

List of Figures

Figures	Title	page
1.1	Concentrating solar thermal technologies.	2
1.2	Classification of central receivers for solar tower.	4
1.3	(a) A schematic of the designed solar convective furnace (b) Solar air tower simulator facility, 1) open volumetric air receiver; 2) thermal energy storage; 3) heat exchanger; 4) blower; 5) solar convective furnace; 6) air return system. [Sharma <i>et al.</i> , 2015a, b] and (c) the installed SATS facility at IITJ.	5
1.4	(a) A schematic of the designed open volumetric air receiver at IIT Jodhpur [Sharma <i>et al.</i> , 2015a,b]; (b) The designed model of receiver assembly; and (c) a manufactured absorber with straight circular pores.	6
2.1	Temperature distribution in tubular and volumetric receiver.	9
2.2	A dust storm at Bikaner, Rajasthan.	16
2.3	Failure of an absorber.	17
2.4	Difference in quadratic pressure-drop versus outlet air temperature.	18
3.1	(a) Schematic of dust deposition experiment; (b) Photograph of dust deposited in absorber.	20
3.2	Heat flux distributions on the absorber material viz. (a) the uniform and (b) non-uniform.	22
3.3	(a) Geometries of A: clean pore, B: pore with uniform dust layer (UDL), C: pore with non-uniform dust layer, (b) A schematic showing the same pressure drop across all absorber pores due to suction (c) Employed mesh for the clean and (d) partly blocked pore (A:air, B:brass and D:dust).	24
3.4	(a) A comparison between experiment and numerical analyzed air temperature at the absorber outlet; (b) absorbers with heating element during an experiment.	26
3.5	Axial temperature profile of fluid and solid with uniform dust layer thickness (UDL) and with non-uniform dust layer thickness (NDL) in an OVAR with circular straight channels.	27
3.6	Temperature contours for a clean pore and for a partly blocked pore with uniform dust layer (UDL) thickness of 100 μm and the applied uniform heat flux along the pore length.	28
3.7	(a) The reference square absorber [Luque <i>et al.</i> , 2017b]. The schematic depicting (b) clean and (c) dust deposited single straight channel, and (d) generated mesh for the partly blocked pore.	29
3.8	(a) Axial temperature profile along the centerline of absorber solid and fluid with UDL and a uniform heat flux distribution with reference square absorber [Luque <i>et al.</i> , 2017b] and (b) Variation of solid temperature along the longitudinal direction for a clean and partly blocked channel at the central plane.	30
4.1	Designed cyclone separator with dimensions.	32
4.2	Forces acting on a particle in circular path.	33
4.3	Schematic of experimental set-up for pressure-drop measurement.	35
4.4	The modeled cyclone separator and an example of generated mesh for CFD analysis.	36
4.5	Comparison of CFD and experimental pressure-drop.	36
4.6	Velocities at different sections of cyclone separator and helical streamlines of air.	37
4.7	(a) A strategy for cleaning of porous absorber based OVAR and (b) experimental evaluation of collection efficiency for the designed cyclone separator.	39
4.8	Pressure-drop in various geometries of 2D2D cyclone separators at different velocities.	40
4.9	A comparison between CFD and predicted K values for 2D2D cyclone separator of 200 mm diameter.	40
4.10	Effect of temperature on pressure-drop.	41
4.11	Comparison between CFD analyzed and K-factor based pressure-drop.	42
5.1	(a) Schematic of experimental setup showing 1:blower, 2:pipe, 3:absorber, 4-5:DPT with probes, 6:valve, 7:rotameter; (b) modeled geometry and a fabricated brass absorber; (c,d) the generated coarse and fine mesh.	45
5.2	A comparison between the measured and the analyzed pressure-drop across an absorber.	46
5.3	The cross-section of a pore without and with a uniform dust layer.	47
5.4	A comparison between (a) the measured thermal efficiency, and (b) correlation based and the measured efficiency (%) of the receiver.	49
5.5	Efficiency ratio (η_r) variation for clean receiver with (a) porosity and \dot{q}/\dot{m}_a , (b) mass flow	49

	rate of air (\dot{m}_a) and, η_r variation for partly blocked receiver with (c) mass flow rate of air (\dot{m}_a), (d) porosity and \dot{q}/\dot{m}_a .	
5.6	Comparison between the derived correlation for pressure drop at different temperatures.	53
5.7	(a) A schematic of the employed mesh of two dimensional geometry of single absorber pore (A: Air, B: Brass), (b) A comparison between theoretical and the numerically analyzed values of Δp^2 .	54
5.8	Variation of T_{out} and Re_p with the kinematic viscosity ratio of air.	55
5.9	Comparison of the analyzed Δp^2 with clean and partly blocked straight channel.	55
6.1	Working of open volumetric air receiver.	57
6.2	Front (a) and part view (b) of the OVAR.	58
6.3	Influence regions and their redistributions (a, b, c); a differential element along the axial-direction (z) for analysis (d).	59
6.4	A schematic showing (a) Crossed (CS) and un-crossed (US) strings and (b) dimensional quantities for view factor calculation between peripheral and central absorbers.	60
6.5	Schematics of (a) Regions for shape factor calculation, (b) calculation of length of regions.	62
6.6	Energy balance for casing.	64
6.7	Energy balance for peripheral absorber.	66
6.8	Energy balance for central absorber.	68
6.9	Energy balance in primary air.	71
6.10	Energy balance in return air.	72
6.11	Comparison between the computed and measured (a) primary air temperature at the steady state and (b) thermal efficiencies, (c) time-dependent primary air temperature at the outlet of peripheral and central absorbers and (d) average primary air temperature at the absorber outlet at different power to air mass flow ratio.	76
6.12	Time dependent development of temperature in (a) solid and (b) air.	77
6.13	Axial variation of temperature in central (c) and peripheral absorbers (p) under (a) uniform and (b) non-uniform heat flux distribution; T_{ap}/T_{ac} : air; T_{p}/T_{c} : absorber.	77
6.14	Variation of thermal efficiency with the ratio of power to air mass flow rate.	78
6.15	Variation of thermal efficiency with porosity of the absorbers.	78
6.16	Variation of thermal efficiency with the absorber diameter to length ratio.	79
6.17	Variation of thermal efficiency with the smallest gap to absorber length ratio.	80
6.18	Variation of thermal efficiency and outlet air temperature with air return ratio (ARR).	80
6.19	(a) Variation of thermal efficiency with differential heating ; Solid and air temperature along the flow direction ($q''_{central}/q''_{peripheral} = 4$) under(b) volumetric heating and (c) non-uniform heat flux.	81