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## ***Experimental Investigation of Heat Transfer Enhancement by Acoustic Streaming in a Closed Cylindrical Enclosure***

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### ***ABSTRACT***

In this study, the effect of acoustic streaming on heat transfer enhancement of a down-ward-facing horizontal heating surface in a closed cylindrical enclosure filled with water was investigated experimentally. Standing waves were generated between the heating source as a reflector and vibrating lower plate. Acoustic streaming is a steady circular flow induced by this standing waves field. The upper plate was heated with a constant heat flux and side-walls were kept at the constant temperature. Therefore, the gravitational effects were negligible and the heat transfer enhancement was due to ultrasonic vibrations. In order to find out the best range of ultrasonic power, the acoustic pressure was measured. The results show that the enhancement of the heat transfer can be up to 400% by the ultrasonic vibrations. The increase in the transducer power and the decrease in the height of the heater cause the higher heat transfer coefficient in the enclosure. In addition, the increase in cavitation phenomenon severely weakens the increase in heat transfer coefficient.

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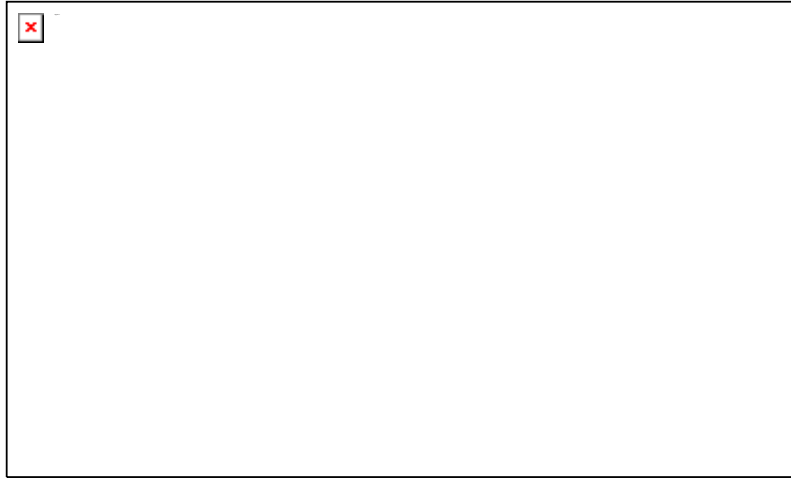
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$(q_n = Q/A)$  (A)  
) K  
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( )  
K  
( ) ± / °C

• ( ) K

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• ( )

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(Q)



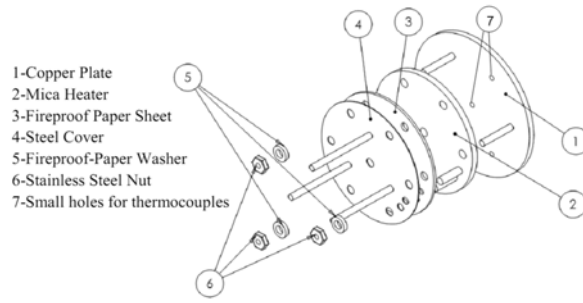
$\lambda \quad \lambda'$

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( )  $\lambda$



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$$\bar{h} = q_n / (\bar{T}_H - \bar{T}_\infty) \quad ( )$$

( ~  $^{\circ}\text{C}$ )

$\bar{h}$

$\bar{T}_H$

$\bar{T}_\infty$

$$D \quad \bar{h} = q_n / (\bar{T}_H - \bar{T}_\infty) \quad (1)$$

$$\overline{Nu}_D = 0.82 Ra_D^{1/5} Pr^{0.034} \quad (2)$$

$$\Delta \bar{T} = \bar{T}_H - \bar{T}_\infty \quad \bar{h} = q_n / (\Delta \bar{T})$$

$$\Delta \bar{T}$$

$$Ra_D^* = \frac{g \beta \Delta T D^3}{\nu \alpha} \frac{q_n D}{K_f \Delta T} = \frac{g \beta q_n D^4}{K_f \nu \alpha} \quad (3)$$

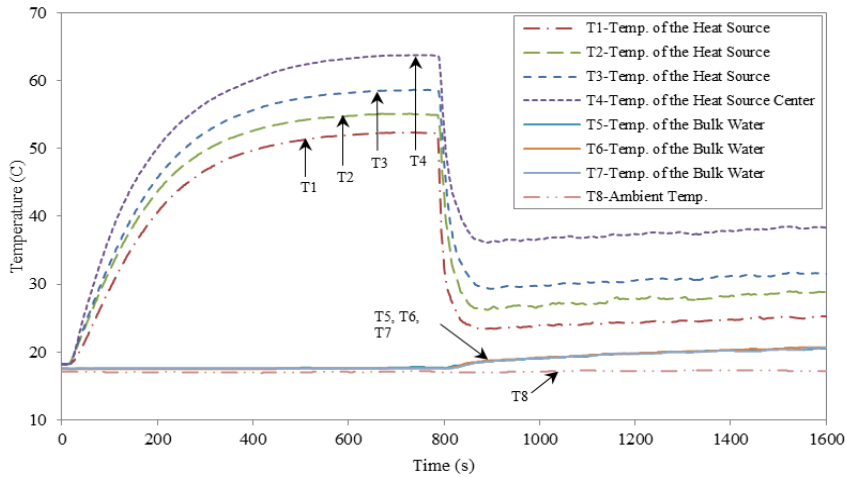
$$Ra_D^* = Ra_D \overline{Nu}_D = \frac{g \beta \Delta T D^3}{\nu \alpha} \frac{q_n D}{K_f \Delta T} = \frac{g \beta q_n D^4}{K_f \nu \alpha} \quad (4)$$

$$\bar{T}_\infty$$

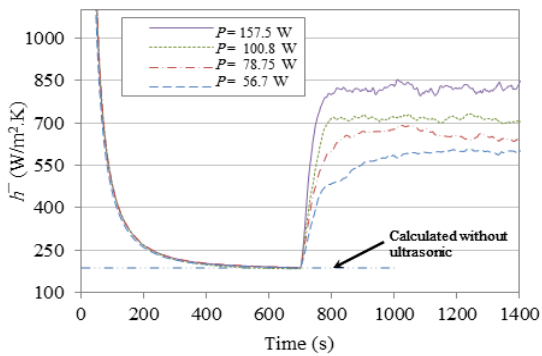
$$Ra_D^* / \overline{Nu}_D = Ra_D \quad (5)$$

$$\Delta \bar{T}$$

[ ]



$$(H_0 = \lambda l \quad P = \quad / \quad W \quad Q = \quad W) \quad (6)$$



$$\beta \quad \Delta \bar{T} \quad T_f = \bar{T}_\infty + (\Delta \bar{T} / 2) \quad \bar{h}$$

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(W/m2K)

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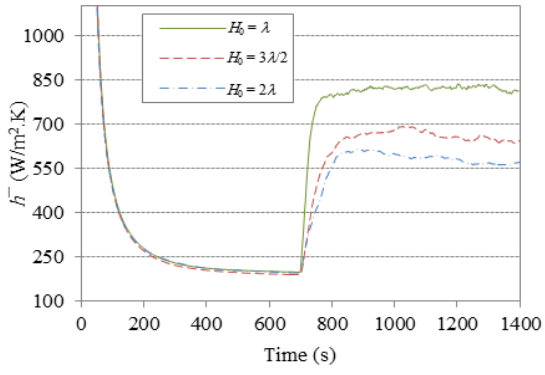
$$Q = \quad W)$$

$$(H_0 = \lambda l$$

(8)



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( $P=$  / W  $Q=$  W)  $H_0$

$$\bar{h} \quad EF \quad \bar{h}$$

$$EF = \frac{\bar{h} \text{ with ultrasonic}}{\bar{h} \text{ without ultrasonic}} \quad ( )$$

( )  $EF$

$$H_0 = \lambda \quad /$$

$$H_0 = \lambda \quad / \quad /$$

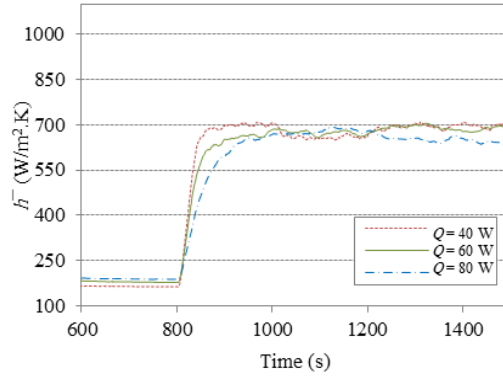
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$\lambda$



( $H_0= \lambda$  /  $P=$  / W)

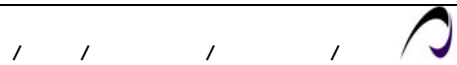
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$\bar{h}$

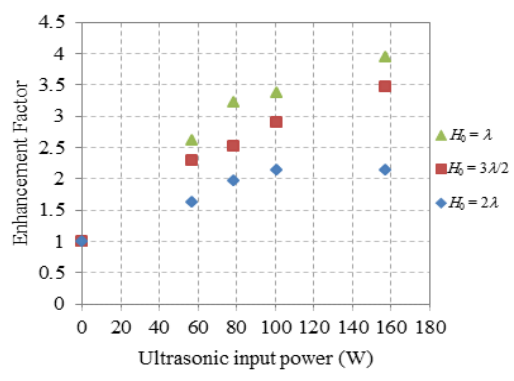
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$\bar{h}$

$H_0$



$\lambda$  /  
 $EF$  / /

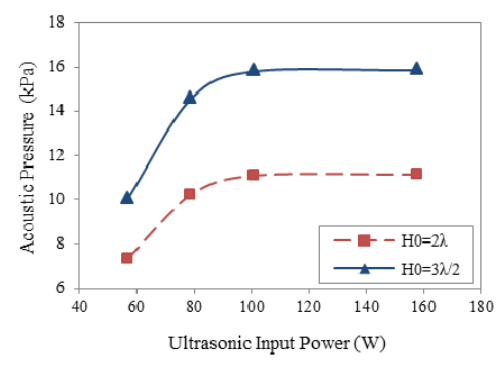


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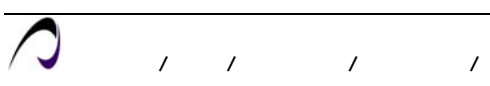
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- <sup>1</sup> Eckart  
<sup>2</sup> Rayleigh  
<sup>3</sup> Polytetrafluoroethylene (PTFE)  
<sup>4</sup> Testo  
<sup>5</sup> Bulk  
<sup>6</sup> Probe  
<sup>7</sup> B&K  
<sup>8</sup> Kadambi  
<sup>9</sup> Drake

