Energy Savings in Pumps with Hydrophobic Coating

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Abstract

This project explores the energy, economical and protective benefits of hydrophobically coating pumps, specifically the Loctite PC 7447 coating by Henkel. Through research many benefits were found such as reduction in energy consumption, a decrease in electricity cost, longer lifespan of pump and protection against cavitation. The project went a step further to develop experiments to test the Loctites' protective ability against cavitation which can reduce pump performance. In the set up a 3D printed plastic pump was prepared to test the coating. Due to time constraints the experiments could not be done in length but are prepared for the next generation of students to take over.

Picture 4 –Pump housing coated with PC 7447 oleophobic coating.

Introduction

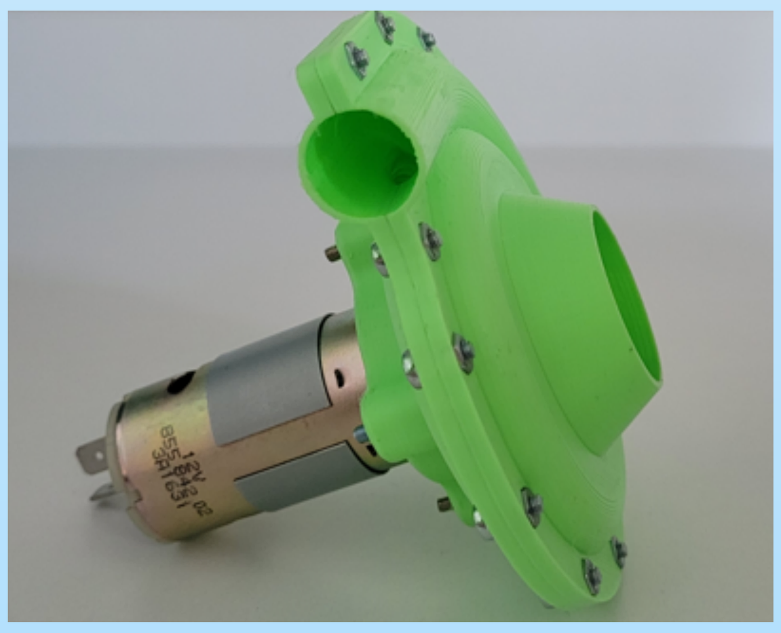
In the industry different machines and elements which consume energy are used. Pumps are one of the elements that consume energy and cause an increase of greenhouse gasses. Hydrophobic protective coatings create a high gloss barrier that repels liquids. Smooth pump surfaces reduce friction and turbulence which, in turn, decrease the energy required for pumping. As an added benefit, the coating provides a protective barrier to isolate the metal surface of the pump from fluids. The aim of the project is to evaluate a pump with a hydrophobic coating and how much it increases the efficiency of the pump and reduces energy consumption; and within this goal to observe its prevention of the effects of cavitation. There are different advantages of reducing the energy consumption both for cost and environment. Previous research and experiments show that hydrophobic coating significantly improves the efficiency of the pump and lifespan of the pump. Friction effect on centrifugal pumps can be reduced by properly studying the impeller friction losses, volute friction losses and disk friction losses.

Details & Tools

For the experiment a hydrophone is mounted as closely as possible to the place of appearance of cavitation and to present results in the frequency domain. Hydrophone is a transducer that converts underwater sound waves into electrical signals, rather like a microphone.The surrounding noise might be considered one of the most significant obstacles for measuring cavitation noise and applying acoustic monitoring techniques in commercial use. In the experiments, to detect the onset of cavitation of the pump, the total head is measured at a constant speed (2900 rpm) and a constant flow rate with varying NPSH current conditions. At the same time, the spectrum and the total emitted noise level are measured with a microphone placed at a distance of 0.5m and 1m; and is perpendicular to the pump-motor axis (Chudina, 2002). The noise generated by the centrifugal pump accounts for the majority of the total noise level. The emitted noise increases slightly when the cavitation process develops (Chudina, 2002). When the NPSH required value is achieved, the emitted noise begins to increase steeply with higher flow rates. At lower flow rates, the emitted noise starts to decrease steeply. When cavitation is fully developed at lower flow rates and the flow is partially or fully blocked, the generated noise decreases since the volume of the vapor bubbles increases so that some of them begin to cushion the collapsing impulses of others. The energy of the emitted noise caused by fully developed cavitation in the pump is nearly twice as high as that without cavitation in the pump. The smaller NPSH values correspond to stronger cavitation in the pump. To find the characteristic frequency within noise spectra, of which magnitude is in correlation with the corresponding NPSH required value at different flow rates, only sound between 20 and 20,000 Hz, was measured. For this you need a microphone and a computer equipped with a sound card. The drawback of background noise, which can disturb sound signal at the characteristic discrete frequency, can be overcome by shielding the microphone. A B&K FFT analyser, Type 2032, is used for the spectral analysis. Since the NPSH values vary with flow rates, the procedure is repeated for different flow rates.

Results

The main goals of the project were met wherein research was concluded about the energy savings and other benefits that could be gained from employing a hydrophobic coating to pumps. These results included raised efficiency by 6%, increased lifespan of pump, increase in the MTBF (Mean Time Between Failure) of pumps, electrical cost reduction by about 20%, reduced hydraulic friction, and reduced energy consumption around 15%. In the next branch of the project to investigate the cavitation reduction offered by the coating, the experimental research and decision of method to be used was completed. A 3D printed model as seen below was also made to carry out the experiment. In time these experiments will be completed and analysed to give a holistic conclusion of the protective effects of the Loctite PC 7447 coating.



Conclusion

Research of the project was very progressive despite a lack of sources related to it. We found the most analogous papers and reports; we investigated and analysed the causes of reduction in pump efficiency to understand the subject of the project. For the implementation, we were planning to execute an experimental set up to observe the positive and protective effect of hydrophobic coating. However, gradually we understood that our equipment resources and our time are not enough to complete that set up or experiments.While the company entered discussions to provide an operating centrifugal pump we decided to use a 3D printed plastic pump. Then we learned that the hydrophobic coating cannot be applied to a fragile plastic surface. Therefore, we could not carry out the experimental set up. The project cannot be completed in the given time but we have readied the groundwork for the next batch of students to continue with the experimentation stage.

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