inter•noise 96
25th Anniversary Congress – Liverpool
INCE: 12

NOISE SOURCE LOCALISATION IN AN HYDRAULIC AGGREGATE USING THE SOUND INTENSITY METHOD

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1. INTRODUCTION

The annoyance caused by the noise of different machines is often determined by their hydraulic aggregates. This is not only obsereved in static applications, but also in the field of mobile hydraulics. Noise reduction in the field of hydraulic drives is becoming more and more important due to increasing power and the higher requirements concerning noise emission of machines (EC-Guidline No. 89/392).

The complete sound energy of a hydraulic system is defined by the sum of the single energy portion of each component. The emission of noise is given by the loudest source or sources of sound. Until now, a noise emission of one single component could not be looked at or measured separately. It is widely known, that successful noise reduction of hydraulic systems can only be achieved when a change of the design at the loudest noise sources is carried out.

The answer to the question, of whether the noise emission of a hydraulic system is caused by fluid borne noise (pressure ripple at the pump outlet) or structure borne noise from internal excitation in the pump, depends upon the structure of the system [1, 2, 3]. The noise behaviour of a hydraulic system also depends largely upon the type of pump used. The relationships between both causes for noise in a real system are very complex.

The natural vibration of the pump and the attached components is caused mainly by the mechanical structure of the whole system. This structure also determines the way the fluid borne noise spreads and its transformation into structure born noise. The use of hydraulic silencer is made possible, when the main sound sources within the hydraulic system and the attached components are known.

The detection of the major noise sources in a hydraulic system is therefore of major importance and is made possible with the intensity measurement method as presented here.

2. MEASUREMENTS ON THE HYDRAULIC AGGREGATE

The measured aggregate is shown in Fig. 1. For the connection between the pump and electrical motor a damping flange was used. The electrical motor was mounted with 4 screws on the oil tank. A flexible pipe was built between the pump and pressure limit valve.

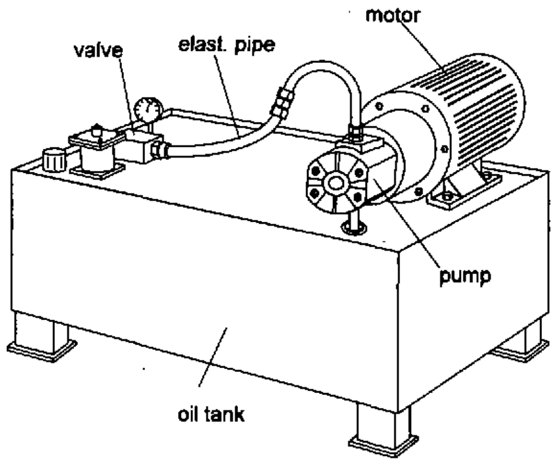


Fig.1: View of the hydraulic aggregate

The measurements were carried out at a pressure of p = 100 bar.

Two types of hydraulic pumps were used on the aggregate:
- a pressure regulated vane pump with a flow rate of Q = 63 l/min
- an external gear pump with a flow rate of Q = 75 l/min.

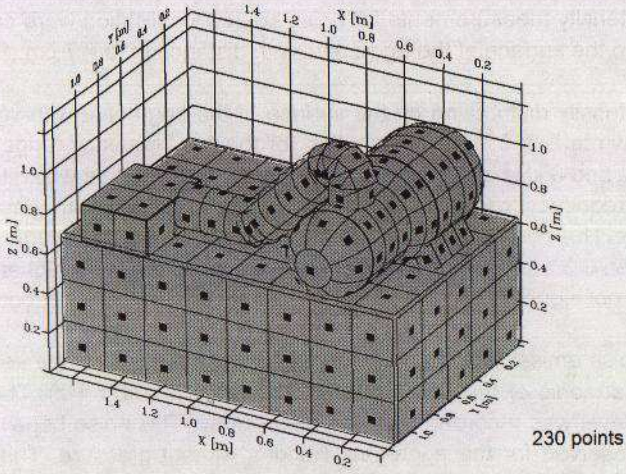


Fig. 2: Distribution of measurements points

The distribution of the measurement points taken into account is shown in Fig. 2.

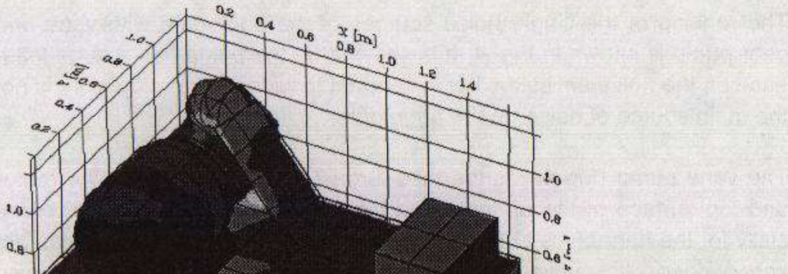


Fig. 3: The intensity distribution on the surface of the aggregate for the vane pump for pressure of p = 100 bar (frequency range f = 100 - 8 000 Hz)

The intensity measurements for noise source localisation were carried out close to the surface of the aggregate with distance of a = 7 cm.

The intensity distribution on the surface of the aggregate with vane pump is shown in Fig. 3 . The distribution for the full frequency range between 100 Hz and 8 kHz is displayed. It can clearly be seen that within the measured frequency range the electrical motor represents the main noise source. The hydraulic pump radiates noise in a higher frequency range between 6.3 and 8 kHz, however noise emission at these higher frequencies is not significant to the global noise emission of the aggregate.

The noise emission of the motor is especially intensive for the second and third harmonic of the pump ground frequency (f = 375 Hz). The highest noise level was recorded near the motor body. This noise behaviour was also observed for the aggregate working without pressure. The intensity distribution of the aggregate can be shown for selected frequencies or frequency ranges.

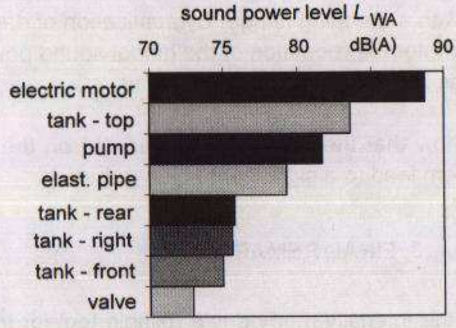
3. RANKING OF NOISE SOURCES

The ranking of the single noise sources of the aggregate with vane and gear pump is shown in Fig. 4. It is shown that the pump has a large influence on the noise emission, but in contrast to widely spread opinion, is not the main source of noise on the aggregate.

The vane pump (Fig 4a) is the third largest noise source after the motor and top surface of the oil tank. The high level of the motor noise, especially for the harmonics of the ground frequency of the pump has been acknowlwdged. It shows that the pump is responsible for the noise deve-lopment of the motor.

By using an external gear pump (Fig. 4b) instead of a vane pump, the sound intensity of the top surface of the oil tank radiates more noise. But the noise emission of the electric motor is also relatively high. The gear pump is the sixth largest noise source. It is clear that for the aggregate with gear pump other measures for noise reduction should be applied. The capsulation of the motor will not be as effective as for the aggregate with the vane pump.

a)



b)

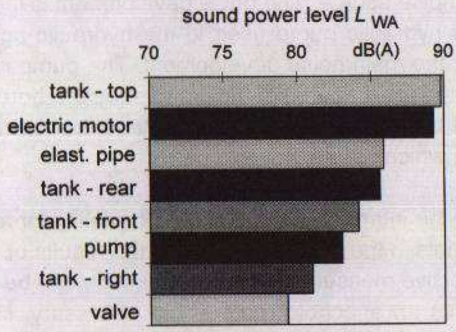


Fig. 4: The ranking of noise sources in the hydraulic aggregate for the pressure of p = 100 bar
a) with a vane pump b) with an external gear pump

Based on the results of measurements for the aggregate with the vane pump, the efficiency of the different measures for noise reduction was proved. The sound power measurements based on ISO 9614 Part 2 were carried out.

The following results were achieved:

-Simple capsulation of the electrical motor was applied. The ventilator and pump side were partially open. Global sound power level reduction of 4 dB(A) was achieved.

- In the standard realisation of the aggregate, the pump is connected to the electrical motor with a damping flange. By application of damping elements under the motor the reduction of the global sound power level of 1.5 dB(A) was reached.

These results clearly show that the measures carried out on the loudest noise source in the system lead to a significant noise reduction.

3. FINAL REMARKS

It has been shown that the intensity method is a reliable tool for the noise source localisation in hydraulic aggregates. It was observed that the electrical motor is the main noise source. The noise development is largely dependent on the type of hydraulic pump used in the hydraulic aggregate, which is responsible for the main noise development. The pump is not the main noise source, but the main source of fluid and structure borne noise. The vibration energy of the pump is transmitted to the other components of the hydraulic system, which radiate noise.

The main advantage of the intensity method is the possibility for fast identification of the weak points in the system. Based on the results of intensity measurements, the effective measures for noise reduction can be applied. For these measurements an anechoic room is not necessary. Measurements can be carried out on the aggregate in situe.

4. REFERENCES

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