REDUCING RETESTS OF BETWEEN BEARING RADIAL SPLIT PUMPS

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A survey of performance tests, conducted on the pump manufacturer shop floor, indicates that a certain class of between bearing radial spit pumps has an unacceptably low probability of meeting API 610 8th edition vibration limits on the first test. The design parameters affecting vibration have been statistically identified in the survey data and a vibration abatement process was put in place, which improves the probability of passing on the first test to 90% or better.

The vibration abatement process includes: (1) structural changes to the pump case, to increase the foot stiffness; (2) changes in the bearing bracket, to shift the natural frequencies; (3) hydraulic design changes to the impeller, to reduce the re-circulation and vane passing forces, and (4) modifications to the test loop to reduce piping interactions, as shown in figure 1.

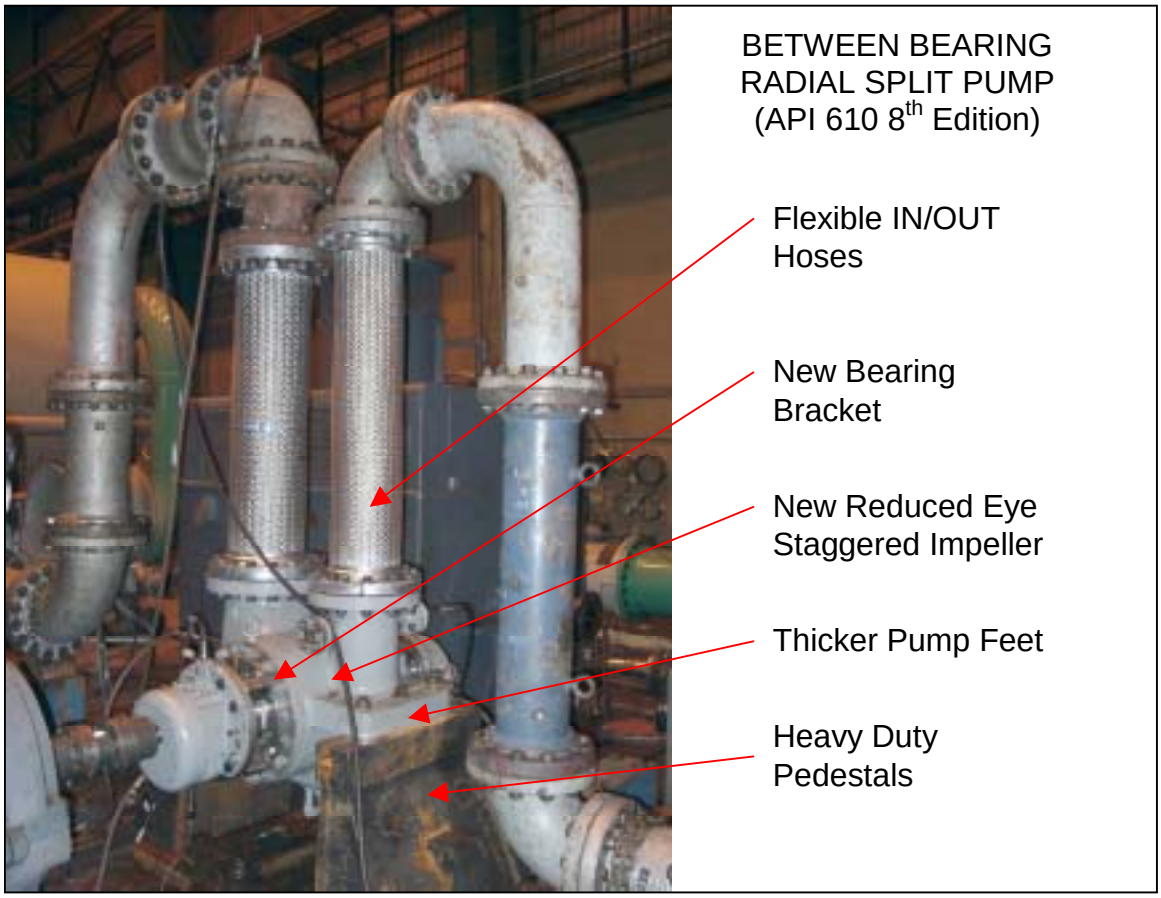

Figure 1 Vibration Reducing Test Loop

The specific class of pumps with high vibration as determined by the vibration survey is type BB2 of API Standard 610. These are centrifugal, between bearing, 1 & 2 stage, radial split pumps and typically have a double suction impeller designed for low NPSH service. There is a correlation between bearing housing vibration and impeller tip speed, with the higher vibration pumps typically having impeller tip speeds above 60 m/sec (197 ft/sec).

The vibration measurement locations are in the horizontal and vertical directions on the inboard bearing housing and in the horizontal, vertical and axial directions on the outboard bearing housing. The maximum vibration limits in API 610 8th Edition, are overall Vu < 3.0 mm/sec RMS (0.12 in/sec RMS) for the preferred operating region, with an increase of 30% for the allowable operating region. These limits are significantly reduced from the previous flat overall limit of Vu < 5.39 mm/sec RMS (0.212 in/sec RMS) for API 610 7th Edition. As such, the historical data includes many unmodified class BB2 pumps, which are not suited to meet the reduced API 610 8th Edition vibration limits, as indicated by the low success rate in figure 2.

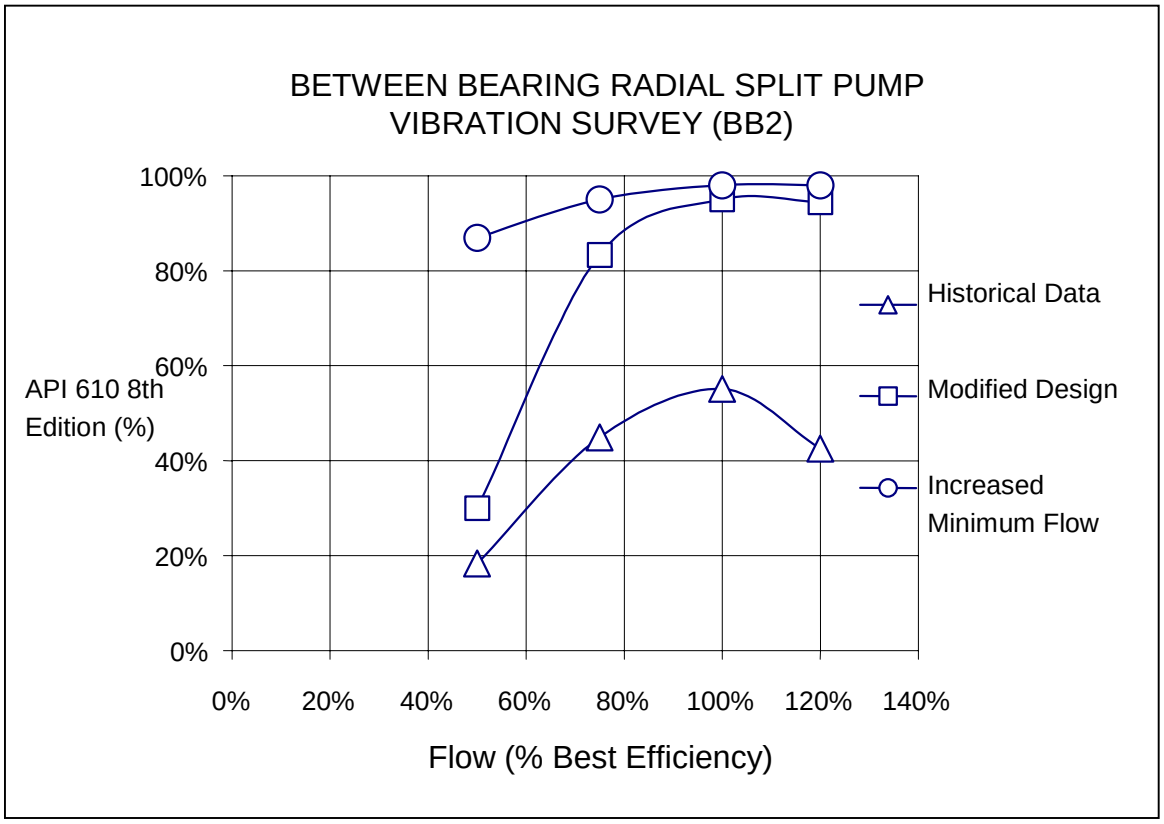

Figure 2 Survey of Tests Meeting API 610 8th Edition Vibration Limits

These results are applicable on the pump manufacturer shop floor using water as a test medium. The vibration is typically lower in the field for hydrocarbon service and with a fully grouted base-plate.

After making the prescribed design modifications, the probability of success on the first test improves from approximately 50% to 90% near best efficiency point. For some of the higher impeller tip speed, class BB2 pumps, a higher specified minimum flow is also required in order to meet API 610 8th edition vibration limits at off design operation. In this case, the minimum flow is derived from a curve fit of the maximum bearing housing vibration versus flow rate for each pump size at a given operating speed, with the allowable operating range corresponding to a rise of 30% above the basic vibration limit. When the minimum flow is specified in this way, the probability of success on the first test is 90% or better over the full operating range of the pump.

Based on a survey of historical vibration data, the systematic vibration abatement process and re-specification of minimum flow, has resulted a design which is more consistent, avoided potential trouble jobs and significantly reduced costly delays on the shipping floor for the pump manufacturer.