Acoustic and Flow Analysis to Reduce Boiler Hum

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Abstract

A client of LBPSIGHT was confronted with a serious problem of low frequency noise, caused by a forced draft boiler installation. The boiler has a capacity of 220 ton/hr. An overview of the installation is shown in figure 1 with air intake, fan, air ducting, furnace untill the stack exhaust at 40 m above ground level. Several noise measurements were performed which showed that the problem occurred between 66% and 80% of the boiler load. The measurements showed high noise levels around the boiler, with 30Hz as dominant frequency. This hum caused serious annoyance in the surrounding, and therefore the problematic load range was avoided as much as possible.

With an acoustic study with COMSOL Multiphysics®, several acoustic resonances were found, including strong resonances around 30 Hz. Such studies can, however, not explain causes of excitation. Therefore, further study towards possible causes of the hum was needed. A review of the design gave rise to the suspicion that poor flow conditions existed at the inlet and outlet of the forced draft fan (a radial fan with max air flow 44 m3/s; power 0,7 MW). The force draft fan supplies combustion air to the boiler. It was decided to study the flow patterns with CFD calculations.

The CFD calculations of the turbulent flow (k-eps) indeed showed that both the inlet and outlet flow contained large vortices, which are likely the cause of the strong hum. Extra CFD calculations were used to compare different possible solutions to reduce these vortices, therewith reducing the hum. Based on the calculations, the necessary changes in the design were determined. The finally proposed changes consist of changing the overall shapes of the inlet and outlet duct, in combination with several flow guiding vanes. The original situations and proposed redesign for respectively the inlet and outlet duct are shown in figures 2 and 3.

In order to have more assurance that the boiler hum would disappear, additional silencing was designed with the Acoustics Module of COMSOL Multiphyics®, resulting in a large absorbent section directly behind the fan. The acoustic response of the original situation and the situation with absorption is shown in figure 4, which shows a reduction of 5 dB at the strongest resonance at 30 Hz.

In July of 2014, the changes in the installation will be made in a major overhaul of the air ducting of the installation, so in September, during the COMSOL Conference in Cambridge, the results of the improvements will be known.

Figures used in the abstract

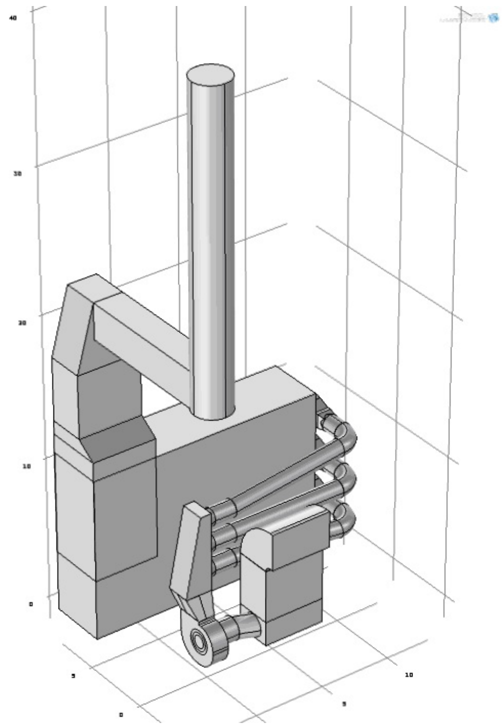

Figure 1: Overview of the boiler installation

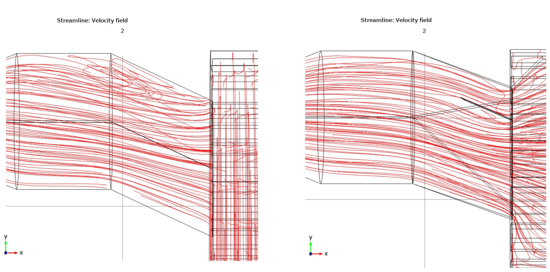

Figure 2: Inlet duct: streamlines in original duct and with proposed measure

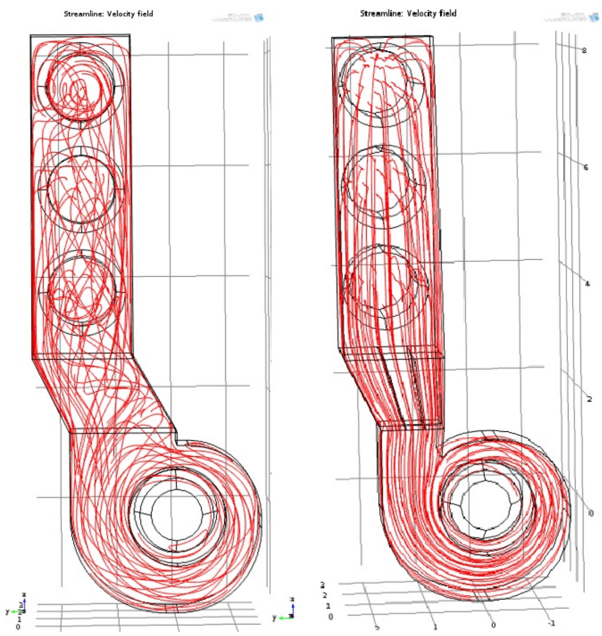

Figure 3: Outlet duct: streamlines in original and with proposed measure

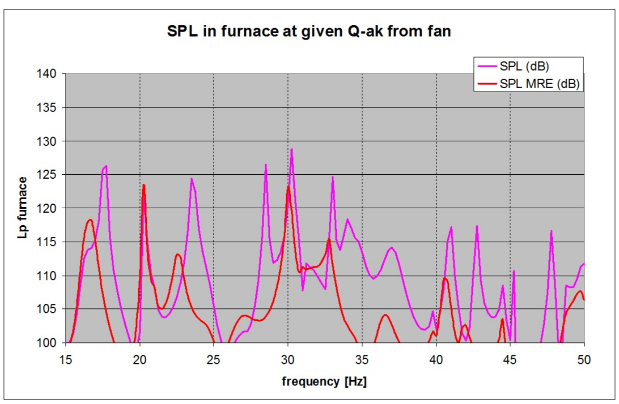

Figure 4: Acoustic response in furnace without and with absorbent measure