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- **Name of Topic:** "Thermal Performance Investigation of Dimple Roughened Multiple Arc Pattern Solar Air Heater

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FINDINGS

The effects produced by changing roughness and operating parameters on 'Nu' and 'f' characteristics has been determined and a comparative study for performance of multiple arc dimple roughened SAHs has been performed. The outcomes of present investigations were conclusive and the same has been reproduced below:

1. 'Nu' and 'f' varied as 'p/e', 'e/D_h' 'W/w' and 'α' was varied under given operating range. In the entire range of 'Re' studied, 'Nu' increased as 'p/e' was increased from 4 to 12. On further increasing 'p/e', 'Nu' started decreasing for roughened duct.
2. 'Nu' increased as 'e/D_h' was increased from 0.018 to 0.036, beyond this, Nusselt number started decreasing with increase in e/D_h for roughened duct. An increase in W/w resulted in an increase in Nusselt number from 1 to 4. Upon increasing W/w from 4 to 5, 'Nu' value was less than so obtained at W/w of 4 for roughened duct. As α increased from 30° to 60°, 'Nu' increased. Upon further increasing α value, 'Nu' decreased.
3. Rise in 'Nu' based on Nusselt number enhancement ratio (Nu_r/Nu_s) lied in range of 3.19-5.56, 2.87-5.61, 3.29-5.16 and 2.74-5.18 times compared to smooth duct for varying "p/e, e/D_h, W/w and α" respectively.
4. Rise in heat transfer is always accompanied with rise in frictional losses. In present investigation, friction was found to decrease monotonously with increase in p/e from 4 to 16. With variation in 'e/D_h' from 0.018 to 0.045, friction increased monotonously for roughened ducts. As 'W/w' varied from 1-5, friction factor increased monotonously. As α increased from 30° to 60°, friction decreased. Upon further increasing α value, friction increased. Maximum rise in 'f_r' over 'f_s' for varying "p/e, e/D_h, W/w and α" respectively was found 1.14-1.62, 1.36-2.27, 1.88-2.15 and 1.01-2.16 times.
5. The thermal efficiency values was found to be increasing with increasing 'p/e' from 4-12, beyond which any further increase in p/e value resulted in decreasing 'η_{th}' for given values of other flow and roughness parameters.

6. Thermal efficiency of roughened SAHs was found increasing as ‘e/D_h’ increased from 0.018 to 0.036. As ‘e/D_h’ varied from 0.036 to 0.045, ‘η_{th}’ values started decreasing for given values of other flow and roughness parameters.
7. A similar trend for the variation in thermal efficiency was obtained for variation in relative roughness width (W/w) values. Thermal efficiency for roughened SAHs increased as W/w increased from 1 to 4. As W/w varied from 4 to 5, ‘η_{th}’ values started decreasing for given values of other flow and roughness parameters.
8. Thermal efficiency was seen to increase as α increased from 30° to 60° beyond which any decrease in α values resulted in decrease in thermal efficiency for roughened SAHs.
9. The maximum values of thermal efficiency for roughened ducts have been found as 0.873 compared to 0.529 for smooth duct corresponding to optimum roughness parameter i.e. ‘p/e’=12, ‘e/D_h’=0.036, ‘W/w’=4 and ‘α’=60° in the range of investigated parameters. Also, multiple arc dimple roughened SAHs have high ‘η_{th}’ value of order of 34-71 % more than that of smooth SAH for the range of flow & roughness parameters investigated.
10. The effective efficiency (‘η_{eff}’) of roughened SAH has been compared with smooth ones. It was observed that for low flow rate range, ‘η_{eff}’ increased with increase in mass flow rate, attains maxima & then decreased for larger mass flow rate value.
11. At lower mass flow rate say $\dot{m} \leq 0.032$ kg/s, pumping power required to propel air across smooth and roughened ducts is very low compared to pumping power required at higher mass flow rates.
12. For flow under roughened duct with varying p/e, maximum effective efficiency was found at $\dot{m}$ =0.0386 kg/s with the value of efficiency being 0.62. This value of effective efficiency decreased as mass flow rate increased or decreased. For flow under smooth duct, maximum effective efficiency was obtained at mass flow rate of $\dot{m}$ =0.0284 kg/s with value of efficiency being 0.39 that decreased as mass flow rate increased or decreased.
13. For flow under roughened duct with varying ‘e/D_h’, maximum effective efficiency was found at $\dot{m}$ =0.0391 kg/s with the value of efficiency being 0.748. This value of effective efficiency decreased as mass flow rate increased or decreased. For flow under smooth duct, maximum effective efficiency was obtained at mass flow rate of $\dot{m}$ =0.0319 kg/s with value of efficiency being 0.38 that decreased as mass flow rate increased or decreased.
14. For flow under roughened duct with varying ‘e/d_b’, maximum effective efficiency was found at $\dot{m}$ =0.04 kg/s with the value of efficiency being 0.725. This value of effective efficiency decreased as mass flow rate increased or decreased. For flow under smooth duct, maximum effective efficiency was obtained at mass flow rate of $\dot{m}$ =0.0319 kg/s with value of efficiency being 0.38 that decreased as mass flow rate increased or decreased.