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Sound Quality Analysis of Sloshing Noise from a Rectangular Tank

Authors : Siva Teja Golla, B. Venkatesham

Abstract : The recent technologies in hybrid and high-end cars have subsided the noise from major sources like engines and transmission systems. This resulted in the unmasking of the previously subdued noises. These noises are becoming noticeable to the passengers, causing annoyance to them and affecting the perceived quality of the vehicle. Sloshing in the fuel tank is one such source of noise. Sloshing occurs due to the excitations undergone by the fuel tank due to the vehicle's movement. Sloshing noise occurs due to the interaction of the fluid with the surrounding tank walls or with the fluid itself. The noise resulting from the interaction of the fluid with the structure is 'Hit noise', and the noise due to fluid-fluid interaction is 'Splash noise'. The type of interactions the fluid undergoes inside the tank, and the type of noise generated depends on a variety of factors like the fill level of the tank, type of fluid, presence of objects like baffles inside the tank, type and strength of the excitation, etc. There have been studies done to understand the effect of each of these parameters on the generation of different types of sloshing noises. But little work is done in the psychoacoustic aspect of these sounds. The psychoacoustic study of the sloshing noises gives an understanding of the level of annoyance it can cause to the passengers and helps in taking necessary measures to address it. In view of this, the current paper focuses on the calculation of the psychoacoustic parameters like loudness, sharpness, roughness and fluctuation strength for the sloshing noise. As the noise generation mechanisms for the hit and splash noises are different, these parameters are calculated separately for them. For this, the fluid flow regimes that predominantly cause the hit-and-splash noises are to be separately emulated inside the tank. This is done through a reciprocating test rig, which imposes reciprocating excitation to a rectangular tank filled with the fluid. By varying the frequency of excitation, the fluid flow regimes with the predominant generation of hit-and-splash noises can be separately created inside the tank. These tests are done in a quiet room and the noise generated is captured using microphones and is used for the calculation of psychoacoustic parameters of the sloshing noise. This study also includes the effect of fill level and the presence of baffles inside the tank on these parameters.

Keywords : sloshing, hit noise, splash noise, sound quality
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