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REGENERATED NOISE DUE TO AIRDUCT ELEMENTS

A.U. UKPOHO AND D.J. OLDHAM

DEPARTMENT OF BUILDING SCIENCE, UNIVERSITY OF SHEFFIELD

INTRODUCTION

In the design of mechanical ventilation systems, the building services engineer is often confronted with the problem of regenerated noise, amongst other aerodynamic problems. The term regenerated noise is used to describe the noise generated on the supposedly quiet side of attenuators fitted to control fan noise. This type of noise would not present much problem if it could be predicted with any measure of accuracy, at the design stage, when a suitable remedial treatment could be prescribed.

Although extensive research on flow generated noise has been conducted over the past two decades or so, this has had a strong emphasis on jet engine noise. The air speeds associated with jet engines are very close to the speed of sound, and information related to the noise they generate is of very little benefit to the heating and ventilating engineer who handles air of very much lower velocities. Thus there is a lack of reliable information on which the design of the acoustics of air distribution systems in buildings can be based.

Research on noise generated by ventilation system components has tended to be of an ad hoc nature where the objective has been to acquire a catalogue of element characteristics (1). Some investigators have attempted to produce generalised prediction techniques with a limited amount of success (2-5). The difficulty in arriving at generalised methods is that the range of parameters which require investigation is large and the conventional techniques employed are both laborious and time consuming.

The conventional method of determining the relationship between the sound power generated by a duct element and the air speed, is based on measurements of the noise level in a reverberation chamber for a number of different air speeds. An alternative method, one which permits data to be rapidly acquired, is described in this paper based upon measurements of sound power generated by a decaying air flow.

In the decaying air flow technique, the plenum chamber (anechoic room) acts as a large reservoir of air which is pressurised by the fan (Fig. 1). On switching off the fan this air is discharged through the duct element under test. This makes it possible to investigate the effect of a whole range of air flow rates in a short time since both the regenerated noise and the air speed decay exponentially. The following expression, which is based on reverberant field theory, is used for estimating the sound power:

$$W(1 - \bar{\alpha}) = \frac{\varepsilon c}{4} S\bar{\alpha} + V\frac{\delta \varepsilon}{\delta t}$$

where W = acoustic power, ε = reverberant energy density in the room,

$\bar{\alpha}$ = average room absorption coefficient, s = total room surface area, v = room volume, c = speed of sound and $\delta\varepsilon/\delta t$ = rate of sound energy decay.

Results of applying this technique to a 300mm x 300mm duct fitted with a single blade damper inclined at different angles, are reported below.

OUTLINE OF METHOD

After the fan is switched off, the decay of the sound level in the reverberant chamber is recorded simultaneously with the decay of air speed. The sound level decay is recorded on one level recorder and another level recorder is used to record the decay of air speed which is measured using a calibrated duct length and a Setra pressure transducer. The above procedure is followed for each frequency band of interest. Fig. 1 depicts a schematic of the measuring system.

RESULTS

The results obtained by the conventional and decaying flow methods are compared in fig. 2a,b, for a damper setting of 30^{0}. The agreement between the two sets of data is consistently good. Fig. 3a, b and c show the sound power spectra for blade angles of 0^{0}, 15^{0}, and 30^{0}, based on the decaying flow method. They follow the same general form as the spectra given by Ingard et al (1).

CONCLUSION

The decaying flow technique offers a quick method of investigating flow generated noise in air ducts. This method could form the basis of an automated technique by incorporating a suitable real time analyser controlled by means of a desk top calculator. This would make it possible to sample at regular intervals, during each decay, all of the 31 third octaves covering the audio frequency range. Data thus acquired could make it possible to investigate a wide range of parameters and possibly arrive at a more accurate technique of predicting regenerated noise in ventilation systems than is at present available.

REFERENCES

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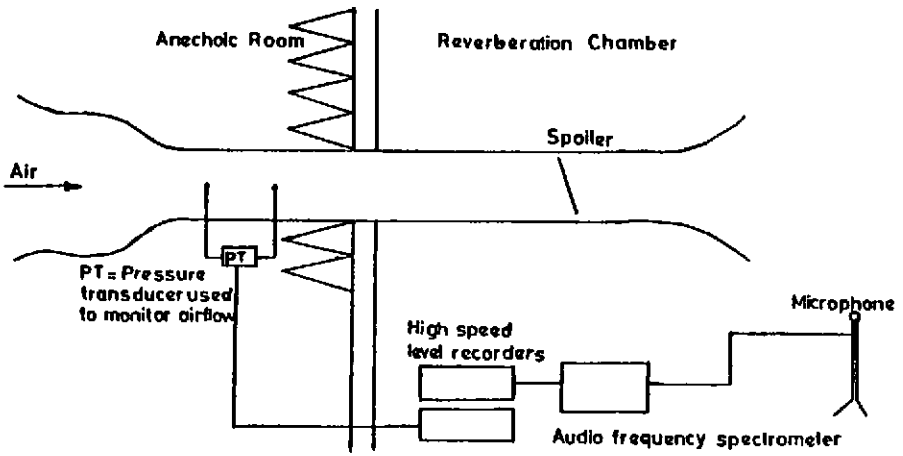

Figure 1. Schematic of measuring system

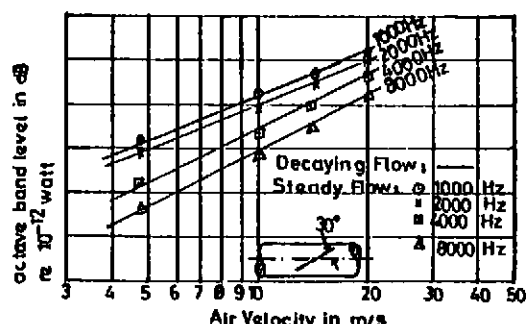

Figure 2A. Sound Power produced by a damper in a 300 mm x 300 mm duct against air velocity

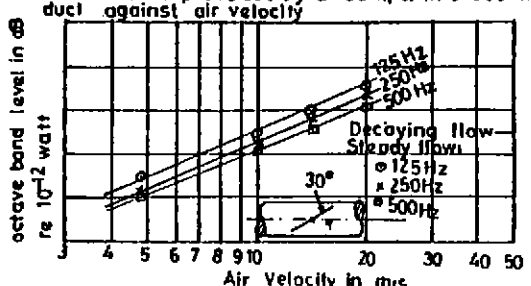

Figure 2B.

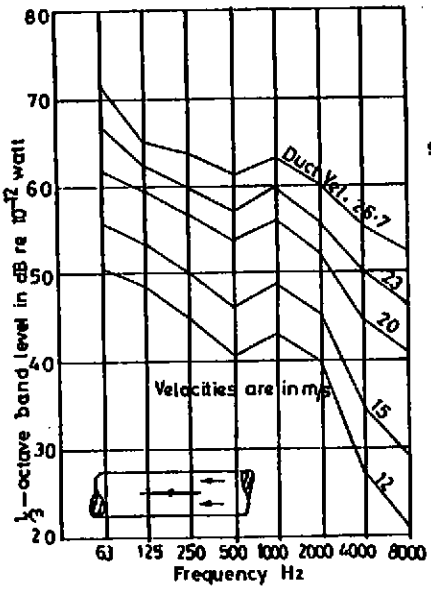

Figure 3A. Sound power spectra produced by a single damper in a 300mm x 300mm duct at 3 angles.

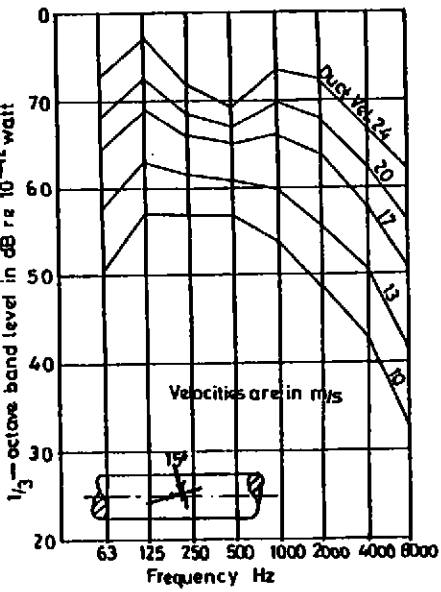

Figure 3B.

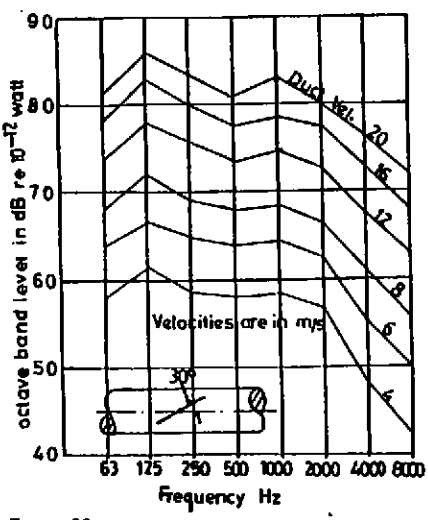

Figure 3C.