Fig. 4.1 Variation of the stagnation Nusselt number ($\text{Nu}_0$) and dimensionless distance between nozzle-to-resistor spacing ($H/d$) with flow rate for $\text{Re} = 6500$ to $16000$
Fig. 4.2 Effect of local Nusselt number on dimensionless radial distance for different nozzles
Fig. 4.3 Comparison of the present data with the experimental data of previous investigators

- Yan and Sainel\textsuperscript{183}(1997)  
- Baughn and Shimizu\textsuperscript{14}(1989)  
- Gao et al\textsuperscript{14}(2003)  
- Lytle and Webb\textsuperscript{66}(1994)  
- Present Work

Flow rate = 15 LPM
$T_o = 95^\circ$
$d = 10$ mm
$Re = 23000$
$H/d = 6$
Fig. 4.4 Variation of velocity profiles on dimension less radial distance with H/d for Ts = 98°C
Fig. 4.5 Effect of Reynolds number on pressure distribution at the impingement surface for a circular nozzle
Fig. 4.6 Variation of local heat transfer coefficient distribution with $H/d$. 

- $H/d = 2$
- $H/d = 3$
- $H/d = 4$
- $H/d = 5$
- $H/d = 8$
- $H/d = 10$

Re deposition

$Re = 15500$

$d = 5\text{ mm}$
Fig. 4.7 Effect of temperature on cooling time at different $Re_d$ and $H/d$ ratios
Fig. 4.8 Variation of surface heat flux (q) of electronic components with Re_d and H/d
Fig. 4.9. Comparison of present correlation with Ma and Bergles\textsuperscript{74} (1990) and Lienhard et al\textsuperscript{65} (1992) correlations
Fig. 4.10 Comparison of experimental data with theoretical results of Lytle and Webb (1994) and Gao et al (2003)
Fig. 4.11 Comparison of experimental data with the numerical data of Gardon and Akfirat\textsuperscript{38}(1965) and Zhou and Lee\textsuperscript{105}(2007)

<table>
<thead>
<tr>
<th>Study</th>
<th>Nozzle Diameter</th>
<th>Reynolds Number</th>
<th>Data Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardon and Akfirat\textsuperscript{38}(1965)</td>
<td>d = 3.175 mm</td>
<td>Re = 11000</td>
<td></td>
</tr>
<tr>
<td>Present work</td>
<td>d = 6 mm</td>
<td>Re = 5850</td>
<td></td>
</tr>
<tr>
<td>Zhou and Lee\textsuperscript{105}(2007)</td>
<td>d = 11 mm</td>
<td>Re = 3100</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 4.12 Comparison of present experimental data with the correlation of Lytle and Webb\textsuperscript{66} (1994)

\[
\begin{align*}
\text{N}_{\text{u}_0} &= 0.726 \text{Re}^{0.53} \left( \frac{H}{d} \right)^{-0.121} \\
(1) \quad \text{Correlation of Lytle and Webb}\textsuperscript{66} (1994) \\
(2) \quad \text{Experimental data}
\end{align*}
\]
Fig. 4.13 Effect of local Nusselt number on dimensionless radial distance for different nozzles
Fig. 4.14. Effect of Stagnation Nusselt number on distance between nozzle-to-resistor spacing for different Re
Fig. 4.15 Variation of streamwise Nusselt number and dimensionless radial distance with different Re for $H/d = 4$
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Fig. 4.18 Comparison of present correlation with Zumbrunnen et al\textsuperscript{104} (1993), McMurry et al\textsuperscript{71} (1966) and Kendoush\textsuperscript{54} (1998) correlations
Fig. 4.19 (a, b) Variation of stagnation Nusselt number ($\text{Nu}_0$) with heated surface area –to-jet diameter ($W/d$)
Fig. 4.20 Validation of Experimental data with the present correlation Eq.(3.82)
Fig. 4.21 Validation of Kendoush correlation\textsuperscript{54} (1998) with experimental data
Fig. 4.22 Validation of Experimental data with the present correlation Eq. (3.81)
Fig. 4.23 Comparison of present Experimental data with the correlation of Vader et al. 96 (1991)
Fig. 4.24 Effect of recovery factory on dimensionless radial distance at $Re = 23000$
Fig. 4.25. Comparison of theoretical data with experimental data at $Re_d = 6800$, $H/d = 4$, $T_S = 95^\circ C$
Fig. 4.26 Variation of effectiveness with dimensionless radial distance - Effect of Re and H/d
Fig. 4.27 Variation of heat transfer rate on different Re For H/d = 5
Fig. 4.28 Effect of normalized velocity with different Re for $u = 32\text{m/sec}$
Fig. 4.29. Variation of heat transfer rate on difference between the temperature of surface and ambient for different nozzle types - Effect of Re = 6500 and H/d = 2
Fig. 4.30 Effect of heat transfer rate on difference between the temperature of surface and ambient for different at $H/d = 2$ and $H/d = 6$