ICSC 2017

CAE for virtual product
CAE for innovation
CAE for process transformation

IDAJ CAE Solution Conference

集成中冷器式进气歧管热固耦合仿真分析

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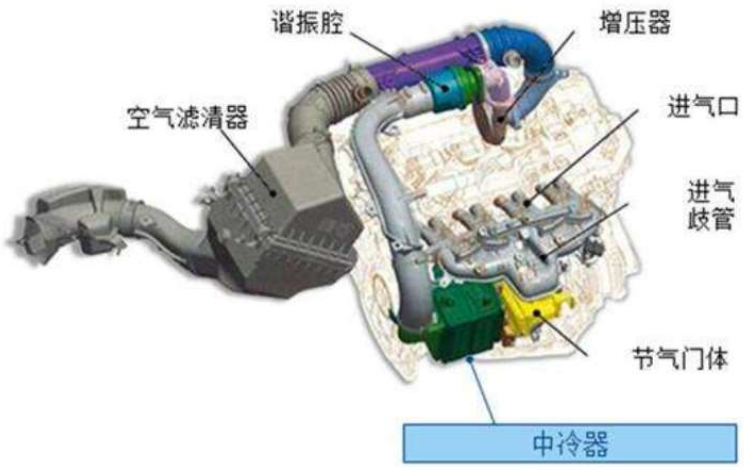
- CFD数值计算方法
- FEA模型建立
- 数值映射与耦合计算
- 实验结果验证

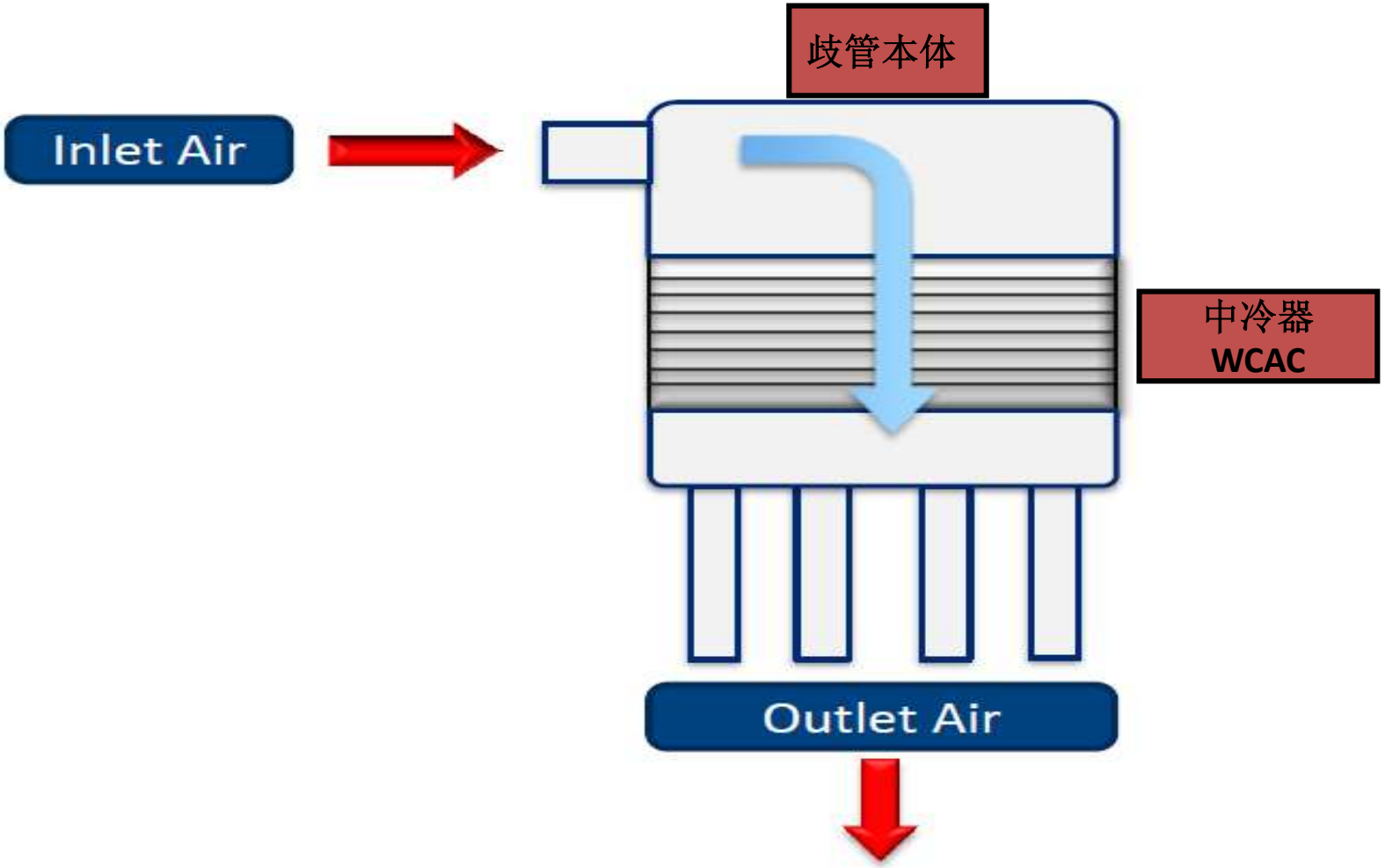
集成中冷器式进气歧管结构



传统式结构

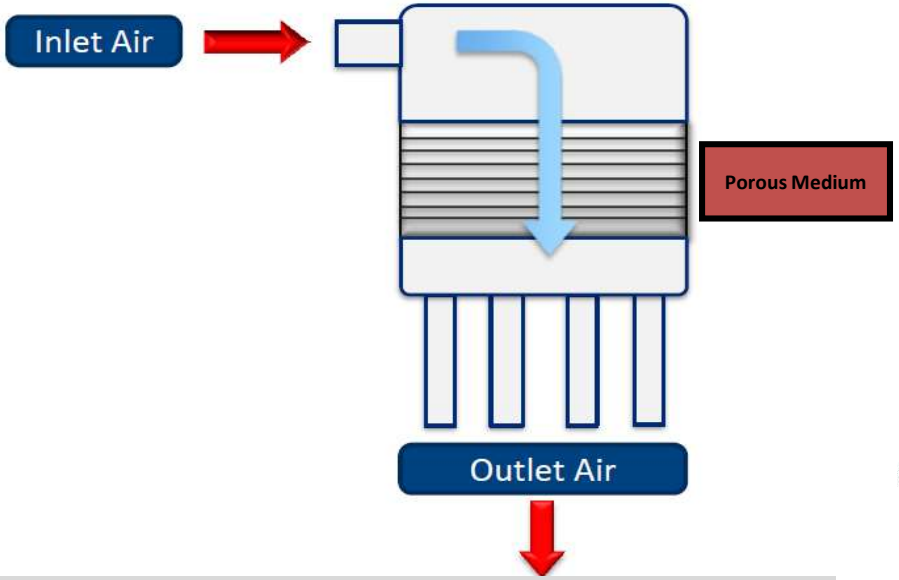
集成式结构

集成中冷器式进气歧管结构



集成中冷器式进气歧管图示

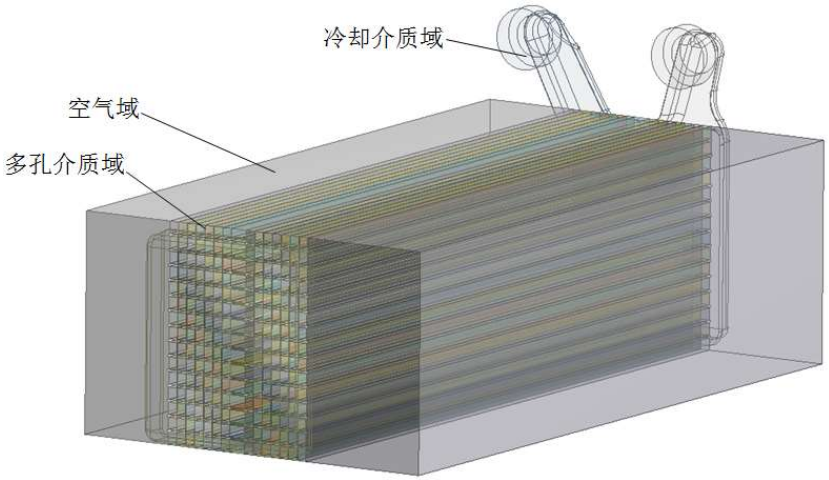
CFD数值计算方法



多孔介质域

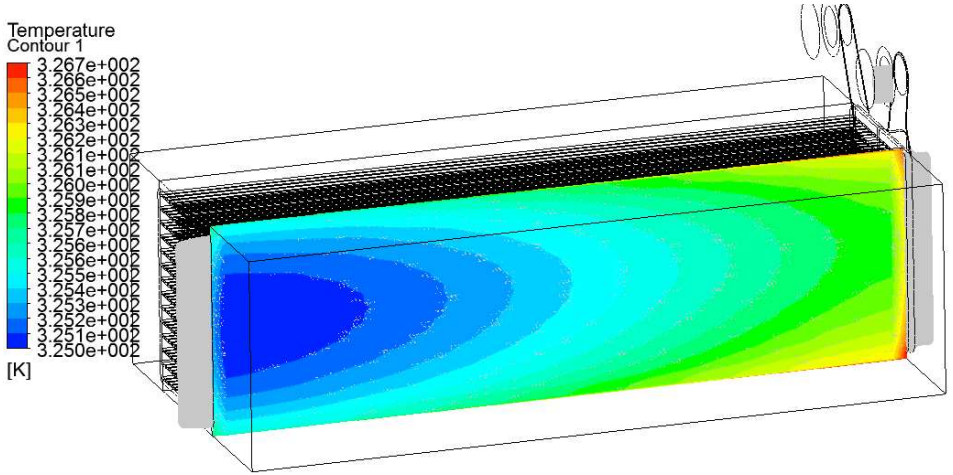
$$\frac{\partial P}{\partial Xi} = -\frac{\mu}{K_{perm}} * ui + Kloss * \frac{P}{2} * |u| * u_i$$

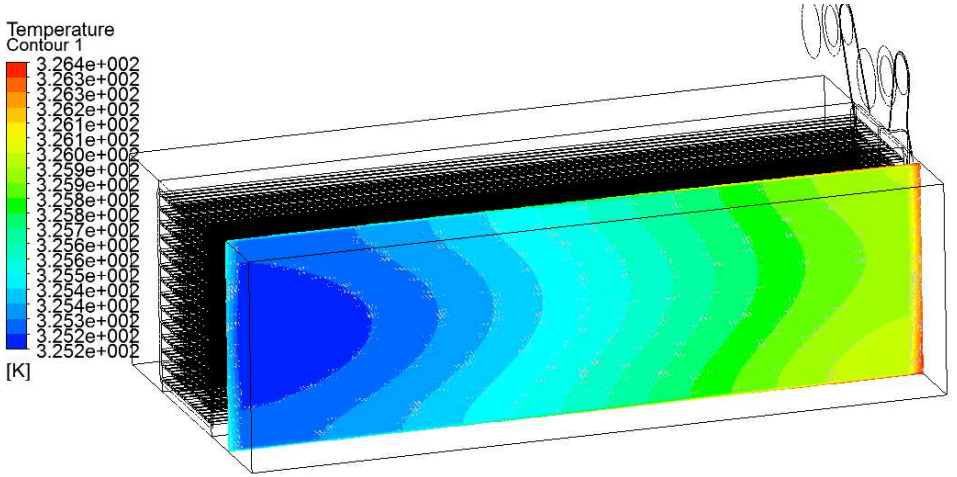
Q: Flow Rate [m3/s]
Kperm: Instrinsic permeability [m2]
μ: Dynamic viscosity [Pa.s]
ui: Velocity in the direction [1/m]
|u|: velocity magnitude [m/s]
$\frac{\partial P}{\partial Xi}$: Pressure Gradient [Pa/m]



CFD 求解域

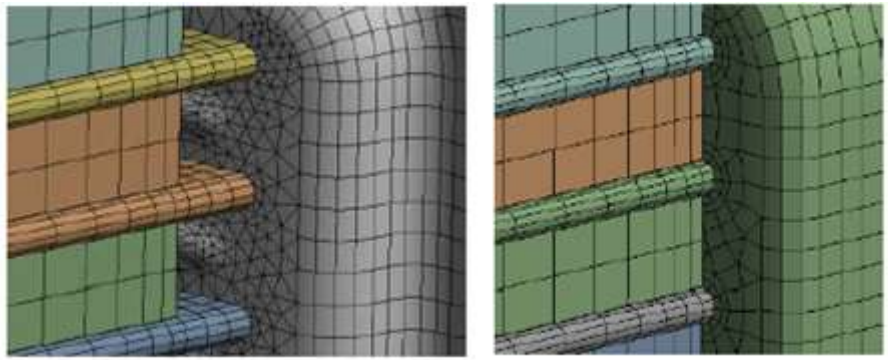
CFD数值计算方法





中冷器CFD计算结果

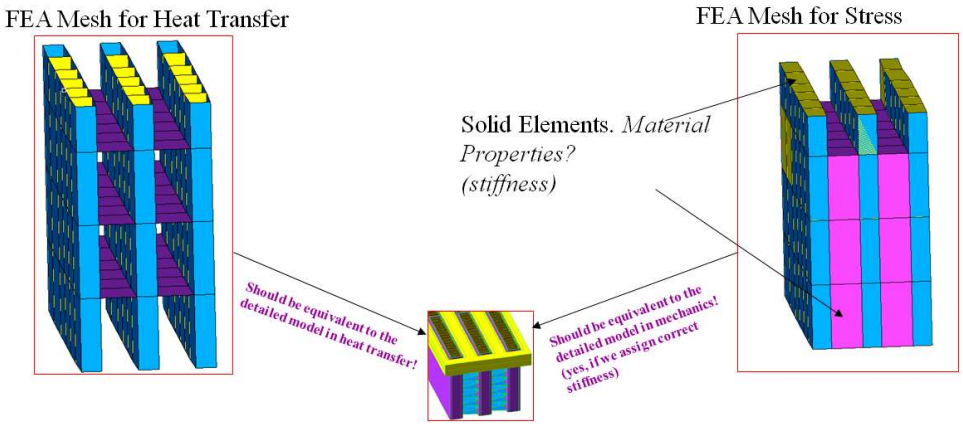
FEA模型建立



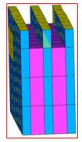
网格模型

FEA模型建立

Use larger and coarser elements; then assign equivalent properties.



Use orthotropic material for solid fin elements.



Stress-strain relation for orthotropic materials

$$\begin{Bmatrix}\sigma_{11}\\ \sigma_{22}\\ \sigma_{33}\\ \sigma_{12}\\ \sigma_{13}\\ \sigma_{23}\end{Bmatrix} = \begin{bmatrix} D_{1111} & D_{1122} & D_{1133} & & & \\ & D_{2222} & D_{2233} & & 0 & \\ & & D_{3333} & & & \\ & & & D_{1212} & & \\ & & sym & & D_{1313} & \\ & & & & & D_{2323} \end{bmatrix} \begin{Bmatrix}\varepsilon_{11}\\ \varepsilon_{22}\\ \varepsilon_{33}\\ \gamma_{12}\\ \gamma_{13}\\ \gamma_{23}\end{Bmatrix} = [D] \begin{Bmatrix}\varepsilon_{11}\\ \varepsilon_{22}\\ \varepsilon_{33}\\ \gamma_{12}\\ \gamma_{13}\\ \gamma_{23}\end{Bmatrix}$$

9 Terms:
3 diagonal stiffness,
3 shear stiffness, and
3 off-diagonal stiffness.

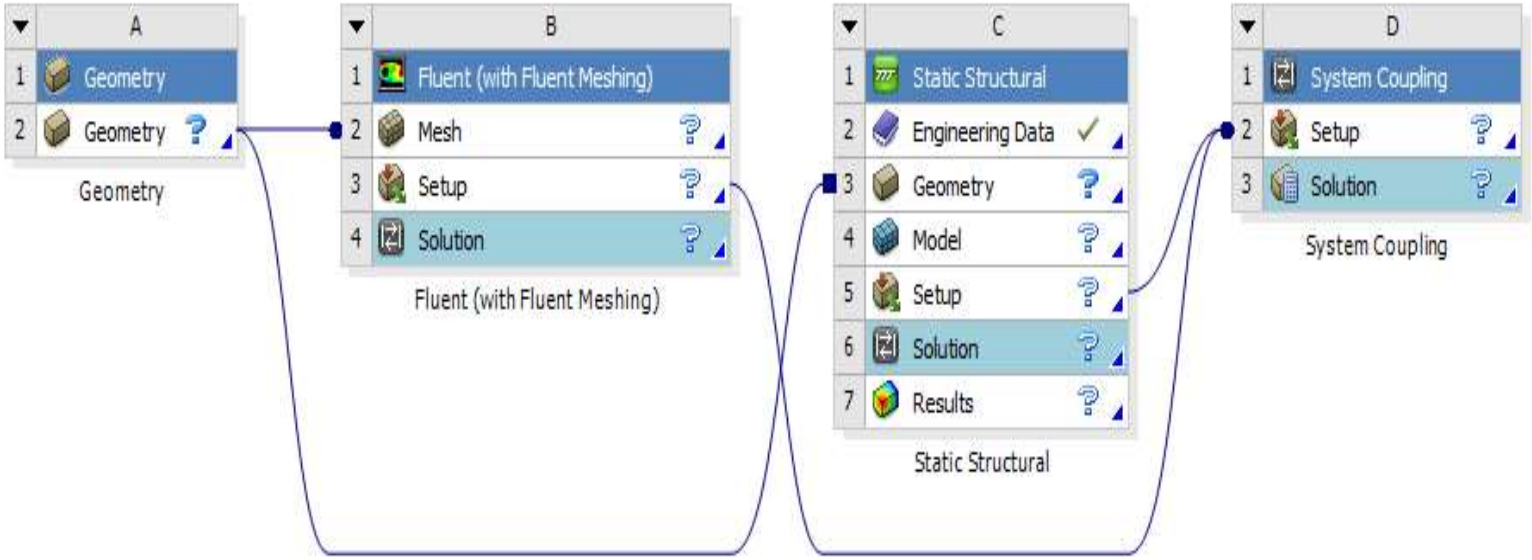
Stiffness Matrix

$$\begin{bmatrix} D_{1111} & D_{1122} & D_{1133} & & & \\ & D_{2222} & D_{2233} & & 0 & \\ & & D_{3333} & & & \\ & & & D_{1212} & & \\ & & sym & & D_{1313} & \\ & & & & & D_{2323} \end{bmatrix}$$

Off-diagonal, diagonal, shear

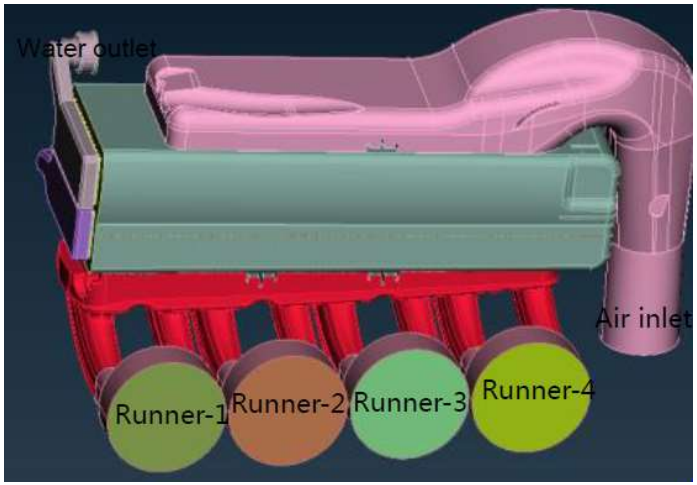
鳍片各向异性材料定义

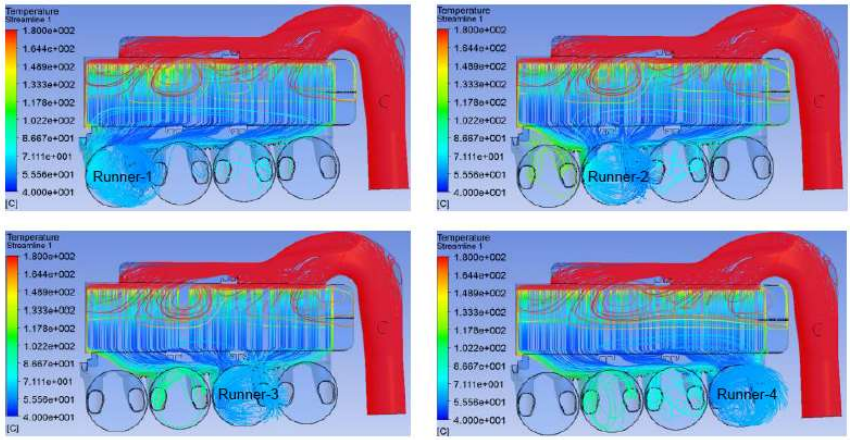
数值映射与耦合计算

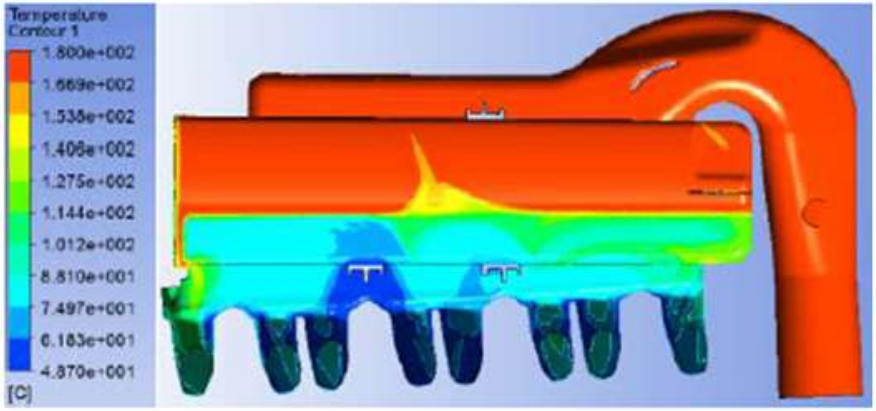


热固双向耦合

数值映射与耦合计算



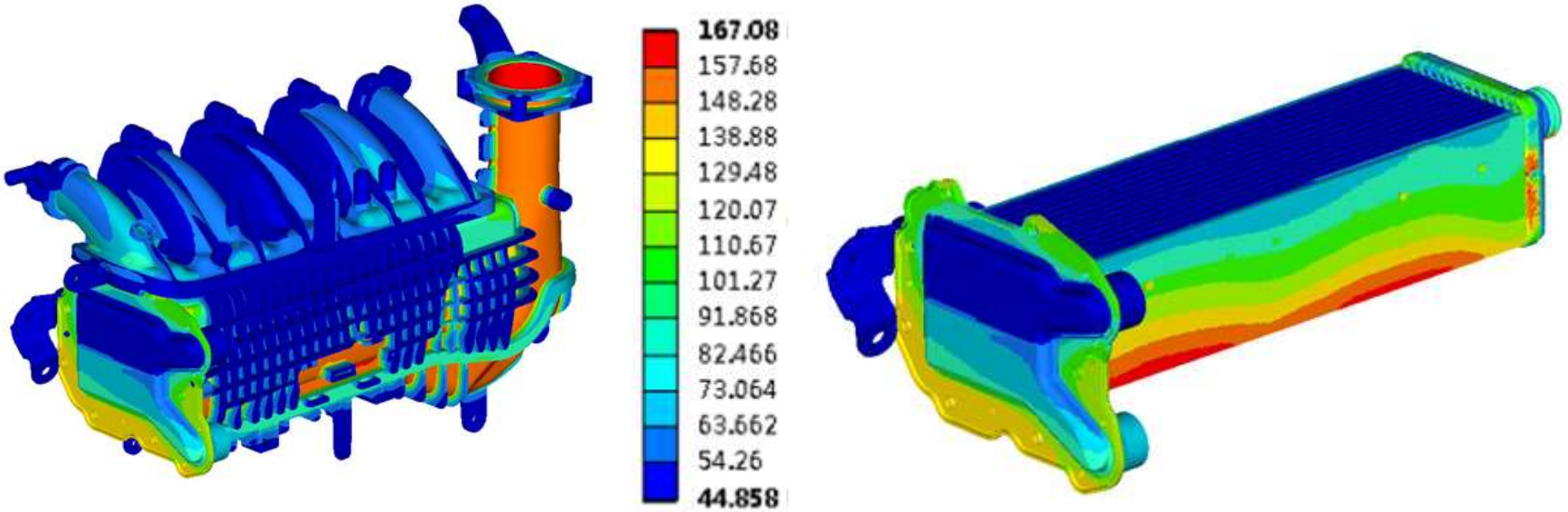




Temperature contour

CFD 求解温度场

数值映射与耦合计算

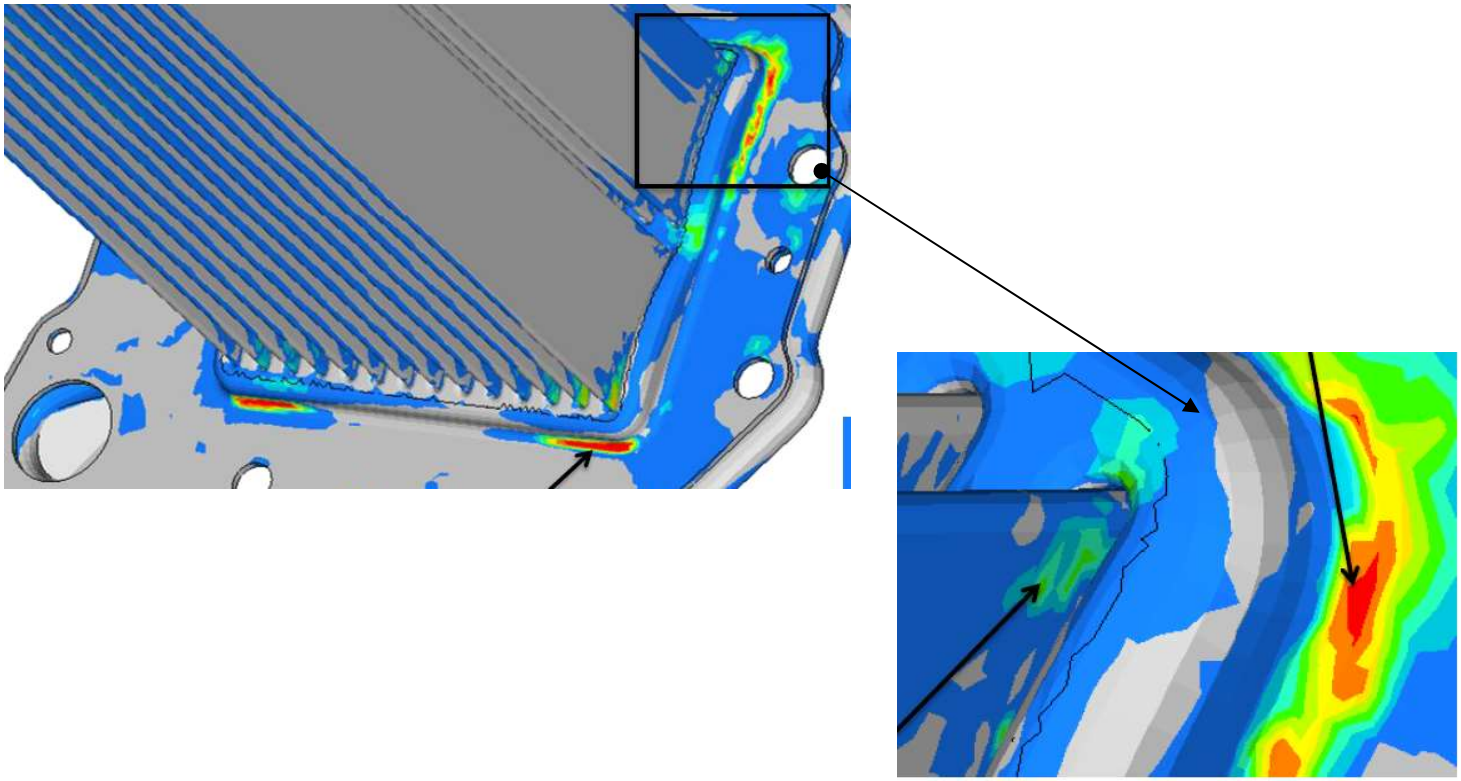


温度场映射到歧管上和中冷器表面

Runner	Average temperature （°c）
Runner-1	55.40
Runner-2	55.14
Runner-3	55.31
Runner-4	55.76
Temperature distribution	1.1%

歧管各个出口温度分布

数值映射与耦合计算



FEA 结果

实验结果验证

Runner	Average temperature (°c)
Runner-1	55.40
Runner-2	55.14
Runner-3	55.31
Runner-4	55.76
Temperature distribution	1.1%

仿真结果

VS

Runner	Average temperature (°c)
Runner-1	58.13
Runner-2	57.54
Runner-3	58.42
Runner-4	58.12
Temperature distribution	1.5%

实验结果

实验对比结果

Thank You!

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