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THERMAL GROWTH INFLUENCE ON THE SHAFT ALIGNMENT OF CENTRIFUGAL PUMPS

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ABSTRACT
The value of thermal growth has an important index for the shaft alignment of pumps. If parts of the pump unit (pump and electromotor) are heated identically, then thermal growth is evened and not taken into consideration. But usually a pump and electromotor have different coefficients of thermal growth and it is very important. In the article temperature growth influence on the shaft alignment of centrifugal pump unit is examined.
Keywords: laser alignment, machine reliability, algorithm

1. CENTRIFUGAL PUMPS SHAFT ALIGNMENT
In an order to provide reliable and long work a pumping unit (Figure 1), it is necessary to provide the precision shaft alignment of pump and electromotor. There are a great number of shaft alignment methods. There are:

- Alignment with feeler-gauge
- A rim and face method
- Reversed indicator method
- Laser method

For the shaft alignment of all rotor equipment, including centrifugal pumps , it is most correct to apply a laser method. This method abbreviates time of alignment, not only considerably, but also allows to conduct alignment with maximal exactness (to 0,001 мм).

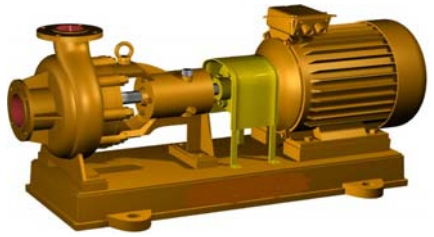

Figure 1. Centrifugal pumping unit

Now in the world exists a great number of companies which produce equipment for laser shaft alignment. Principle of the laser shaft alignment system operation is simple enough. Any laser alignment systems consists of two sensors: S (stationary) and M (moving), which in same queue are set on stationary (S) and mobile (M) machines. As sensors used the PSD (Position Sensitive Device) sensor. It is an analog component, with theoretically unlimited resolution. When the laserbeam hits the PSD, an electric current flows through the point hit by the beam. The electric currents at the two electrodes are proportional to the position of the beam. This makes it possible to determine the position of the beam center. The resolution possible is, quite literally, one in a million. [1]
Mainly, the laser shaft alignment systems uses a visible red laser beam as a measurement reference. The laser beam is directed to the PSD detector. Then the measurement programs in the computer calculate the values from the PSD and present the result according to which program is used. [1]
On the figure 2 the laser shaft alignment conducting algorithm is presented.

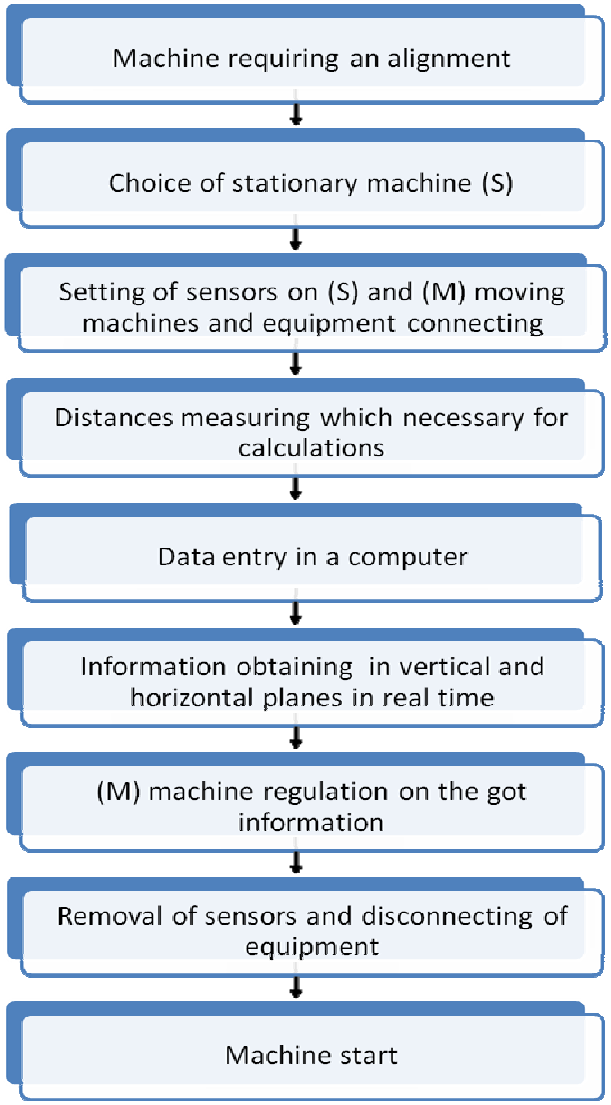

Figure 2. Laser shaft alignment conducting algorithm

2. THERMAL GROWTH

A coefficient of thermal growth is the standard length or volume of material relative measuring, attributed to unit of temperature scale.

Under thermal growth it is necessary to understand the change of pumping unit components sizes due to heating of moving parts. The electro motors of pumping unit are most strongly subject to thermal growth. Heating takes place due to mechanical friction and electric energy transformation to thermal energy.

Thermal growth of stationary and moving machines parts can influence on the measuring results. For example, the thermal growth coefficient of steel is approximately equal 0,01 mm/m on every increasing degree of temperature. If moving and stationary machines have identical workings temperatures, then influence of thermal growth it is possible to ignore. Otherwise, it is necessary to conduct an alignment till machines will cool off after a shutdown, or it will be necessary to take into account the difference of temperature growth coefficients. At determination of temperature growth factor role it is needed always to check following:

- Working temperature of both machines
- Temperature coefficient for both machines
- Influence of surrounding heat sources at machine, including machines and mechanisms isolation, external heat sources, action of the cooling systems.[1]

The coefficient of linear thermal growth calculates on a formula (1):

$$X = \frac{\Delta L}{L_0 \Delta T} \qquad (1)$$

Where, X - coefficient of linear growth (^0C); ΔL - specimen length change at heating or cooling; L_0 - specimen length at a room temperature; ΔT - difference of temperatures (^0C), which the specimen length change is measured for.

3. THERMAL GROWTH CALCULATION

If the direction and extent of growth are known, the machines may be purposely misaligned such that they grow into place, resulting in good alignment condition during normal operation. Most laser shaft alignment systems contain a special function designed especially to incorporate such alignment target values. The most readily available target specifications for cold alignment are generally obtainable from machine manufacturers. Where this information is not available the following calculations will assist in establishing thermal growth (2):[2]

$$\Delta L = L \cdot X \cdot \Delta T \qquad (2)$$

Where, L - height centerline to base of machine

For example: A centrifugal pump with liquid at 150 ^0C . Base to center height 660 mm. Ambient temperature 10 ^0C :

$$\Delta L = L \cdot X \cdot \Delta T = 0{,}66 \cdot 0{,}01 \cdot (150 - 10) = 0{,}924\, mm$$

Thermal expansion is not however the only cause of machine position change. Many elements can impinge on the accuracy of the final result such as:

- Thermal Expansion of bearing supports
- Changes in radial or axial forces;
- Changes in oil film thickness on bearings;
- Changes in foundation or base plate supports and
- Changes in piping forces [2].

4. CONCLUSIONS

At the centrifugal pump laser shaft alignment it is necessary to take into account influence of thermal growth on further unit work. For this purpose it is needed a few days prior to alignment to measure the working temperature of pumping unit components. If the pump and electromotor temperature is approximately identical (with a difference ±10ºC), thermal growth it is possible to ignore. If a difference more, then it is necessary to calculate the thermal growth size and take into account it at an alignment. It is also possible to conduct an alignment on a yet not getting cold unit. In this case there is not a necessity to calculate and take into account thermal growth. But experience shows, that at alignment the unit rarely is hot, and, consequently, in most cases, thermal growth needs to be taken into account.

5. REFERENCES

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