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A Two –Dimensional numerical Study of the effect of variable heat transfer coefficient on the performance of annular fins

Abstract

This work involves a numerical two-dimensional study on the effect of the variation in heat transfer coefficient on the performance of annular fins. The object was to study the effect of varying the heat transfer coefficient on the fin efficiency. , Fin effectiveness, optimum length and the heat flow for fins of different cross-section, namely, constant thickness, and trapezoidal assuming a two dimensional flow inside the fin (radial and axial).

The results were obtained through setting up the governing equations and solving them by a finite difference technique employing the method of grid generation and coordinate transformation with the aid of the Gauss-Siedel method.

A power relationship was used to describe the variation of the heat transfer coefficient as a function of the fin length.

It was found that the variation in heat transfer coefficient reduces the fin efficiency, effectiveness, optimum length and the temperature gradient at the root of the fin and consequently the amount of heat transfer. Further more this variation led to an increase in the volume required to dissipate a known quantity of heat as compared to the constant coefficient case It was also found that heat dissipation increased with the increase in fin length to a certain limit and then begins to drop.

قبل في ٢٠٠٥/٥/٣١ استلم في ٢٠٠٤/١٢/٤

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M	[illegible]	W	M2	[illegible]	Ar
	[illegible]	r,z	M2	[illegible]	Az
	[illegible]	ξ,η	M2	[illegible]	Ab
	[illegible]	η		[illegible]	F
	[illegible]	ε		[illegible]	FLOP
[illegible]			W/m2k	[illegible]	H
	[illegible]	E	W/m2k	[illegible]	ha
	[illegible]	O		[illegible]	J
	r [illegible]	r,rr	W/m k	[illegible]	K
	z [illegible]	z,zz		[illegible] am [illegible]	Ka
	rÅ z [illegible]	Rz	M	[illegible]	Lf
	ξ [illegible]	ξ,ξξ		[illegible]	M
	ηξ [illegible]	ηξ		[illegible]	N
	η [illegible]	η,ηη	W	[illegible]	Qcond.
			W	[illegible]	Qconv.
			W	[illegible]	Qf
			W	[illegible]	Qnf
			W	[illegible]	Qr
			W	[illegible]	Qr+Δr
			W	[illegible]	Qz
			W	[illegible]	Qz+Δz
			M	[illegible]	R
			M	[illegible]	re
			M	[illegible]	ro
			M	[illegible]	RL
			K/kw	[illegible]	Rs
			K/kw	[illegible]	TR
			K/kw	[illegible]	Rt
			K/kw	[illegible]	s,sξ,sη
			K	[illegible]	T
			K	[illegible]	Tf
			K	[illegible]	To

[illegible]

[illegible]
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[illegible] (heat transfer coefficient) [illegible]
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[illegible] [3] Imre Razelos [illegible]
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[illegible] [5] Jameil [illegible]

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[illegible] [6] Manzoor Ă Ingham Ă Heggs [illegible]

[illegible] Han Ă Lefkowits [illegible] % [illegible]

[illegible] [1] [illegible]

[illegible] [1] [illegible] chen Ă Zyskowiski [illegible]

Vind [illegible] Han ĂLefkowits

[illegible] [1]

[illegible] (Vind,Chen,Han) [illegible]

[illegible] [7] Rofa [illegible]

[illegible] [8] SparrowĂBahrami [illegible]

[illegible] [9] Irey [illegible]

[illegible] [10] Myron [illegible]

[illegible] [11]Tan Ă Wahlan [illegible]

[illegible] [12] Abdul-Rahman [illegible]

[illegible] 835 [illegible]

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ýùlǁ ƔĂǁùƪĐĂ Õǂǁ Tù!ƒ þùŏ!Ăǩ ƔĂǁƪĐ yǆ Ƚ!þǴǆ!ƒ ýơ Õ5 ǴnjlŏƱǩ Ǆǩ Õǩ!ƒ þþơǆ!ƒ ƨƧ5!ƒ ȽlŏƧƱ ÕNjĂ Ǆùǩ. ȽƽǁƵƨ!ƒ yƱlǆ Ǆŏƪlǩ þǁƵ ȽǆƯǩǁǆ Ƨŏƺ ǴŏǗƤ LJĂǂǩ! ǁ!ƦĂ Ƚŏþþƶ!ƒ ȽlŏƧƱ!ƒ ǁƦNj ƘǆþƤǩƪƒ ƘǴŏƛƒþơǗƒ lƧƒƧùơ!ƒ ƔǴŏƪùǁƒ LJƒ ÕNjĂ ƘǴŏưƧ5!ƒ LJǆ ȽƵĂǆƞǆ ǏǁƵ þǴǆǩƵǗǴ Ƚǆǂơǩǆ!ƒ Ƚŏǁư Ǵ5ǩ!ƒ Ƚ!þǴǆ!ƒ ƨǴlǩTƒ Ǆǩ Ü ȽƽǁƵƨ!ƒ ýƤƒþ lþ!Ăǩǆ lƧƒƧơ þƞĂǩ Ǚ Ü LJǆƨ!ƒ ǏǁƵ þǆǩƶŏ Ǚ ȽƽǁƵƨ!ƒ ýǗƤ lƧƒƧơ!ƒ ƘǴƞƧþ yŏƨĂǩĂ ȽƞƧþ Ü ȽƽǁƵƨ!ƒ ÕnjƞĂ LJǆ ȽǁǩǁǆƧ!ƒ ǁǩ yǆ ȽǁƧǴlǆ!Ǵ ȽƽǁƵƨǁ! ȽŏƞƧǴƤ!ƒ ȽŏǴnjǁ!ƒ LJǆ ȽǁǩǁǆƧ!ƒ lƧƒƧơ!ƒ ýǴǆNjǫ LJĂǂŏ ȽƽǁƵƨ!ƒ ýǗƤ lƧƒƧơ!ƒ ƔǴŏƪǁƒ Ü LJŏǩǩǴƛ Ǐlǩ ȽƽǁƵƨǁ! ƧĂǴƞǆ!ƒ yƑǴǆ!ƒĂ ȽƽǁƵƨ!ƒ ƧƦƞ LJǆ ýǂ lƧƒƧơ . ǐƧĂơǆ!ƒĂ ǐƧƱl!ƒ ǴǆNjĂ LJŏþǆǴƶǩǆ LJŏNjǴƞǩǴ

LJŏùǁǆ Ǵǆǂ ȽŏlǁơȽƽǁƵƨ! ÕƑƒĂTƵ yƱlǆ Õ5 lƧǴǩƤǆ ȽơŏƧT ǏǁƵ ȽŏƧƒƧơ!ƒ ȽǁƨƒĂǆ!ƒ ƨŏƱǩ þƶǁ . lƧƒƧơ!ƒ ƘǴƞƧþ yŏƨĂǩ 2 Ƭǩ Õǩ!ƒ Ƚŏ!Ǵǩ!ƒ Ƚŏǁư Ǵ5ǩ!ƒ Ƚ!þǴǆ!ƒ ǏǁƵ ýĂƬơ!ƒ Ǆǩ (č)ýǂT!ƒ Õ5

$$-kA_r\frac{\partial^2 T}{\partial r^2}\cdot\Delta r-k\frac{\partial A_r}{\partial r}\cdot\frac{\partial T}{\partial r}\Delta r-kA_z\frac{\partial^2 T}{\partial z^2}\cdot\Delta z-k\frac{\partial A_z}{\partial z}\cdot\frac{\partial T}{\partial z}\Delta z=0.0 \qquad \ldots(1)$$

2ǁǴùƵƨ!ƒ LJùǆ ȽƽǁƤǆ yƱǴlǆ! lƧƒƧơ!ƒ ƘǴƞƧþ yŏƨĂǩ Ǆǂơǩ ȽŏƑƨƞ Ƚŏǁư Ǵ5ǩ Ƚ!þǴǆ (1) Ƚ!þǴǆ!ƒ ýùơ! þǆǩƶǩƪ Õǩ!ƒĂ ƘǁǴƛ!ƒ ǁǆƪ!ƒ ƘƒƦ ȽŏlǁơȽƽǁƵƨ!Ǵ ȽƬǴƤ Ǵnjǁƶƞǁ! (1) Ƚ!þǴǆ!ƒ ƱƪǁǁÜ [13]Ƚŏlǁơ!ƒ (P.D) ǐĂǴŏƨŏ5!ƒ ǐĂǩƪǆ!ƒ LJǆ Ƚ!þǴǆ!ƒ ǏǁƵ ýŏĂơǩ!ƒ ǅƒƧƞĐ þƶǁ 2 Ƨơǁǆ!ƒ NǁT ýǂT!ƒ ƘƒƦ ƧƤǗƒ yƱlǆ!ƒ .Õ!Ǵǩ!ƒ ýǂT!Ǵ ƱŏƪǁǩƑ þƶǁ LJĂǂǩ5 (C.D)ÕǁǴƪơ!ƒ ăĂǩƪǆ!ƒ Ǐ!ǫ

$$\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}+\frac{\partial^2 T}{\partial z^2}=0.0 \qquad \ldots(2)$$

ǴnjlŏƱǩ ǄǩŏƪÕǩ!ƒ þþơǆ!ƒ ƨƧ5!ƒ ȽlŏƧƱ ÕNjĂ ǐþþƶ!ƒ ýŏǁơǩ!ƒ ȽlŏƧƱ ǄþƤǩƪǁ lƧƒƧơ!ƒ ƘǴƞƧþ yŏƨĂǩ þǴƞŏǗ (2) Ƚ!þǴǆ!ƒ ýơ! ƘƒƦ ȽƞǩǴǁ!ƒ ȽǂǁT!ƒ LJĂǂǩ Õǂ! ƘǴŏƛƒþơǗƒ ýǁǁĂ ȽǂǁT!ƒ þŏ!Ăǩ ƔĂǁƪĐ ǄþƤǩƪŏ.ƘǴŏƛƒþơǗƒ ýǁǁ ƔĂǁƪĐĂ ÕǂǁT!ƒ þŏ!Ăǩ ƔĂǁƪĐ yǆ ǄŏƪùlǩþùǁƵ) ǐĐ (P.D) ǐĂǴŏƨŏ5!ƒ ǐĂǩƪǆ!ƒ Õ5 ȽǆƯǩǁǆ Ƨŏƺ ƘǁǴǂ Õǩ!ƒĂ (C.D) ÕǁǴƪơ!ƒ ǐĂǩƪǆ!ƒ Õ5 ȽǆƯǩǁǆ ƘǴ5ǴƪǆǐĐ Õù5 ƘǴ5Ǵƪǆ!ƒ ƘǁǴǂ ƒƦǫ ăƧƤĐ lƧǴƶǁ.(yƱlǆ!ƒ þĂþơ yǆ ȽŏĂǴƪǩǆ Ƨŏƺ ƘǴ5Ǵƪǆ LJĂǂǩǩ ǴŏǗƤ!ƒ LJǆ þþƵ Ǐ!ǫ ȽƽǁƵƨ!ƒ yƱlǆ ýùơǩ LJĐ LJǂǆŏ Ǆǂơǩ!ƒ ƘǗþǴǆ LJĐ ǂŏơǁ ǁǴƞǩǗƒ ƒƦnjǁ ýŏĂơǩ!ƒ ƨŏǁƱǩ ǄƑǚǆ!ƒ LJǆ5 ȽƪǁǴƞǩǆ Ƨŏƺ ǐĂǴŏƨŏ5!ƒ ǐĂǩƪǆ!ƒ Õ5 ǁǴƞǩƒ .Õ!Ǵǩ!ƒ ýǂT!Ǵ LJĂǂŏ ýŏĂơǩ!ƒĂ (2)ýǂT!ƒ Õ5 Ǵǆǂ ÕǁǴƪơ!ƒ ǐĂǩƪǆ!ƒ Õ5 ȽƪǁǴƞǩǆ ƘǴ5Ǵƪǆ ƘƒƦ ȽǂǁTǂ

$$\xi=\xi(r,z)$$

$$\eta=\eta(r,z) \qquad \ldots(3)$$

(ξ , ÕǁǴƪơ!ƒ ýlơ!ƒ Ǐ!ǫ (r,z) ǐĂǴŏƨŏù5!ƒ ýùlơ!ƒ LJǆ Ǆǂơùǩ!ƒ ƘǗþǴùƶǆ ýŏĂơùǩ! ǄþƤǩùƪǩ LJĐ LJǂùǆŏ Õǩ!ƒ
: Õǁŏ Ǵǆǂ LJĂǂǩ ȽŏƑƨƞ!ƒ ƘǴlǩTǆ!ƒ LJǴ5 ÕƑƨƞ!ƒ ýưǴ5ǩǁ! ȽǁƪǁƪƒLJĂǁǴƥ ǄƒþƤǩƪǴƞ)

$$\frac{\partial}{\partial r}=\xi_r\frac{\partial}{\partial \xi}+\eta_r\frac{\partial}{\partial \eta} \qquad \ldots(4)$$

$$\frac{\partial}{\partial z}=\xi_z\frac{\partial}{\partial \xi}+\eta_z\frac{\partial}{\partial \eta} \qquad \ldots(5)$$

ǐĂǩƪùǆ!ƒ LJùǆ ȽùƽǁƵƨ!ƒ yùƱlǆ Õù5 lƧƒƧùơ!ƒ ƘǴùƞƧþ yùŏƨĂǩ Ǆǂơǩ Õǩ!ƒ (2) Ƚ!þǴǆ!ƒ ýŏĂơǩǁ ǄĂlǁ LJǙĐ
. (C.D)ÕǁǴƪơ!ƒ ǐĂǩƪǆ!ƒ Ǐ!ǫ (P.D) ǐĂǴŏƨŏ5!ƒ

$$\frac{\partial T}{\partial r}=T_\xi\cdot\xi_r+T_\eta\cdot\eta_r \qquad \ldots(6)$$

$$\frac{\partial T}{\partial z}=T_\xi\cdot\xi_z+T_\eta\cdot\eta_z$$

$$\frac{\partial^2 T}{\partial r^2}=\xi_r{}^2T_{\xi\xi}+2\xi_r\eta_rT_{\xi\eta}+\eta_r{}^2T_{\eta\eta}+\xi_{rr}T_\xi+\eta_{rr}T_\eta$$

…(7)

…(8)

$$\frac{\partial^2 T}{\partial z^2} = \xi_z{}^2 T_{\xi\xi} + 2\xi_z \eta_z T_{\xi\eta} + \eta_z{}^2 T_{\eta\eta} + \xi_{zz} T_{\xi} + \eta_{zz} T_{\eta} \quad \ldots(9)$$

.ŎķŰĠŧ ƠŀŢķ5 (2) Ŧ!þĠƶďž!ƒ Ŏ5 ǉŭƵĐ ƘŮþĠƶďž!ƒ Ʊ'ŏĂƶķŀ ĐžĂǀǉ ǈŮĐ

$$(\xi_r{}^2+\xi_z{}^2)T_{\xi\xi}+2(\xi_r\eta_r+\xi_z\eta_z)T_{\varsigma\eta}+(\eta_r{}^2+\eta_z{}^2)T_{\eta\eta}+(\xi_{rr}+\xi_{zz})T_{\xi}+(\eta_{rr}+\eta_{zz})T_{\eta}+\frac{1}{r}(T_{\xi}\xi_r+T_{\eta}\eta_r)=0.0 \cdots(2)$$

$T_{\xi\eta}$ T_{η} T_{ξ} $T_{\eta\eta}T_{\xi\xi}$ ǈďž ýŧ ǈƵ ƧŏŀƶķƒĐžķŏ Ŧŏơ (ŦŏPƒþ!ƒ) ŦŏƱƪĂ!ƒ þǀƶ!Ġŀ ŦŢĠP (2) Ŧ!þĠƶďž!ƒ
.ĬƱƪĂ!ƒ þþơďž!ƒ ƽƧ5!ƒ ƘŮþĠƶďžŀ
ǈĠù5 ǈŏķƛĠďžķďž ǈŏ5Ţǉ Ĭ!ǫ Ŧ5ǉƵƨ!ƒ ýƱǀďž Đžƪǀŏ ĭ Ʀ!ƒ ýƛĠďžķ!ƒ ƱP ĬƵ ŦƶpƒĂ!ƒ þǀƶ! ŦŀƪǉĠŀ ĠďžĐ
ĂǋǉĠǌďžŧơŏ ĭ Ʀ!ƒ ƻƧƱ!ƒ

$$\frac{\partial T}{\partial z} = 0.0$$

ŦŏķŬƒ ŦƺŏŢ!Ġŀ ýŏĂơķ!ƒ þƶŀ ǈĂŧķĂ

$$\frac{\partial T}{\partial z} = T_{\xi}\cdot\xi_z + T_{\eta}\cdot\eta_z = 0.0 \quad \ldots(10)$$

η_Z Ă T_{ξ}Ġùďž Ŏďž Ġùďž Ű ƒ þþơďž!ƒ ƽƧ5!ƒ ƘŮþĠƶďž Ŧ!Ůþŀ Ġďžǌǉ Ƶ Ƨŀƶǉ ǈĐ Ɣηŏ r_{η} Ă T_{η} ǈďž ýŧ ƔĠƪơ!
.ŎƱƪĂ!ƒ þþơďž!ƒ ƽƧ5!ƒ ƘŮþĠƶďž Ŧ!Ůþŀ Ġǌǉ Ƶ Ƨŏŀƶķ!ƒ Ɣηŏ5
.ŎķŰƒ ƻƧƱ!Ġŀ ŦďžĂŧơďž ǈĂŧķ Ġǌǉď5 Ŧ5ǉƵƨ! ŦŏηƧĠP!ƒ ŦŏĠǌǉ!ƒ ĬƵ ŦƶpƒĂ!ƒ þǀƶ!ƒ ĠďžĐ

$$\frac{\partial T}{\partial r} = 0.0$$

$$\frac{\partial T}{\partial r} = T_{\xi}\cdot\xi_r + T_{\eta}\cdot\eta_r = 0.0 \quad \ldots(11)$$

ŎùƽP!ƒ þþùơďž!ƒ ƽƧù5!ƒ ƘŮþĠùƶďž Ŧ!Ůþŀ Ġǌǉ Ƶ Ƨŀƶǉ ǈƒ Ɣηŏ T_{ξ},Z_{ξ} ǈďž ýŧ ƔĠƪơ!Ă
.ŎďžĠďžŰƒ þþơďž!ƒ ƽƧ5!ƒ ƘŮþĠƶďž Ŧ!Ůþŀ Ġǌǉ Ƶ Ƨŏŀƶķ!ƒ Đžķŏ5 T_{η},ξ_rĠďžĐ
ƽùŏŀƱķŀ ĐžĂùǀǉ5 Ŧùƽǉƶƨ!Ġŀ Ʊŏơďž!ƒ ýƒĠďž! Ʊ'Ƨƶďž!ƒ ŎηƧĠP!ƒ ƠƱƪ!ƒ ĬƵ ŦƶpƒĂ!ƒ þǀƶ!ƒ ĠďžĐ
ƘĠηƧþ þŏþơķ! ĐžƒþPķƪŭ! Ŧ!Ăŀǀďž ǈĂŧķ ǈĐ ýηƒ ǈďž Ŧ5ǉƵƨ!ƒ ƠƱƪ ĬƵ þǀƶ!ƒ ǈŏŀ ƘĠ5Ġƪďž!ƒ ĬƵ ýŏĂơķ!ƒ
.ŎķŰĠŧ Ŧ5ǉƵƨ!ƒ ƠƱƪ ýĂƱ ĬƵ ƘĠ5Ġƪďž!ƒ ǈĂŧķĂ þǀƶ!ƒ ǉƦǌ! ǀƧƒƧơ!ƒ

$$S = \sqrt{dr^2 + dz^2} \quad \ldots(12)$$

Ŧ5ǉƵƨ!ƒ ýĂƱ ĬƵ Ŧ5Ġƪďž!ƒ ýŏĂơķ!Ă

$$dr = r_{\xi}\cdot d\xi + r_{\eta}\cdot d\eta \quad \ldots(13)$$

$$dz = z_{\xi}\cdot d\xi + z_{\eta} d\eta \quad \ldots(14)$$

ƘŬƥƓùƶdž!ƒ ƠƕŢùƙ ǁ!Ʀù! ƚùƙƕƓƛ ηǸŏƼ ǇǍǂƙ ǐƦ!ƒ ƱƤ!ƒ ýǍƱ ǏǁƵ dξ=1Ǎ d η=0.0 ǇǍǂƙ ƚŏơ
ǑƙǕƓǂ (14),(13)

$$dr = r_{\xi}$$
…(13)

$$dz = z_{\xi}$$
…(14)

ǑƱƶƙ Ǒƙ!ƒǍ

$$S_{\xi} = \sqrt{r_{\xi}^{\,2} + z_{\xi}^{\,2}}$$
…(15)

(12) ƚù!ƥƓƶdž!ƒ ƠƕŢùƙ ǁ!Ʀ! ƚƙƕƓƛ ξǸŏƼ ǇǍǂƙ ǐƦ!ƒ ƱƤ!ƒ ýǍƱ ǏǁƵ d η=1Ǎ dξ=0.0 ǇǍǂƙ ǁ!ƦǂǍ
: ǑƙǙƓǂ

$$S_{\eta} = \sqrt{r_{\eta}^{\,2} + z_{\eta}^{\,2}}$$
…(16)

:Ǒƙdŏ Ɠdžǂ ǇǍǂƙ i-1 Ǎ i ǀƥǀƶ!ƒ ǇǑƕ ƚƽǉƵƨ!ƒ ƠƱƪ ýǍƱ ǏǁƵ ƚƼƓƪdž!ƒ

$$S_{\xi 2} = \sqrt{(r(i+1,j) - r(i,j))^2 + (z(i+1,j) - z(i,j))^2}$$
…(17)

i+1 Ǎ i ǀƥǀƶ!ƒ ǇǑƕ ƚƼƓƪdž!ƒ ƓdžƊ

$$S_{\xi 1} = \sqrt{(r(i,j) - r(i-1,j))^2 + (z(i,j) - z(i-1,j))^2}$$
…(18)

:ǑƙǗƊǂ ǇǍǂƙƼ j-1 Ǎ j ǇǑơƱƪ!ƒ ǇǑƕ ƱƕƧŏ ǐƦ!ƒ ƱƤ!ƒ ýǍƱ ǏǁƵ ƚƼƓƪdž!ƒ ƓdžƊ

$$S_{\eta} = \sqrt{(r(i,j) - r(i,j-1))^2 + (z(i,j) - z(i,j-1))^2}$$
…(19)

ǑǸ ƚƽǉƵƨǁ! ǑηƧƓƤ!ƒ ƠƱƪ!ƒ ǏǁƵ ƚƶpƒǍ!ƒ (i , j) ǀƥǀƶǁ! ƚƕƪǉ!Ɠƕ ƚpƓƱ!ƒ ƚ!ƥƓƶdžǍ

$$Q_{cond} = Q_{conv}$$
…(20)

.ƚƽǉƵƨǁ! ǑηƧƓƤ!ƒ ƠƱƪ!ƒ ǏǁƵ ƚƶpƒǍ!ƒ ƥǀƶ!Ɠƕ ƚŢƓƤ (20) ƚ!ƥƓƶdž!ƒ
ǀƧƒƧùơ!ƒ ƘƓùηƧƥ ýƥùƶdž ǇǑùdž ǀƧƒƧơ!ƒ ƘƓηƧƥ ƔƪơƙƼ ǇǑƙŏǍƒƨ!ƒ ýƛdžƙ Ǒƙ!ƒ ƥǀƶ!Ɠ ƚƕƪǉ!Ɠƕ ƓdžƊ
ƓdžǌǉǁƵ ǇǑƙƧǍƓηdž!ƒ ǇǑƙƥǀƶǁ!
ƴùƱǀdž ýǖùƤ ǀƧƒƧơ!ƒ ƘƓηƧƥ ƴŏƨǍƙ ƥƓηŏƚƕ ƚŢƓƤ!ƒ ƘŬƥƓƶdž!ƒ ýŏǍơƙ ýdžƙǂ!ƒ ƥp ǇǍǂŏ ǉƦǋǉƕǍ
.[14]ǑƕƓƪơ!ƒ ǎǍƙƪdž!ƒ Ǐ!ǫ ǐǍƓŏƨŏƼ!ƒ ǐǍƙƪdž!ƒ ǇǍdž ƚƽǉƵƨ!ƒ
ǉƦùǸ ýùơ! ǑƕƓƪùơ!ƒ ǐǍƙƪùdž!ƒ Ǐ!ǫ ǐǍƓŏƨŏƼ!ƒ ǐǍƙƪdž!ƒ ǇǍdž ƚdžǂơƙdž!ƒ ƘŬƥƓƶdž!ƒ ýŏǍơƙ ƥƶƕ
ƚùƷǁƕ ƔǍùƪƓơ ǅdžƓùǉƧƕ ǅŏdžŢùƙ ǅùƙǍ Ǘ[15]ƥƥùơdž!ƒ ƫƧùƼ!ƒ ƘŬƥƓƶdž ƚ!Ŭƥƕ ƓǌƶƶƨǍ ǅƙ ƘŬƥƓƶdž!ƒ
.[16]ǇƒƧƙƧǍƼ
ƧùƲǉƕ ƦùƤŬƒ ǅùƙ ǐƊ ƓùǌǉƓdžǸǫ ǅƙ ƘƕƓƛ!ƒ ǀƧƒƧơ!ƒ ýƓǀƙǉƒ ýdžƓƶdž ƚŏƴƧƼ Ǉǫ ǁǀƕƓƪ ƓǉǑƕ Ɠdžǂ
ƚ!ƥƓƶdž!ƒ ǑƼ Ɠdžǂ (ǐƧƱǀ!ƒ ǉƓηƙǓƒ)ǍǸǍ ƥơƒǍ ǉƓηƙƓƕ ǀƧƒƧơ!ƒ ýƓǀƙǉƒ ýdžƓƶdž ǑƼ ýŢơŏ ǐƦ!ƒ ƧŏƷƙ!ƒ ƧƓƕƙƵǓƒ
: [3]ƚŏ!Ɠƙ!ƒ

$$h(r) = ha \cdot \frac{\left[\left(\frac{r_e}{r_o} + 1\right) * (am+1) * (am+2)\right]}{2 * \left[(am+1) * \frac{r_e}{r_o} + 1\right]} * \left[\frac{(r - r_o)}{(r_e - r_o)}\right]^{am}$$
…(21)

ƧùƛǂƒƘƥƕ (ƚŏƪǓƒ ƚ!ƥƓƶdž!ƒ ǐƊ) ǀƧƒƧơ!ƒ ýƓǀƙǉƒ ýdžƓƶdž ƧŏƷƙ 2 ŢǍ! ƚǀƕƓƪ!ƒ ƚpǖƶ!ƒ ƧƓŏƙƤƒ ǇǫƏǁƵ ƥƓdžƙƵǓƓƕ ǀƧƒƧơ!ƒ ýƓǀƙǉƒ ýdžƓƶdž ƧŏƷƙ! 2 ŢǍ ǇǍdž ƧƛǂƒǑƱƶƙ Ǒƙ!ƒǍ.ƚǀƕƓƪ!ƒ ƘƓƪƒƧƥ!ƒ ýƕp ǇǍdž ǕǍƕp

(3) (am) (am =0.0) (am=1.0) (am=2.0) (d') .[3]

[12] Abdul Rahman

$$R_L = \frac{\mathrm{Ln}\left(\frac{r_e}{r_o}\right)}{2\pi k w} \quad \ldots(22)$$

$$R_t = \frac{w}{4\pi k w} \quad \ldots(23)$$

$$R_s = \frac{1}{2\pi h a (r_e^2 - r_o^2)} \quad \ldots(24)$$

$$TR = \sqrt{R_L^2 + R_t^2} + R_s \quad \ldots(25)$$

. (k=380 W/m.K)

. ($ha=500 W/m^2.K$)

(1)

$$\eta = \frac{Q_f}{Q_{max}} \quad \ldots(26)$$

.[17]

$$\varepsilon = \frac{Q_f}{Q_{nf}}$$

(27)

ǈĴùdž ƖƧdž ýĂŬ ϴƧkpf ĭŘ!f Ŧùs̈ǉƵƨ!f ýĂƱ! Ŧöǐǘ5Ǖf ýùdžĜƵ ĂNj ĭŘ!f Ŧ!Ĝùƛ!f ýdžĜƶ!f ĜdžĐ
ĭĂĜʅùöĂ. Ĭ ùƱƶdž!f Ŧùs̈ǉƵƨ!f ǉþƵĜp ǁdžʅ! ýĂƱ ý ǘ5f ŐƱƶö ýdžĜƶ!f fŘNj ǈĴf Ŧöơ Jasim Ŧ ơĜh!f ýhp
.[18]Ŏ!ĜǩĜǂ ǇĴĂǂö5 ĜnjǩöĜƶ5 Ŏ5 Ŧs̈ǉƵƨ!f ǉĈĜ5ǂ ƔƧǘ ýʅĜơ

…(28) $FLOP = \eta \cdot \varepsilon$

[18] Ŧ ùơĜh!f yùdž Ŧùǉ̈ƧĜǉdž ĈfƧɳf Džǩ Ŧ!ĜʅdžĜh f ĜƤ!fĂ DždžʅTdž!f ǇdžĜǉƧh!f ƧĜhǩƤf ýɳf ǇĴdž
ƻĂƧùǗ!f ǇĴf Ŧ ùöơ ƘùhĜƛ!f ýdžĜƶdž!f Ŧ!Ĝơ!Ă ƘhĜƛ ǁdžʅ ƘfŘ Ŧöǉǐơ Ŧs̈ǉƵƨ! ƘǉĜǂ ŦǉƧĜǉdž ǇĴĐ Ř Jasim
Ŧùs̈ǉƵƨǐ! ŦöɳƧĜƤ!f ŦöĜnjǉǉ!f ǇĴfĂ ŦǩhĜƛ Ĭ ǉhǩ Ŧs̈ǉƵƨ!f ǉþƵĜp ƖƧfƧơ ŦɳƧþ ǇĴf ŎNj ĜnjdžfþƤǩʅf Džǩ Ŏǩ!f Ŧöþơ!f
ƖƧfƧùơ!f ýĜùǉǩǉf ýùdžĜƶdžĂ [k=202 w/mk] Ŧùs̈ǉƵƨ!f ǉþĜdž! ŦöƧfƧơ!f Ŧöǐ ʅĂdž!f ǇĴf Ŧ öơ Ü Ŧ!Ăƨƶdž
ǇĴöùhǩö . [Ro=5cm] ĭĂĜʅö ŎǐƤfþ!f ƧƱǉ!fĂ [Tf=100] ƱöơDž!f yFĜdž!f ƖƧfƧơ ŦɳƧþĂ [h=10w/m]
ƽhĜʅ!f ýdžƶ!fĂ Ŏ!Ĝơ!f ýdžƶ!f ǇĴöh ƔƧĜǉǩ!f ǇĴf Ŧs̈ǉƵƨ!f ǉĈĜ5ǂ ýƛdžö ĭŘ!f .(þ 3)ýǂƬ!f ŦǗơǖdž ýǖƤ ǇĴdž
.ăƧƤǕf ƧþĜʅdž!f Ŏ5 Ŧö5Ĝǂ!f ƘĜǉĜöh!f Ƨ5Ăǩ Džþƶ! ƱǉǄ ƧþʅDž!f fŘNj yDž ŦǉƧĜǉdž ƘöƧɳĐ Ü þöɳ

hʅ5FdžĐŽǁƐNj ƛƏFŦdžǁƐ - Ď

Džùǩ Őùǩ!f þþơdž!f ƽƧ5!f ŦǉöƧƱ ŐNjĂ Ŧöþþƶ!f ŦǉöƧƱ!f DžfþƤǩʅĜh Ŧdžǂơǩdž!f ƘǕþĜƶdž!f ýơ þƶh
ŦùöƱʐk! ŦùöƧfƧǂǩ!f ýþöùʅ ƩĂĜǂ ŦǉöƧƱ yDž ƘĜöƛfþơǕf ýǉǉ ƔĂǐʅĐĂ ŦǂhƬ!f þö!Ăǩ ƔĂǐʅĐ yDž ĜnjǉöhƱǩ
Džùǩ Őùǩ!f ǇFĜùǩǉ!f ǇĴùƵ ŦdžĜƵ ƖƧĂʅ ĈĜƱƵǫ Džǩöʅ Ŧöơ .ƔĂʅĜơ ǇdžĜǉƧh DžöDžʅǩ ƘhǐƱǩ Őǩ!fĂ Ŧ!ǅʅdž!f
ýöŋʅùǩ Ŧùöʐh ƘĜùöǉơǉdž ýǂƬh ĜnjǘƧƵ ƽöƧƱ ǇĴƵ ǁ!ŘĂ Ŧdžǂơǩdž!f ƘǕþĜƶdž!f ýơ ǇĴdž ĜnjöǐƵ ýĂʅơ!f
. ĜnjǐöǐơǩĂ ĜnjǩƬþĜǉdž

ýĜǉǩǉf ýdžĜƶdž Ƨöʐǩ ƻʅǩ Őǩ!f Ŧ!þĜƶdž!f Ơö ǘĂǩ ĭþþƶ!f ýơ!fĂ Ő ǘĜöƧ!f ýöǐơǩ!f ǉƧǉ Ŏ5 Džǩ
ƩǕf Ĝnjö5 ǇĴĂǂö Ŏǩ!f Ŧ!Ĝơ!Ĝ5 (2.0 , 1.0 , 0) ŐNjĂ Ʃǖ! Džöp Ŧ ǖƛ þdžǩƵfĂ ŦöʅĐ Ŧ!þĜƶdž ŐNjĂ ƖƧfƧơ!f
ƩǕf Ĝùnjö5 ǇĴĂǂö Őǩ!f Ŧ!Ĝơ!f ĜdžĐ ƠƱʅ!f ĬǐƵ ƘhĜƛ ƖƧfƧơ ýĜǉǩǉf ýdžĜƶdž Ŧ!Ĝơ ýƛdžǩ (am =0.0) ĭĂĜʅö
(am = ƩǕf ĭĂĜʅö ĜdžþǉƵ ĜdžĐ ĜöùƱƤ ƖƧfƧơù!f ýĜǉùǩǉf ýdžĜƶdž Ƨöʐǩ ǇĴĂǂöù5 (am = 1.0) ĭĂĜùʅö
Őǩ!f Džöǉ!Ĝ5 Ŧs̈ǉƵƨ!f ǉþƵĜp ǁdžʅ ǇĴƵ ĜdžĐ .ŦöǉĜùƛ!f ŦɳƧþ!f ǇĴdž ƖƧfƧùơ!f ýĜǉùǩǉf ýdžĜƶdž Ƨöʐǩ ǇĴĂǂö5 2.0)
Ĭ ù!ǫ 0.0) ǇĴùdž Ƨöʐǩǩ ǈǩdžöǉ5 Ŧs̈ǉƵƨ!f ýĂƱ ĂNj ƧöƤǕf ýdžĜƶ!fĂ (0.005m ,0.003m) ŐNj ĜnjǩöƱʐǩ Džǩ
. (0.1m

ǈhùƬ ýǂƬù!f ƘfŘĂ ƘhĜƛ!f ǁdžʅ!f ƘfŘ ŐNjĂ Ŧöǉǐơ!f ƻǉĜƵƨ!f ǇĴdž ǇĴöƵĂǉ DžfþƤǩʅf Džǩ Ĝdžǂ
yùöƨĂǩ ýǂƬ ĬǐƵ ǇFĜǩǉ!f ĬǐƵ ýĂʅơ!f DžǩĂ ǇĴöǐǂƬ!f ǖǂ! ĜʅǉĜ ƖƧĂǂŘdž!f ýdžfĂƶ!f Ƨööʐǩ Džǩ Ŧöơ ƻƧơǉdž!f
. Ŧs̈ǉƵƨǐ! ýƛdžǕf ýĂƱ!fĂ ĜnjǩöĜƶ5Ă Ŧs̈ǉƵƨ!f ǉĈĜ5ǂĂ ǉþþhdž!f ƖƧfƧơ!f Ŧödžǂ Ă Ŧs̈ǉƵƨ!f ýǖƤ ƖƧfƧơ!f ƘĜɳƧþ

:ƔþƐþϴǁƐ ǉFǕþǫ ǗĭŘNjǂ Ĭʐ ƔþƐþϴǁƐ üFƽŦdžƐ üDŽFyDŽ þĭƩŦ þĭǩĐŦ Č - Ď

Ʃ Ǖ Ŧs̈ǐǩƤdž Džöǉ! ĭƧƱ!f ǉĜɳǩǕĜh ƖƧfƧơ!f ƘĜɳƧþ ƱʅĂǩdž Ƨöʐǩ (7,6,5,4) ýĜǂƬǕf ýƛdžǩ
(am) ƩǕf ǉþĜùöƨ ǇĴǫ ǗùơǖǉǄ ýĜǂùƬǕf ǇĴdž .Ŧs̈ǉƵƨ!f ƧŘɳ ǁdžʅ! Ŧs̈ǐǩƤdž Džöǉ!Ă ƖƧfƧơ!f ýĜǉǩǉf ýdžĜƶdž
ǇĴĂǂö Őǩ!f Ŧ!Ĝơ!f yDž ĜnjǉǉƧĜǉdžh ǁ!ŘĂ Ŧs̈ǉƵƨ!f ƧŘɳ ǇĴdž ŦhöƧǉ!f Ŧ!ƱǉDž!f Ŏ5 ƖƧfƧơ!f ƘĜɳƧþ ǉþĜöƨ ƔhʅǩǕ
ƖƧfƧơ!f ýĜǉǩǉf ýdžĜƶdž! ŦöƶpĂdž!f Džöǉ!f ǇĴĂǂǩ Őǩ!f Ŧ!Ĝơ!f ĭĐ) ƠƱʅ!f ĬǐƵ ƘhĜƛ ƖƧfƧơ!f ýĜǉǩǉf ýdžĜƶdž Ĝnjö5
Džöùǉ!f ǇĴĜù5 Ƨùöʐǩdž ƖƧfƧơ ýĜǉǩǉf ýdžĜƶdž ƽöhƱǩ þǉƶ5 Ü(DžþƤǩʅdž!f ƖƧfƧơ!f ýĜǉǩǉf ýdžĜƶdž ƱʅĂǩdž ĭĂĜʅǩ
ýùdžĜƶdž ƱùʅĂǩdž ǇĴdž ýpf ǇĴĂǂǩ Ŧs̈ǉƵƨ!f ƧŘɳ ǇĴdž ŦhöƧǉ!f Ŧ!ƱǉDž!f Ŏ5 ƖƧfƧơ!f ýĜǉǩǉf ýdžĜƶdž! ŦöƶpĂdž!f
Ƨùöʐǩdž!f ýùdžĜƶdž!f Ŧù!Ĝơ Őù5 ƧhǂĂ ýdžơ!f ŦdžĂĜǉdž! ŦöƶpĂdž!f Džöǉ!f ǇĴĂǂǩ ǁ!Ř! DžþƤǩʅdž!f ƖƧfƧơ!f ýĜǉǩǉf

[illegible]

[illegible] (11,10,9,8) [illegible]

(am = 0) [illegible]

[illegible] (am) [illegible] (am) [illegible]

[illegible]

[illegible] (15,14,13,12) [illegible]

[illegible]

[illegible]

[illegible]

[illegible] (19,18,17,16) [illegible]

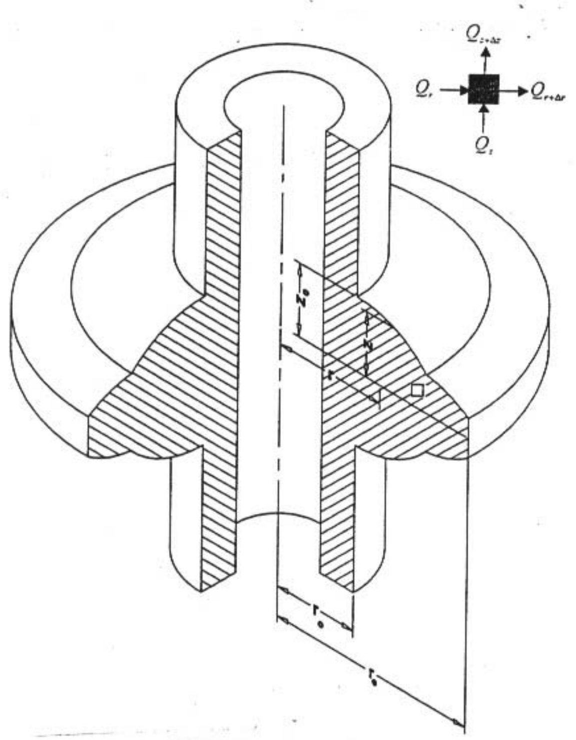
[illegible]

[illegible] (23,22,21,20) [illegible]

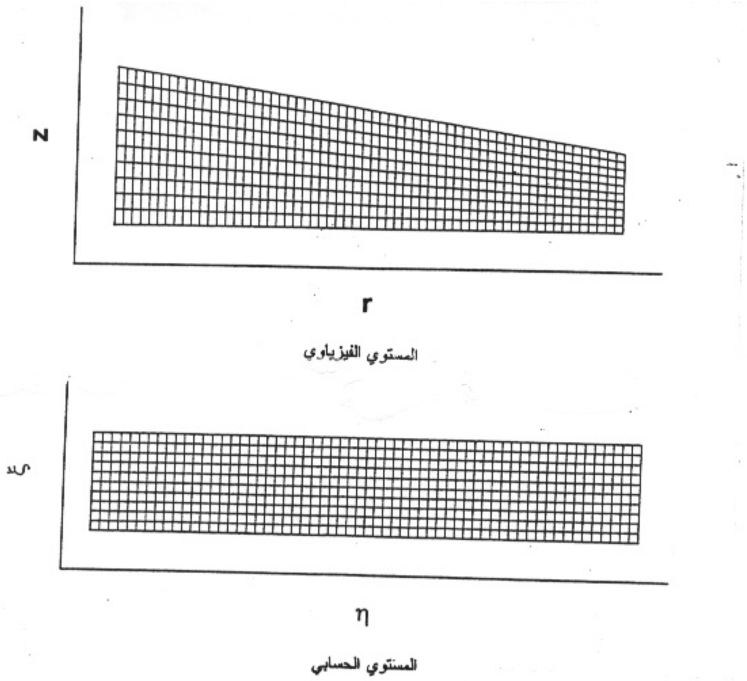
[illegible]

Lf	R_L	R_t	Rs	TR
W=0.003				
0.01	56.608	1.2565	636.638	693.261
0.02	96.772	0.52355	265.266	362.040
0.03	127.926	0.29917	151.580	279.507
0.04	153.381	0.1963	99.474	252.856
0.05	174.902	0.1396	70.737	245.640
0.06	193.545	0.10471	53.0532	246.599
0.07	209.989	0.08159	41.340	251.330
0.08	224.699	0.06544	33.1582	257.857
W=0.004				
0.01	42.456	1.6753	636.638	679.127
0.02	72.579	0.6980	265.266	337.849
0.03	95.945	0.3988	151.580	247.528
0.04	115.036	0.2617	99.474	214.511
0.05	131.177	0.1861	70.737	201.914
0.06	145.159	0.1396	53.0532	198.212
0.07	157.492	0.1087	41.340	198.832
0.08	168.524	0.0872	33.1582	201.683
W=0.005				
0.01	33.965	2.0942	636.638	670.668
0.02	58.063	0.87258	265.266	323.336
0.03	76.756	0.4986	151.580	228.338
0.04	92.028	0.3272	99.474	191.504
0.05	104.941	0.2326	70.737	175.679
0.06	116.127	0.1745	53.0532	169.180
0.07	125.993	0.1359	41.340	167.334
0.08	134.819	0.1090	33.1582	157.978

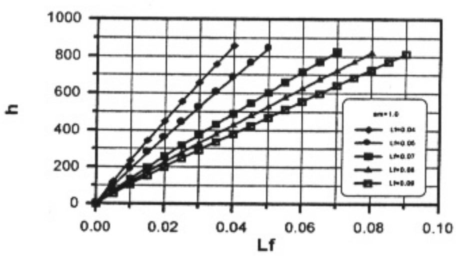
الجدول رقم(1) يمثل قيم المقاومات لزعنفة حلقية ذات مقطع ثابت



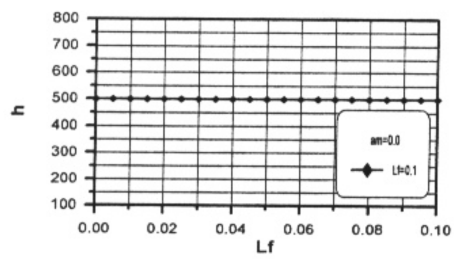
الشكل رقم(1) يمثل مقطع عام لزعنفة حلقية



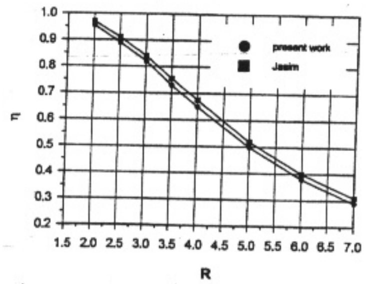
الشكل رقم(2) يوضح تكوين الشبكة للزعنفة ذات الشكل شبه المنحرف

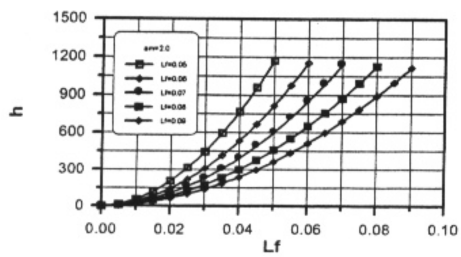


(أ)



(ب)

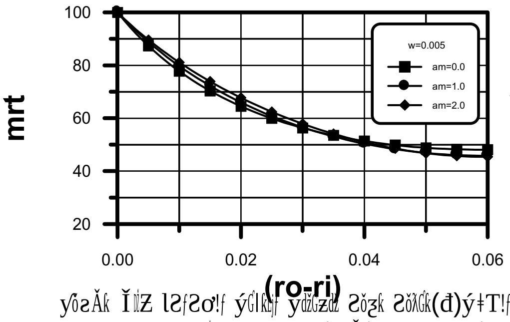




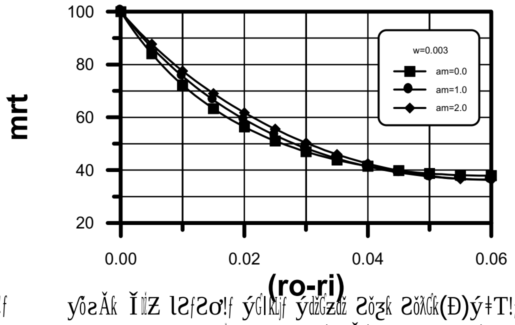
(جـ)

الشكل(3 د)يمثل مقارنة لكفاءة الزعنفة ذات السمك الثابت بين العمل الحالي وعمل سابق(18)

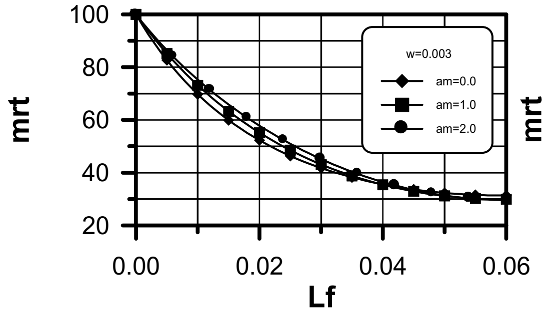
الشكل(3 ,أ,ب,جـ) يوضح حالات التغير لمعامل انتقال الحرارةعلى سطح الزعنفة



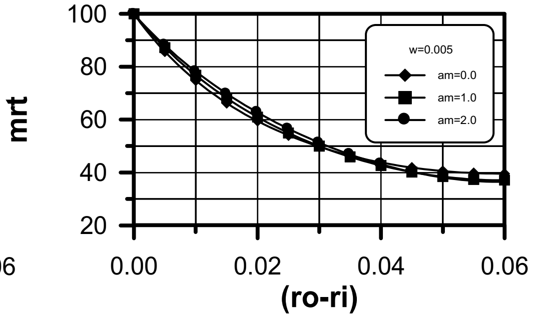
ýôƨĂk ĬĨŽ lƧƒƧơ!ƒ ýĜlkĳƒ ýďžĜƶďž Ƨŏʒk ƧŏλĜk(đ)ý‡T!ƒ
‖dž˥!ƒ ƘƒƦ ŧƽǉŽƨǁ! ĭ ƧƠl!ƒ ljĜɳkŬĜŵ lƧƒƧơ!ƒ ƘĜɳƧþ
ƘhĜλ!ƒ



ýôƨĂk ĬĨŽ lƧƒƧơ!ƒ ýĜlkĳƒ ýďžĜƶďž Ƨŏʒk ƧŏλĜk(Đ)ý‡T!ƒ
‖dž˥!ƒ ƘƒƦ ŧƽǉŽƨǁ! ĭ ƧƠl!ƒ ljĜɳkŬĜŵ lƧƒƧơ!ƒ ƘĜɳƧþ
ƘhĜλ!ƒ



ýôƨĂk ĬĨŽ lƧƒƧơ!ƒ ýĜlkĳƒ ýďžĜƶďž Ƨŏʒk ƧŏλĜk(ē)ý‡T!ƒ
ý‡T!ƒ ƘƒƦ ŧƽǉŽƨǁ! ĭ ƧƠl!ƒ ljĜɳkŬĜŵ lƧƒƧơ!ƒ ƘĜɳƧþ
ƻ Ƨơǉdž!ƒ ŇhT



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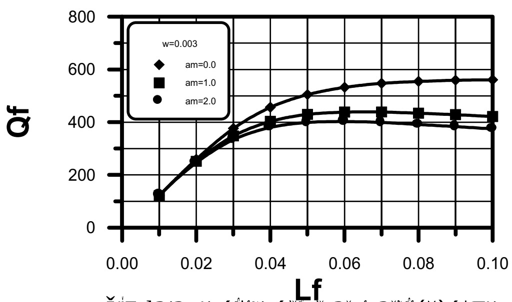
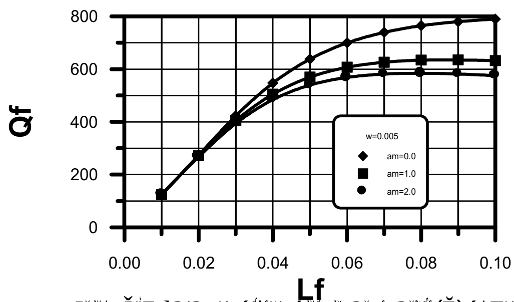
ý‡T!ƒ ƘƒƦ ŧƽǉŽƨǁ! ĭ ƧƠl!ƒ ljĜɳkŬĜŵ lƧƒƧơ!ƒ ƘĜɳƧþ
ƻ Ƨơǉdž!ƒ ŇhT



ĬĨŽ lƧƒƧơ!ƒ ýĜlkĳƒ ýďžĜƶďž Ƨŏʒk ƧŏλĜk(ě)ý‡T!ƒ
ƘhĜλ!ƒ ‖dž˥!ƒ ƘƒƦ ŧƽǉŽƨǁ! lþþhdž!ƒ lƧƒƧơ!ƒ ŧŏdž‡



ŧŏdž‡ ĬĨŽ lƧƒƧơ!ƒ ýĜlkĳƒ ýďžĜƶďž Ƨŏʒk ƧŏλĜk(Ě)ý‡T!ƒ
ƘhĜλ!ƒ ‖dž˥!ƒ ƘƒƦ ŧƽǉŽƨǁ! lþþhdž!ƒ lƧƒƧơ!ƒ