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Synergism of flow and noise control technologies ☆

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Abstract

This paper will discuss the synergism of flow and noise control technologies relevant to both air and undersea vehicles. Because many review publications specifically focus on either flow control or noise control, this presentation will not provide an exhaustive literature survey. Sufficient citations will highlight the effectiveness of the technologies; however, the primary goal of this paper is to outline direct and indirect linkages, counterproductive linkages, and examples with no linkages between noise and flow control technologies. Hence, woven through out the individual sections is a focus on the various forms of linkage between flow and noise control applications.
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Nomenclature

A	amplitude
AAAC	aerodynamics, aerothermodynamics, and acoustics competency
ADP	advanced ducted propulsor
AEDC	Arnold Engineering Development Center
AST	Advanced Subsonic Transport (program)
BART	Basic Aerodynamic Research Tunnel
BEM	boundary element method
C_d	drag coefficient
C_{dpu}	uncorrected drag coefficient due to pressure
C_f	skin friction coefficient
C_{f0}	baseline skin friction coefficient without micro-bubble injection
C_{lu}	uncorrected sectional lift
C_p	pressure coefficient
C_μ	mean + oscillatory suction/blowing coefficient
CAA	computational aeroacoustics
CADCAM	computer aided design, computer aided manufacture
CMT	continuous mold line technology
c	chord
D/D_{FP}	drag to drag for baseline flat plate
dB	Decibel
DR	drag reduction: one minus drag of polymer flow divided by drag without polymers
DFP	ducted fan propulsor
DGV	Doppler global velocimetry
DNL	day-night level
DNS	direct numerical simulation
DNW-LFF	German–Dutch Large Low-Speed Facility
DOD	Department of Defense
DSPs	digital signal processors
d	diameter
d_c	core jet exit diameter
d_{31}(pC/N)	strain in x-axis per volt when an electric field is parallel to the z-axis
EPNdB	effective perceived noise (Decibels)
F^+	dimensionless frequency for oscillatory excitation
FAA	Federal Aviation Administration
FEM	finite element method
HARV	high angle of attack research vehicle
HLFC	hybrid laminar flow control
HSCT	High Speed Civil Transport (program)
h	height
h^+	dimensionless height, $h(u_\tau/\mu)$
ICAO	International Civil Aviation Organization
IR	infrared
L/D	lift-to-drag ratio
LEBU	large-eddy breakup (device)
LES	large eddy simulation
LFC	laminar flow control
LITA	laser induced thermal acoustics
LTPT	low turbulence pressure tunnel
LSAF	Low Speed Aeroacoustic Facility
M	Mach number
MDOE	modern design of experiments
MEMS	micro-electromechanical systems
MIT	Massachusetts Institute of Technology
NACA	National Advisory Commission for Aeronautics
NASA	National Aeronautics and Space Administration
NLF	natural laminar flow
P	pressure
PAA	propulsion airframe aeroacoustics
PDV	point Doppler velocimetry
PIV	particle image velocimetry
PMI	projection Moiré interferometry
PSP	pressure sensitive paint
P_T	total pressure
$P_{T\infty}$	free-stream total pressure
PVDF	polyvinyldine-flouride
PVG	pulsed vortex generator
PVGJ	pulsed vortex generator jet
PZT	piezoceramic
Q/Q_s	normalized injection flow rate
Q_s	flow rate in the viscous sub-layer per unit span
QFF	Quiet Flow Facility
QSP	quiet supersonic platform
R	radius
RANS	Reynolds averaged Navier–Stokes
R_c	Reynolds number based on free-stream velocity and chord length
Re/m	Reynolds number per meter
rms	root mean squared
SATS	Small Aircraft Transportation System (program)
SSBD	shaped sonic boom demonstrator
SPL	sound pressure level
SVT	Supersonic Vehicle Technology Program
SWCNT	single-wall carbon nano-tubes
s	(riblet) spacing
s^+	dimensionless spacing, $s(u_\tau/\mu)$
T/W	thrust-to-weight
TAPS	Trans Alaskan Pipeline System
THUNDER	piezoceramic actuator (trademark)
TVA	tuned vibration absorbers
U_w	streamwise velocity of compliant wall
U_∞	free-stream velocity
UFAT	unsteady flow analysis tool kit
u_τ	wall velocity
V_w	normal velocity of compliant wall
VG	vortex generator
VGJ	vortex generator jet