Noise reduction at heating system exhaust pipes

Peter Brandstätt[1], Karlheinz Bay[1], Günther Fischer[2]
[1] Fraunhofer-Institut für Bauphysik IBP, D-70569 Stuttgart, Germany, E-Mail: brandstaett@ibp.fhg.de
[2] Kutzner+Weber GmbH, D-82216 Maisach, Germany, E-Mail: fischer@kutzner-weber.de

Introduction

New burner technologies known as blue- or rocket-burner in house heating systems and thermal power stations have increased the efficiency of gas and oil consumption but also led to an increase of the noise levels in the exhaust pipes that show the broadband characteristic according to Figure 1. Additional pure tones are present in thermal power stations due to the combustion engines with a typical fireing frequency in the range from 60 to 80 Hz. The exhaust pipes are reflective on both ends (acoustically hard burner chamber and tube with open end, Figure 2), which can lead to resonances. At present a guideline for the measurement of the acoustic emission is prepared [1] apart from the existing noise control standards, in order to gain data for the planning of heating systems and to allow the design of silencers.

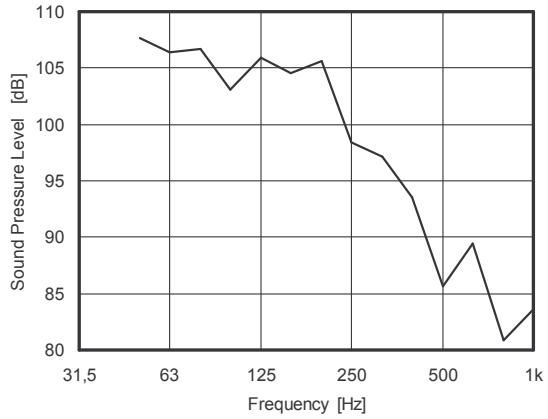

Figure 1: Sound pressure level in the connecting pipe between boiler and chimney of a heating system (100 to 500 kW).

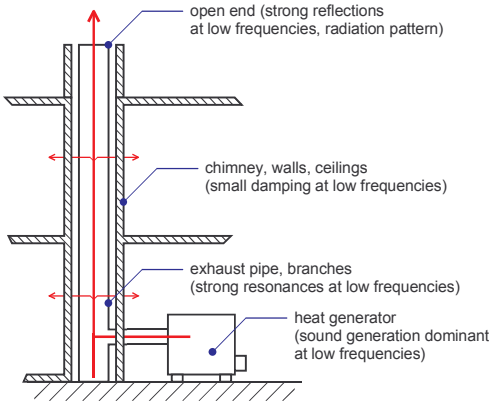

Figure 2: Schematic of a heating system [5].

Silencers for heating systems

The well-known and often used passive tubular silencers with mineral fiber filling works satisfactorily in the frequency range above 500 Hz. However, at lower frequencies they are less effective or need large lining thicknesses and lengths, which are difficult to be accommodated under the cramped space conditions between the boiler and chimney only. Alternative Fiber-free Absorbers (ALFA), developed by IBP and its licensees, avoid these disadvantages and are particularly effective at low frequencies [2, 3].

Example Slot Absorber

The Slot Absorber [4] consists of a porous absorber layer which is covered almost entirely by sheet metal with narrow slots facing the duct, whereby a resonator is created, which can be tuned with the geometrical data of the cover and the thickness of the absorber preferentially to the middle frequencies between 100 and 500 Hz. It can be integrated in compact design as silencer into the boiler. The photo in Figure 3 shows a Slot Absorber as tubular silencer directly after the combustion chamber of a boiler leading to a level reduction of approximatly 8 dB(A) in the exit gas line. The measured level reduction is presented in Figure 4.

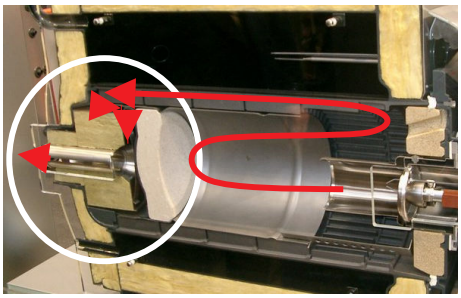

Figure 3: Slot Absorber at the exit of the combustion chamber of a boiler (photo: Viessmann).

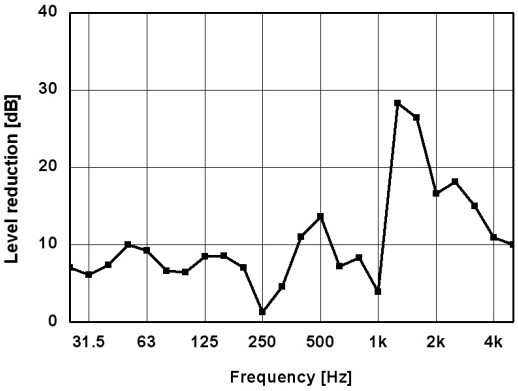

Figure 4: Level reduction of the Slot Absorber (Figure 3).

Example Aktiv+ Silencer

The Aktiv+ Silencer consists of the combination of a passive tubular silencer and an active branch resonator [5, 6], which may be combined additionally with a λ/4-resonator. A typical installation of the Aktiv+ Silencer is presented in Figure 5 and demonstrates the very restricted space available for silencers, which have to be installed at boilers. Its compo-

nents and acoustic analogy [3] are shown in Figure 6. The resonance system formed by the mass of the loudspeaker membrane and the air volume in the cabinet as spring is actively amplified by a microphone, which picks up the sound pressure in front of the loudspeaker membrane, and an amplifier, which supplies the inverted microphone signal to the loudspeaker. Additionally, the active module is separated from the exhaust line by a piece of pipe acting as waveguide which is covered by a temperature- and condensate-resistant protective plastic film. A remarkable increase of the insertion loss and a shift of the resonance frequency to lower frequencies is obtained for the active system switched on, which can be tuned by the geometrical, mechanical and electrical data of the overall system.

Example Cleanable Reactive Silencer CRS

In thermal power stations likewise cramped space conditions are found due to numerous equipment installations. Here the chimney, which in general is long and acoustically untreated, may be replaced in parts by the CRS [2] for a broadband attenuation at the low and middle frequencies and an addional attenuation of the tonal components caused by the engines. According to Figure 7 the silencer consists of several elongated chambers enclosing the chimney, which are connected with it by ring-shaped perforated plates. Each chamber works as a λ/4-resonator which can be tuned to a certain frequency. A PC-program was developed for this purpose that also considers the coupling of the chambers. A broadband attenuation at low frequencies is achievable by adequate tuning of the different chambers.

Figure 5: Aktiv+ Silencer [5] with additional reactive (λ/4) branch resonator (photo: Kutzner+Weber).

Conclusion

Often a low-frequency noise from heating systems or a tonal component caused by the engines in thermal power stations remain audible in the neighborhood, since passive silencers are ineffective at low frequencies. With resonator silencers, like the Slot Absorber, CRS and Aktiv+ Silencer, it is possible to attenuate these noises effectively and in a space-saving manner. Supported by special design programs [7] for the modelling and analysis of duct systems, the resonant behaviour of such systems may be predicted and, as illustrated in Figure 8, considered in the silencer design.

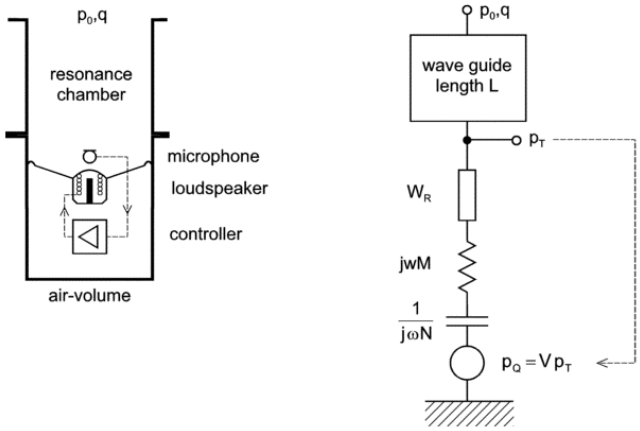

Figure 6: Principles of the active branch resonator [3].

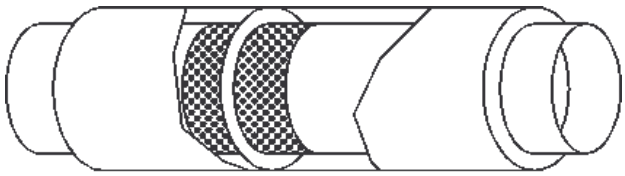

Figure 7: CRS [2] with 2 chambers (design: Kutzner+Weber).

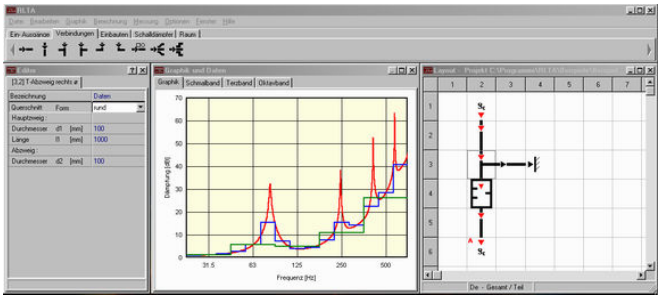

Figure 8: Screen copy of the PC program for the acoustic analysis and layout of piping systems [7].

References

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