UNIVERSITÉ CATHOLIQUE DE LOUVAIN
FACULTÉ DES SCIENCES APPLIQUÉES

VON KARMAN INSTITUTE FOR FLUID DYNAMICS
TURBOMACHINERY & PROPULSION DEPARTMENT

High Frequency Gas Temperature and Surface Heat Flux Measurements

Vasiliki Iliopoulou

Von Karman Institute for Fluid Dynamics

Chaussée de Waterloo, 72
B-1640 Rhode-Saint-Genèse
Belgium

Phone: +32 (02) 359 96 11
Fax: +32 (02) 359 96 00
e-mail: info@vki.ac.be
website: http://www.vki.ac.be

Université Catholique de louvain
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Unsteady interactions, short duration facilities, tip leakage flows.

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Nomenclature

a	Angle of the pressure perturbation on the second stator with the horizontal
a	Gain, coefficient [dependent on subscript]
A	Surface, area
c	Class index
c	Specific heat [$J/(kgK)$]
C	Blade chord [m]
C	Capacity [F]
C	Clearance [m]
D	Depth [m]
D	Diameter [m]
f	Frequency [Hz]
$f(\ldots)$	Function of …
h	Heat transfer coefficient [$W/(m^2K)$]
H	Transfer function in Laplace domain
H^{-1}	Inverse transfer function in Laplace domain
I	Current intensity [A]
j	$j^2 = -1$
k	Thermal conductivity [$W/(mK)$]
L	Length [m]
M	Mach number
n	Total number of points
Nu	Nusselt number
p	Laplace variable
P	Pressure [bar]
Pr	Prandtl
Q	Heat flux [W/m^2]
r	Radial coordinate [m]
r_c	Recovery factor
R	Gas constant [$287\ j/(kg\ K)$]
R	Radius [m]
R	Resistance [Ω]
Re	Reynolds number
S	Curvilinear abcissa
St	Strouhal number
t	Time [s]
T	Temperature [K, ^oC]
Tu	Turbulence intensity
u	Auxiliary variable Eq. (50)
U	Peripheral velocity [m/s]
V	Voltage [V]
W	Velocity [m/s]
W	Width [m]
x	Distance, depth, coordinate [m]
y	Distance, coordinate [m]
Y	Distance [m]
α	Thermal diffusivity [m^2/s], $\alpha = k/(\rho c)$
γ	ratio of specific heats
δ	Clearance [m]
delta	Boundary layer thickness [m]
Δ	Variable change
ΔR	Radial increase/decrease
ε	emissivity
ζ	correction factor for non-uniform heating
μ	Absolute viscosity [Ns/m^2]
ξ, η	Non dimensional axes
π	3.14…
ρ	density [kg/m^3]
σ	Thermal products ratio
σ:	Contraction coefficient
τ	Clearance [m]
Φ	Phase locked time on periodic passing events
Φ	Incidence angle of the flow
ω	Frequency [rad/s]
Ω	Rotational speed [RPM]

Subscripts / Superscripts

*	Total conditions
∞	Free stream
0	Reference, Zero
0	Total flow conditions
1	Cascade inlet
1	First hemispherical head
1	First layer of the substrates
1	First linear system
1	Nozzle inlet
1	Stage inlet
2	Cascade exit
2	Nozzle exit
2	Second hemispherical head
2	Second layer of the substrates
2	Second linear system
3	Second stator inlet
4	Second stator exit
AIR	Properties of air
AMB	Ambient conditions
AV	Average value
AW	Adiabatic wall
AX	Axial direction
C	Conduction
CYL	Cylindrical geometry
E, e	Jet exit
FP	Geometry of flat plate

GAS	Gas temperature dependent
inf	Property of the free stream flow
INIT	Initial value concerning the time
INP	Input
IS	Isentropic conditions
j	Space step
L	Properties of liquid
m	time step
M	Medium
M	Model
M	Space step
OS	Periodic oscillations
P	Time step
R, ΔR	Resistance dependent
RAD	Dependent on Radiation
REL	Flow conditions expressed to the relative frame
S	Dependent on sampling
S	Static conditions
T	Test
T, ΔT	Temperature dependent
V	Dependent on the vortex shedding
V, ΔV	Dependent on the Wheatstone bridge
W	Wall, surface

Abbreviations

1D	One dimensional
2D	Two dimensional
3D	Three dimensional
B.C.	Boundary condition
BL	Boundary layer
CL	Blade camber line
ct	constant
CT2	I.L.P. facility-test section: a cascade
CT3	I.L.P. facility-test section: a 1.5 stage turbine
D.T.F.	Dual thin film
D.T.F.P.	Dual thin film probe
DEM	Demodulated
FFT	Fast Fourier Transform
G	Galvanometer
HP	High Pressure
I.L.P.	Isentropic Light Piston
L.E.	Leading edge
L.P.	Low pass filtered
Ma	Exit Mach number
MAX	Maximum value
MID	Midspan
MOD	Modulated
P.S.	Pressure Side
PLA	Phase Locked Average
R	Reattachment (point, line)
REF	Reference
RMS	Root Mean Square
RPM	rotor speed
S	Separation line
S.S.	Suction side
T.F.	Thin film
W/B	Wheatstone bridge