velocity and acceleration of fluid molecules. In this approach the records are collected over a certain time period, say 24 hours, during both high demand rate and low demand rate times. These 4 indicators give sufficient information to plot the graph of variations and to evaluate cavitation phenomena. If data suggests the inception of cavitation these valves need to be changed in order to have an efficient flow.

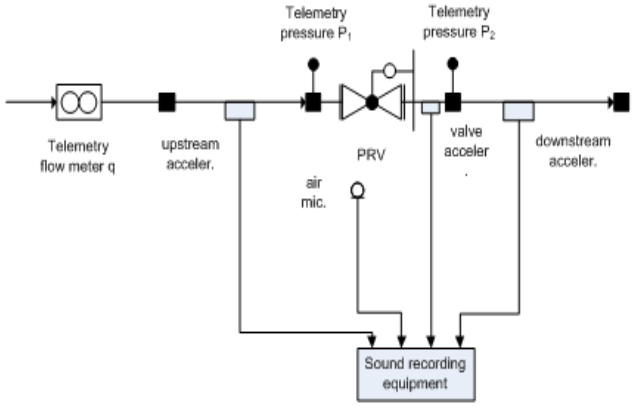

Fig.3Methodology

Above figure shows the setup to find the cavitation. And it also shows the position of 4 indicators used.

2.2 CAVITATION IN LARGE DOUBLE SUCTION PUMPS:

An end user installed large double suction pumps, and found that they were creating a noise . This noise created the suspicion towards the occurrence of cavitation. Son Mechanical Solutions, INC developed a device with a high frequency accelerometer. This device can find the rate of cavitation happening with quite a good precision. They used this device to find the amount of noise and vibration in different cases, by altering the material used, vane angle, velocity of flow etc. And plotted the graph of performance in these different cases. By this method they found that the impeller needs some modification and ring material should be changed. And after making these changes it was clear that the life period of use of impeller is increased by some years and also the repairing cost is now decreased by a significant amount. This new method to identify the quantity of cavitation is very beneficial in many cases and also quick and easy.

3. EXPERIMENTAL STUDY OF CAVITATION CORROSION:

3.1 ROTATING DISK IN TURBULENT FLOW:

In this experiment a disk is rotated under the turbulent flow. The rotation speed of the disk can be varied easily. And also can move at very high linear velocity. In this method the surface of rotor cavitation can be seen clearly.

3.2 VIBRATING DEVICE

The basic principle on which vibrating device work is basic magnetic effect and piezoelectric. In this experiment only a small volume of liquid is required on which through a transducer a high frequency and low amplitude vibration is passed. Due to this vibration, cavitation bubbles start forming.

3.3 VENTURI SYSTEM

This experiment can be applied in many ways but the basic principle on which it governs is always the same. In this experiment fluid first passes through the constricted passage and then through the divergent passage. This pattern of flow causes first pressure drop and then pressure rise resulting in forming bubbles which implode on surfaces.

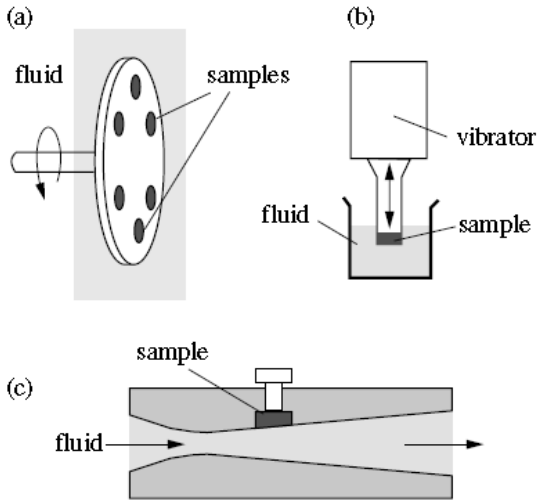

Fig4. a)Rotating disk. b)Vibrating device. c)venturi system

Samples and results obtained from above three methods are subjected to some numerical process and a cavitation number is found from the data obtained through experiments.

Cavitation number can be defined as a number indicating the frequency of cavitation. If cavitation number is higher for them, then it means that cavitation would occur under those conditions and it is necessary to change some conditions to decrease cavitation.

4. CASE STUDY:

The water pumps generally used for farming purposes to water the farms fail constantly after a certain time period. No matter how new the pump is being used, under the conditions it is being used it is always subjected to some problems. When we deeply investigated this particular kind of failure then it is found that there are some problems in the methods of using these pumps. And one of the biggest drawbacks is the improper supply of electricity. Farm pumps run direct supply of electricity from distributing panel. Because of this direct supply there is not a constant supply of voltage which results in the change of current continually and ultimately which changes the flow rate irregularly. As we earlier stated that change of flow causes change of pressure resulting in cavitation.

Due to above reason and incorrectly specified pump, (which is a normal case for farm pumps) motor overheats, and bearings fail constantly resulting in regular breakdown and needing repair.

This problem can be overcome by a significant amount by supplying a constant current. So we specified the correct pump which would be suitable for the existing system along with ABB inverter. The results are positives for this experiment.

5. CONCLUSION:

Cavitation is a very big problem which once started becomes bigger. It is harmful for every factor of functioning of a pump, like cost, efficiency, smoothness, flow rate, noise or vibration etc. To counter this problem is still a question mark in front of scientists and researchers. Therefore this particular area of fluid science needs some developments. Above discussed researches and theories are some of the steps which are taken to control cavitation and many more will come. From the above results it can be concluded that cavitation can be controlled upto some extent at operational level.

Cavitation will not happen if at suction point there is enough pressure not to cause vaporisation. And this can be achieved by reducing losses that mostly occur in flow hence in pumps. There should be the lowest possible friction in the pipe. For that purpose cleaning should be done at a regular interval of time. Friction can also be reduced by using a large diameter pipe. To reduce losses, pumps should be located as near as possible to the tank. Elbows , and sudden change in geometry of pipe should be avoided.

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