journal of applied mechanics

discussion

Acoustically Induced Vibration of Slender Rods in a Cylindrical Duct[1]

F. J. FAHY.[2] The following points should be noted:

1 Pressures caused by rod motions have been ignored because of the relatively low density of the gas compared with that of the rods. The conclusions from the analysis will probably be valid for slender rods in fluids of much higher densities, provided that the reactive (inertial) fluid loading due to motion is included. This will reduce the flexural wave speeds, and therefore the natural frequencies of the rod.

2 The coincidence phenomenon will occur with rod diameters which are considerably larger in comparison with the duct diameter than in the reported experiments, but the pressures due to rod motion will become increasingly important as the thickness of the fluid annulus decreases.

3 Presumably the conclusion regarding the requirement for a single diametral node holds only for a centrally placed rod. In a cluster of small rods other acoustic modes with multiple diametral nodes could excite off-center rods at completely different frequencies.

4 Experiments performed by the United Kingdom Atomic Energy Authority (which supported the work reported in the paper) on a full-scale fuel channel test rig at the Reactor Fuel Element Laboratories, Preston, have shown acoustically induced response peaks at rather low frequencies (c. 60 Hz). These have been demonstrated to be due to vibration of the fuel rods via the support grids.

[1] By M. J. Hine, published in the June, 1973, issue of the JOURNAL OF APPLIED MECHANICS, Vol. 40, TRANS. ASME, Vol. 95, Series E, pp. 459–463.

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Author's Closure

The author agrees in principle with points 1 and 2 made by Dr. Fahy.

Regarding point 3, the conclusion that only acoustic modes having one diametral pressure node may force a slender rod was based on a theoretical analysis, which was verified by experiment. Experiments also showed that this conclusion was applicable for a single eccentrically placed rod. For the case of a cluster of rods in the duct, only preliminary experiments were carried out, and the area probably deserves more investigation. It should be noted that the rods of a cluster responded only to the acoustic duct modes having one diametral pressure node. However, this diametral node was at no time observed to pass through the plane of any rod not on the duct axis. This was also true for a cluster with no rod on the duct axis. The manner in which these outer rods were excited is not clear from the experiments made. To check that one acoustically excited rod was not mechanically exciting other rods in a cluster, all rods except one in particular were sequentially removed and it was seen that the response of the observed rod did not change. The rods of a cluster were not observed to respond measurably at the frequencies of acoustic modes with multiple diametral nodes.

Excitation of the rods by duct vibration was guarded against in the reported experiments by small diameter string suspensions.

With regard to the experiments conducted by the U. K. Atomic Energy Authority, it would be interesting to see if the support grids could be isolated from the vibrations of the fuel channel duct.

