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CTA

(Constant-Temperature Anemometer)

mm / m
 f ~ kg/h
 m/s l d β K
 Mesh
 m/s m/s

Sensy flow
Sensy flow

: ()

$$Q = h \cdot A_s \cdot (T_w - T_a) = h A_s \left(\frac{R_w - R_a}{R_a \alpha} \right) \quad ()$$

T_a T_w A_s h
 α R_a T_w R_w
 T_w

...

$$Nu = 0.42 Pr^{0.20} + 0.57 Pr^{0.33} Re^{0.50} \quad (1)$$

$$T_f = (T_w + T_a) / 2$$

$$Ud/\mu \rho Re = \frac{Ud}{\mu \rho Re} \quad Pr = \mu Cp/k \quad Nu = hd/k \quad (2)$$

$$\dot{Q} = R_w I^2 \quad (3)$$

$$R_w I^2 = h A_s (T_w - T_a) \quad (4)$$

$$R_w I^2 = h \pi d l (T_w - T_a) = \pi l Nu k (T_w - T_a) \quad (5)$$

$$R_w I^2 = \frac{\pi l k}{\alpha_a} \left(\frac{R_w - R_a}{R_a} \right) (0.42 Pr^{0.20} + 0.57 Pr^{0.33} Re^{0.50}) \quad (6)$$

$$\frac{R_w I^2}{(R_w - R_a)} = A + BU^{0.5} \quad (7)$$

$$A = 0.42 \left(\frac{\pi k l}{R_a \alpha_a} \right) \left(\frac{\mu c_p}{k} \right)^{0.2} \quad (8)$$

$$B = 0.57 \left(\frac{\pi k l}{R_a \alpha_a} \right) \left(\frac{\mu c_p}{k} \right)^{0.33} \left(\frac{\rho d}{\mu} \right)^{0.5} \quad (9)$$

$$B A \quad (10)$$

$$U \quad (11)$$

$$(\bar{E} + e)^2 = E^2(t) = A + BU^n(t) \quad (12)$$

$$E(t) \quad A, B, n \quad \bar{E} \quad U(t) \quad (13)$$

$\cdot / \cdot \cdot < Re <$ [] . / / () n
 n
 A, B . m/s $Re =$

CTA
 μm

μm

CTA

CTA

[]

CTA

$R_w = (R_3 \cdot R_1) / R_2$

R_w

R_3

$R_w = R_a (1 + \alpha (T_w - T_a))$

R_w

()

E

$E^2(t) = A + BU^n(t)$

: ()

Δp

$\Delta p = K \frac{1}{2} \rho U^2$

()

()

K

ρ

U

: []

...

$$K = 6(1-\beta)\beta^{-5/3} \left(\frac{Ud}{\nu}\right)^{-1/3} \quad ()$$

$$\beta = \frac{\nu}{d} \quad ()$$

$$\beta = \left[1 - \frac{d}{l}\right]^2 \quad ()$$

:[] () ()

$$f = \frac{l}{\sqrt{l+K}} \quad ()$$

$$f = \frac{\sqrt{(\overline{u'_2})^2}}{\sqrt{(\overline{u'_1})^2}} \quad ()$$

$$\sqrt{(\overline{u'_2})^2} \quad \sqrt{(\overline{u'_1})^2}$$

$$\left(\frac{R_w - R_a}{R_a}\right) = 0.6$$

() n

()

()

B A

()

l (v)

E_{zero}

$U^{0.45} E^2$

l (v)

() ()

() ()
 ()

$U(t)$ $E(t)$

$(T_w - T_a)$
 ()
 [] °C %

T_w

$(T_w - T_a)$

$(T_w - T_a)$

$$\left(\frac{T_w - T_r}{T_w - T_a} \right)^n$$

()

n

T_w

T_r

T_a

[]

CTA

/

()

$$T_r = \text{ } ^\circ\text{C}$$

$$T_w = \text{ } ^\circ\text{C}$$

() $n = 1$

%

°C

$$T_r = \text{ } ^\circ\text{C}$$

$$T_w = \text{ } ^\circ\text{C}$$

...

() $n = l$

() n

$$\left(\frac{T_w - T_r}{T_w - T_a} \right)^{0.5(l \pm m)} \quad ()$$

(+) []

()

l () m

mm mm

$\beta = 0.51$

$\beta = 0.43$

mm (x)

U

(u')

$$\frac{\sqrt{(u')^2}}{U} T_u =$$

($T_u = \%$)

mm

(

mm

mm

x = mm

m/s

%

$\beta = 0.43, 0.51$

%

[]

%

%

% ~%

%

mm

mm

Hz

$\beta = 0.43, 0.51$

U = m/s

...

β

$$\delta^* = \frac{1}{U} \int_{-D/2}^{D/2} (U - u) dy \quad ()$$

m/s m/s

$x =$ mm

$\beta = 0.43$

mm

mm

$\beta = 0.51$

mm

mm

$\beta = 0.43$

CTA

Sensy Flow

mm

.[]

cm

mm

mm

%

%

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CTA

$m = /$

()

/

mm

mm

m/s % % / $\beta = 0.41$

m/s % / % /

$\beta = 0.53$

%

$\beta = 0.41$

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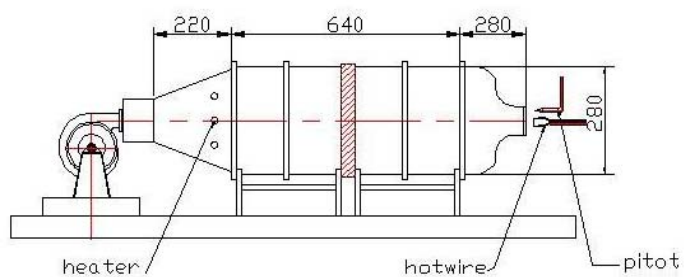
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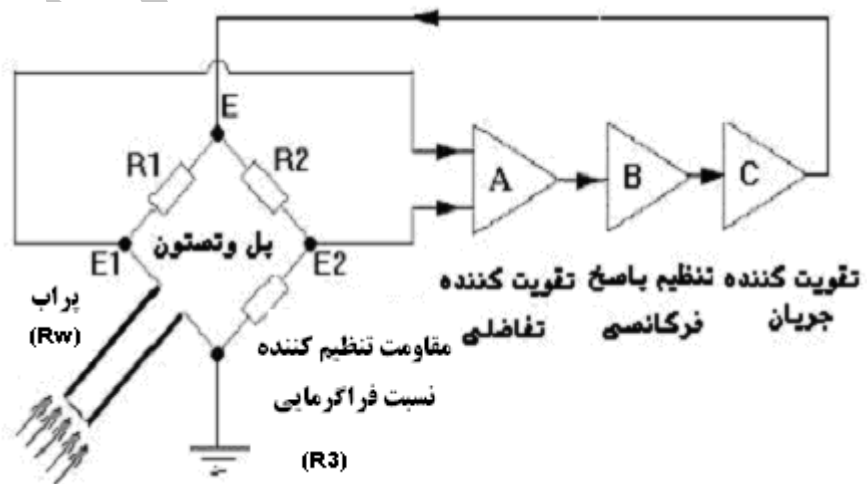
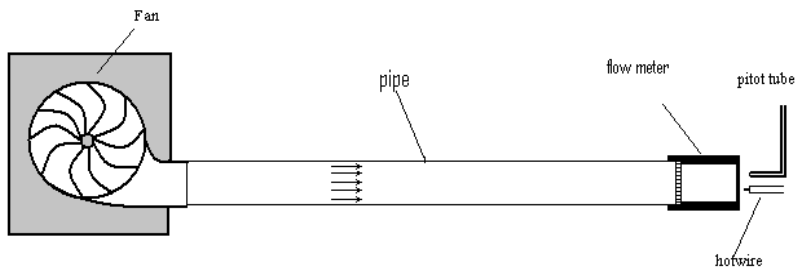
- : A_s
- : C_p
- : d
- : e
- : $E(t)$
- : \bar{E}
- : f
- : h
- : K
- : k
- : l
- : $Mesh$
- : $Nu=hd/k$
- : $Pr=\mu C_p/k$
- : R_w
- : R_a
- : $Re=Ud/\mu \rho$
- : T_w
- : T_a
- : $U(t)$

- : α
- : β
- : ρ
- : μ
- : Δp

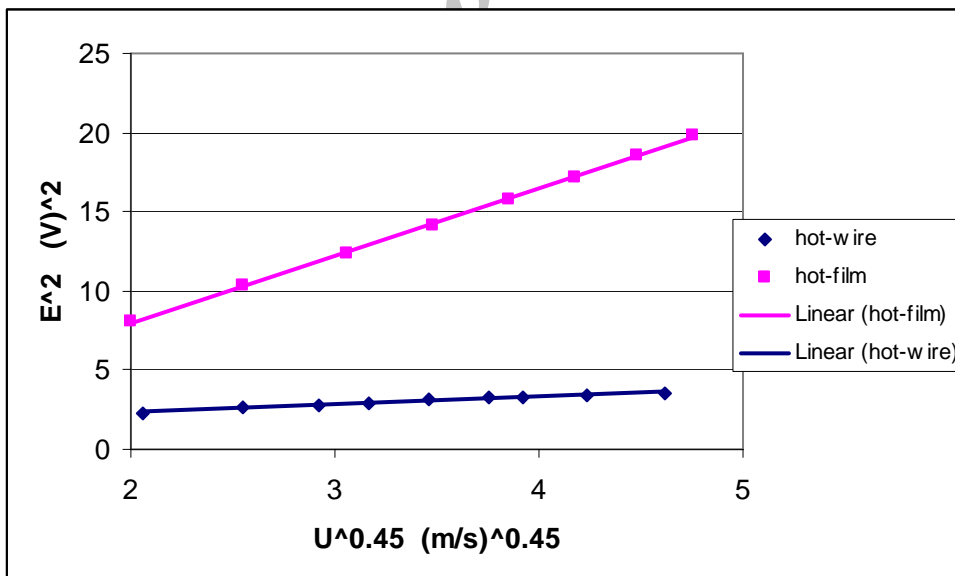
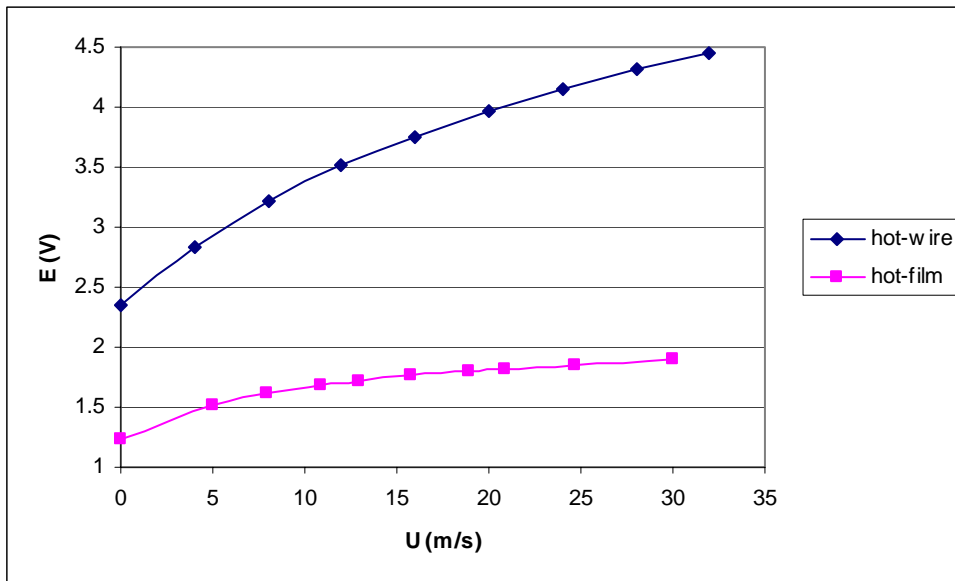
		$R (\Omega)$	$\alpha_{20} (1/^\circ\text{C})$	oh	$T_w (^\circ\text{C})$
		/	/	/	
		/	/	/	

$U(\text{m/s})$	f	K	B	$d(\text{mm})$	$l(\text{mm})$	$\text{Mesh}(1/\text{mm})$
10	0.560815	2.179516	0.435392	0.36	1.058333	24
10	0.659874	1.296564	0.513423	0.48	1.693333	15
20	0.60524	1.729883	0.435392	0.36	1.058333	24
20	0.702021	1.029083	0.513423	0.48	1.693333	15
30	0.631045	1.511192	0.435392	0.36	1.058333	24
30	0.72567	0.898987	0.513423	0.48	1.693333	15



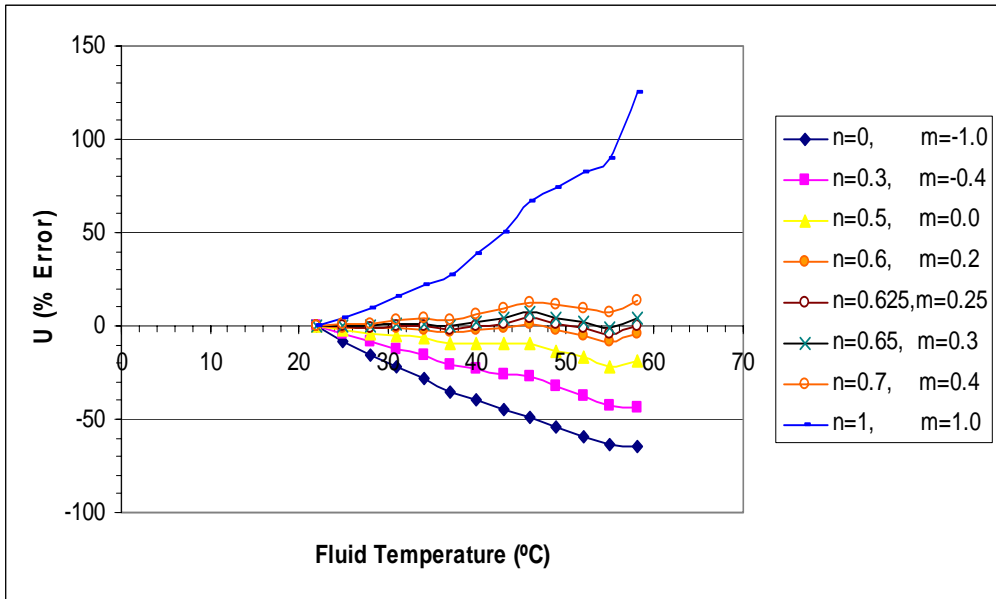


CTA

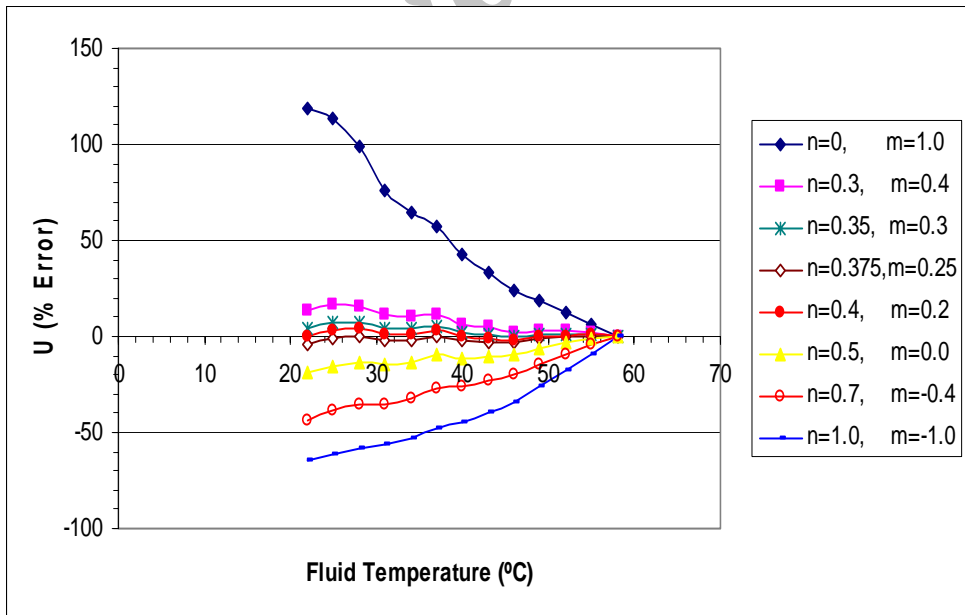


$$\left(\frac{R_w - R_a}{R_a} \right) = 0.6$$

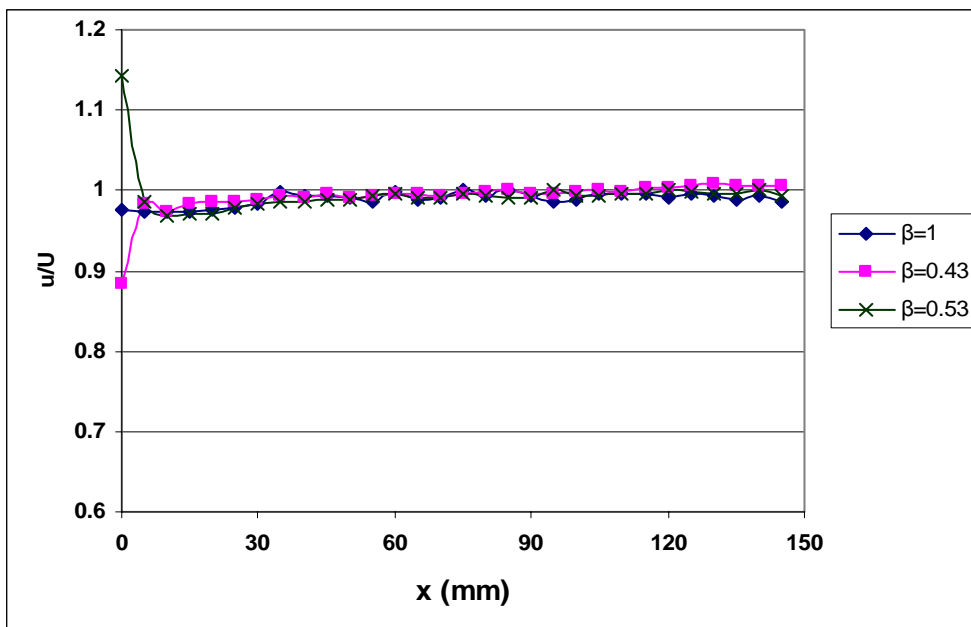
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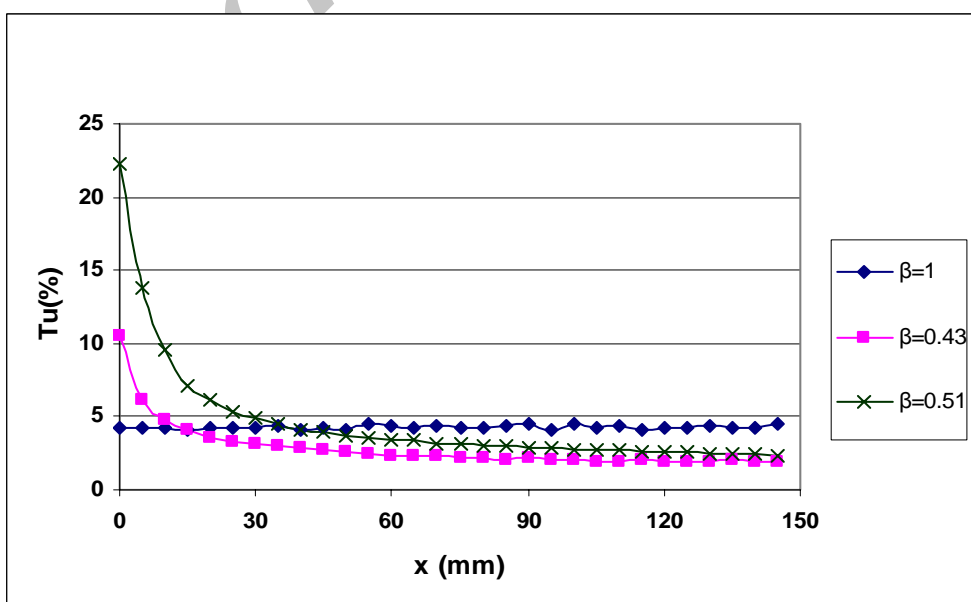
$$(T_r = C, T_w = \text{ }^\circ C)^\circ$$



$$(T_r = C, T_w = \text{ }^\circ C)^\circ$$

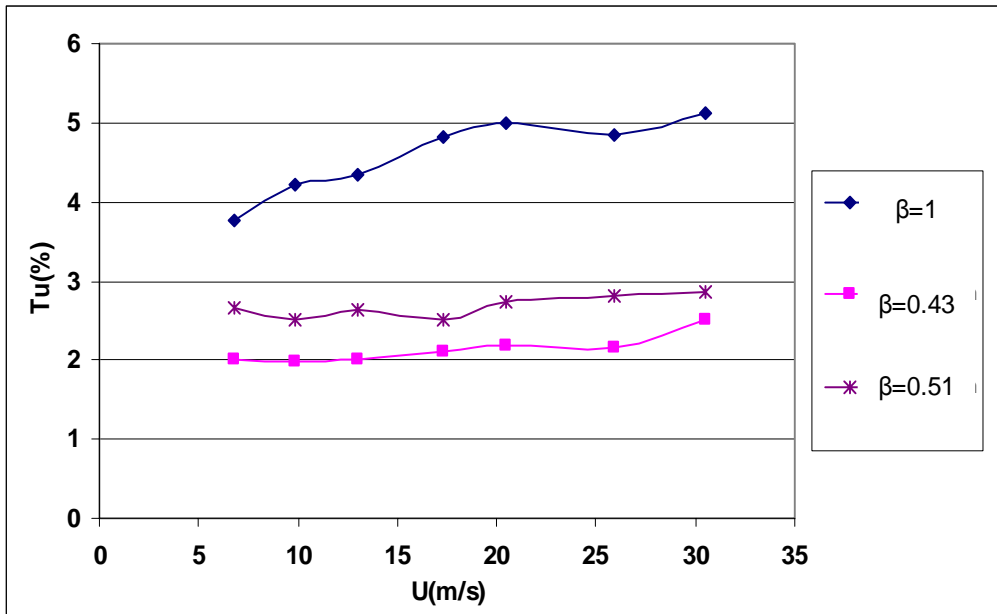


($U = \quad$ m/s)

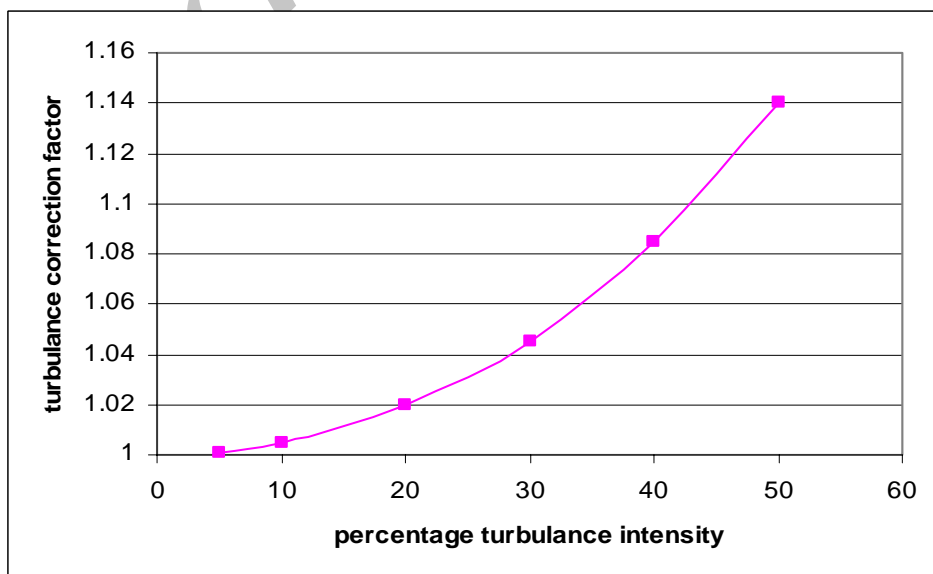


($U = \quad$ m/s)

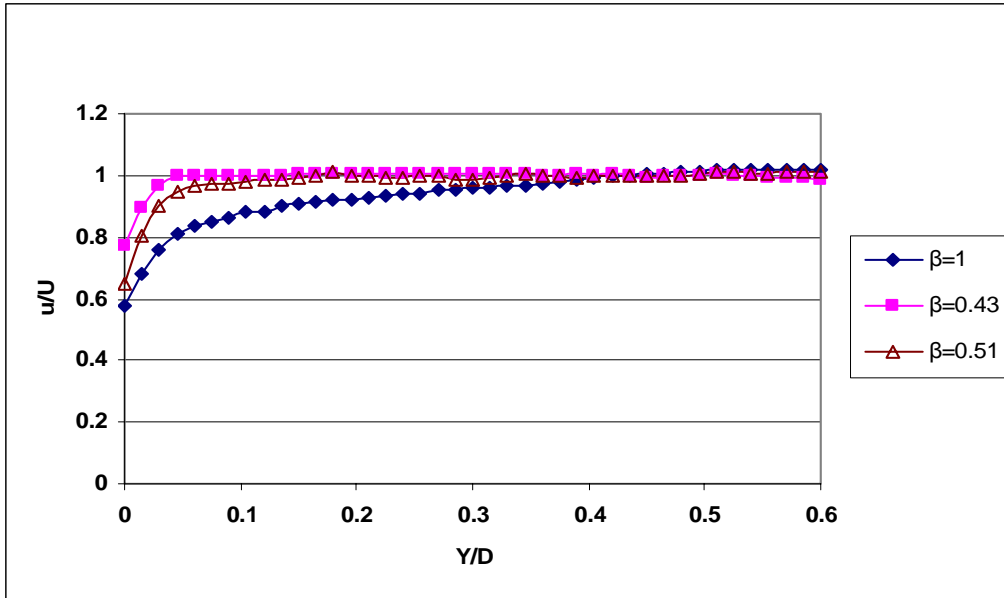
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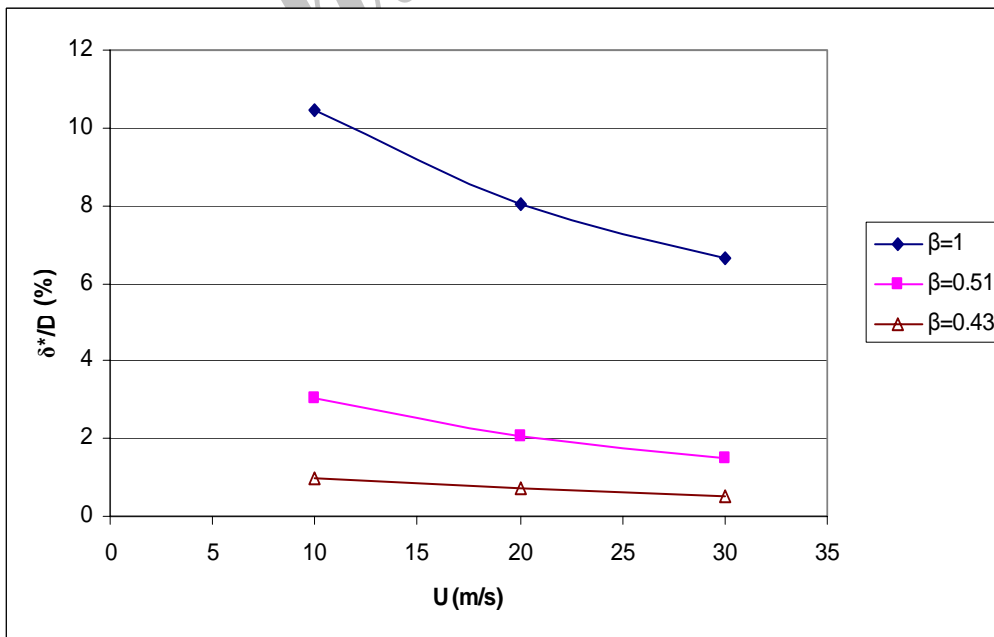
($x = \text{mm}$)



[]

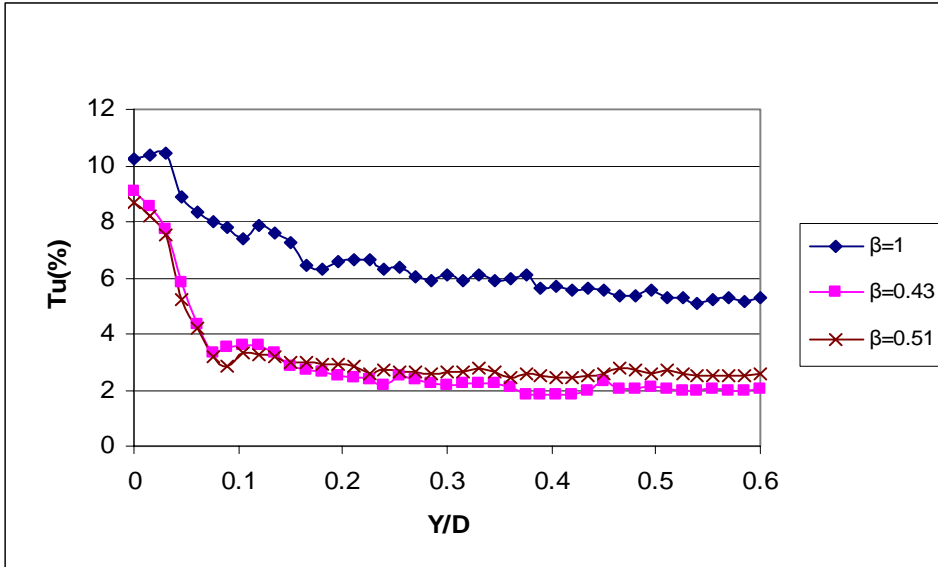


($U = \text{m/s}$, $x = \text{mm}$)

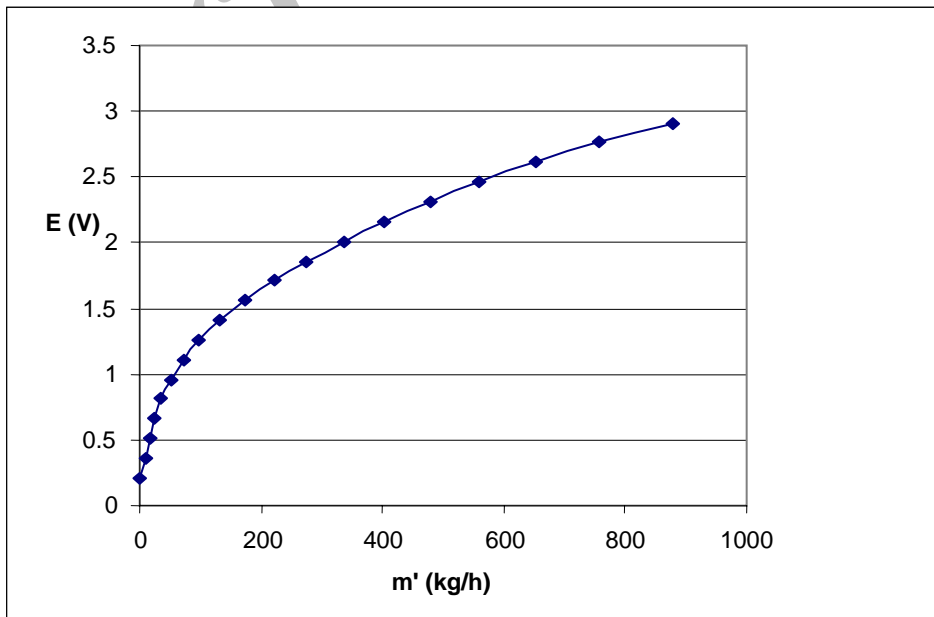


($x = \text{mm}$)

...



($x = \text{mm}$)



Abstract

Optimization of fluid systems requires flowmetry. Various flow measurement methods are used such as differential (pressure difference), linear (ultrasonic, vortex shedding) and non-linear (hot-wire/or hot-film). Each method has its own merits and demerits. The advantages of hot-wire or hot-film anemometry are high accuracy, ability to measure low flow rates, wide measurement range, and low pressure drop. This type of flow meter consists of a sensor, electronic circuits, software and various mechanical parts such as tube, screen and honeycomb for obtaining a uniform air flow. In this paper the calibration curves for hot-wire and hot-film sensors have been compared, and suitable sensors for flow meter applications have been selected. The effect of type of screen on the uniform air flow and reduction of air turbulence has been discussed, and suitable sensor position has been determined. The effects of temperature on the sensor calibration and the required factor for the correction of the temperature effects have been presented. Calibration of the flow meter has been given for completion of the paper.

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