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Heat transfer enhancement in solar air channel with broken multiple V-type baffle

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A B S T R A C T

A current investigation deals with experimental analysis of the heat transfer behavior and optimum relative width parameter of the solar air channel of aspect ratio of 10.0 with 60° angled broken multiple V-type baffles. The current experiment enclosed a wide range of parameter such as Reynolds number varied from 3000 to 8000, relative width varied from 1.0 to 6.0, relative baffle height of 0.5, relative baffle pitch of 10.0, relative discrete distance of 0.67 and relative gap width of 1.0. The obtained experimental results showed that higher overall thermal performance occurred at a relative baffle width of 5.0. Also, the results reveal that the broken multiple V-type baffles are thermo-hydraulically superior as compared to the other baffles shaped solar air channel.

1. Introduction

Solar energy in the form of solar radiation is freely available and non-polluting source of energy. The solar energy is converted into thermal energy by using solar collector for various engineering applications. The various heat transfer techniques has been developed to improve the thermal performance of solar collectors and these techniques has been applied in several industrial applications. According to literature, the thermal performance of SAC can be improved by the use baffles. Baffles in the SAC are used to produce turbulence, so as to augment the Nu_{rs}. In order to create turbulence, baffles are placed into the forced flow to generate a secondary stream. Among the techniques used to improve Nu_{rs} in a without baffle SAC one is to place broken multiple V-type baffles on the channel walls [1–8]. For entire information of several experimental and mathematical techniques on baffles with distinct shapes, size, and orientations, readers may refer to.

Dutta and Hossain [9] investigated the Nu_{rs} and f_{rs} in a SAC with inclined solid and perforated baffles. During experimentation they found that local Nu_{rs} distribution significantly depends on the perforation, orientation, and position of the second baffle plate and Nu_{rs} was 5.0 times high as compared to flat channel. Karwa et al. [10] experimentally studied the effect of solid and perforated baffles with Re varies from 2850 to 11,500, W_D/H_D of 7.77, P_B/H_B of 29, H_B/H_D is 0.495. Lin [11] experimentally investigated the Nu_{rs} and f_{rs} in SAC with baffles. Author examined the experimental outcomes of Nu_{rs} for baffle designed with various heights and pores. Romdhane [12] examined that effect of Nu_{rs} in a baffled solar air collector. The baffles were attached in the SAC. Baffles extend the trajectory of the circulation and keep the air in contact with the absorber and act as wings and improve Nu_{rs} of the air. Shin and Kawak [13] studied the effect of the perforation shape for a blockage wall on the Nu_{rs} in a stream passage. Five wide, narrow and circular hole geometries were tested. Karwa and Maheshwari [14] experimentally study Nu_{rs} and f_{rs} in a SAC with transverse fully perforated baffles and half perforated

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Nomenclature

A_p	surface area of heated plate, m^2
A_o	area of orifice, m^2
C_{do}	coefficient of discharge
C_p	specific heat of air, J/kg K
D_d	gap or discrete distance [m]
G_w	gap or discrete width [m]
G_w/H_B	relative gap width
h_t	convective heat transfer coefficient [W m^{-2} K^{-1}]
D_{hd}	hydraulic diameter of channel, m
f	friction factor
f_{rs}	friction factor of roughened baffle
f_{ss}	friction factor smooth baffle
h_t	convective heat transfer coefficient, W/m^2 K
H_D	height of channel, m
H_B	height of baffle, m
H_B/H_D	relative baffle height
K_a	thermal Conchannelivity of air, W/mK
L_t	length of test section, m
L_v	length of V-pattern baffle, m
D_d/L_v	relative discrete distance
m_a	mass flow rate of air, kg/s
Nu	Nusselt number
Nu_{rs}	Nusselt number of rough surface
Nu_{ss}	Nusselt number of smooth surface
P_B	pitch of baffle channel, m
P_B/H_B	relative pitch ratio
$(\Delta_p)_d$	pressure drop across test section, Pa
$(\Delta_p)_o$	pressure drop across orifice plate, Pa
Q_u	useful heat gain, W
Re	Reynolds number of fluid
T_f	average temperature of air, K
T_i	inlet temperature of air, K
T_o	outlet temperature of air, K
T_p	plate temperature of air, K
U	mean air velocity, m/s
V	velocity of air, m/s
W_D/H_D	channel aspect ratio
W_D	width of channel, m
W_B	width of a single V-broken baffle, m
W_D/W_B	relative baffle width
SAH	solar air heater
SAC	solar air channel

Greek symbols

α_a	angle of attack, deg.
β_R	ratio of orifice meter to pipe diameter, dimensionless
β_O	open area ratio, (%)
ρ_a	density of air, kg/m^3
ν_a	kinematic viscosity of air, m^2/s
η_p	thermo-hydraulic performance

baffles attached to one of the broad wall. Ozgen et al. [15] reported the thermal performance in a SAC with baffles fitted to the heated wall. Bopche and Tandale [16] reported the wholly developed stream in a roughened SAC with U-shaped pattern baffles. Eiamsa-ard et al. [17] investigated the heat transfer augmentation in a SAC with winglet delta twisted tape baffles with different β_O and H_B/H_D. Their studies shows that Nu_{rs} and f_{rs} data with winglet delta twisted tape were superior as compared to without winglet delta twisted tape. Promvong et al. [18] mathematically examined the performance of Nu_{rs} and f_{rs} in square channel attached with 45° inclined baffles with a*Re* ranging from 100 to 1200. Promovong [19] experimentally investigated the turbulent forced convection Nu_{rs} and f_{rs} loss behavior in a high W_D/H_D channel attached with 60° V-shaped baffles. Akpinar et al. [20] experimentally investigate the performance analysis of four types of SAH with different obstacles and without obstacle. They reported that efficiency of SAH depends on the surface geometry of collectors, solar radiation of air stream line. Chompookham et al. [21] experimentally studied the effect of winglet vortex type generators on the Nu_{rs} and f_{rs} behaviors for a turbulent stream. Bekele and Mishra [22] carried out the experimental studied of the turbulent air stream and heat transfer characteristics of SAC with delta shaped obstacle attached to the upper wall of a channel. Zhou and Ye [23] carried out the experimental studied of the turbulent air stream and heat transfer characteristics of SAC with delta winglet vortex generator baffles attached to the upper surface of a channel. Chamoli and Thakur [24] conducted an indoor experimental investigation to study Nu_{rs} and f_{rs} data of air passing through an air channel that was roughened by V-shaped perforated baffles. Tamna et al. [25] investigated the effect of multiple V baffle vortex generators to improve Nu_{rs} in a channel fitted with 45° BVG with Re ranging from 4000 to 21,000, H_B/H_D=0.25, P_B/H_B=0.5, 1 and 2 and α_a equal to 45° respectively. Alam et al. [26] experimentally investigated the effect of H_B/H_D of 0.4–1.0, P_B/H_B of 4–12, β_O of 5–25%, α_a of 60° and Re varies from 2000 to 20,000 on V-shaped perforated blocks SAH with W_D/H_D of 10. Table 1 summarises the experimental investigations of some important baffle arrangements reported by various researchers.

In view of the above, it can be stated that broken multiple V-type baffle preparation can yield improved performance as compared to without broken baffle preparation. However, investigations have not been carried out so far to optimize the width ratio between the baffle elements to form the broken baffle and also to locate the optimum position of this broken. The present investigation was therefore taken up to determine the optimum location and width baffle ratio in an multi V-baffle to form a broken baffle. This study will help in determining the width baffle ratio while discretizing the multi V-pattern baffle for enhancing the performance as compared to continuous multi V-pattern baffle. In the present work, experimental investigation on the performance of solar air channel, having the heated plate with rough in the form of multi V-baffle has been carried out. The stream Re has been varied between 3000 and 8000. The variations of Nu_{rs} and f_{rs} as a

Table 1
Previous experimental investigations in various baffle shapes in a solar air channel.

Baffle shapes	Parameter ranges	Principle findings
Transverse perforated block baffles [1]	$H_B/H_D=1.0$, $P_B/H_B=7.5$, $Re=$ 20,000–40,000	The heat transfer and pressure drop augmentations of 1.45 and 1.87 times were reported over a smooth solar air channel.
Discrete V-pattern baffles [4]	H_B/H_D=0. 50,P_B/H_B=10. 0,D_d/L_v=0. 67,G_w/H_B=1. 0,α_a=60°, Re=3000–21,000	The heat transfer and pressure drop augmentations of 3.23 and 3.55 times were reported over a smooth solar air channel. These studies have shown that V-shaped baffle perform better than angled baffle.
Angled baffles [9]	$H_B/H_D=0.078$–0.086 , $P_B/H_B=10$–14, $\alpha_a=45$–$60°$, $Re=9000$–$76{,}000$	The heat transfer and pressure drop augmentations of 1.98 and 2.11 times were reported over a smooth rectangular channel. These studies have shown that angled baffle perform better than transverse baffle.
Perforated baffles [10]	$H_B/H_D=0.495$, $P_B/H_B=7.21$–28.84, $\beta_o=26$–46.8%, $Re=2700$–$11{,}150$	The heat transfer and pressure drop augmentations of 2.09 and 2.34 times were reported over a smooth solar air channel.
Multi V-shaped baffles [19]	$H_B/H_D=0.25$, $P_B/H_B=5$–12, α_a $=45°$, $Re=4000$–$21{,}000$	The heat transfer and pressure drop augmentations of 5.87 and 6.08 times were reported over a smooth solar air channel. These studies have shown that multi V-shaped baffle perform better than other baffle.
Delta shaped baffles [22]	$H_B/H_D=0.5$, $\beta_o=45°$, $\alpha_a=20°$, $Re=4000$–$14{,}000$	The heat transfer and pressure drop augmentations of 2.34 and 2.65 times were reported over a smooth solar air channel.
Single V-Perforated shaped blocks [24]	$H_B/H_D=0.4$–1.0, $P_B/H_B=4$–12, $\beta_o=5$–25%, $\alpha_a=60°$, $Re=2000$–$20{,}000$	The heat transfer and pressure drop augmentations of 3.43 and 3.78 times were reported over a smooth solar air channel. These studies have shown that V-shaped perforated blocks perform better than angled and simple V-shaped baffle.
Discrete multi V-pattern baffle [Present study]	$H_B/H_D=0.50$, $P_B/H_B=10.0$, $D_d/L_v=0.67$, $G_w/H_B=1.0$, α_a=60°, $W_D/W_B=1.0$–6.0, $Re=3000$–8000	Literature review shows that single discrete V-pattern baffle have better overall thermal performance than simple continuous V-pattern baffle solar air channel. Multi V-pattern baffle have batter overall thermal performance than other baffle shapes solar air channel. It is thought that discrete multi V-pattern baffle will augment heat transfer compared to without discrete V-pattern baffle.

function of rough parameter including width baffle ratio have been evaluated to examine the η_p of the system to determine the assistance of this selected roughness geometry. The main objectives of the present numerical analysis are as follows:

1. To investigate the effect of relative baffle width (W_D/W_B) on the heat transfer, friction factor, and overall thermal performance.
2. To find out the best overall thermal performance parameter under the same pumping power constraint in order to examine the overall effect of the relative baffle width (W_D/W_B).

2. Experimental program

Experimental approach has been adopted to produce the data in form of Nu_{rs} and f_{rs} for a solar air channel with broken multiple V-type baffle roughness to search the effect of W_D/W_B and Reon Nu_{rs} and f_{rs}. The experimental study encompasses the fabrication and installation of indoor test facility. The experimental setup has been validated by comparing experimental data collected on without baffle wall with the available standard data. After validation of experimental setup, extensive

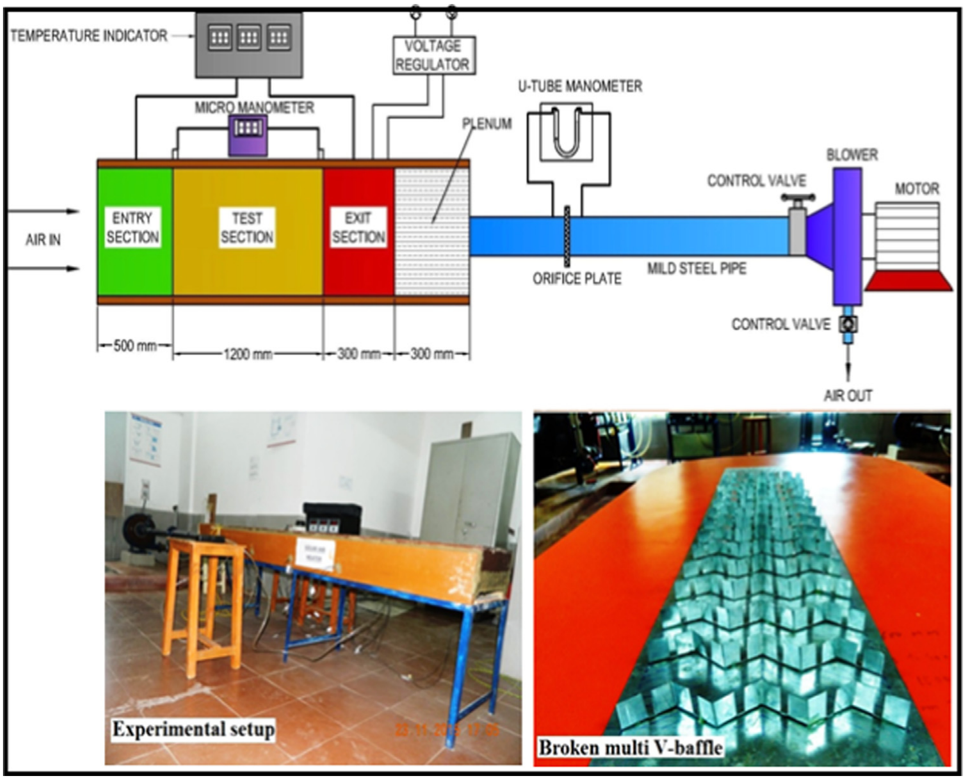

Fig. 1. Schematic and photographic view of experimental setup and broken multi V-baffle.

experimentations have been conducted on broken multiple V-type baffle to produce raw data on heated wall temperatures, air stream rates, and inlet and outlet temperature of air and pressure drop across the channel under stable conditions.

2.1. Experimental setup and procedure

To examine the influence of broken in the limbs of multi V-type baffle turbulent promoter on Nu_{rs} and f_{rs} of air stream, an experimental setup was designed and made-up. A schematic diagram of an experimental set up and photographic view are shown in Fig. 1. The setup comprised a rectangular wooden channel coupled to a centrifugal blower through a circular galvanized iron (GI) pipe. The rectangular channel had W_D of 300 mm, H_D of 30 mm, and W_D/H_D of 10. It consist of inlet and exit sections that were interposed by test sections. The upper wall of the test section was an aluminum heated plate that was heated by an electric heater which provides a uniform heat flux over the whole top wall. Air mass flow rate through the SAC was measured with a calibrated orifice meter that was attached to a U-tube manometer. Air flow was regulated with two gate valves that were coupled in the lines. The temperature was calculated at different locations with calibrated 0.3 mm diameter Copper constantan thermocouples, which were coupled to a digital micro voltmeter (DMV) to illustrate the temperature. Calibrated copper–constantan (T-Type) thermocouples with data acquisition system, indicating output temperature in degree centigrade with an accuracy of 0.5 °C were used. To minimize the percentage error in measurement of temperatures, minimum heat flux value is so selected as to raise the temperature of air by about 8 °C in the test section. The temperature difference between the heated plate and the bulk air was observed to be above 20 °C. Mass flow rate of air through the duct was measured by a orifice meter connected to U-tube inclined manometer. Orifice plate was calibrated against standard pitot tube. The pressure drop across the test section was measured with a micro-manometer having least count of 0.001 mm of water. Data were noted under the steady-state condition, which was assumed to have reached when the plate and air temperatures showed negligible variation for around a 10-min duration. The steady state for each test run was obtained in about 1.5–2 h.

3. Range of parameters

SAC has an L_t equal to 2000 mm while H_D is set equal to 30 mm and W_D is 300 mm; the hydraulic diameter, $D_{hd}=4A_p/P_B=2H_D$ is equal to 54.54 mm. The 4.0 mm thick wall is made up by aluminum and a constant heat flux equal to 1000 w/m^2 has been applied. The baffle parameters are determined by baffle height (H_B), pitch of baffle (P_B), length of

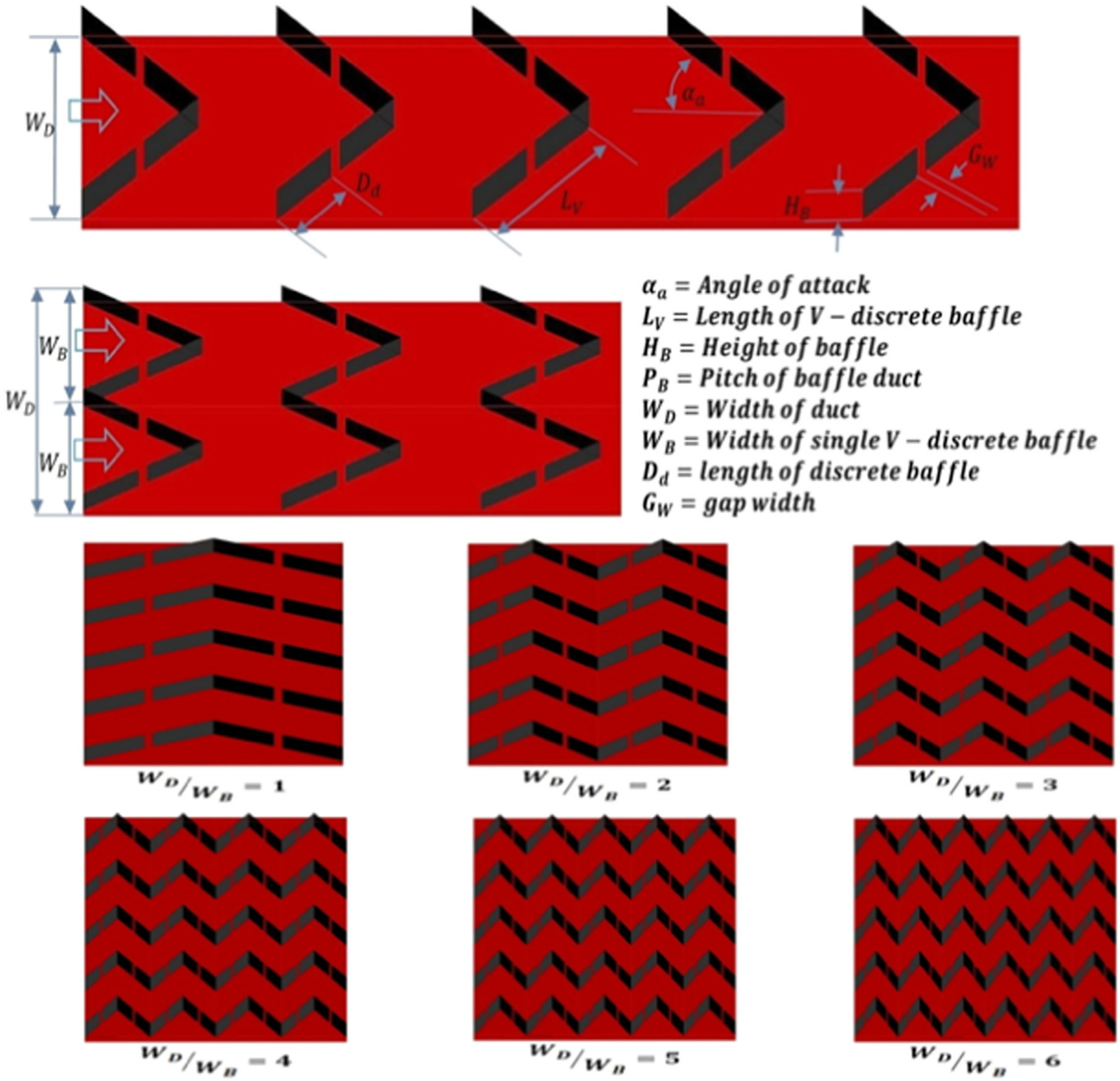

Fig. 2. Discussed broken multiple V-type baffle and variation of W_D/W_B.

V-pattern baffle (L_v), Gap or discrete distance (D_d), Gap or discrete width (G_w), angle of attack (α_a), and the shape of the roughness elements. For a specific roughness type, a family of geometrically similar roughness is probable to recognize by altering relative baffles width (W_D/W_B) while keepingH_B/H_D, P_B/H_B, D_d/L_v, G_w/H_B and α_a constant. The broken multiple V-type baffle is shown in Fig. 2, Table 2 shows the range of parameters.

Table 2
Flow and baffles roughness parameters.

S.N.	Parameters	Ranges
1.	W_D/W_B	1.0–6.0
2.	H_B/H_D	0.50
3.	P_B/H_B	10.0
4.	D_d/L_v	0.67
5.	G_w/H_B	1.0
6.	α_a	60°
7.	Re	3000–8000

4. Data reduction

The data composed have been used to calculate h_t, Nu, and f. Relevant expressions for the computation of the above parameters and some intermediate parameters have been given below.

4.1. Temperature measured

Weighted average plate air temperature:
The mean temperature of the plate is the average of all temperatures of the heated plate:

$$T_p = \frac{\sum T_{pi}}{N} \tag{1}$$

The mean air temperature is a simple arithmetic mean of the inlet and outlet temperature of air flowing through the test section:

$$T_f = \frac{T_i + T_o}{2} \tag{2}$$

where $T_o = (T_{A2} + T_{A3} + T_{A4} + T_{A5} + T_{A6})/5$, $T_i = T_{A1}$..

4.2. Mass flow rate measurement

Mass flow rate of air (m_a) has been calculated from the pressure drop measurement across the calibrated orifice meter by using the following formula:

$$m_a = C_{do} A_o \left[\frac{2\rho_a (\Delta p)_0}{1 - {\beta_R}^4} \right]^{0.5} \tag{3}$$

where $(\Delta p)_0$=9. 81.$(\Delta p)_0 \rho_a m_a$. $Sin\theta$..

4.3. Velocity of air through channel

The velocity of air (V) is calculated from the mass flow rate and given by

$$V = \frac{m_a}{\rho_a W_D H_D} \tag{4}$$

4.4. Equivalent hydraulic diameter

The hydraulic diameter (D_{hd}) is given by

$$D_{hd} = \frac{4.(W_D.\ H_D)}{2.(W_D + H_D)} \tag{5}$$

4.5. Reynolds number

Reynolds number of the air flow in the rectangular channel is determined as

$$Re = \frac{V.\ D_{hd}}{\nu_a} \tag{6}$$

4.6. Friction factor

The friction factor (f) is calculated from the measured value of $(\Delta_p)_d$ across the test section length using the Darcy equation as

$$f = \frac{2(\Delta_p)_d D_{hd}}{4\rho_a L_t V^2} \tag{7}$$

where $(\Delta_p)_d$=9. 81.$(\Delta_h)_d$.$D_{hd} \rho_a m_a$..

4.7. Heat transfer coefficient

The useful heat gained by air is calculated as

$$Q_u = m_a c_p (T_0 - T_i) \tag{8}$$

The heat transfer coefficient for the heated test section has been calculated from

$$h_t = \frac{Q_u}{A_p.\,(T_p - T_f)} \tag{9}$$

4.8. Nusselt number

The h_t can be used to determine the (Nu), which is given by

$$Nu = \frac{h_t D_{hd}}{K_a} \tag{10}$$

5. Validation of experimental data

The value of Nu and f calculated from experimental data for a without baffle channel have been compared with the data obtained from the Dittus-Boelter equation Eq. (11) for the Nu_{ss}, and modified Blasius equation Eq. (12) for the f_{ss}.

Nu_{ss} for a smooth channel is given by the Dittus-Boelter equation as [27–29]:

$$Nu_{ss} = 0.\,023 Re^{0.8} Pr^{0.4} \tag{11}$$

f_{ss} for a smooth channel is given by the modified Blasius equation as [27–29]:

$$f_{ss} = 0.\,085 Re^{-0.25} \tag{12}$$

The comparison of the experimental and estimated data of Nu_{ss} and f_{ss} as a function of Re is shown in Fig. 3.

6. Uncertainty analysis

An uncertainty analysis has been carried to estimate the errors involved in experimental data measurement. The uncertainty is estimated based on errors associated with measuring instruments [30]. The maximum possible measurement errors in the values of major parameters are given below:

Mass flow rate (m_a): 2.14%
Reynolds number (Re): 6.34%

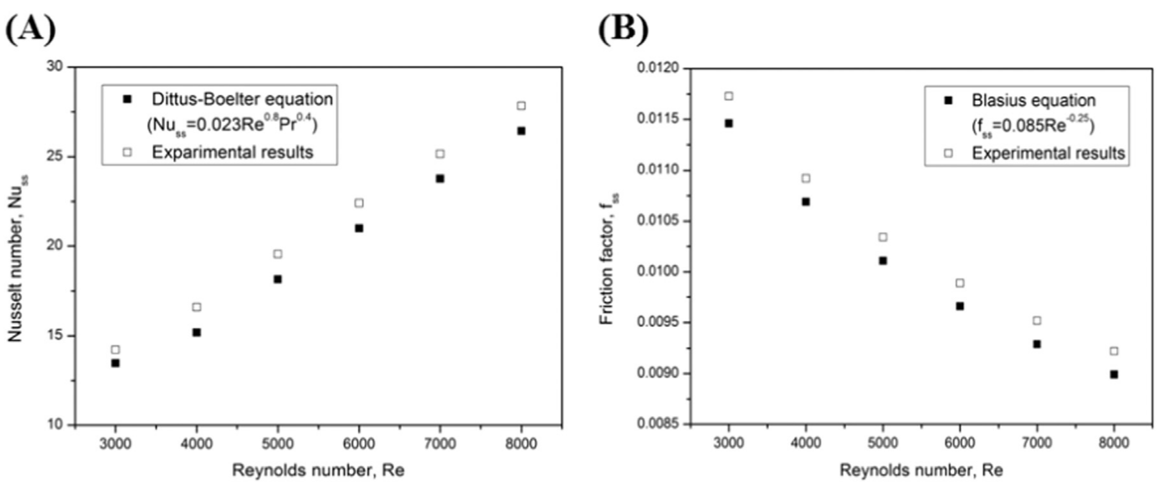

Fig. 3. Comparison of experimental and predicted values of Nu_{ss} and f_{ss} for smooth wall.

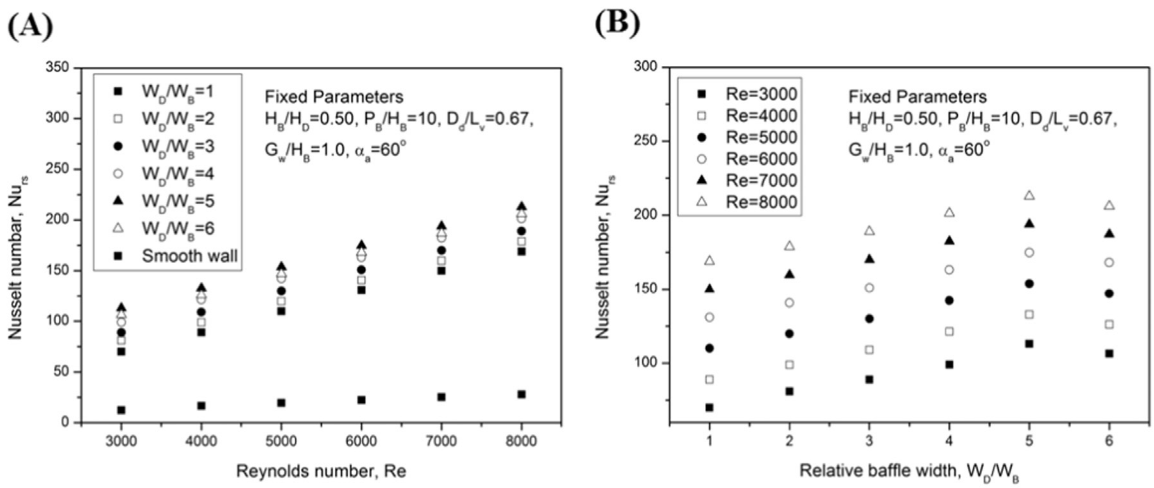

Fig. 4. (A) Effect of W_D/W_B on Nu_{rs} (B) Effect of W_D/W_Bon Nusselt number at selected Re.

Heat transfer coefficient (h_t): 6.13%
Nusselt number (Nu_{rs}): 5.98%
Friction factor (f_{rs}): 3.88%

7. Results and discussion

An experimental analysis was carried out to discuss the effect of Re on Nu_{rs} and f_{rs} and slots in multi V-type baffle used to provide roughness for a solar air channel. The outcomes related with broken multiple V-type baffles channel have been compared with those obtained from the without baffle surface under similar working conditions in order to find the enhancement in Nu_{rs} and f_{rs}.

7.1. Heat transfer and fluid flow

In a SAC the effect of W_D/W_B on Nu_{rs} and f_{rs} in the stream of air are presented. The outcomes have been compared with those obtained in case of without baffle surface working under similar experimental conditions. For kept data of the parameters such as$H_B/H_D = 0.50$, $P_B/H_B = 10.0$, $D_d/L_v = 0.67$, $G_w/H_B = 1.0$ and α_a=60°, the data of Nu_{rs} a function of W_D/W_B for the data of Re as shown in Fig. 4(A). It has been found that Nu_{rs} increases with increase in W_D/W_B and gets highest possible data corresponding to W_D/W_B data of 5.0. As expected, in all the cases the broken multiple V-type baffles wall produces higher Nu_{rs} as compared to without baffle wall. A better heat transfer performance is given by broken multiple V-type baffles because the baffles top induces secondary streams jets. These secondary jets have the form of two counter rotating vortices which carries cold fluid from the central core area towards the baffled walls. These secondary flow jets interacts with the main stream affect the flow reattachment and recirculation among baffles and interrupt boundary layer growth downstream of the reattachment regions [27–29].

It can be observed that as the data of W_D/W_B of 3.0 is increased, the number of leading end and trailing end also increased which rises the secondary stream cells resulting in expected enhancement in Nu_{rs} as observed in Fig. 4(B). However Nu_{rs} increased continuously only up to a data of W_D/W_B of 5.0. With further increase in the data of W_D/W_B, the data of Nu_{rs} decreases. Broken multiple V-type baffles induces strong secondary stream jet along the limbs and promote turbulence mixing when jets passing from brokens reattach and mix with main stream. The broken multiple V-type baffles used across the width of the heated wall increases number of leading and trailing edges also increase the number of jets. These jets are responsible for rise in heat transfer [27–29]. Fig. 5 shows that the data of Nu_{rs} as a function of relative baffle width (W_D/W_B) for a 60° broken multiple V-type baffles channel at various selected Re. It is found that the data Nu_{rs} is the highest for the W_D/W_B of 5.0 for all data of Re..

Invariable use of roughness on heated wall significantly enhances Nu_{rs} from heated wall of solar air channel however there occurs a corresponding increase in friction losses. In this experimental investigation it was studied that how friction characteristic of the solar air channel were affected when broken multiple V-type baffles roughness parameter W_D/W_B has been varied and other roughness parameter are kept as $H_B/H_D = 0.50$, $P_B/H_B = 10.0$, $D_d/L_v = 0.67$, $G_w/H_B = 1.0$ and α_a=60°. Fig. 6 (A) represents the change in f_{rs} with Re for distinct values of W_D/W_B. From the plot it has been observed that f_{rs} increases with decrease in Re in every case. It can observed that f_{rs} increases monotonically with increase in W_D/W_B. At W_D/W_B of 6.0, the maximum data of f_{rs} has been observed. This due to the fact that the angling of the baffle helps in the prochannelion of secondary stream jets. The number of secondary stream jets are increased with in the increasing value of W_D/W_B. This leads

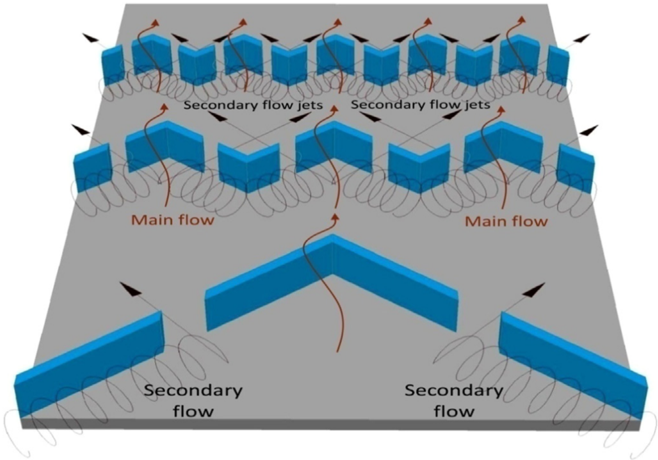

Fig. 5. Secondary flow pattern in broken multiple V-type baffle.

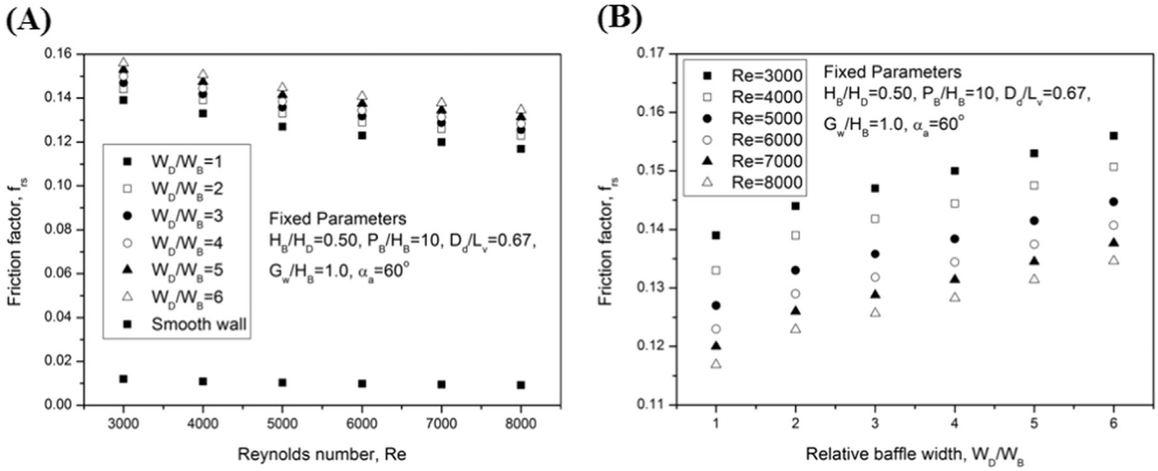

Fig. 6. (A) Effect of W_D/W_Bon f_{rs} (B) Effect of W_D/W_Bon Nu_{rs} at selected *Re*.

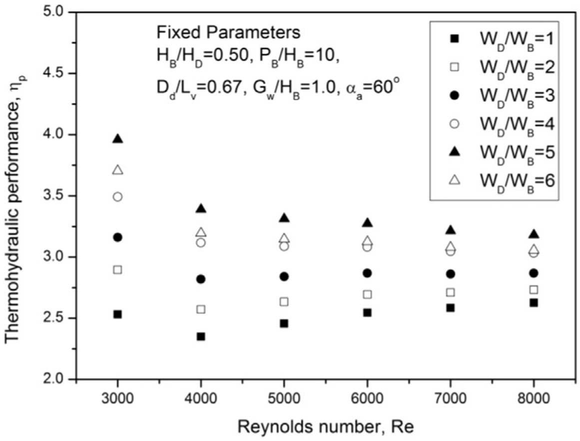

Fig. 7. Effect of W_D/W_Bon η_p.

the rise in the data of Nu_{rs} up to W_D/W_B of 5.0. Further increase in the W_D/W_B beyond 5.0 may results in partition of flow from top baffle wall which reduces Nu_{rs}. With the increase in W_D/W_B the value of f_{rs} increases and attain a maximum data corresponding to W_D/W_B value of 6.0 in the range of parameter considered. Due to separation of stream, the data of f_{rs} goes on account of configuration of vortices. Several vortices rises mixing of air due to which Nu_{rs} rises. Because of this reason, the

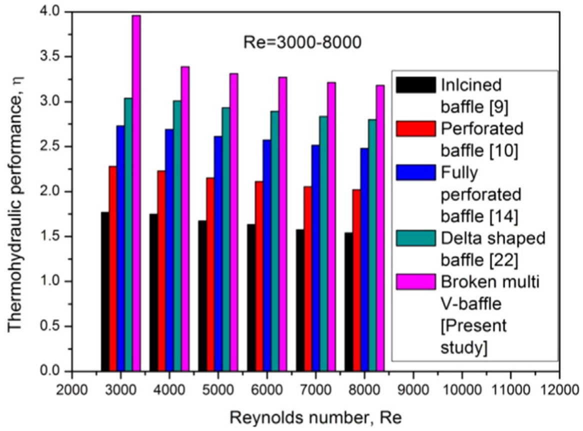

Fig. 8. Comparison various baffle rough surface air channels.

Nu_{rs} from plate to air rises but these vortices also increase the huge Nu_{rs} through the flow across the solar air channel. The number of vortices is more in case of W_D/W_B of 6.0 as compared to W_D/W_B of 5.0. Therefore in case of $W_D/W_B$of 6.0, vortices and air mixing is more which causes the higher f_{rs}. This extreme formation of vortices and mixing of fluid also does not contribute in rising the Nu_{rs} with further rise in the data of W_D/W_B as shown in Fig. 6(B).

7.2. Thermo hydraulic performance

From the investigation of Nu_{rs} and f_{rs} behaviors it is concluded that Nu_{rs} in the broken multiple V-type baffled channel is improved with a significant rise in the f_{rs}. So it is important to choose geometry that should not only outcomes in Nu_{rs} but also retain the f_{rs} at its minimum possible level. In order to achieve this goal of simultaneous consideration of thermal as well as hydraulic performance a parameter known as thermo-hydraulic performance(η_p), designates the Nu_{rs} by the W_D/W_B of broken multiple V-type baffles per unit pumping power comparing with the heat transfer for completely developed turbulent stream in the channel with without baffle walls is given by the following Eq. (13).

$$\eta_p = (Nu_{rs}/Nu_{ss})/(f_{rs}/f_{ss})^{0.33} \tag{13}$$

A high data of this parameter shows comparatively higher utility of the augmentation device and can be used to compare the performance of number of preparations to decide the better among these. The data of η_p for the distinct data of W_D/W_B is plotted in Fig. 7. It can be observed that the data of, $\eta_p = (Nu_{rs}/Nu_{ss})/(f_{rs}/f_{ss})^{0.33}$ is maximum for W_D/W_B of 5.0 for all values of Re considered for the current examination.

The data of $\eta_p = (Nu_{rs}/Nu_{ss})/(f_{rs}/f_{ss})^{0.33}$ for the shapes of broken multiple V-type baffles have been compared with the data for other baffles shapes solar air channel as shown in Fig. 8. It is seen that from the Fig. 8 broken multiple V-type baffles shape outcomes in the greatest thermo-hydraulic performance between all the shapes studied.

8. Conclusion

This experimental examination of Nu_{rs}, f_{rs} and $\eta_p = (Nu_{rs}/Nu_{ss})/(f_{rs}/f_{ss})^{0.33}$ of solar air channel attached with broken multiple V-type baffle on the base of the heated wall. The heat transfer enhancement is a strong function of W_D/W_B and broken multiple V-type baffles outcomes in significant improvement in Nu_{rs} of air flow in a solar air channel. With an increase inRe, Nu_{rs} rises while f_{rs} reduces. In comparison of a solar air channel without baffles, a broken multiple V-type baffles have high data of Nu_{rs} and f_{rs}. This causes the change in the fluid flow characteristics due to baffles roughness which outcome in stream separation, reattachment and generation of secondary stream jets. For broken multiple V-type baffle baffles with W_D/W_B of 5.0, the extreme data of Nu_{rs} is observed and extreme data of f_{rs} occurs for broken multiple V-type baffle baffles with W_D/W_B of 6.0. In broken multiple V-type baffles solar air channel, the optimal data of thermo-hydraulic performance has been found corresponding to W_D/W_B of 5.0. The broken multiple V-type baffles has also been found to be thermo hydraulically superior as compared to other baffles shapes solar air channel.

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