Numerical prediction of SDOF-Perforated Plate Acoustic Treatment Impedance. Part 1 : Linear domain

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A new numerical prediction tool has been developed in order to improve acoustics impedance predictions for typical Nacelle SDOF with perforated-plate liners, accounting for realistic geometry and flow. This method is based on domain breakdown and Linearized Compressible Navier-Stokes equations in the holes. Numerical Results are successfully compared to analytical predictions and measurements in the linear domain without flow. Next steps are non-linear effects and the influence of grazing mean flow.

Nomenclature

c_0	=	Sound velocity, m.s^{-1}
d	=	Holes diameter, m
d_1, d_2	=	Elementary period sizes, m
D	=	Cavity lateral size, m
e	=	Plate thickness, m
e'	=	Corrected thickness, m
f	=	Frequency, Hz.
h	=	Cell depth, m
$k=\omega / c_0$	=	Wave number, m^{-1}
p	=	Acoustics pressure, Pa
p^{inc}, p^{sc}	=	Incident, scattered pressure, Pa
R	=	Reduced Resistance
V	=	Acoustics velocity, m.s^{-1}
x_1, x_2, x_3	=	Spatial coordinates, m
Z	=	Reduced Impedance
Z_{cav}, Z_{res}	=	Impedance of the cavity, of the resistive sheet
λ	=	Wavelength, m
σ	=	Porosity (POA), %
ν	=	Kinematic viscosity, m^2.s^{-1}
χ, χ_r	=	Reduced Reactance, Residual Reactance
ρ_0	=	Air density, kg.m^{-3}
Σ_r	=	Rigid surface
Σ^+, Σ^-	=	Interfaces between holes and Euler domain
$\omega = 2\pi f$	=	Wave pulsation, s^{-1}

I. Introduction

FAN Noise represents half of Aircraft Noise at both landing and take-off conditions. This noise source is mainly reduced thanks to Acoustic treatments installed inside nacelle inlet and bypass ducts. These treatments allow decreasing the overall Aircraft Perceived Noise Level by 4 to 5 dB at take-off and 2dB at approach. In the last decades, Airbus invested a lot in the development of nacelle low noise technologies and associated optimisation

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