

Supplementary information

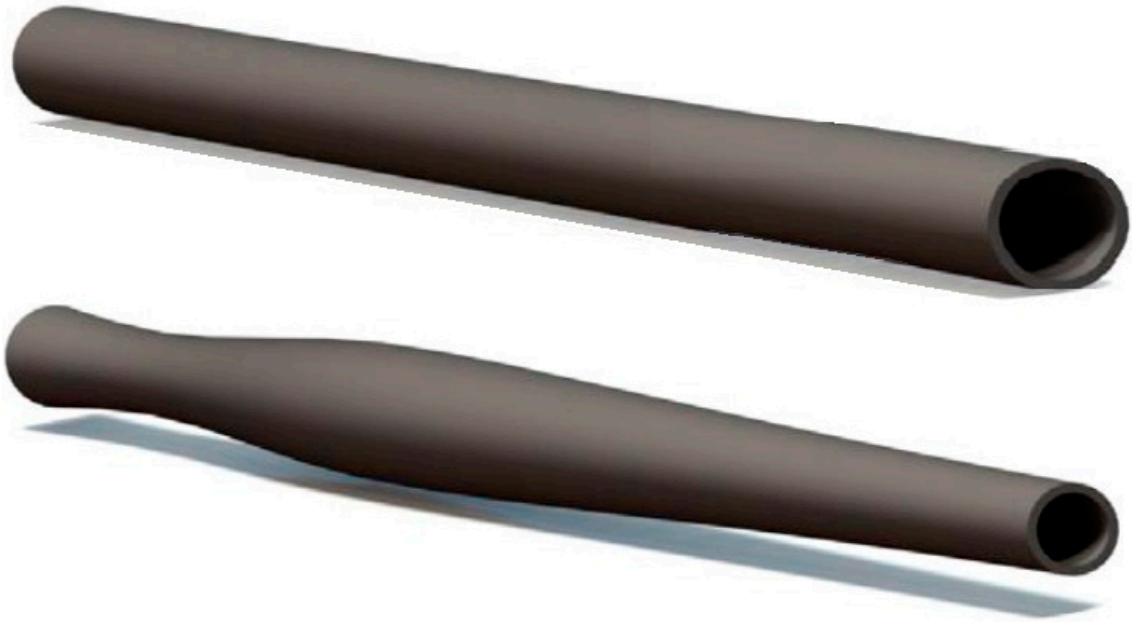


Figure S1. Tubular reactors: (a) cylindrical; (b) hydraulic diameter D_h - based.

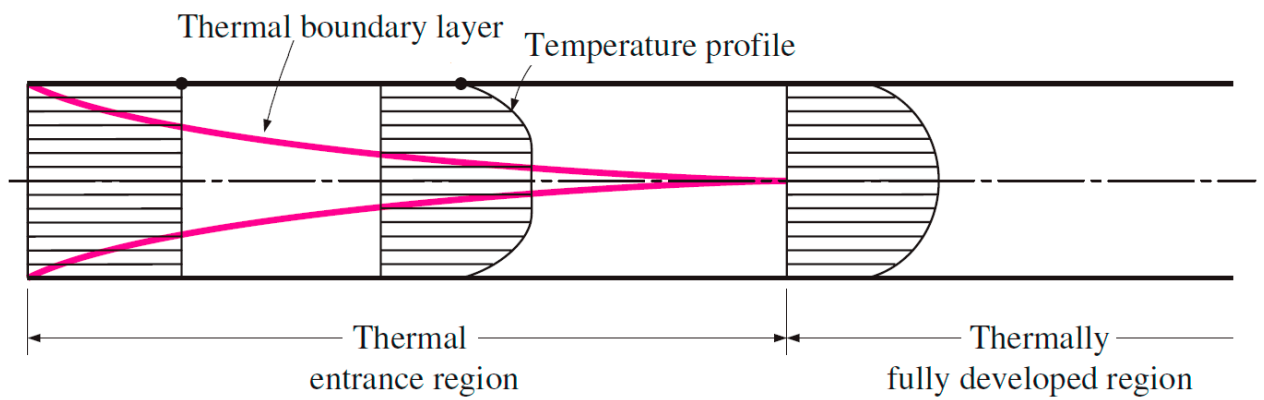


Figure S2. Development of thermal boundary layer.

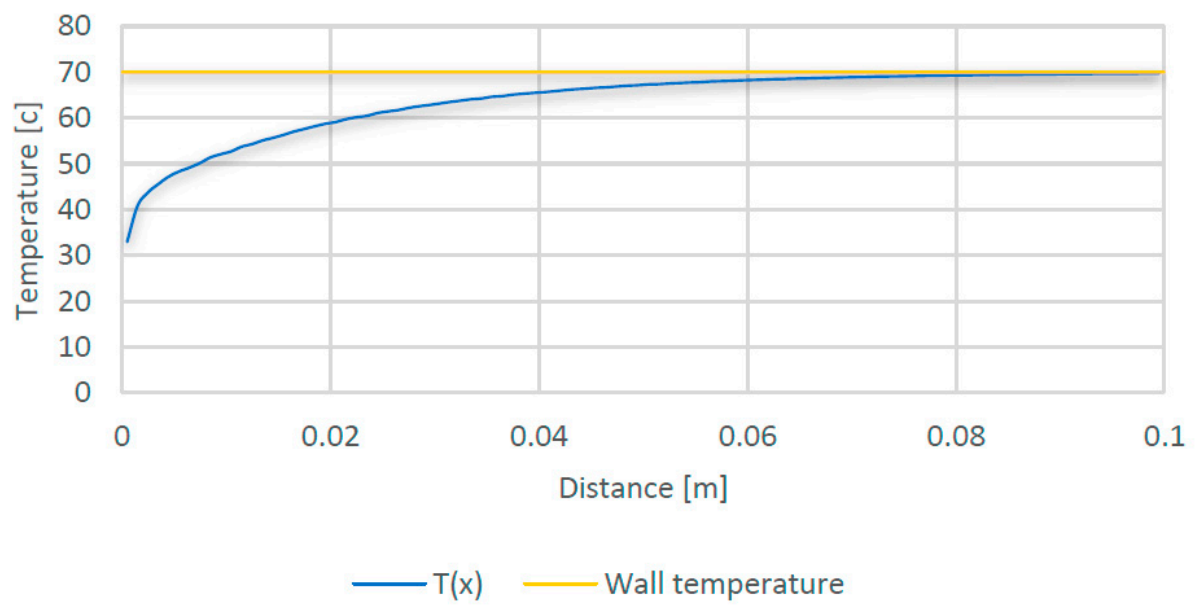
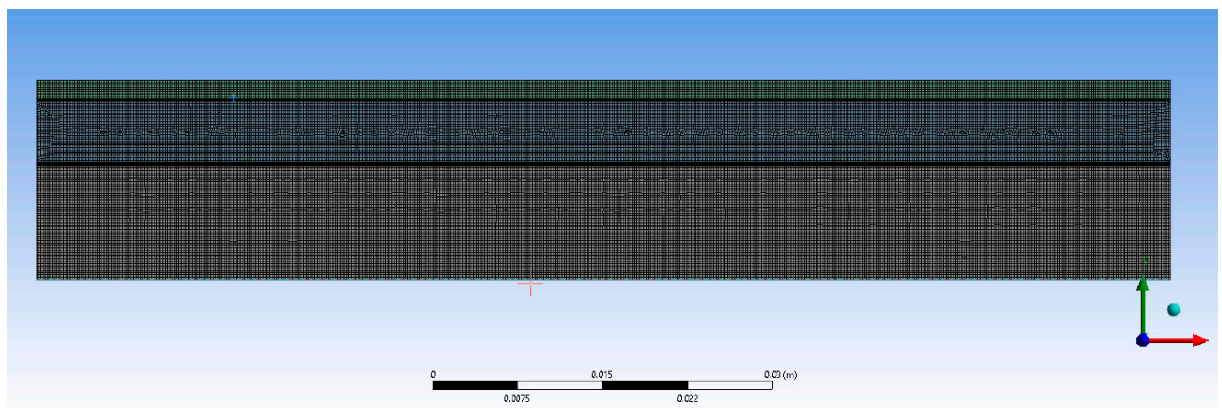
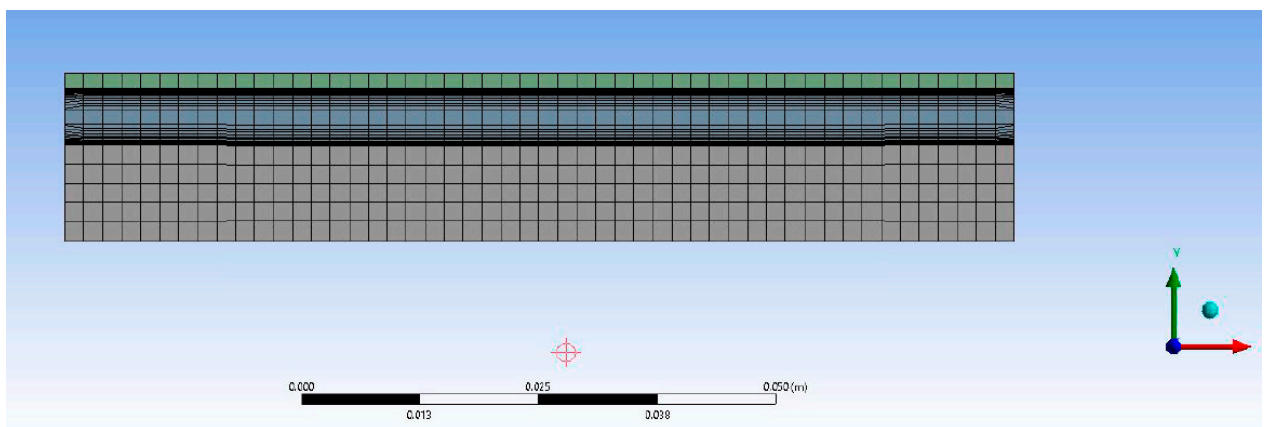


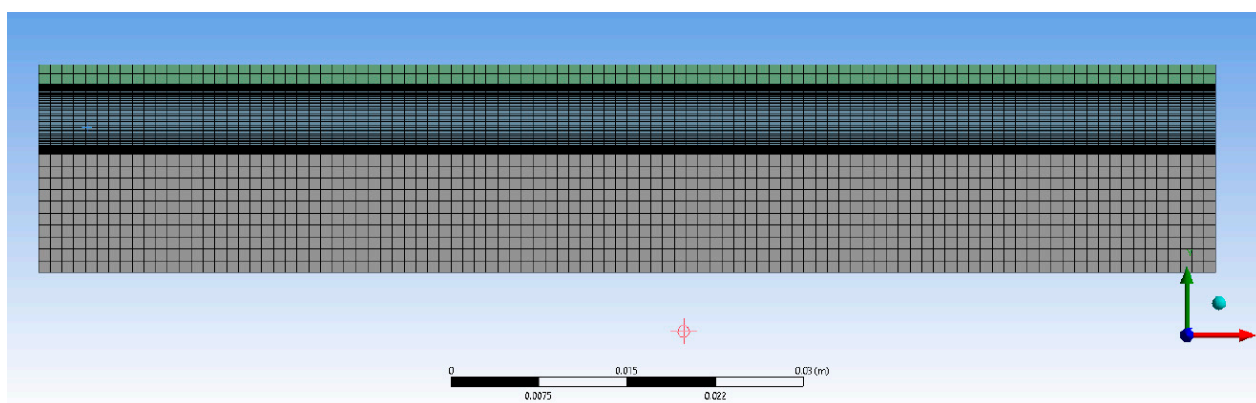
Figure S3. Temperature profile along the axis of the tube.



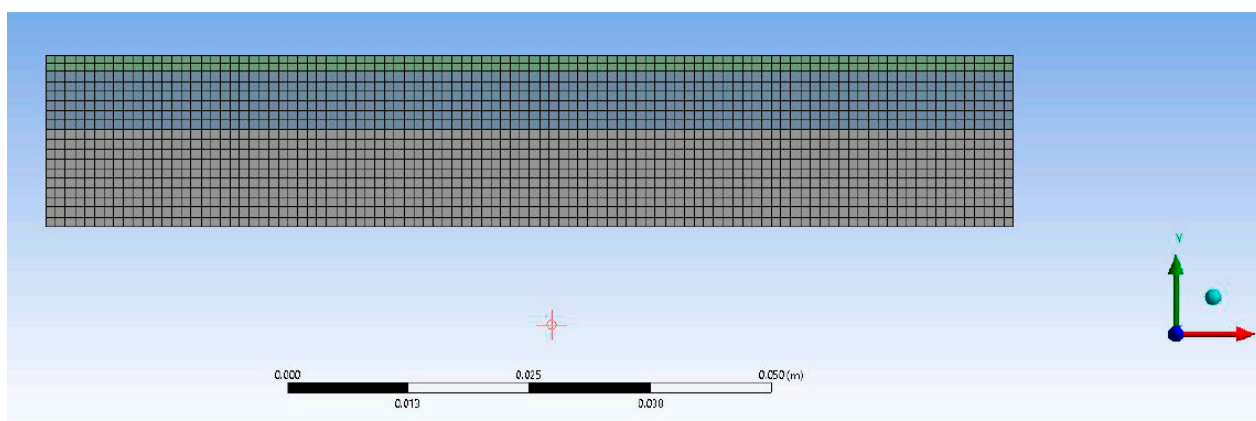
a



b



c

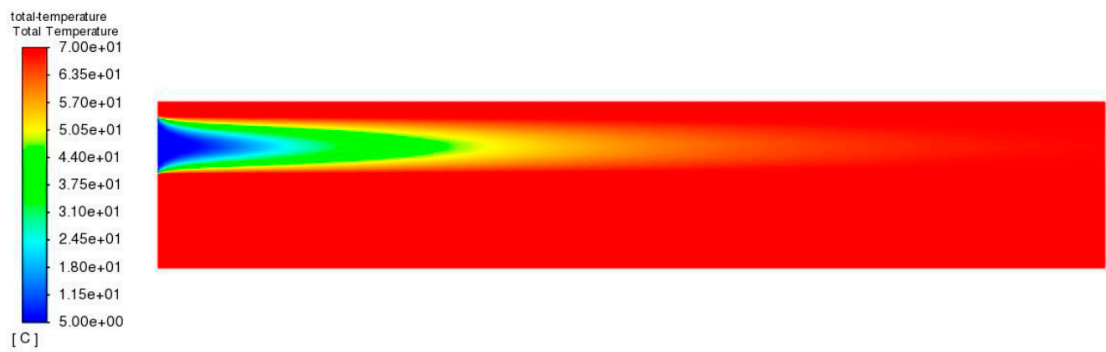


d

Figure S4. Mesh-independence test: (a) mesh1; (b) mesh2; (c) mesh3; (d) mesh4.

Table S1. Mesh details.

	<i>Mesh 1</i>	<i>Mesh 2</i>	<i>Mesh 3</i>	<i>Mesh 4</i>
<i>Element order</i>	Linear	Linear	Linear	Linear
<i>Element size</i>	2×10^{-4}	2×10^{-3}	1×10^{-3}	1×10^{-3}
<i>Inflation</i>	Inflation: smooth transition, Transition Ratio: 0.272, maximum layers: 20, Growth rate: 1.2	Inflation: smooth transition, Transition Ratio: 0.272, maximum layers: 20, Growth rate: 1.2	None	None
<i>Bias</i>	None	None	Bias factor: 11, Element size on edges: 1×10^{-4} , behaviour: hard	None
<i>No. of nodes</i>	128,278	5,100	15,150	4,242
<i>No. of elements</i>	62,512	2,350	7,200	1,800



a



b



c



d

Figure S5. Temperature contour plots for the mesh-independent test: (a) mesh1; (b) mesh2; (c) mesh3; (d) mesh4.

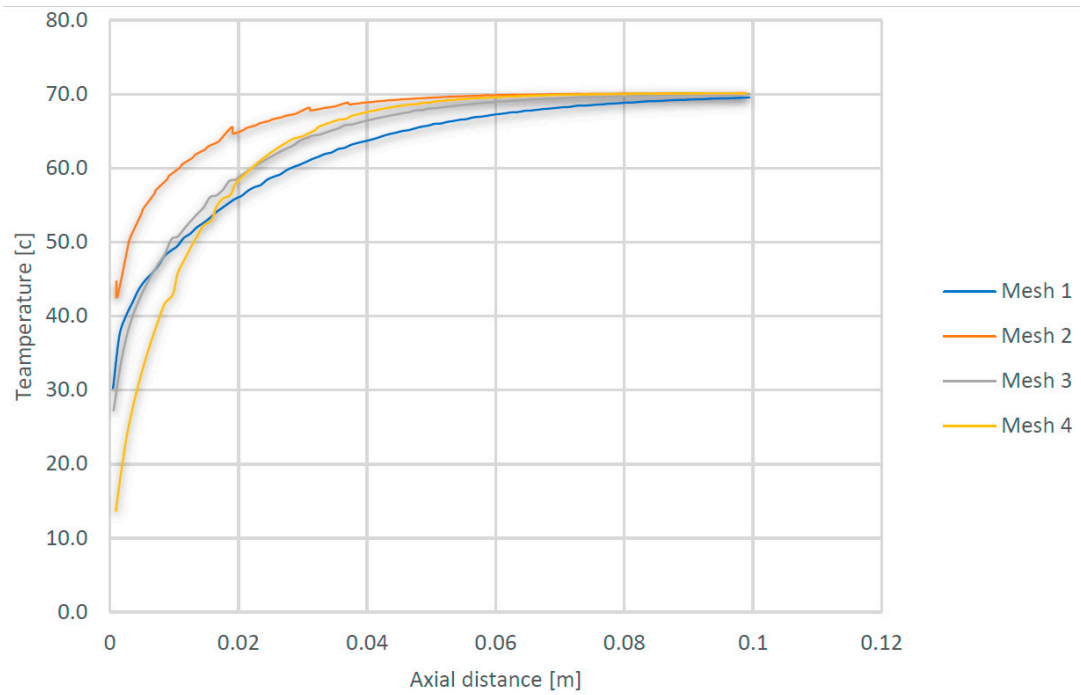
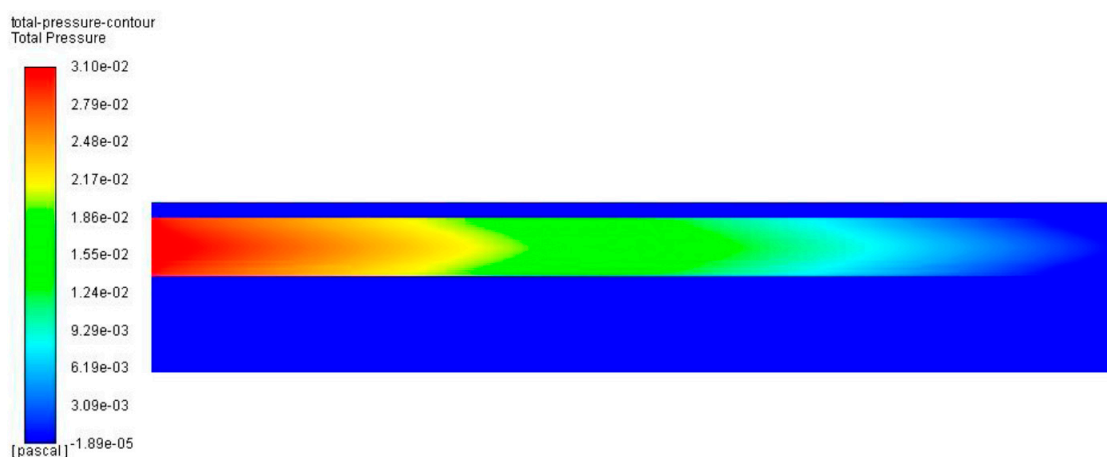


Figure S6. Temperature profiles for the mesh-independent test.

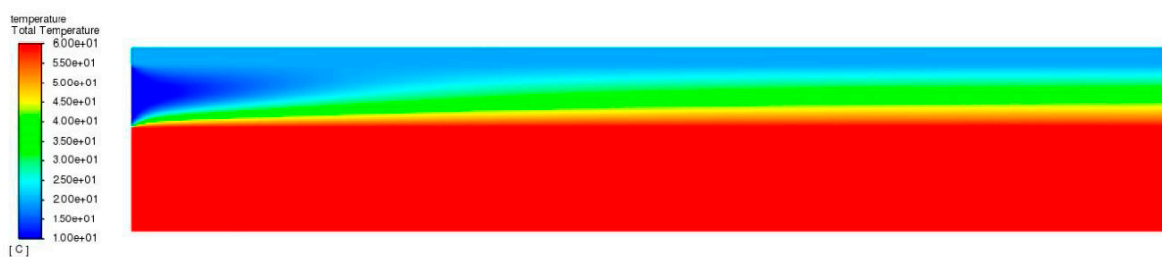


a

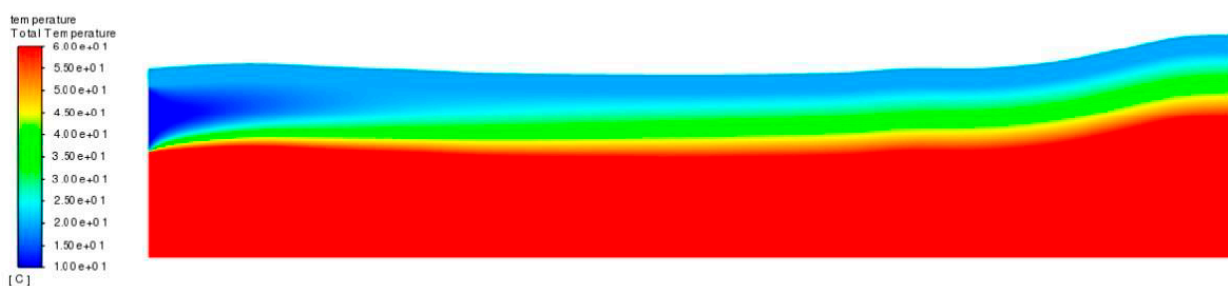


b

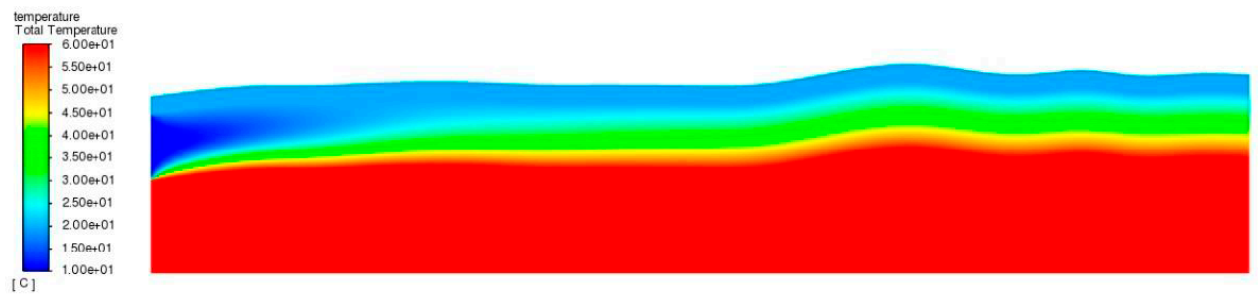
Figure S7. Contour plots of the pressure distribution in the cylindrical reactor (Geom1): **(1)** static pressure; **(b)** total (dynamic) pressure.



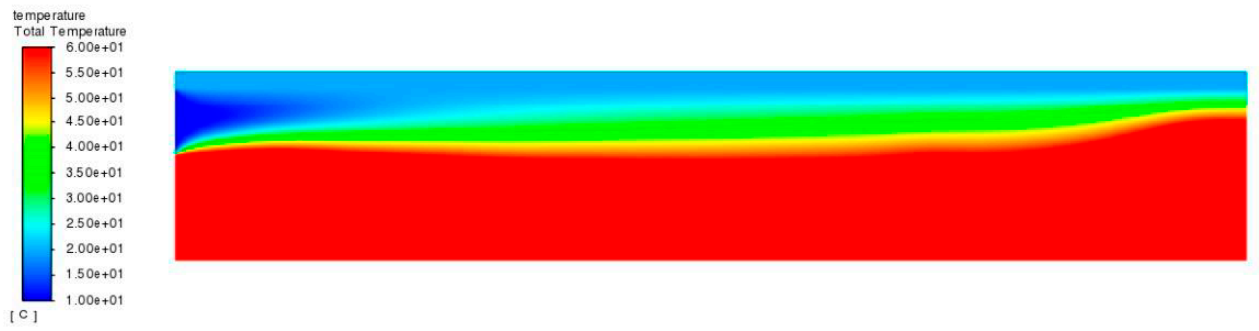
a



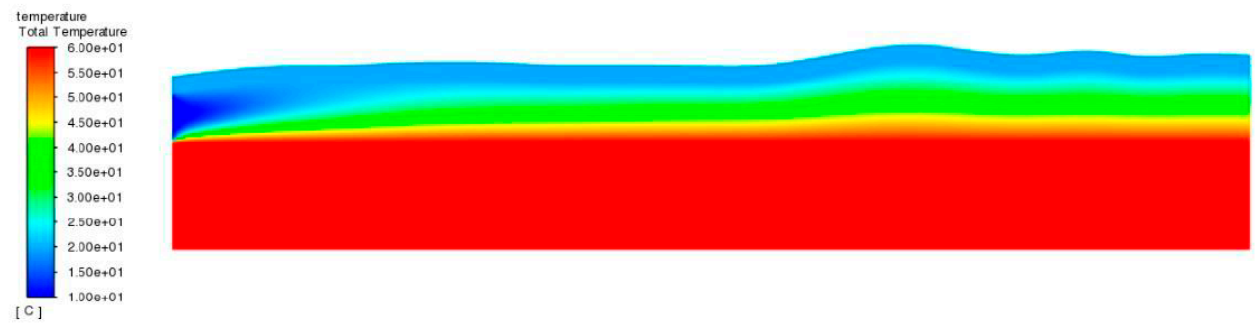
b



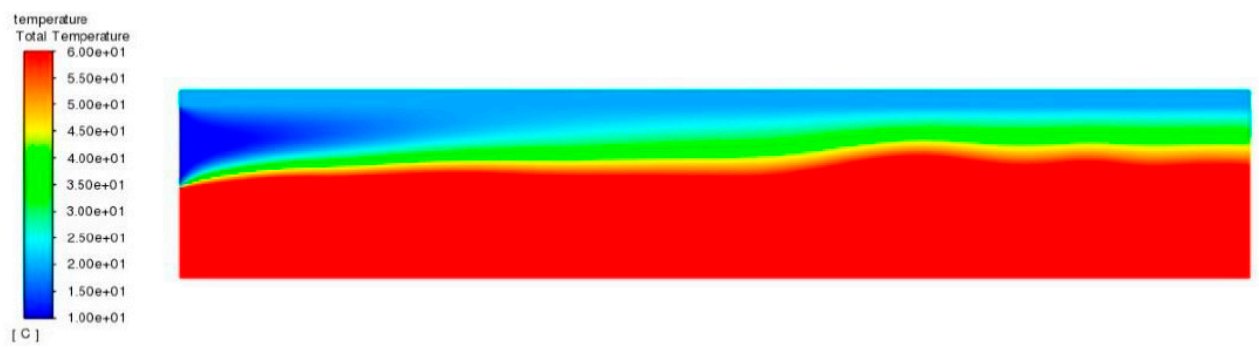
c



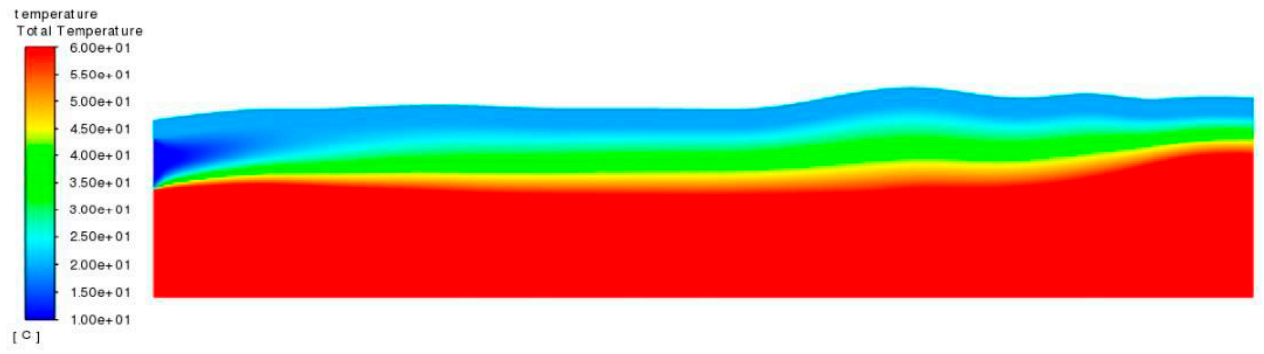
d



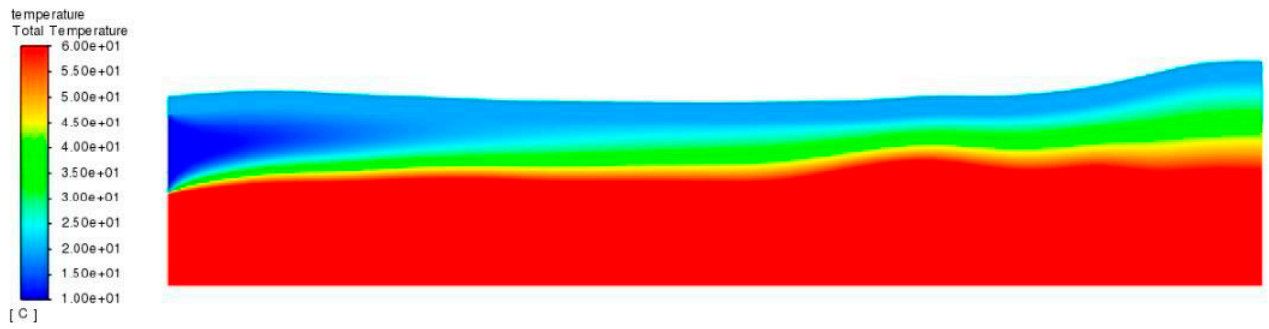
f



g



h



i

Figure S8. Contour plots of temperature distributions in different geometries: **(a)** Geom1; **(b)** Geom2; **(c)** Geom3; **(d)** Geom4; **(e)** Geom5; **(f)** Geom6; **(g)** Geom7; **(h)** Geom8; **(i)** Geom9.