Sorrento SAPEM'23 常熟

Symposium on the Acoustics of Poro-Elastic Materials

Design and sound performance analysis of porous materials with gradient airflow resistivity

Shanghai University Of Engineering Science

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1. Research background

1、Research background

Development Path of Gradient Structured Porous Materials

Multi-layer material

Structure design

Gradient perforation

Gradient parameter

Compression ratio

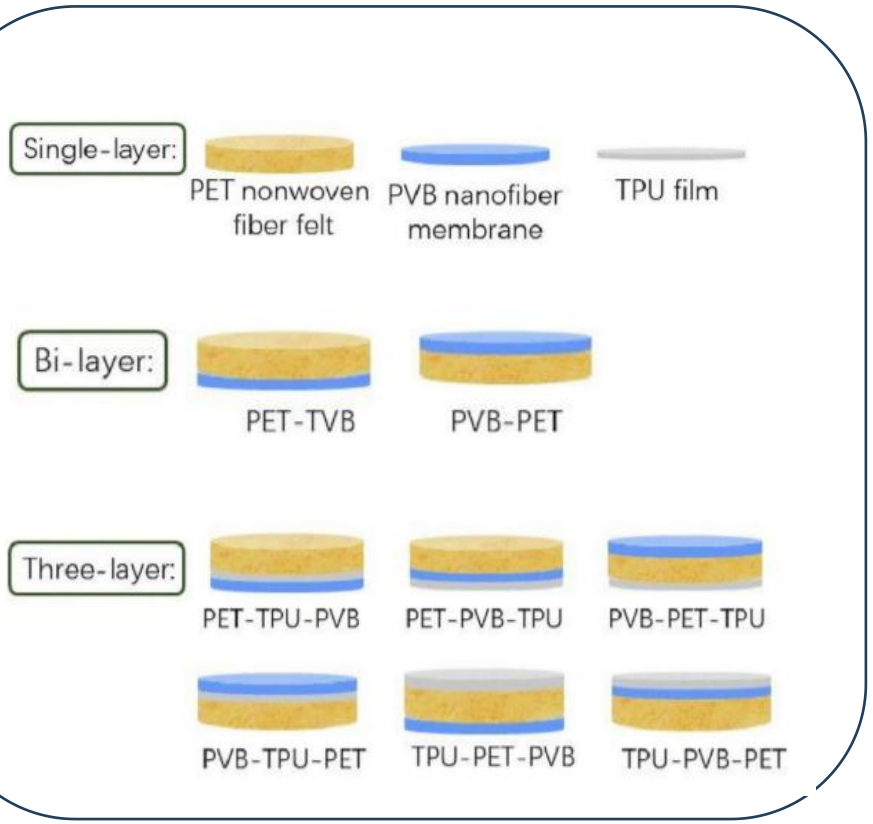
Porosity

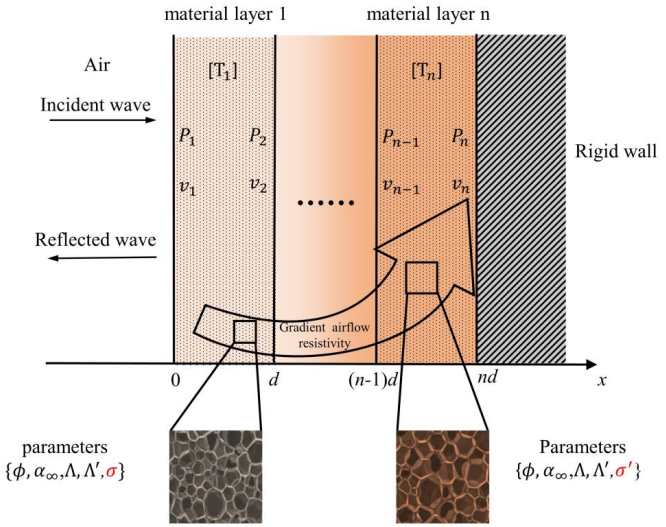
Impedance

Airflow resistivity

Structure: layered changes, nonlinear changes

Physical→Biot parameters

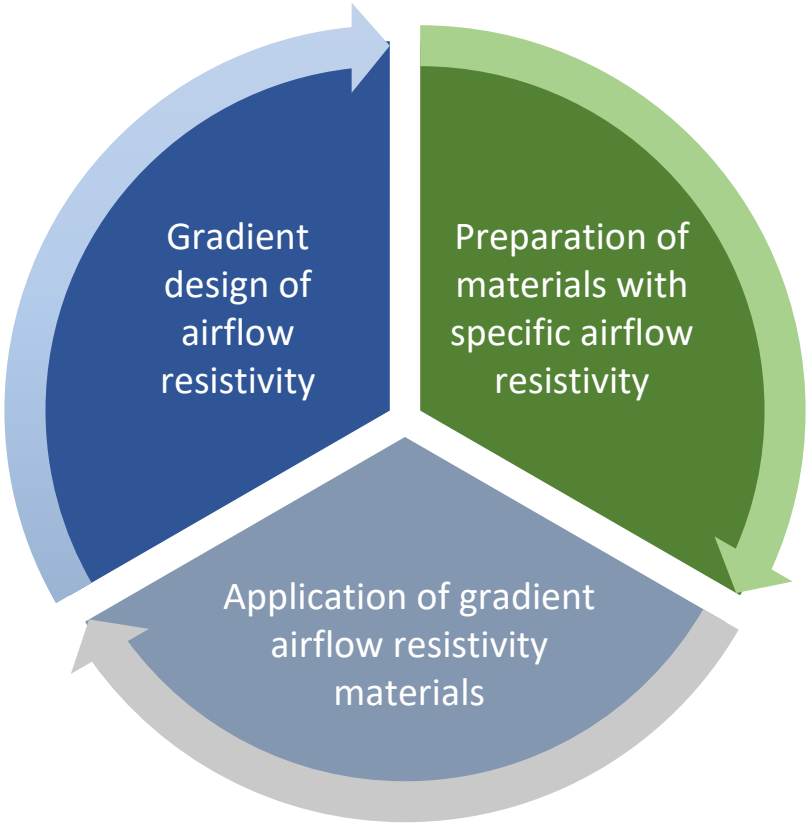




Problems and challenges faced

How to design?

gradient structure + gradient form



How to prepare?

Material density + Fiber Diameter

Design + Preparation determines Application! ! !

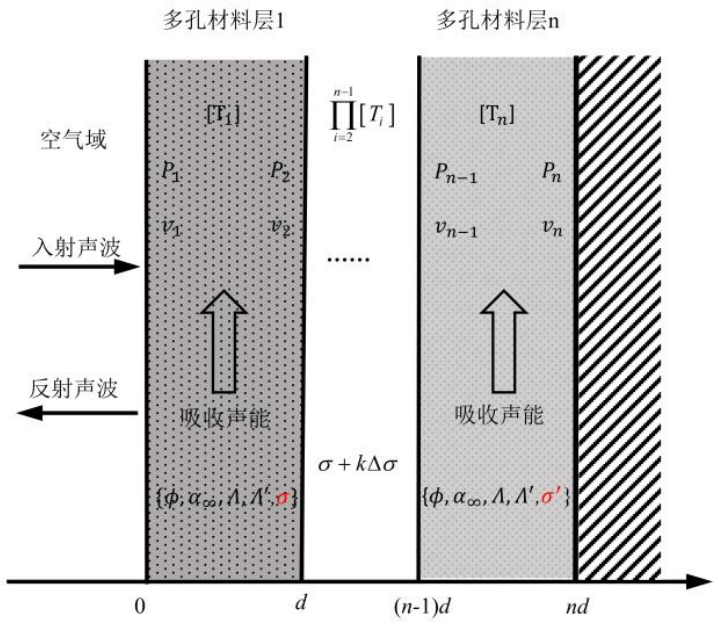
2. Research

2、 Research

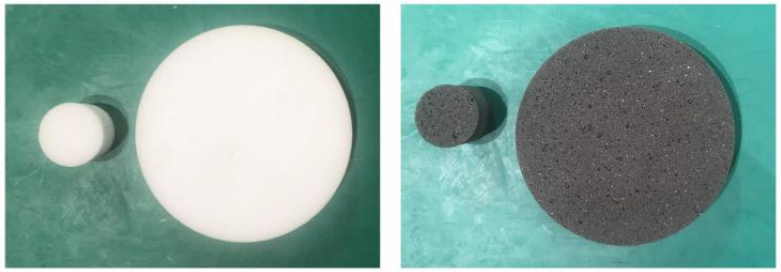
1	JCA model + TMM for modeling sound absorption of gradient materials	Experimental validation model for impedance tubes
2	Determine the design range of airflow resistivity rates	Discrete material layering program
3	Gradient structure study	Gradient difference study
4	Gradient distribution form study	Gradient distribution functions study

2、 Research

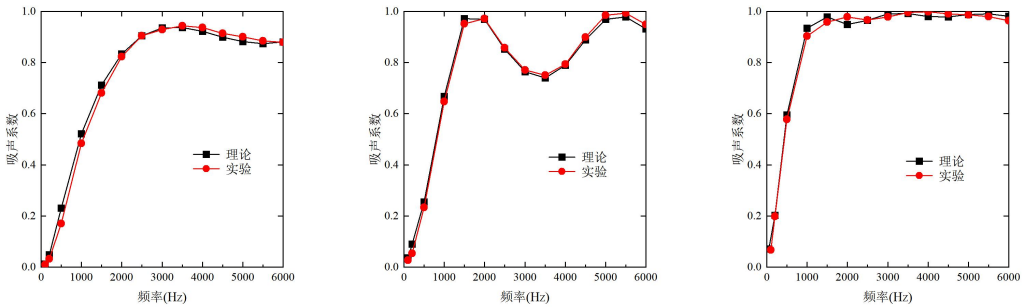
2.1 Gradient material sound absorption modeling and validation



TMM method in gradient airflow resistivity materials



(a) 三聚氰胺泡沫样件 (b) 聚氨酯泡沫样件

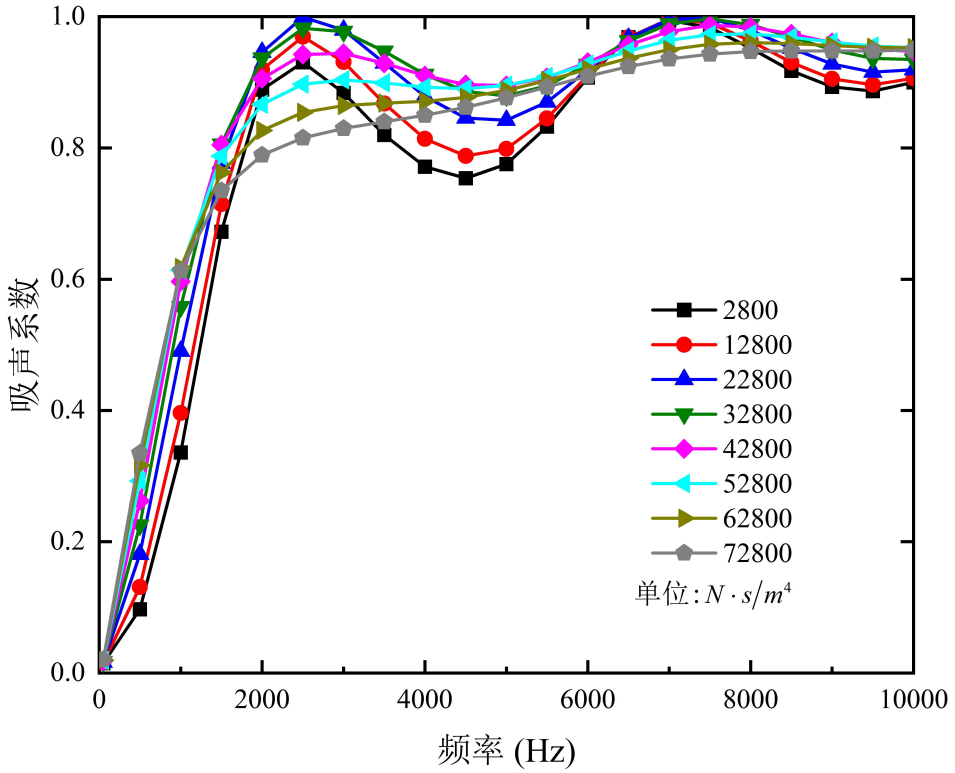


(a) 三聚氰胺泡沫 (b) 聚氨酯泡沫 (c) 三聚氰胺-聚氨酯泡沫

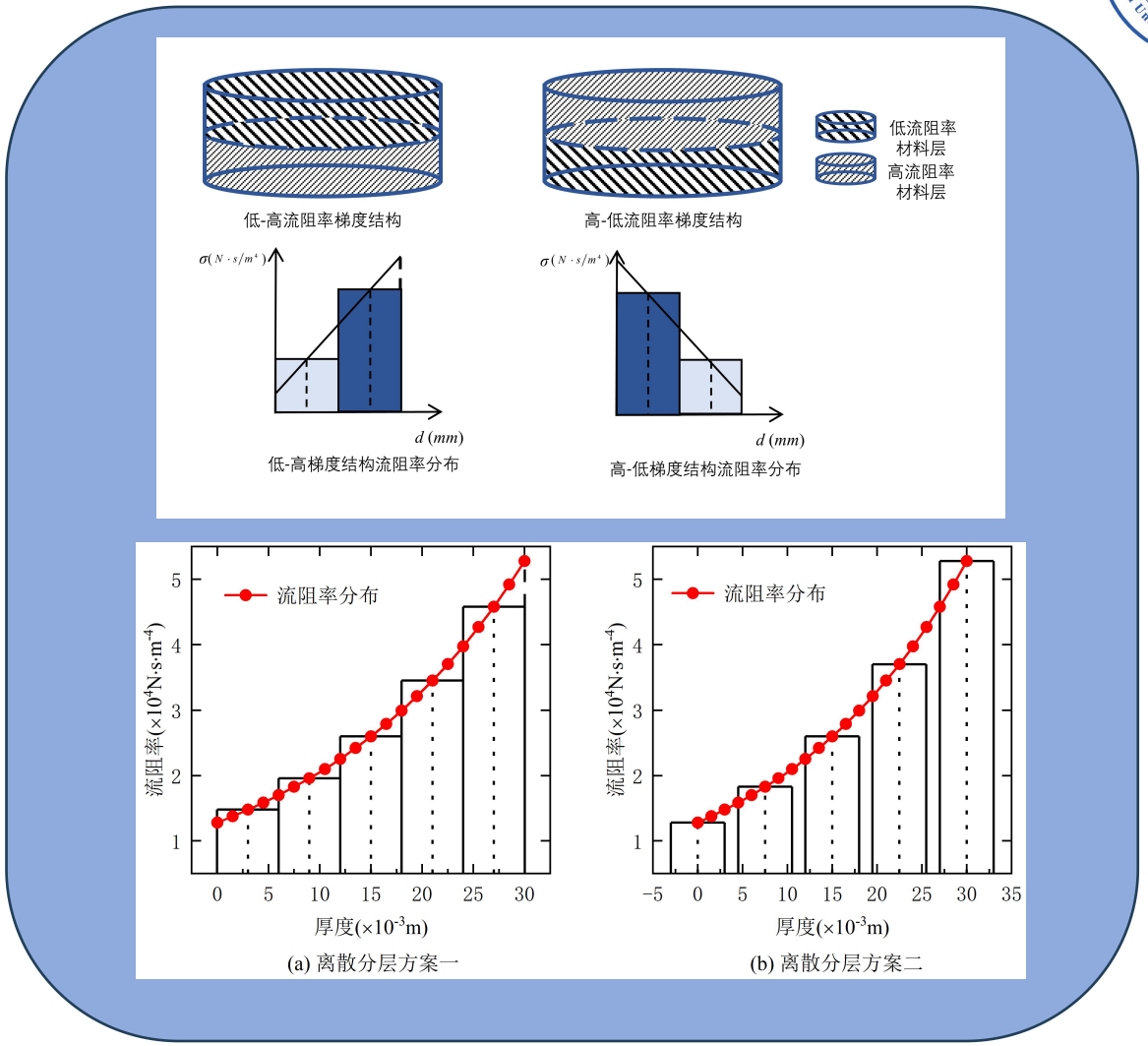
Experimental validation of sound absorption models for impedance tube

2、 Research

2.2 Gradient design program analysis



Effect of airflow resistivity on SAC of polyurethane foam

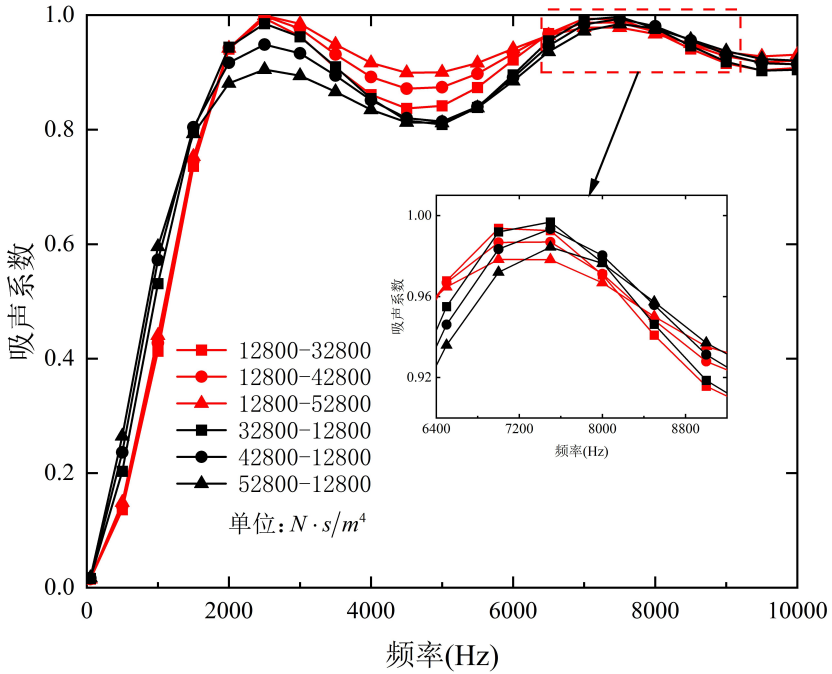


Gradient airflow resistivity discrete layering scheme

2.3 Gradient structure study

	第一层流阻率 （$N \cdot s/m^4$）	第二层流阻率 （$N \cdot s/m^4$）
低-高梯度变化	12800	32800
	12800	42800
	12800	52800
高-低梯度变化	32800	12800
	42800	12800
	52800	12800

Different gradient structures and gradient difference schemes



SAC for different gradient schemes

Airflow resistivity gradient structure: Low to High

Range of variation:12800-52800

2、 Research

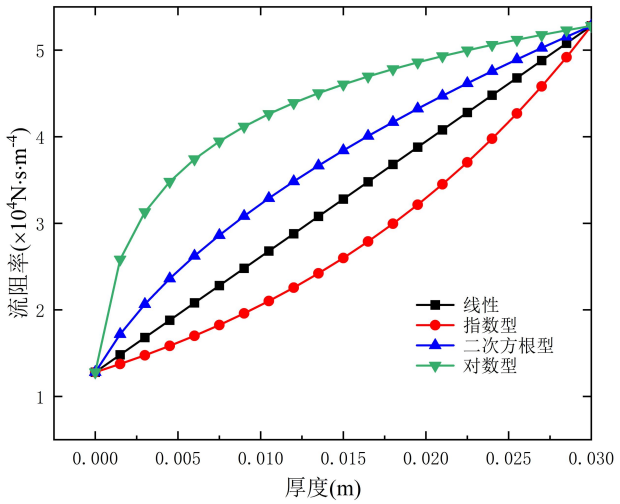
2.4 Gradient form study

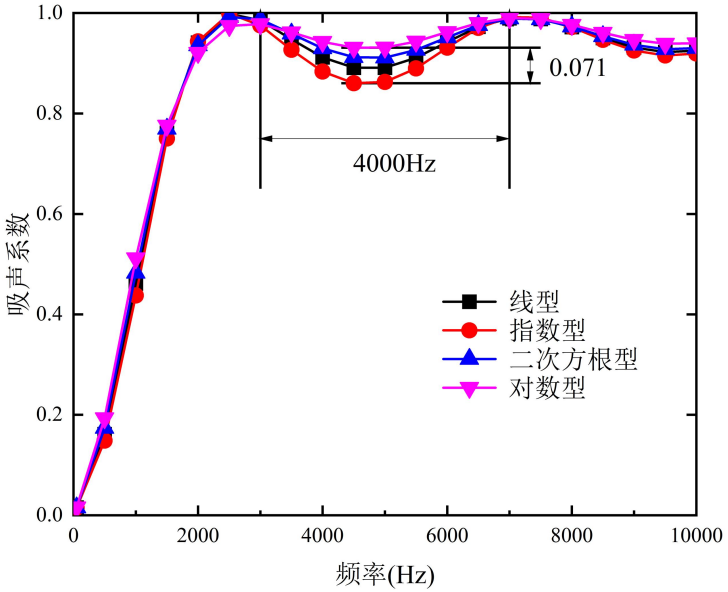
线型： $\sigma(x)=\frac{\sigma_h-\sigma_l}{D}x+\sigma_l$

指数型： $\sigma(x)=\sigma_l e^{\frac{1}{D}\ln\frac{\sigma_h}{\sigma_l}x}$

平方根型： $\sigma(x)=\sqrt{\frac{\sigma_h^2-\sigma_l^2}{D}x+\sigma_l^2}$

对数型： $\sigma(x)=\ln(\frac{e^{\sigma_h}-e^{\sigma_l}}{D}x+e^{\sigma_l})$





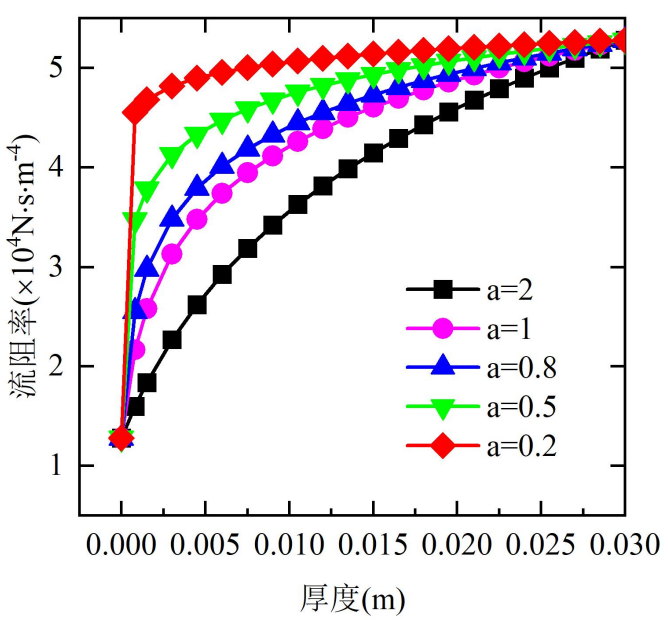
The gradient difference between the first and second layer

Airflow resistivity designed as a logarithmic gradient

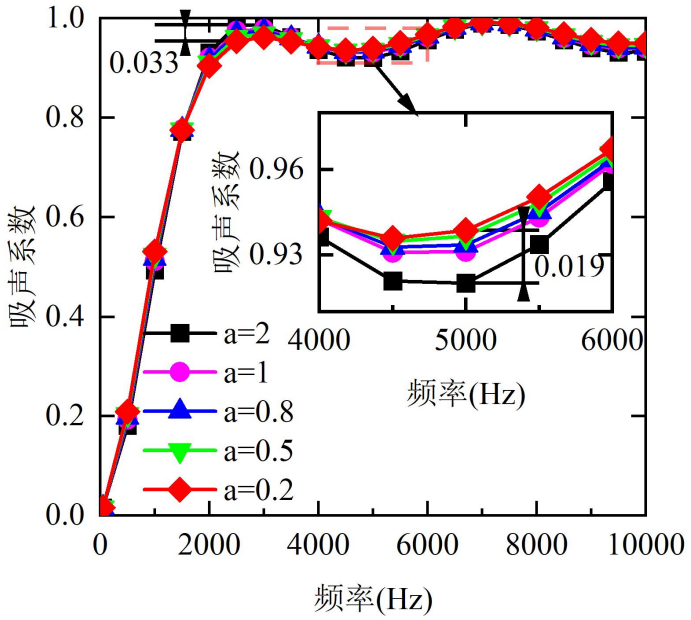
2.4 Gradient form study

$$\sigma(x) = a\ln(bx + c)$$

a= 0.2 ,0.5 ,0.8 ,1 ,2



(a) 不同曲率对数型流阻率分布形式



(b) 不同曲率对数型梯度材料吸声系数

Logarithmic gradient form factor *a* of 0.8

3. Conclusions

3、 Conclusions

(1) Gradient structure: from low to high.

(2) Gradient form: logarithmic.

(3) Airflow resistivity to logarithmic gradient distribution, the logarithmic coefficient a optimal value of about 0.8

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Thanks for your attention!

Yuxiang Cheng