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Study of the behavior of vapor fraction in a turbo pump inducer using an X-ray tomography

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This work intended to study the behavior of the instantaneous vapour fraction in the turbo-pump inducer of a liquid propellant rocket engine. Experimentations held on an experimental pump test facility and cavitations was attained by reducing the inlet pressure in the machine while maintaining constant the inducer rotational speed. Measurements of vapour fraction through the rotating inducer were achieved by means of an x-ray-based system. The system exerted an industrial x-ray generator and 10 collimated scintillation detectors. Detectors were functioning in current mode thus permitting an acquisition at 5 kHz for each detector. A reference x-ray detector situated between the x-ray generator and the machine permitted the treatment of x-ray beam energy fluctuations related to industrial generators Acquisitions were performed in three axial positions on the inducer. For each measurement position, three cavitations sequences with different flow rate conditions (Q/Qn=0.9, 1, 1.1, where Qn is the nominal flow rate) were accomplished. Each cycle is performed by decreasing gradually the pressure while maintaining an imposed rotational speed of 4000 rpm. Each test is constituted of 10 pressure points varying from 2.40 to 0.48 bars representing a complete cavitations sequence. X-ray acquisition was performed for each pressure point and it was carried out for 10 seconds thus corresponding to 667 tours of the inducer. Vapour fraction was determined instantaneously thus showing the applicability and the precision of the method in such measurements despite of the geometry and rotation speed constraints. Consequently a quantitative and qualitative evaluation of the vapour fraction is presented. Results show that the vapour distribution is well related to cavitations development on the blades of the inducer for steady cavitations condition. A cavitations regime mostly synchronous with the rotation of the inducer was detected. This permitted the use of tomographic reconstruction for the localization of vapor in the machine. An algebraic reconstruction algorithm (ML-EM) was used to achieve image reconstruction

Biography

Walid Hassan is Ph.D. in industrial imaging, DEA and Engineering diploma in Biomedical Engineering. Worked in the department of atomic energy in France on tomographic reconstruction and tomographic systems. Active research in tomographic reconstruction for emission and transmission data. Active research on biomedical sensors and signals and specifically in developing a contactless medium for the measurement of electrophysiological parameters for premature newborns. Special attention to the analysis and comprehension of full-band EEG signals.

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