

Computer-Aided Project of 2023 Numerical Heat Transfe

Xi'an Jiaotong University

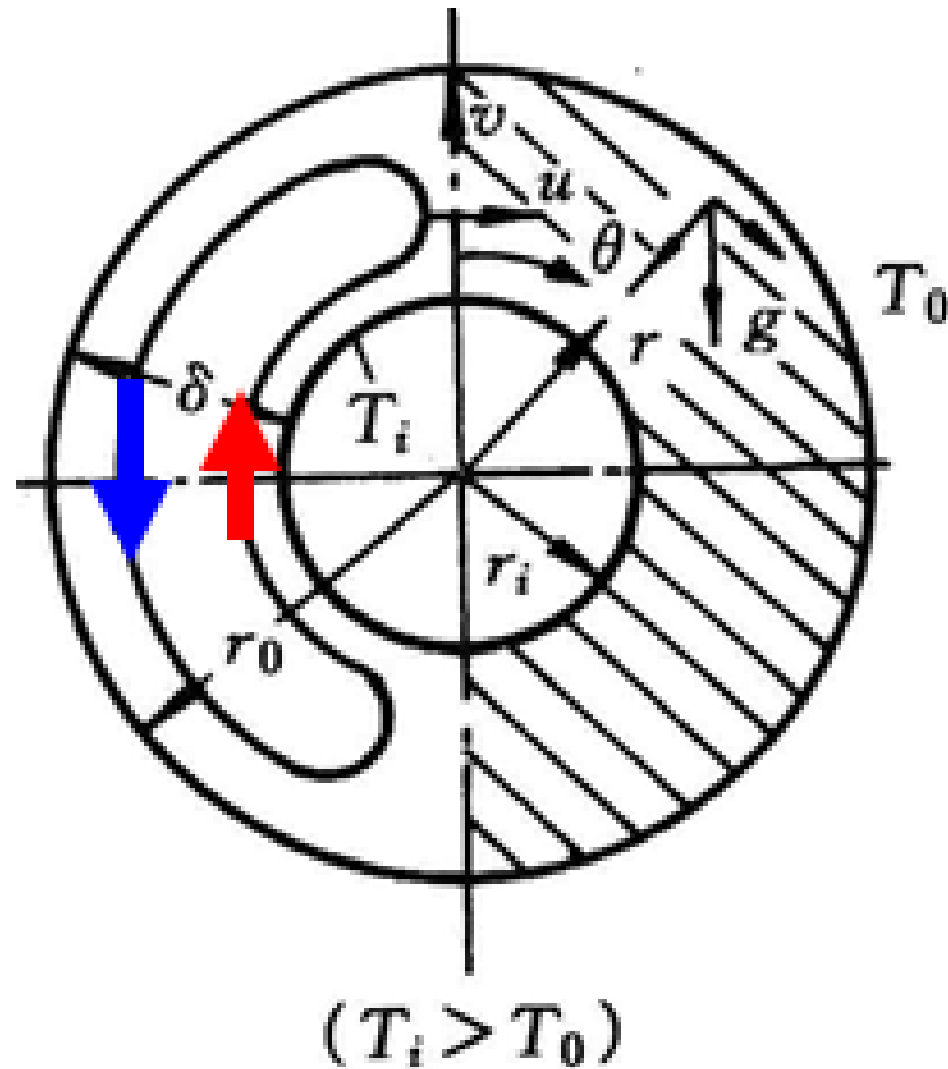
We present three computer-aided projects: one is to be solved by our teaching code (Project 1) , the 2nd and 3rd ones are to be solved by FLUENT (Fundamental , Project 2, Intermediate Project 3) . Every student can choose one project according to your interest and condition.

For the first project the self-developed computer code (USER) should attached in your final report. **Students are encouraged to take Project 1.**

For the second and third project Class F and Class I will have different projects. The instructors will assign the project at the end of the lecture.

Computer-Aided Project (1) of NHT-2023, Xi'an Jiaotong University

(Laminar natural convection in annular space)



1. Project formulation

For air natural convection within an annular space as shown in Fig. 1 , following conditions are given: $\delta/r_o = 0.4$, flow is laminar and the average air temperature is 50°C For $\text{Ra} = g\beta\Delta T\delta^3\nu/a^2 = 10^2, 10^3, 10^4, 10^5$, determine the relative thermal conductivity: $\lambda_{eq}/\lambda_{air}$.The temperature difference between inner wall and outer wall is not large, so the Boussinesq assumption can be adopted. By using Tecplot or other software, display the isotherms and streamlines and the variation of $\lambda_{eq}/\lambda_{air}$ vs. Ra. Natural convection heat transfer rate between the inner and outer surface is expressed by an effective thermal conductivity λ_{eq} as follows:

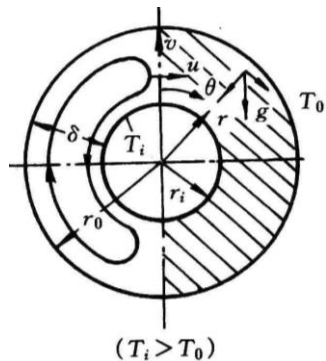
$$\phi = \frac{2\pi L \lambda_{eq} \Delta T}{\ln(d_2 / d_1)} \quad \lambda_{eq} \text{ is the equivalent thermal conductivity of the entire annular space.}$$

2. Suggestions and Requirements

- 1) Considering the symmetry of the geometry, only half of the structure should be simulated.
- 2) The solution should be grid-independent.
- 3) The project report should be written in the format of the Journal of Xi'an Jiaotong University. Both Chinese and English can be accepted.
- 4) Examples in teaching codes may be consulted.
- 5) Please submit in the USER part developed by yourself for solving the problem.

**The project report should be due in before April 30, 2024.
Teaching assistant group will inform you where to submit your results.**

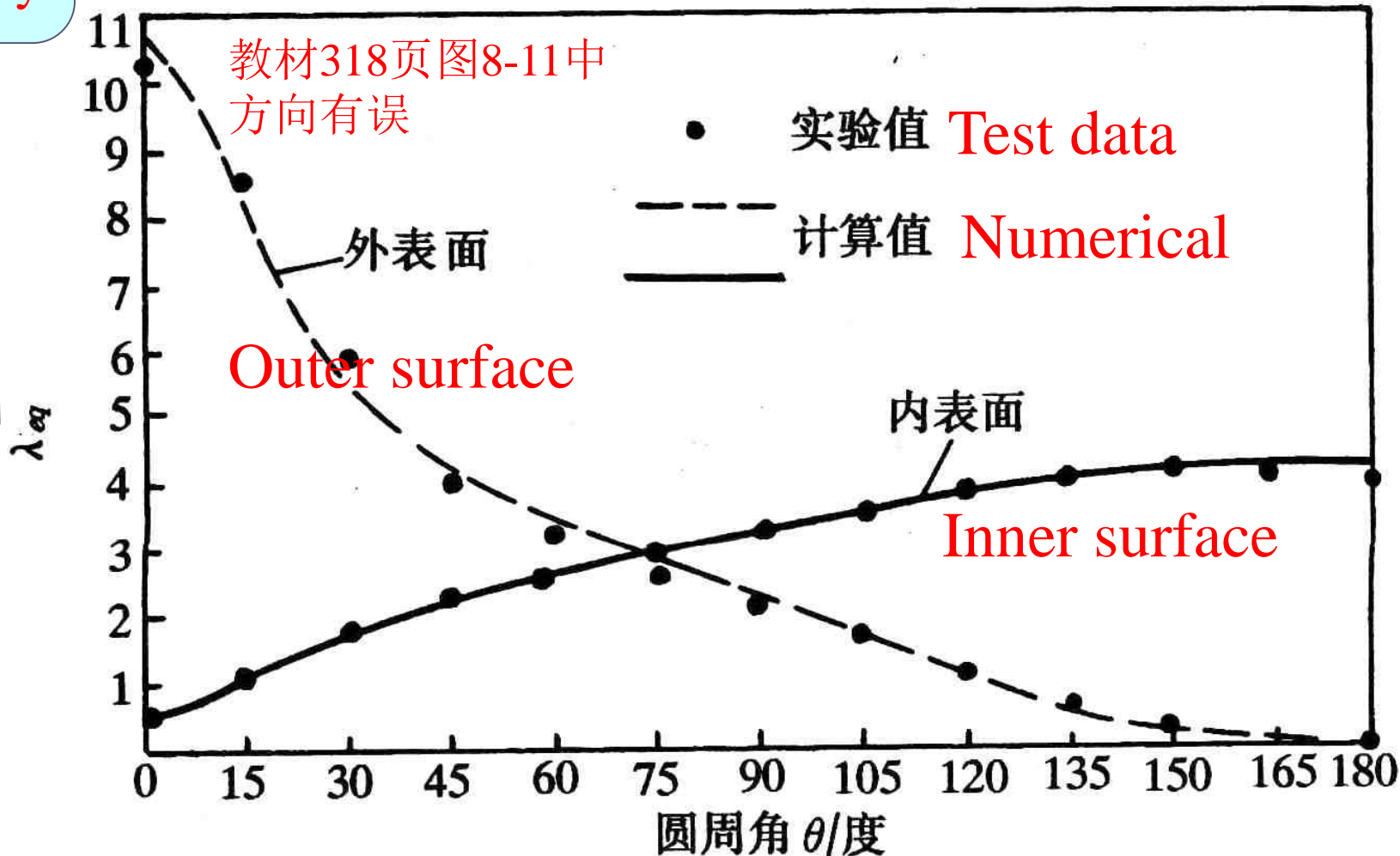
Local dimensionless thermal conductivity



Local relative thermal conductivity

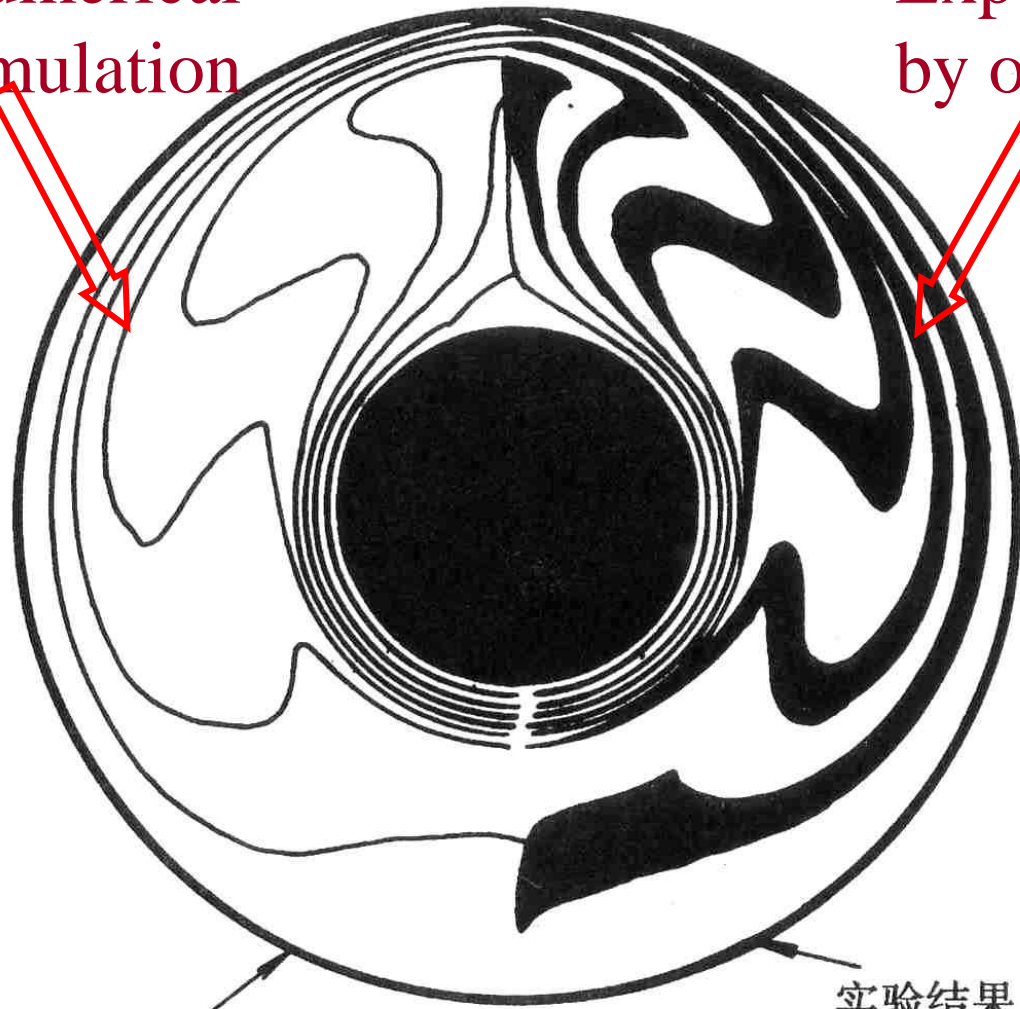
$$\overline{\lambda}_{eq} = \left(\frac{q_{convection}}{q_{conduction}} \right)_{\theta}$$

Kuehn T H, Goldstein R J. An experimental and theoretical study of natural convection in the annulus between horizontal concentric cylinders. *J Fluid Mech*, 1971, 74:605-719



Numerical
simulation

Experiment
by optical method



计算结果

实验结果

实验与计算条件

	实验	计算
Ra_δ	4.7×10^4	5×10^4
Pr	0.706	0.7
δ/D_i	0.8	0.8

Comparison of isotherms (等温线)

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Teaching PPT will be loaded on ou website



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渡彼岸!

People in the
same boat help
each other to
cross to the other
bank, where....