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'APPLIANCE NOISE'

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DOMESTIC GAS APPLIANCE NOISE

J. TICKNER, WATSON HOUSE
BRITISH GAS CORPORATION

1. Introduction

An important consequence of the decision to convert the country's gas appliances to burn natural gas was the re-introduction of aerated burners into domestic appliances. As aerated burners generate rather more noise than do the previously used non-aerated jets, it became apparent that appliances which had hitherto been very quiet would become at least audible under normal operating conditions with natural gas. A programme of research was therefore embarked upon at Watson House, in order to determine the sources of noise in burners and appliances, to develop appropriate means of noise reduction, and to produce standard test procedures for the assessment of appliance noise.

2. Sources of noise in domestic gas appliances

2.1 Burner noise

The systematic identification of the noise sources in aerated burners was reported by Dance and Sutherland[1] in 1967, and their results are applicable to all aerated burners in domestic appliances. The principle of operation of an aerated burner is as follows. Gas at a pressure of, say, 15mbar above atmospheric is supplied to an injector containing a small orifice, and is discharged at a velocity of 60-70 ms^{-1} towards one end of a mixing tube. The high velocity jet of gas entrains air from the region surrounding the burner, and turbulent mixing of the air and gas takes place in the mixing tube. The resulting mixture is discharged through the burner ports, to the flame front, with secondary air being drawn in from around the burner to ensure complete combustion. The high degree of turbulence occuring close to the injector produces the characteristic broad-band hiss associated with aerated burners, while the process of combustion generates noise at lower frequencies (up to 1kHz). In the middle frequency region, resonance in the mixing tube can be a problem, but this can usually be suppressed by fitting a quarter wave tube or a Helmholtz resonator to the side of the mixing tube, about halfway along its length. In gas fires of conventional design, the burner is virtually the only source of noise, and the combustion noise component is not usually of sufficient intensity to give rise to problems of annoyance, so that the injector remains the most troublesome component. The use of multihole injectors and absorbent lined shields, where practicable, generally reduces the overall burner noise to an acceptable level.

2.2 Central heating boilers

In addition to burner noise, central heating boilers sometimes generate noise due to incipient boiling in the heat exchanger, and this problem has been accentuated by the recent development of low thermal capacity boilers with lightweight heat exchangers. The heat transfer rates in these boilers are such that, at the water flow rates demanded by the heating system, nucleate boiling of the water occurs in the heat exchanger. Some alleviation of this noise can be achieved by fitting a by-pass to return a part of the boiler flow directly from outlet to inlet, and increasing the pump output so that higher velocities, resulting in reduced levels of boiling, are obtained in the heat exchanger. Boiling noise is strongly influenced by heat exchanger design and it is therefore possible that investigation of currently produced heat exchangers will lead to the development of quieter boilers. As a palliative, additives such as soap solutions are sometimes used to reduce boiling noise. These have the effect of increasing the wettedness of the heat exchanger surfaces, thereby dislodging some of the small bubbles of entrapped gas which form the nuclei for boiling to take place. The effective lifetime of such additives is not known, however, and neither is any information available on their long term effects on the system generally.

Pump vibration problems are occasionally encountered and are usually obviated by fitting short flexible pipes at the pump inlet and outlet. It may also be necessary to sit the pump on anti-vibration mountings.

Control valves and governors can give rise to complaints of noise and this may be due to resonant oscillation of the mass-spring system comprising the control element. Substitution of a valve of different mass, or a spring of different stiffness provides a solution, while the use of a dashpot to give resistive damping can be a useful alternative.

3. Test methods

Appliance noise assessment at Watson House is made from determinations of sound power, using the reverberation chamber method. Appliances are installed in a manner resembling typical installation conditions as closely as possible, in order that practical operation can be simulated. Measurements of the appliance noise and ambient noise, together with reverberation time determinations are made in octave bands from 125Hz to 8kHz in the usual way. Calculations of sound power can then be compared with suitable criteria determined from the I.S.O. noise rating curves and the acoustical characteristics of typical domestic environments. This procedure suffices for classes of appliance which might be called 'local' sources, in that the noise which they generate is only heard in the room in which they are situated; but for 'distributed' sources, such as warm air heaters, different methods must be considered.

4. Limitations of the current noise assessment method

The assessment procedure described above takes into consideration only the broad-band steady-state noise radiated by a single appliance. It is known that noise measurements obtained from a single sample are reasonably representative of the appliance population, given correct installation and operation, and it has always been realised at Watson House that pure tones and transient components of gas appliance noise can cause annoyance under certain circumstances. It is intended to consider these latter factors, and how they can be included in an overall assessment procedure, once sufficient experience and confidence have been obtained in applying the present procedure to a wide range of appliances.

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