ANALYSIS OF THE ACOUSTIC INPUT IMPEDANCE OF A VIBRATING TROMBONE BELL

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ABSTRACT

The acoustic oscillations of the internal air column of a wind instrument induce wall vibrations of the body. However, the importance of the influence of such vibrations on the produced sound is an open question. The case of the trombone bells is particular because of the small thickness of the wall and large diameter of the horn's extremity which favors the vibroacoustic coupling between the body's vibrations and the internal acoustical field.Experimental investigation of this vibroacoustic coupling is performed on a Courtois trombone. An experimental modal analysis of the bell is performed using a miniature impact hammer and a miniature triaxial accelerometer: bell modes are classified using their modal circumferencial index m. Most of the bell modeshapes are found to be non axisymetric. One of them (around 800Hz) is found to be axisymetric. The bell is placed inside a tank where the water level can be varied. Measurements of the acoustic input impedance of the duct and measurements of the mechanical mobility of the bell for different water levels show that the bell mechanical eigenfrequencies are significantly shifted by the fluid-loading. Small and repetable changes in the acoustic input impedance are also observed and show clearly the wall vibration effect.Modelling of such vibroacoustic coupling is performed using a plane wave representation of the internal acoustic field and a modal representation of the wall vibrations. This model allows us to compute the input acoustic impedance for different sets of bell eigenfrequencies and for different positions of the slide. The change of the input acoustic impedance by the wall vibrations is quantified when coincidence conditions between acoustical and structural modes are satisfied or not.