reducing the noise of pressure pulp screen

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July 1994

1- INTRODUCTION

A pressure pulp screen is a device able of classifying and separate fibers in paper pulp. The machine is made of two concentric cylinders closed at both extremities. The inner cylinder, called "basket" is perforated. The size and the form of holes is determined by the considerations on the quality of paper and the time where classification occurs during the process.

The pulp is injected under pressure in the centre part of the machine. The accepted pulp goes through the holes of the basket and is collected by a pipe connected at the part between the two cylinders. Refused pulp is collected by an other pipe in the centre part of the machine.

In order to clean the holes of the basket, the depression made by blades moving at less than 5 mm of the inner side of the basket is used. These blades are supported by a rotor running at 1150 rpm (fig. 1).

The noise of this machine is characterised by a discrete spectrum in middle and high frequencies (fig. 3). Levels depends of the consistency of pulp (1 to 4 % of fibers), the type of holes (vertical slots, profiled circular holes) and speed of rotation of the rotor.

Classical sound power levels in industry are 95 dB(A) for a basket with circular holes for a diameter of 90".

2- SOURCE CHARACTERISATION

The basket is excited by the rotor. Mathematical representation of rotating forces shows a temporal dependence of the form of $e^{-jN\Omega t}$ Ω, the speed of rotation. It corresponds to a discrete spectrum with lines $\beta\Omega/2\pi$ Hz away from each other, β corresponds to the number of blades.

A theoretical study made by R. Panneton [1] has shown that the response of a cylinder excited by this type of force shows a discrete spectrum with lines on the same frequencies as the excitation. The amplitude of these lines is much important when a coincidence between the frequencies of excitation and the modes of the cylinder occurs.

For our problem, the typical speed of rotation of the rotors and the typical modes of baskets implies that the response must be important only at the first ten harmonics of the frequency of rotation. The problem is that we have the greatest part of the acoustic energy around the 150-200 harmonics of the speed of rotation. In order to understand this phenomenon, R. Panneton studied the effect of an amplitude modulation of the force around the cylinder. He found that the response of the cylinder shows a new set of lines centred around the ξth harmonic of the speed of rotation, with ξ, the number of modulations around the cylinder. Figure 2 shows a numerical result with 75 modulations.

A typical basket for a small screen pressure presents 150 to 200 holes along its circumference. Analysis of the acoustic spectrum emitted by the machine shows that holes are effectively responsible of the modulation of the rotating force exciting the cylinder. This assertion is confirmed by the great dependence between the size and the form of holes and the acoustics levels emitted by the machine.

3- TRANSMISSION PATH CHARACTERISATION

The basket is vibrating under the excitation made by the rotor. These vibrations can be transmitted to the outer cylinder, which is the radiated part of the machine, along two paths:

- Liquid transmission through the pulp.
- Solid transmission through the clamped parts of the basket.

Some measurements are made in order to find the principal path of transmission. The general principle of these measurements is always the same: cutting one path and looking at the result on the overall noise emitted by the machine. Acoustic power is measured using an intensity probe. In order to get comparative results, all measurements are made in water (consistency of pulp = 0%). Tests were made on an ANDRITZ SPROUT BAUER PSV 2100 pressure screen.

At first, we tried to cut the liquid path. We used a "cushion" made of mineral wood enclosed in a plastic sheet hermetically closed. Note that in this case, the attenuation is not due to the absorption in the wool, but to the impedance discontinuity between the pulp and the air inside the cushion. Results of this first trial showed a difference of only 1 dB(A) with and without cushion.

For the second trial, we decided to cut the major part of the solid path. We have made a mechanical isolation between the basket and the rest of the machine by inserting a set of "o" rings. The high frequency problem allows us to use a quite hard suspension system. Results of this trial are shown in fig. 3.

For frequencies of interest, this system has reduced the global noise by nearly 10 dB. This result confirms that the major part of the vibro-acoustic energy is transmitted through solid path.

4- WAYS OF REDUCING NOISE

Like for all types of machines, there is three ways for reducing noise:

- Action at the source,
- dissipating energy during transmission to the radiator,
- action on the radiator.

A: Action on the source:

We know that the excitation is the depression force due to the blades of the rotor. this depression can be seen from the basket like a rotating force acting on the structure. High levels at high frequency are due to the presence of holes causing the modulation. Some production imperatives do not allow us to reduce the speed of rotation (and thus the force acting on the basket). Size of holes is also fixed by the kind of paper produced.

Only two actions are possible here:

- increasing the mechanical impedance of the basket,
- decreasing the phenomenon of modulation by local perturbations around the holes.

Some new types of baskets, with different types of profile which are made to increase productivity present modification on this type. For example, baskets with "Liehmann" profile presents vertical ribs on their inner face. These ribs act like stiffeners and provoke a perturbation in the pulp flow. The acoustical result is that there is a reduction of nearly 15 dB at high frequency. This type of baskets must be used when it is possible.

B: Action on transfers path:
Solid path is the principal one. The solution is a mechanical isolation between the basket and the rest of the machine. For an industrial application, it is very important to fix strongly the basket to the rest of the machine. The suspension must not involves large amplitudes of vibration because clearance between the basket and the blades is very low. The suggested solution is a set of "o" rings and a special device of fixation with mechanically isolated screws maintaining the basket in position. With this kind of device, noise can be reduce by 10 dB(A).
One of the advantage of this solution is that just a few modifications must be done on the machine but it will increase the number of manipulations needed to change the basket.

c: Action on the radiator:
It is possible to reduce the noise emitted by the outer cylinder by using a double shell with acoustic absorption. Note that this solution present the advantage of a thermal isolation of the machine, which is very important for paper makers.

5- CONCLUSION

A combination of solutions presented below can allow us to design a low noise pulp pressure screen (less than 85 dB(A) with pulp). Different actions are possible in respect with production imperatives:
- profiled basket when it is possible.
- mechanical isolation of the basket.
- acoustic barrier on the outer cylinder (with thermal isolation).

6- ACKNOWLEDGEMENTS

The authors would like to thank IRSST for financial support and ANDRITZ SPROUT BAUER for technical and logistical help, Christian Clavet for its technical support.

7- REFERENCES

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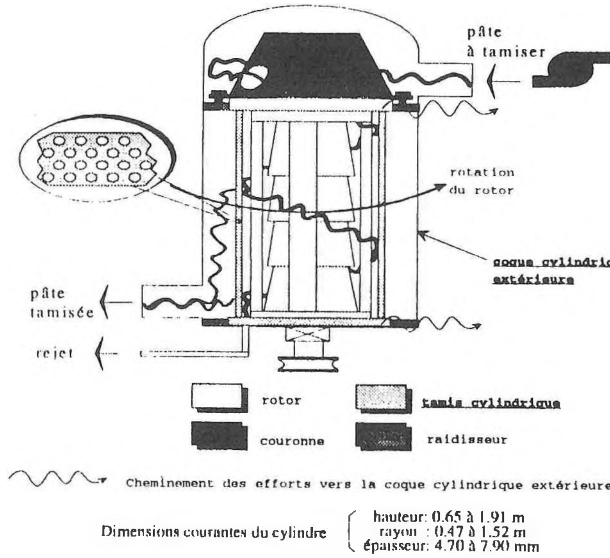

fig. 1 description of a pressure pulp screen

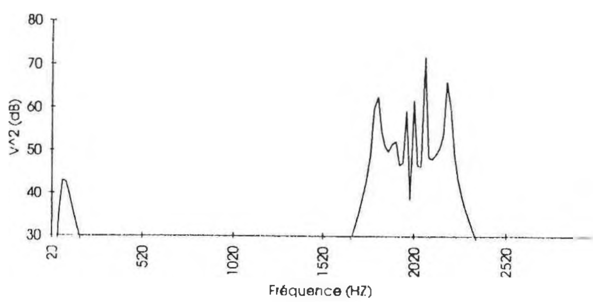

fig. 2 Quadratic velocity of a cylindrical shell
(numerical result with 150 modulations)

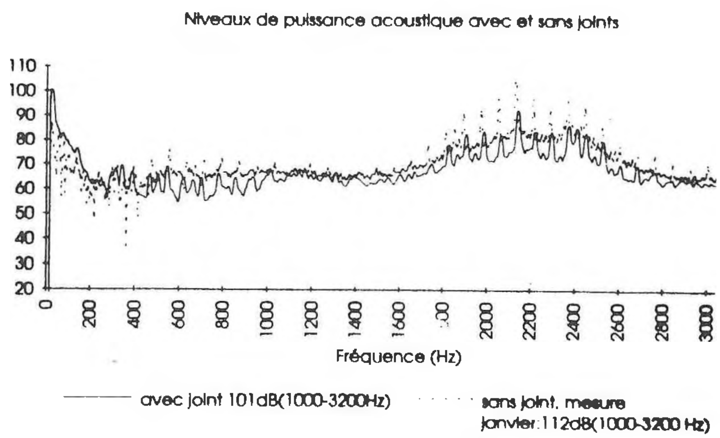

fig. 3: Effects on the global noise of a machinical isolation
between the basket and the rest of the machine