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A simple acoustic model to characterize the internal sound field in centrifugal pumps originated by blade-tongue interaction

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Conventional centrifugal pumps with volute casing generate fluid-dynamic noise particularly at the so-called blade-passing frequency, due to the interaction of the flow exiting the pump impeller with the volute tongue. The amplitude of the sound generated is very dependent on the pump operating point. Following previous studies by the authors, a methodology has been applied to quantify the generation of tonal noise for a given centrifugal pump, previously tested in laboratory. The procedure is based on a simple acoustic model for the pump, in which one or several ideal point sources are located at some arbitrary position in the volute. These ideal sources are assumed to radiate plane sound waves along the volute, which was considered to be composed by a succession of slices, each of them equivalent to a linear 3-port acoustic system with sound transmission and reflexion coefficients according to the corresponding port areas. A series of tests was conducted to check the assumptions of the acoustic model, by applying external acoustic loads onto the pump outlet duct and measuring the noise reflected. The resulting reflection coefficient was in good agreement with the predictions of the acoustic model.