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RECENT LABORATORY MEASUREMENTS ON THERMAL/ACOUSTIC LAGGING

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Noise inside power stations, particularly local to certain items of the plant, can rise to levels which would present an auditory risk if personnel were continuously exposed to them. Fortunately, existing work schedules in power stations generally prevent the problem becoming too serious. Nevertheless the power supply industry has realised the need for noise control of modern plant[1,2] and in this country the aim is to achieve a maximum surface noise level of 93 dB(A). This level is considered capable of being met by the careful application of the latest engineering methods.

Ideally plant noise should be reduced by measures which lower the acoustic efficiency of the noise source within the plant. However, this can only be achieved if mechanical, electric or fluid energy or force levels are reduced or isolated from the plant casings which are at present employed to resist internal forces. The reduction of energy or force levels is not consistent with the efficiency and economics of advanced machine design and the isolation of forces would mean a degree of compliance between elements and a complexity of design inconsistent with present technology.

In power stations many machine casings, most vessels and all pipework are lagged with thermal insulation, generally protected by a heavy outer covering such as steel or aluminium cleading or an impervious cement rendering. Such a thermal insulation system contains the basic ingredients to provide acoustic insulation of a vibrating surface, i.e. resilience, mass and high damping. The problem lies in the proper utilisation of these properties, whilst retaining the thermal characteristics and the protective features of the outer cover.

It is estimated that, at high frequencies, fibrous insulating materials at the thicknesses normally needed for thermal reasons on turbines and steam pipework should be inherently capable of providing all the acoustic attenuation that is required. This has been confirmed by recent laboratory studies[3,4]. The higher density outer covering should generally provide the additional attenuation needed at low and medium frequencies, provided it is adequately isolated.

In practice the acoustic insertion loss of thermal laggings has fallen far short of the laboratory figures. Exposed flanges, pipe carriers and the mechanical supports for the insulation system provide major flanking paths. For example, the weight of the insulation on large surfaces such as turbine casings or vertical pipework is carried by regularly spaced support pins fastened to the casing. These pins provide a direct path between the vibrating surface and the outer cover.

The paper presented here is concerned with assigning a value to the short-fall resulting from the lagging support system and showing how the problem can be overcome by using a resilient support pin.

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TEST METHOD

The noise source consisted of an 18 mm diameter orifice located inside a 200 mm nominal bore schedule 40 test pipe, with steam at 1.38 MPa (200 psi) venting through it. The test pipe passed through a semi-reverberant test chamber (Fig. 1). The sound power level from the pipe when unlagged and when lagged was obtained by the method of substitution using a B & K type 4204 Reference Sound Source. The difference in sound power level between the unlagged and lagged pipe was taken as a measure of the Insertion Loss of the lagging.

MATERIALS TESTED

1. Mineral wool pipe lags, 25 mm thick, 192 kg/m^3 density, fitted in two layers with staggered joints, retained using a wire binding.

2. Cement finish, nominal thickness 6 mm, applied over a 25 mm wire mesh. Typical measured surface density 4.7 kg/m^2.

3. Resilient mastic finish, nominal thickness 6 mm, applied over No. 10 weave glass cloth. Typical measured surface density 5.4 kg/m^2.

LAGGING ARRANGEMENTS TESTED

The tests carried out are listed below with a key, in brackets, assigned to assist identification in Fig. 2.

a) 50 mm mineral wool only (M.W.)

b) 50 mm mineral wool and cement with no insulation support pins (+ C)

c) 50 mm mineral wool and cement with rigid support pins (+ C,S)

d) 50 mm mineral wool and cement with resilient support pins (+ C,R)

e) 50 mm mineral wool and mastic with rigid support pins (+ M,S)

RESULTS AND DISCUSSION

The 1/3 octave band insertion loss values for the lagging arrangements tested are presented graphically in Fig. 2. The use of rigid insulation support pins with a cement outer cover produced the expected large reduction in lagging performance due to flanking vibration via the pins[2,4], insertion loss being fairly constant at about 18 dB at frequencies above 800 Hz. Above 1.25 kHz this reduced the insertion loss below that of the underlying mineral wool on its own. Using the 'resilient' insulation pins to support the cement covered lagging produced a marked improvement on the above performance with rigid pins, producing values, up to about 5 kHz, as though no support pins at all were present and then tailing off to give a maximum insertion loss value of about 60 dB.

An alternative method to the use of resilient pins for reducing the effect of flanking vibration, but retaining the simplicity of the rigid support pins, is to use a 'resilient' surface. The resilient surface used in these tests was a trowellable mastic. The effect of replacing the cement with the mastic was to increase the insertion loss generally by about 15 dB at frequencies above 1.6 kHz, but there does appear to have been a reduction in the lower frequency performance at 500 Hz and below.

WHY SURFACE NOISE TREATMENT AND NOT ENCLOSURE?

The alternative to surface noise control of machines is to provide a secondary wall in the form of an enclosure around a machine. Although such enclosures are relatively easy to design to give, say, 20 dB attenuation, they have a number of practical disadvantages, such as increased internal noise levels, interference with maintenance and surveillance routines and the need for additional lighting and fire control. The protection to a plant operator by the use of enclosures is thus small, unless of-course the plant can be remotely controlled.

Surface treatment has none of these disadvantages and although it has less potential attenuation than enclosures, because of coupling between internal and external surfaces, it is predicted that the attenuation it will give matches the needs on most machines. The performance of noise control measures that it is necessary to apply to machines commonly employed in power stations is around 5-10 dB insertion loss to enable Standard 989907 (1) to be met. When considering the performance of individual wall or insulation treatments it is necessary to aim for treatments to give 15-20 dB insertion loss to allow for paths of noise transmission that cannot be readily controlled due to complexity of manufacture. As already stated enclosures are easily devised to achieve this. Surface treatment is seen to have a similar potential but requires very careful design and often requires changes to existing designs which have been devised to achieve an optimum performance for other reasons and within other disciplines. Consequently such a change may be difficult to arrange!

REFERENCES

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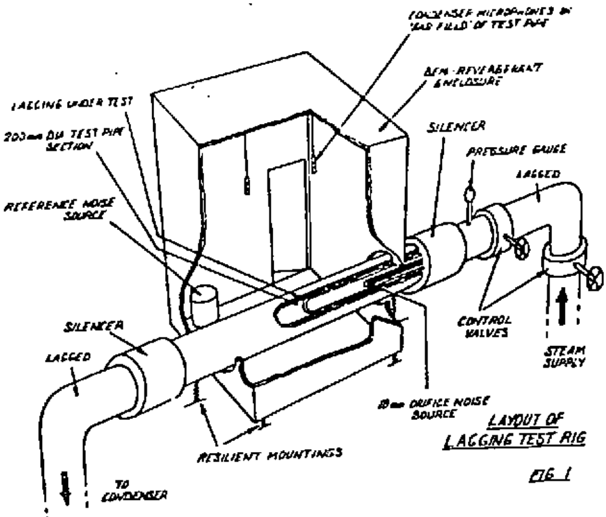
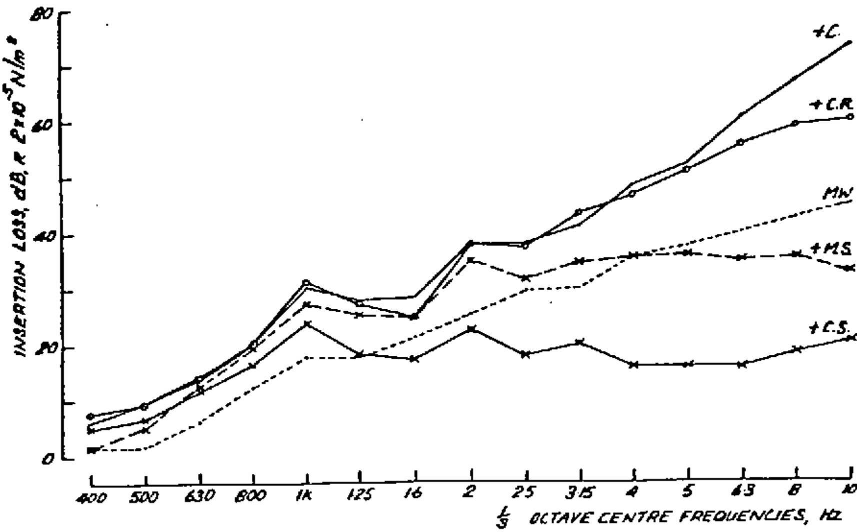


LAYOUT OF LAGGING TEST RIG

FIG 1



INSERTION LOSS VALUES FOR LAGGINGS TESTED   FIG 2