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基于正交设计房间甲醛排放通风最优方案分析

200000

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摘　要：在化工和木材工业中，广泛会运用甲醛这一材料，甲醛在我们的日常生活中起到了必不可少的一个部分，然而甲醛自身对我们人体是有很大危害的，如没有处理得当，甲醛会对我们的身体造成不可逆的伤害，长时间接触甲醛的也会增加我们患上癌症的风险，本课题研究主要房间内窗户数量和安装位置对于甲醛排放量产生的影响，选用 ANSYS FLUENT15.0 软件求解，在自然通风状况下，经过对于房间内部以及窗户进出口雷诺数的计算，房间内的气流流动应为湍流，因此采用 k-ε 湍流模型进行计算，而后采用正交设计分析窗户数量，安装位置，入口风速这三个因素对甲醛的排放量产生的影响，从而对房间内的自然通风进行优化。

关键词：正交设计；甲醛；排放通风；残留浓度
中图分类号：X327　**文献标识码：**A

Analysis of the Optimal Solution for Formaldehyde Emission Ventilation in a Room based on Orthogonal Design

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Abstract: Formaldehyde is widely used in the chemical and wood industries and plays an essential part in our daily lives. However, formaldehyde itself is very harmful to our bodies and can cause irreversible damage to our bodies if not treated properly. Prolonged exposure to formaldehyde can also increase our risk of developing cancer. This paper examines the effect of the number and location of windows in the main rooms on formaldehyde emissions. ANSYS FLUENT15.0 was used to calculate the Reynolds number for the interior of the room and for the inlet and outlet of the window under natural ventilation conditions. The airflow in the room is turbulent, so a k-ε turbulence model is used to calculate and then an orthogonal design is used to optimize the natural ventilation in the room by analyzing the effect of three factors - number of windows, installation location and inlet air velocity - on formaldehyde emissions.

Keywords: Orthogonal design; Formaldehyde; Emission ventilation; Residual concentration

前言

CH_2O

1 数值模拟方法

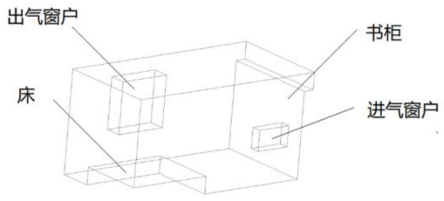
1.1

1

2

3

1.2



1

ANSYS FLUENT15.0

k- ε

1.3

$$\frac{\partial(\rho u_i)}{\partial x_i}=0$$

1

$$\frac{\partial(\rho u_i u_j)}{\partial x_j}=\frac{\partial}{\partial x_j}\left[\mu_{eff}\left(\frac{\partial u_i}{\partial x_j}+\frac{\partial u_j}{\partial x_i}\right)\right]_i-\frac{\partial p}{\partial x_j}$$

2

$k-\varepsilon$

k $$\frac{\partial}{\partial x_j}(\rho u_j k)=\frac{\partial}{\partial x_j}(\frac{\mu_{eff}}{\sigma_k}\frac{\partial k}{\partial x_j})+G-\rho\varepsilon$$

3

ε

$$\frac{\partial}{\partial x_j}(\rho u_j\varepsilon)=\frac{\partial}{\partial x_j}\left(\frac{\mu_{eff}}{\sigma_\varepsilon}\frac{\partial\varepsilon}{\partial x_j}\right)+\left[\frac{C_{\varepsilon1}G\varepsilon}{k}-\frac{C_{\varepsilon2}\rho\varepsilon^2}{k}\right]$$

4

$$G=\mu_t\frac{\partial u_i}{\partial x_j}\left(\frac{\partial u_j}{\partial x_i}+\frac{\partial u_i}{\partial x_j}\right)$$

$$\mu_{eff}=\mu_l+\mu_t=\mu_l+\rho C_\mu k^2/\varepsilon \quad 5$$

Spalding

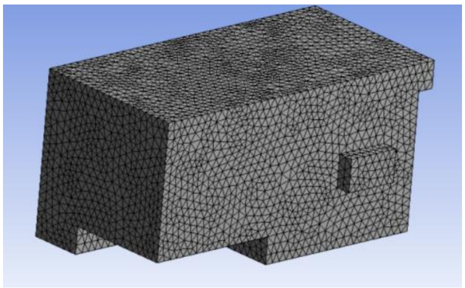
$C_{\varepsilon1}=1.43$ $C_{\varepsilon2}=1.92$ $C_\mu=0.09$ $\sigma_K=1.0$ $\sigma_\varepsilon=1.3$

1.4

447 000

“ ”

1 3 0.5m/s 1.5m/s



2

2 实验方案与结果分析

2.1

3

1 2 3

0.5m/s 1.0m/s 1.5m/s

9 1

1

			m/s
1	1		0.5
2	1		1.0
3	1		1.5
4	2		1.0
5	2		1.5
6	2		0.5
7	3		1.5
8	3		0.5
9	3		1.0

2.2

3

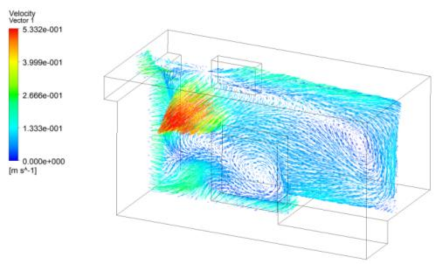
3

A-C

3 D-F

3 G-I

1.5m/s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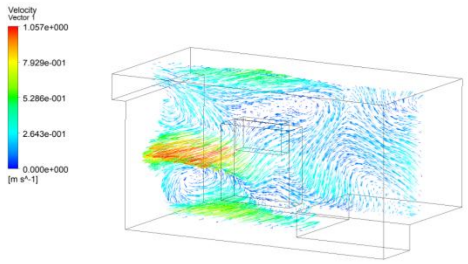
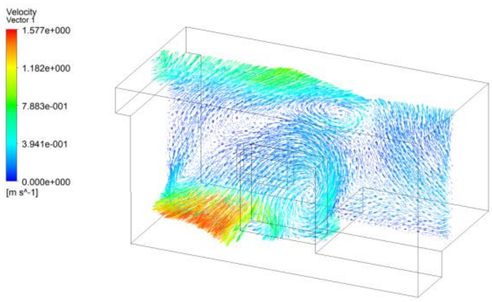
Vector 1
5.332e-001
3.999e-001
2.666e-001
1.333e-001
0.000e+000
[m s^-1]

A


Velocity
Vector 1
1.057e+000
7.929e-001
5.286e-001
2.643e-001
0.000e+000
[m s^-1]

B


Velocity
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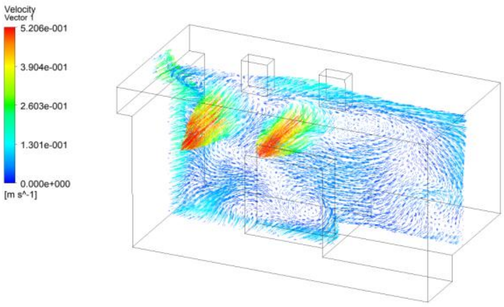
1.182e+000
7.883e-001
3.941e-001
0.000e+000
[m s^-1]

C


Velocity
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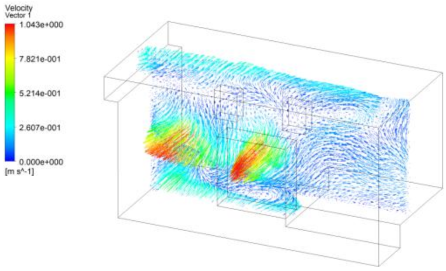
5.206e-001
3.904e-001
2.603e-001
1.301e-001
0.000e+000
[m s^-1]

D


Velocity
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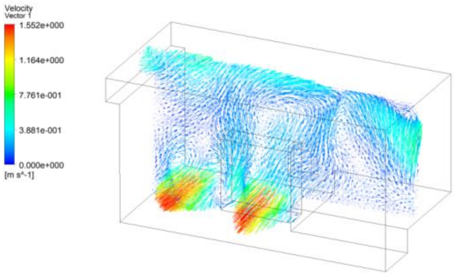
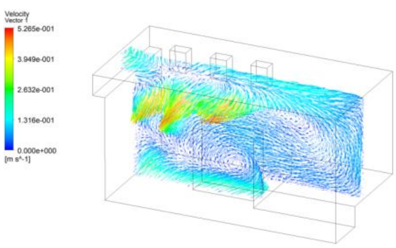
1.043e+000
7.821e-001
5.214e-001
2.607e-001
0.000e+000
[m s^-1]

E


Velocity
Vector 1
1.552e+000
1.164e+000
7.761e-001
3.881e-001
0.000e+000
[m s^-1]

F


Velocity
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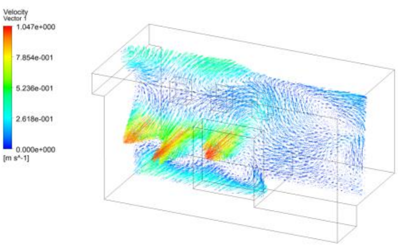
5.265e-001
3.949e-001
2.632e-001
1.316e-001
0.000e+000
[m s^-1]

G


Velocity
Vector 1
1.047e+000
7.854e-001
5.236e-001
2.618e-001
0.000e+000
[m s^-1]

H

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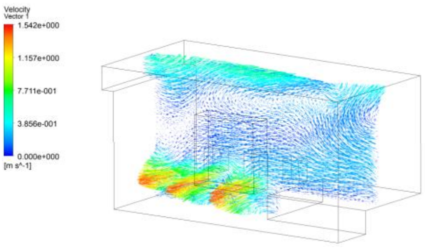
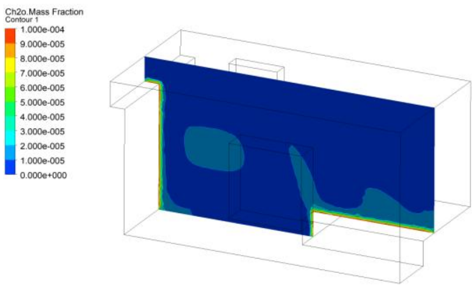


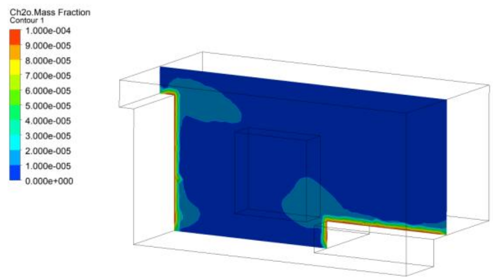
I

3 A 1 B 2 C 3 D 4 E 1 F 2 G 3 H 4 I 9

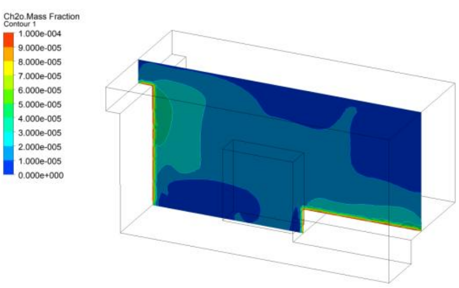
3 A 1 B 2
C 3 D 4 E 1 F 2 G 3 H 4 G-I
4 I 9
4
4 A-C



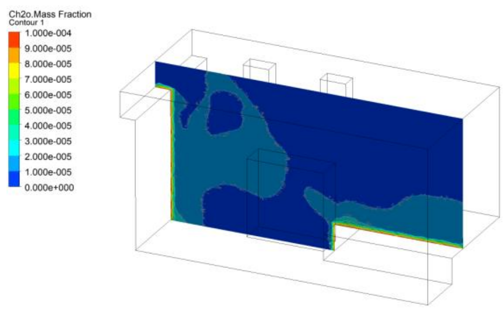
A



B



C



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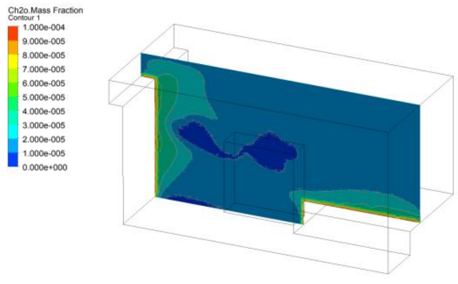

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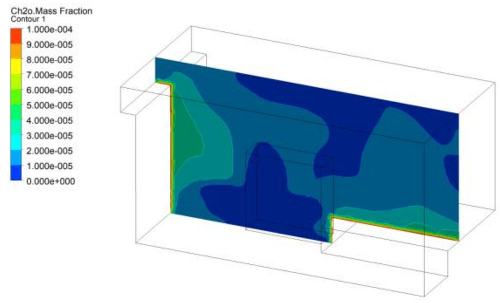

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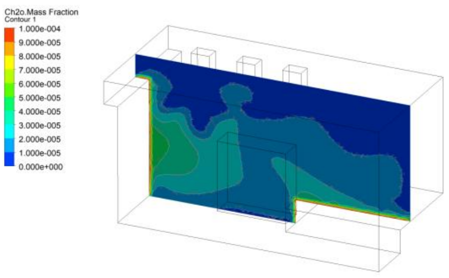
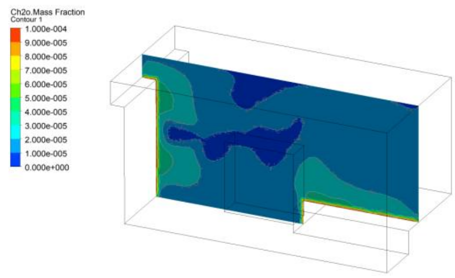
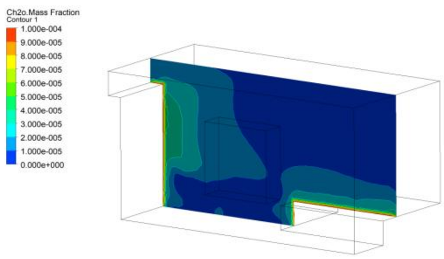


G



H



I

4 A 1 B 2 C 3 D 4 E 1 F 2 G 3 H 4 I 9

2.3

Fluent

10min

2

2 10min

			m/s	
1	1		0.5	8.21E-06
2	1		1.0	7.16E-06
3	1		1.5	1.17E-05
4	2		1.0	9.29E-06
5	2		1.5	1.63E-05
6	2		0.5	1.20E-05
7	3		1.5	1.43E-05
8	3		0.5	1.43E-05
9	3		1.0	1.15E-05

10-6

4 7

6
9
1
C R
4.77E-06 R 4.37E-06
1.9E-06
2
1m/s
1.5m/s
3
A1B1C2

3 总结

1
2 L9 33 9
3
1m/s
1.5m/s
A1B1C2

参考文献：

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[2] . [D]. ,2009.