

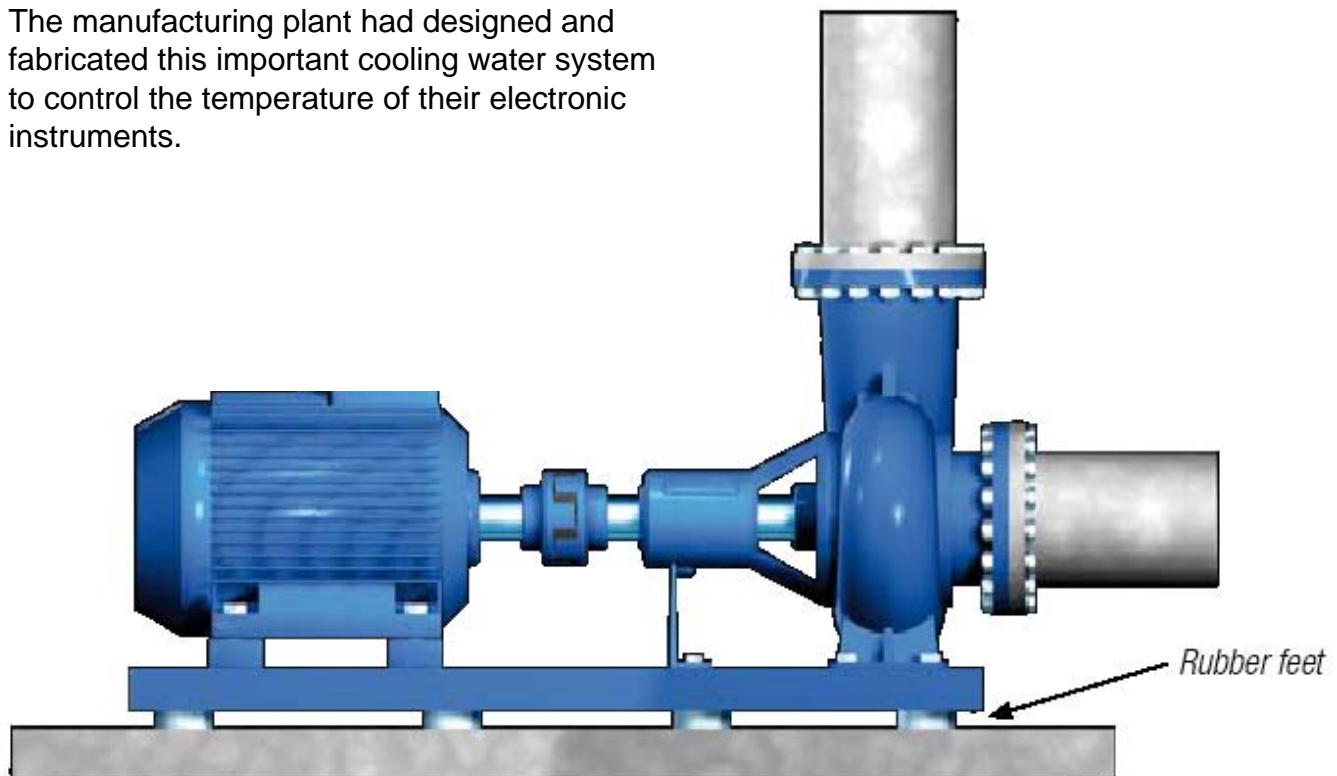
Thermal Growth Case Study

By John Lambert

In this article we will study the effects of thermal growth of a pumping unit used as part of a manufacturing plants process.

The machine units are mounted on a steel base plate which in turn is supported on special rubber mounting pads and secured to a strong foundation.

The manufacturing plant had designed and fabricated this important cooling water system to control the temperature of their electronic instruments.



This is important because if you lose the cooling you could also lose the electronics which would result in the replacement of some components and something even more costly – down time. The system is quite simple consisting of a motor, pump and a filter unit. However, you can see by the size of both the inlet and outlet of the piping system (approx 250mm 10”inches) that it has a fairly large capacity.

The problem for the manufacturer was that the vibration levels increased when the pumping system reached its maximum working temperature. The problem was so severe that it had caused damage to the pump shaft resulting in pump failure (down time). This happened despite the fact that the manufacturer used an Easy-Laser® D505 shaft alignment system to align the motor to the pump in cold condition.

A specified thermal growth compensation calculation was also used which meant that the motor was set high in order to compensate for the growth of the pump.



Cold alignment

This was based on the knowledge that the pump became 15 degrees Celsius warmer than the motor during operation.

The manufacturer then hired someone from Easy-Laser® (Damalini AB) to find a solution to their problem. Nils Anderson, an expert in the machinery installation field, conducted the work and the following is his report.

Report

First, we performed a shaft alignment measurement in cold conditions using the thermal growth specification so that we could verify and document the exact position of the motor and pump shafts compared to each other. We then started the machine and when it had reached its maximum working temperature we quickly shut it down and locked it out.

Once again we performed a shaft alignment measurement. By doing this “hot alignment” we could see how the thermal growth had changed the alignment.

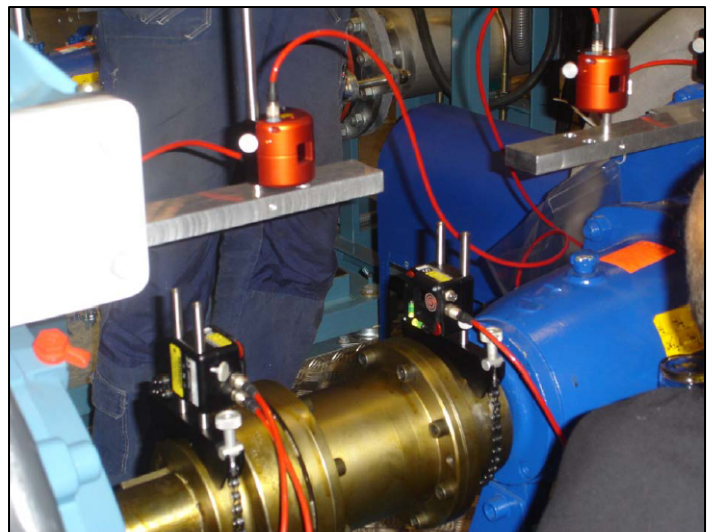
The results were very good matching the calculated thermal growth. We were within tolerance so this could not be a cause for increased vibration levels. Nor would it have caused the damage of the pump shaft.



Hot alignment

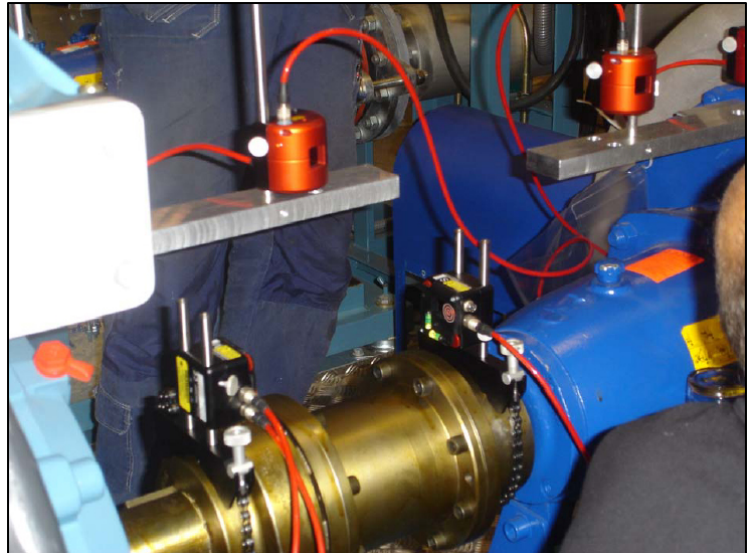
We then decided that the problem might be in the dynamic force that is created when the machine units are working at full capacity, online, and with the complete system at operating temperature. Such a dynamic force can have a great effect throughout the base and foundation.

Although performing a hot alignment gives you a good indication of the thermal growth of the machine units, it does not give you a real time measurement. To do this we then used our D23 Easy-Laser® Spin laser transmitter and four D6 Spin-detectors (2 of which are shown in the picture) which we connected in series. We produced two (2) brackets which were mounted on the pump and motor. On each bracket we then mounted two (2) detectors.



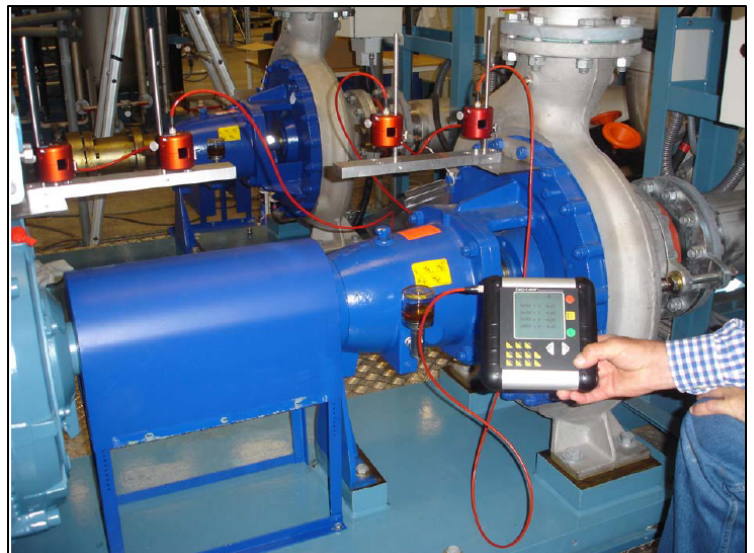
The laser transmitter was placed on a stand on the floor and was levelled so that we could read the spirit levels. This allowed us to confirm that the transmitter did not change its position during the measurement.

The detectors were then adjusted on the mounting rods so that the beam swept the detector surface in the midst of its range. Program 33 (rotation) was used on the display unit which then showed the four (4) detectors with real time measurement readings at the same time. Next we zeroed set the detectors on the display unit.

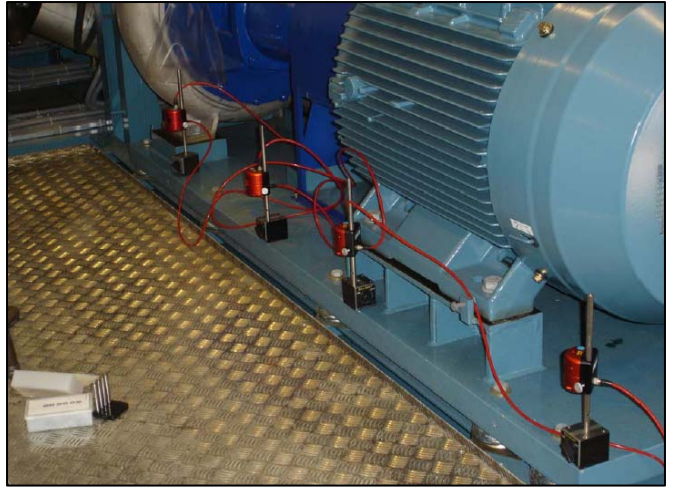


Now all we had to do was start the machine units and watch the display and observe the real time measurement.

We could now read how both the motor and the pump changed their position compared to each other. It showed that the rear part of the pump rose 0.019"thou (0,5 mm) and tilted downwards 0.011" thou (0,3 mm) at the centre of the shaft compared to the centre of the motor shaft. These measurement values did not correspond with the values that we had received in the hot alignment condition.



We then decided to investigate whether the base, which is a solid steel plate with the dimensions of thickness 2.4" (60 mm), width 39" (1000 mm) and length 78" (9200 mm), was moving or not. To do this we mounted the four (4) detectors on the base we wanted to measure and placed the Laser transmitter on another base which was not being used.

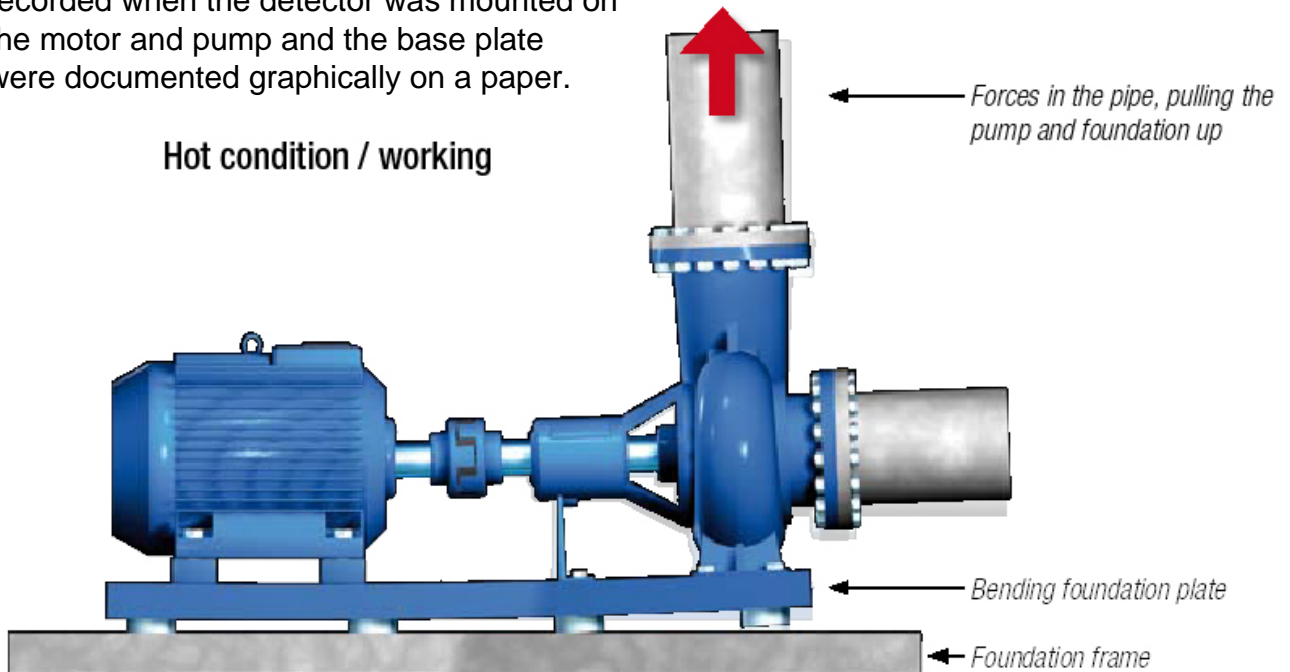


The transmitter was secured by its magnetic base and it was levelled, each detector was set to zero. We then started the motor and ran the machine unit at its full capacity and at its maximum operating temperature. The measurement results showed that the rear part of the base rose 0.019" (0,5 mm) and flexed 0.007" (0,2 mm) in the middle.



Evaluation

All the measurement values that we recorded when the detector was mounted on the motor and pump and the base plate were documented graphically on a paper.



We could then clearly see the position of the pump shaft centre in relation to the motor shaft centre when the machine units were running and under full load.

The force of the connecting pipe on the pump lifted the whole base which flexed at the middle. This was the cause of the large offset and angular misalignment between the pump and motor which then created increased vibrations. Based on the facts of the measurement results we recommended that the customer strengthen the base and modify the piping support and also to consider using a flexible joint between the pipe connection and the pump to minimize the force.

Summary

With this information we would like to emphasise that far too many installation technicians focus on the thermal growth of the motor and pump, but they forget the fact that dynamic force very often gives larger alignment error than the thermal growth. In other words one does not always see the true result by measuring the position of the shafts in cold condition and then in warm condition even though this gives good information about the thermal growth. In this case the thermal growth changed the offset of the centre of the shaft 0.004" thou (0,1 mm). While the dynamic forces when the machine units were running online changed the offset 0.016 thou (0,4 mm).

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