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# NOISE FROM VERTICAL PUMPS WITH PUMP WELL - Analysis of Causes and Methods to Noise Control.

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## INTRODUCTION

In mining industry transport of floating medias is one of the main tasks. When mining underground and when processing the minerals there are large quantities of water, floating pulp and foam that has to be transported. Most of these transports are carried out by pumps. In an ordinary concentration plant there can be hundreds of pumps of varying sizes and types. Most common are centrifugal pumps and the types are mainly vertical pumps, horizontal pumps and pit pumps. The first two are named from the direction of the driving axle. Some of the pumps are emitting very high noise levels. Levels around 95 dB(A) are often found in the reverberation field in concentration plants.

Noise emission from the pump body and connected pipes has been carefully examined by several researchers. Narrow-band noise appears when the impeller blades periodically pass irregularities in the pump body. The main part of the broad band noise generated is caused by the turbulent flow in the pump.

Our work, which is the subject for this paper, has been to examine the interaction between different parts of a vertical pump that is common in Swedish mining concentration plants. It is a complex pump where a centrifugal pump, a cone belt transmission and an electric motor are rigidly mounted to a pump well. Thus making it possible for vibrations to be transferred through and radiated from the construction.

For our experiments we have chosen a modern solid pump with fairly low noise emission. No faults and unbalances were allowed. The motive was to investigate the minimum noise from such a pump. In the industries several defects can often be found in the pumps: e.g. unbalances, worn impeller and pump lining, bearing with defects, too low water level in the pump well or inaccurate dimensions, resulting in high load on the pump. Noise levels from these effects will be added to our measured values.

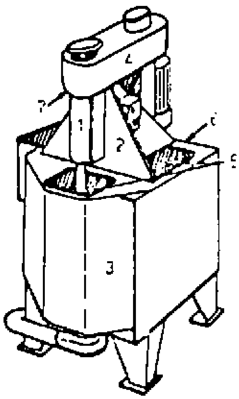

Figure 1. SALVA SPV 304-4 Vertical pump with Variphi variable transmission. Capacity 5,5 $m^3$/min.

We measured the sound power from the pump in a low reverberant room according to the ISO 3744 Standard.

The frequency range 250 to 2000 Hz showed to be the most important for the A-weighted noise level.

The main noise sources in the test pump are: fan noise from the AC-motor, the belt transmission unit, the water flow in the well and the pump itself. There is very little noise radiation from the pump body as it is of relatively thick cast iron and has wear-rubber lining inside. Neither does the elastic output pipe radiate any noise of importance. Vibrations originating from the pump is however found in other parts of the structure.

## IDENTIFYING THE NOISE SOURCES

Our aim was to identify the noise radiation from the different surfaces. We used both accelerometers to determine the vibration velocity and two microphones to determine the acoustic intensity. The accelerometer/velocity method showed to be the most useful method for structure borne noise. The intensity method gave inaccurate results for some surfaces due to strong radiating nearby sources that contaminated the wanted signal. The intensity method was especially used to determine the airborne noise radiation from openings. It was also used on some surfaces to give indications of the accuracy in the chosen radiation factors for the vibrating surfaces.

Results

Vibrations from the pump and from the belt transmission at frequencies $n \times v_2$, where $v_2$ is the speed of the pump 30.5 rps, were found at high levels in especially surfaces 1 and 2, see fig 1. The belt transmission also caused vibrations of frequencies $n \times v_1$, where $v_1$ is the speed of the electric motor 24 rps.

It was also found that the airborne noise is dominating and that it exceeds the structure borne noise with more than 10 dB, see fig 2.

When comparing the main radiating surfaces, fig 3, we found that the radiated sound power is fairly evenly spread over a couple of surfaces, although the sizes and shapes of the surfaces vary considerably. Thus the pump well is not such a dominating noise radiator as was expected.

The influence of the water level in the pump well on the emitted noise level is shown in fig 4. The pump and the water column go into oscillation at very low water levels and there is a slight howling sound produced. This effect is more accentuated in some industrial applications where the howling noise even can pass 100 dB(A). For higher water levels the noise level can be said to be independent on the water level.

When changing the gear ratio to the pump the sound level also changes significantly. In fig 5 a 3D noise spectrum for different pump speeds is shown. At low speeds a screeching sound from slipping in the transmission increases the noise levels at 500 and 630 Hz. Eliminating these we get the total noise level as a function of speed. We found, with a standard deviation of 1.2 dB, that the noise level increases with 4.8 dB(A) per doubling of pump speed.

## CONCLUSIONS

The vertical pump is built up in 5 and 8 mm steelplates thus making up a rigid construction. Other, especially older, types of vertical pumps use thinner steel plates. In the tested pump the structure borne noise is significantly lower than the noise radiated from openings. Weaker pump-constructions will have more noise from structure radiation.

Most efficient ways to noise control the pumps will be:

running the pump at a lower but still efficient speed, keeping the water level above a certain minimum level, build an enclosure around the belt transmission, put a silencer on the electric motor's fan opening, close the opening on the pump well with an isolating screen. We plan to present the results from a couple of the above steps at the conference.

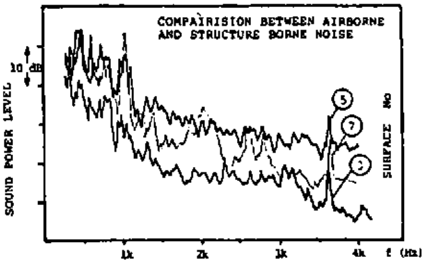


Fig 2. Radiated sound power levels from two openings 5 and 7, and from pumpwell surface 3.

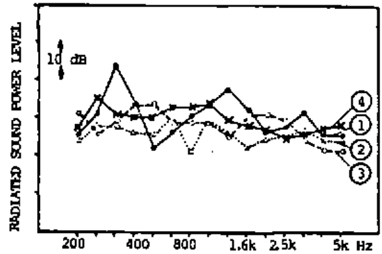


Fig 3. Third octave sound power levels radiating from different vibrating surfaces. Calculated from vibration vel. and radiation efficiency.

Fig 4. Sound pressure levels with varying water levels in the pumpwell

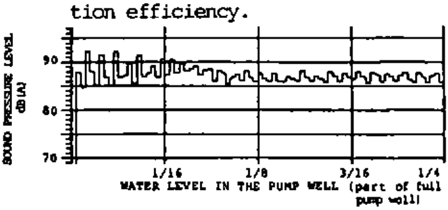


Fig 5. Third octave noise levels at varying pump speed. The electric motor keeps constant speed.