Computer-Aided Project of Numerical Heat Transfer,
Xi'an Jiaotong University, 20150120

1. Project

The cross section of an axis-symmetrical structure is shown in Figure 1. The exhaust gas from the combustion chamber flows into the funnel-shaped channel at inlet ①, and leaves at ②; Water goes in the "water jacket" via inlet ⑤ and out via outlet ⑥. In between the funnel-shaped exhaust channel and water jacket, there goes air which exchanges heat with exhaust gas and water through the separated walls.

The geometric parameters are shown in Table 1. The thickness of the exhaust channel (labelled A in Figure 1) and the inner wall of the water jacket (Labelled B in Figure 1) are both 5mm and made of steel. The working conditions and physical properties of each working fluid are given in Table 2. Under given conditions, conduct a numerical simulation to yield the velocity distribution and temperature distribution of the whole field. The amount of heat exchanges of each fluid and the local convective heat transfer coefficient of the vertical walls for gas and air are also required (extra points will be given for determining the local heat transfer coefficients of gas and air along the inclined wall).

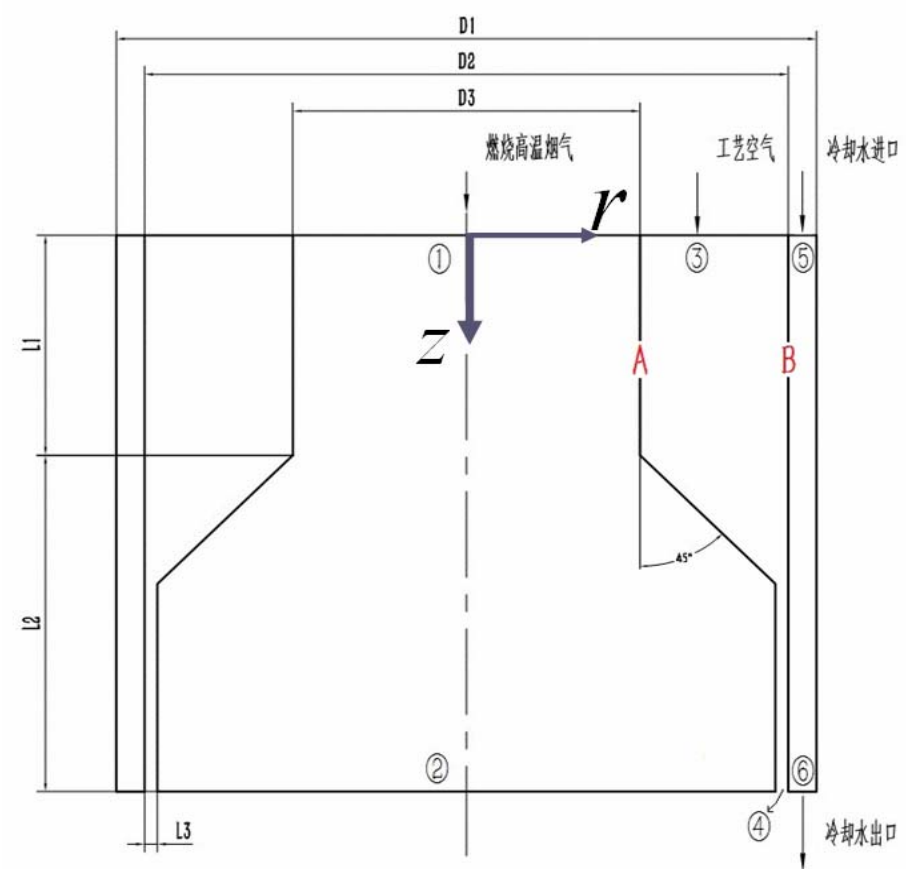

Figure 1 The structure behind a combustion chamber: ①exhaust channel inlet; ②exhaust channel outlet; ③air channel inlet; ④air channel outlet; ⑤water jacket inlet; ⑥water jacket outlet; A. the wall of exhaust channel; B. the inner wall of water jacket

Table 1 Geometric parameters

D1/mm	D2/mm	D3/mm	L1/mm	L2/mm	L3/mm
2460	2262	1220	814	1244	45

Table 2 Working conditions and physical properties

	Inlet temperature ℃	ρ $kg \cdot m^{-3}$	C_p $kJ \cdot kg^{-1} \cdot K^{-1}$	λ $W \cdot m^{-1} \cdot K^{-1}$	μ $Pa \cdot s$	Mass flow kg/h
Exhaust gas	1700	0.23	1.29	0.110	6.57×10^{-5}	185
Air	15	1.53	1.01	0.025	1.78×10^{-5}	280
Water	20	1000	4.18	0.600	1.00×10^{-3}	20000
Steel				14.2		

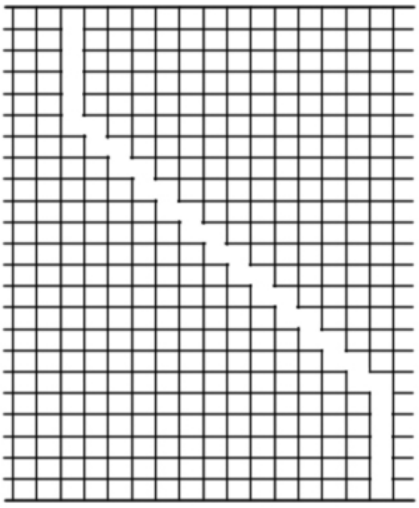

Figure 2 Step-wise approximation

2. Suggestions and Requirements

1) Considering the symmetry of the geometry, only half of the structure should be simulated. The axis-symmetric cylindrical coordinate should be used with θ=1 radian.
2) The step-wise approximation (shown in Figure. 2) is suggested to deal with the inclined wall. As the thermal conductivity of steal is large enough, only one cell for the wall is needed.
3) The whole-field solution method is required to solve the conjugated problem. Radiation heat transfer is neglected; Flow is laminar and in steady state with constant properties.
4) The teaching code is recommended to solve the problem, yet commercial software is also con be used.
5) The grid number in each direction is recommended about 300—500.
6) The project report should be written in the format of the Journal of Xi'an Jiaotong University;
7) When the teaching code is adopted, please submit in the USER part developed by yourself for solving the problem.
8) The project report should be due in before April 30, 2015 to room 204 of East 3rd Building.