

NOMENCLATURE

a	Angle of attack of nozzle-1
B	Breadth of the runner, m
B/D_1	Runner aspect ratio
B/W	Flow spread ratio
D_1	Runner outer diameter, m
D_2	Runner inner diameter, m
D_m	Mean diameter of the runner = $(D_1+D_2)/2$
D_2/D_1	Diameter ratio
g	Acceleration due to gravity
H	Supply Head, m
N	Speed of the runner, rpm
N_b	Number of blades
N_r	Speed ratio = $(N/60)/1/(\sqrt{2gH})$
P	Pressure, N/m^2
P_1	Pressure at nozzle inlet, N/m^2
P_2	Pressure at nozzle exit, N/m^2
P_{atm}	Atmospheric pressure, N/m^2
P_i	Power input, W
P_o	Power output, W
Q'	Unit discharge = $Q/(D_1^2\sqrt{gH})$
Q_1	Discharge through nozzle-1, lps
Q_2	Discharge through nozzle-2, lps
Q_f	Flow fraction
Q_t	Total flow rate, lps
r_b	Radius of curvature of the blade, m
S_o	Nozzle throat width, m
t_b	Blade thickness, m
V	Velocity, m/s
V_x	x- component velocity or radial component velocity, m/s
V_y	y- component velocity or tangential component velocity, m/s
Vsum	Total velocity, m/s
V_{r2}	Relative velocity at first stage runner exit, m/s
W	Width of the runner, m
$2S_o/D_1\delta$	Nozzle throat width ratio
α	Flow angle, deg.
α_1	Flow angle at first stage runner inlet, deg.
α_2	Flow angle at first stage runner exit, deg.

α_d	Design flow angle, deg.
β_1	Blade angle at first stage runner inlet, deg.
β_2	Blade angle at first stage runner exit, deg.
β_2'	Apparent blade angle at first stage exit, deg. (defined in section 4.8)
η	Overall efficiency of CFT, %
η_{max}	Maximum overall efficiency of CFT, %
δ	Nozzle entry arc of nozzle, deg.
δ_1	Nozzle entry arc of nozzle-1, deg
δ_2	Nozzle entry arc of nozzle-2, deg
θ	Angular position, (measured counter clockwise based on nozzle mid section), deg.
θ_1	Orientation of nozzle – 1 from vertical axis, deg.
θ_2	Orientation of nozzle – 2 from vertical axis, deg.
ψ	Stream function
ϕ	Velocity potential
μ	Dynamic viscosity, Ns/m ²
ρ	Density, kg/m ³
γ	Specific weight, N/m ³
CFT	Cross Flow Turbine
C-C	Nozzle with front and rear wall circular arc shape
C-S	Nozzle with front wall circular arc and rear wall spiral vortex shape
S-C	Nozzle with front wall spiral vortex and rear wall circular arc shape
S-S	Nozzle with front and rear wall spiral vortex shape