A Condition Monitoring system for vane pump Using LArVa

Mr.S.VIJAYKUMAR, Mr.PRABAKKARAN, Mr.R.NATESAN

ABSTRACT
Vane pumps are omnipresent in today's vehicle technology. This paper presents an approach to monitor the performance of the PUMP in an economical way to improve the efficiency by analyzing the fluid flow .This paper suggests for the design modification to minimize the opportunity for cavitations and to minimize the opportunity of noise causing conditions The LArVa GRAPH designed using the graphical programming language is capable of performing on-line measurement functions. ARDUINO BOARD facilitates interaction with the physical world via sensors while being able to perform calculations and various functions. In this paper, we perform pressure ripple measurement system and vibration measurement system which is heavily dependent on the system impedance characteristics. A simple pressure ripple measurement will provide clear information about the performance parameter, analyze the data and manage of vane pump. LArVa GRAPH which Graph application is a Labview program that uses the Labview Arduino Driver (LArVa) .

KEYWORDS: Arduino board, pressure ripple measurement, vane pump, LArVa GRAPH, vibration measurement .

1.INTRODUCTION

Predictive and preventive maintenance requires some means of assessing the actual condition of the machinery and we can often detect early failure using condition monitoring techniques. However, most of these parameters do not have a direct relation with the pump's condition and cannot necessarily provide an indication of potential damage at an early stage. Condition monitoring is an area that has seen substantial growth in the last few decades. Method of detecting and identifying cavitations damage on pump side plates via pump flow ripple. The investigation has been done through measurement and simulation. A numerical model of a vane pump is described, and simulated cavitations damage is introduced into the model. This damage is shown to have a clear effect on the simulated flow ripple. The pump flow ripple has also been measured experimentally using the Secondary Source Method. The simulation model does not show good accuracy at high speed and high pressure [1].

Mr.S.VIJAYKUMAR (M. Tech, EIE) Hindustan university, Chennai. PH:+91 9942271341,EMAIL ID:vijaykumarinstrument@gmail.com,
Mr.PRABAKKARAN (ASSISTANT PROFESSOR in automobile deportment) Hindustan university, Chennai.
PH:+91 9791148798,EMAIL ID:prabakkaran@hindustanuniv.ac.in,
Mr.NATESAN (ASSISTANT PROFESSOR in EIE deportment) Hindustan university, Chennai.
PH:+91 9894384329,EMAIL ID:Natesan.raajan@gmail.com

Pump state monitoring and analysis system is a comprehensive system built upon pump performance parameter and historical background. Real-time monitoring and analysis on the running state of marine vane pump can be achieved by the system [2].

In figure-1 the virtual instrument development software LabVIEW (laboratory virtual instrument engineering) is applied to writing a main program of status monitoring and system analysis. The performance signals can be acquired by an Arduino board and can be analyzed and processed through utilizing signal analyzing method. TCP/IP, Data Socket and other technologies can be used to write long-distance transfer server procedure and client program, transfer acquired data to the network, and realize data interchange and sharing function.

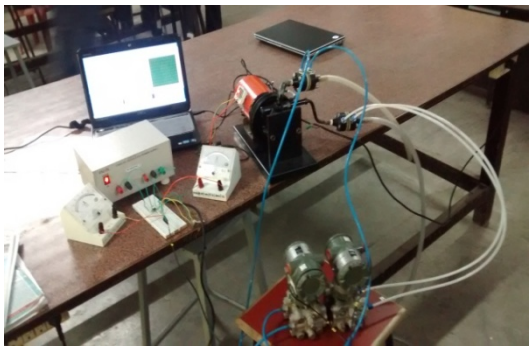

Figure-1 condition monitoring set up of vane pump

2. Introduction to Arduino:

The Arduino (shown in Figure 2) is a relatively inexpensive, yet versatile open-source microcontroller. It is designed to facilitate interaction with the physical world via sensors while being able to perform calculations and various functions. The Arduino can be connected to a computer via a USB cable and programmed using a simplified version of the C programming language, and it has both analog and digital pianos from or to which it can read or write values. The maximum voltage that it is able to supply is 5V; thus, a "HIGH" digital pin corresponds to 5V, while a "LOW" digital pin corresponds to 0V.There are many "shields" and sensors that are designed for interaction with the Arduino, or microcontrollers in general. The Arduino can read values from sensors or other inputs, and it can also write values of other components based on computations given by the program. Arduino is fast becoming one of the most popular microcontrollers on the market. Its ease of use, extensive software library and most importantly, its low cost has come to make it as popular as it is today.

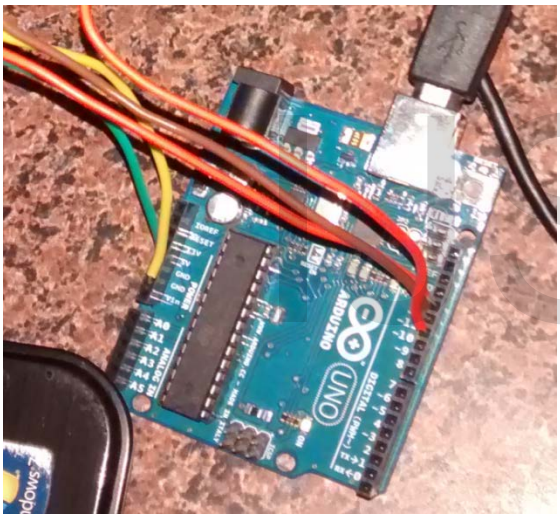

Figure-2 Arduino uno general board.

3. Pump parameters analysis:

3.1.Vibration

The ADXL345 (from figure-3)is a complete 3-axis acceleration measurement system with a selectable measurement range of ±2 *g*, ±4 *g*, ±8 *g*, or ±16 *g*. It measures both dynamic acceleration resulting from motion or shock and static acceleration, such as gravity, that allows the device to be used as a tilt sensor. The sensor consists of a micro-machined structure on a silicon wafer.

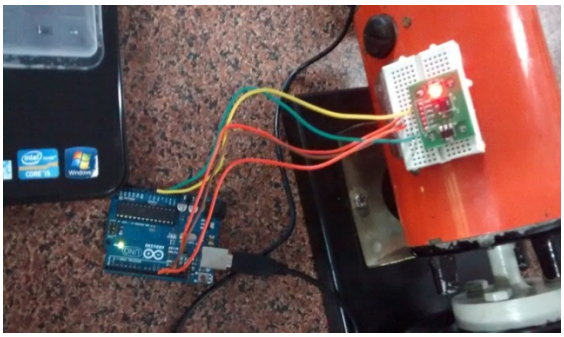

Figure-3 Triple Axis Accelerometer - ADXL345

The structure is suspended by polysilicon springs which allow it to deflect smoothly in any direction when subject to acceleration in the X, Y and/or Z axis. Deflection causes a change in capacitance between fixed plates and plates attached to the suspended structure

3.2. Cavitation

Cavitation defined as the formation of vapor phase of the liquid when it's subsequently to the high pressure. Cavitation is the cavities or bubbles are forming in the liquid that we're pumping. These cavities form at the low pressure or suction side of the pump, causing several things to happen cavities or bubbles will collapse when they pass into the higher regions of pressure, causing noise, vibration, and damage to many of the components. We experience a loss in capacity. The pump can no longer build the same head (pressure). The pump's efficiency drops. The vapor pressure of the pumped liquid can get very close to atmospheric pressure, causing the pump to cavitate every time it rains, or due to a packed valve in the suction piping that is at a negative pressure causing air to leak in through the packing.

4. The system design of condition monitoring and analysis of the vane pump

4.1. The hardware design

The total head is an important performance parameter of vane pump. On the basis of the head calculation formula of the vane pump, the head can be obtained through applying the formula after measuring the inlet and outlet pressure. Therefore, the head measurement is virtually the pressure measuring of the inlet and outlet. According to the requirements of head measurement, referring to related standards and rules. The related sensor parameters are as follows: static accuracy: ±0. 2%, operating temperature: －40℃-＋135℃, pressure range: 10 bar to 50 bar, operating voltage: DC10.5V—DC40V.

In the system of vane pump condition monitoring and analysis, the flow rate is an important physical parameter.

In view of the advantages of a meter in measurement such as high accuracy, good repeatability, simple structure, few moving parts, high pressure resistant, wide measuring range, small size, light weight, little pressure loss, convenient maintenance, etc., it is employed as the flow rate sensor of the vane pump in this measuring system. Referring to related criterion and provision,

4.2. The software design

For the performance test of the vane pump in the processing of test, flow points distributing evenly on the performance curve are taken. The performance parameters of the vane pump can be acquired from these flow points. After the acquisition of the parameters, the data will be analyzed and processed and then the changeful caves followed head, power and efficiency are drawn. The system of state condition monitoring and analysis of the vane pump employs **LArVa** graph as the development platform.

227	237	254
354	305	317
326	284	331
220	105	155
886	986	943
0	0	0
763	890	1023
648	755	657
112	42	105
514	506	435
830	830	844
26	0	19
611	681	550
533	600	551
387	332	398
674	534	480
390	316	340
270	244	269
346	334	337
288	274	301
260	235	261
327	314	321
303	294	319
253	228	257

Figure -4 serail monitoring of ADXL345

The test items and test content can be selected through user-friendly interfaces. In the process of testing, the system monitors the full operating state of the vane pump on the basis of received instructions, and can select the time-domain analysis, amplitude-domain analysis, frequency domain analysis of the signal, and meanwhile can acquire data and real-time display the corresponding parameters and curves.

5. Conclusion:

Centering on virtual instrument technology, the hardware design of state condition monitoring and system analysis are achieved. Extensive testing is proceeding by applying arduino to program the software parts of the state monitoring and analysis system.On the basis of the hardware selection, and software design of state monitoring and systematic analysis of the vane pump, the corresponding measuring tests are proceeding and the performance parameters under working condition of the vane pump are acquired. It has been noticed from the existing methods that the efficiency of pump was not achieved remarkably due to the cavitations.

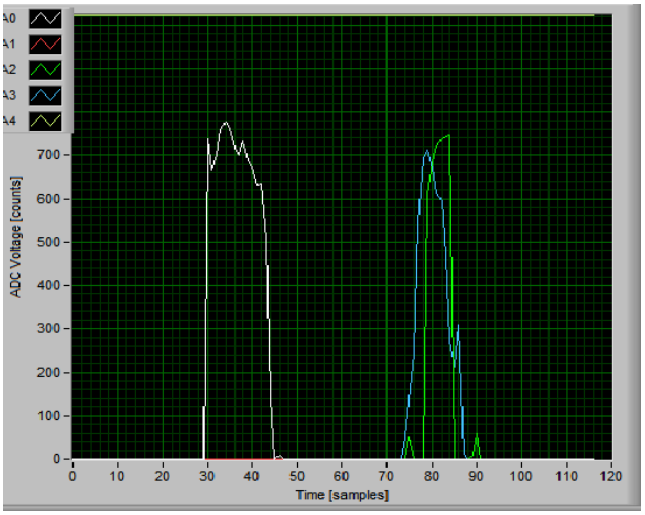

Figure-5 result for pressure and vibration sensors.

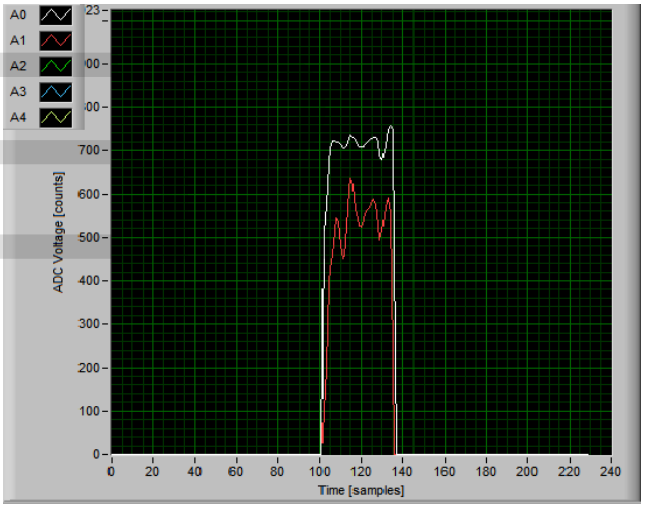

Figure -6 result for vane pmp pressure at different speed.

The Simple Graph application is a Labview program that uses the Labview Arduino Driver (LArVa) to gather between 1 and 6 channels from your Arduino microcontroller and display them on a graph. The program allows to save the raw data and access the full capabilities of the LArVa driver, such as variable acquisition rates and on-board firmware averaging. Though several monitoring tools are available in today's market, no tool is set to fulfill all the key properties assessed by open source condition monitoring. Any monitoring tool that the provider puts at the customer site adds a performance burden to the system.

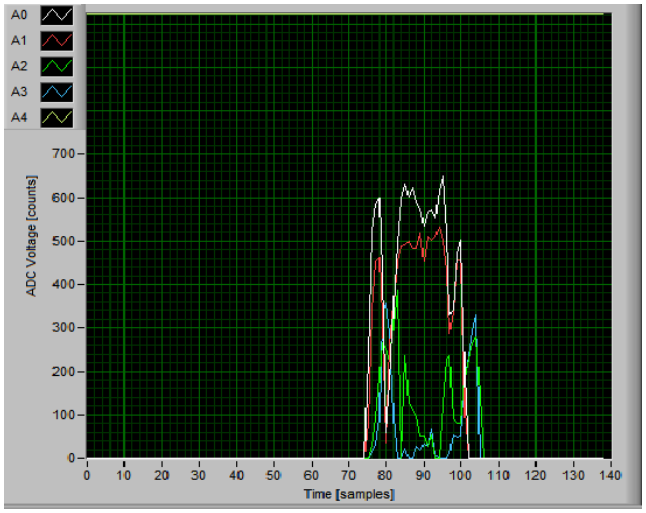

Figure-7 removed one vane in pump pressure

Extensive testing is done by applying program the software parts of the state monitoring and analysis system. From the figure (5&6) **LArVa** graph clearly describes about the issues and the recovery process. From the evaluated results, it is clearly evident that our condition monitoring approach achieves a better performance comparatively.

Future Enhancement:

The simulation of a real time simulator for performance monitoring and data analysis of condition monitoring of vane pump was successfully accomplished. By removing one vane from the impeller and calculation of the cavitations and vibration according to the implemented program will further help to remove the cavitations. As the VI(LabVIEW) technology is used here it can enable a closed response which is very fast. Data security is also very much improved.

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