Numerical investigation of the internal walkway in the air-cooled steam condenser

空冷凝汽器挡风墙内步道的数值研究

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Outline

1. Background and Introduction
2. Physical model and numerical method
3. Results and Discussion
4. Conclusions

1. 背景介绍
2. 物理模型与数值方法
3. 结果与讨论
4. 结论

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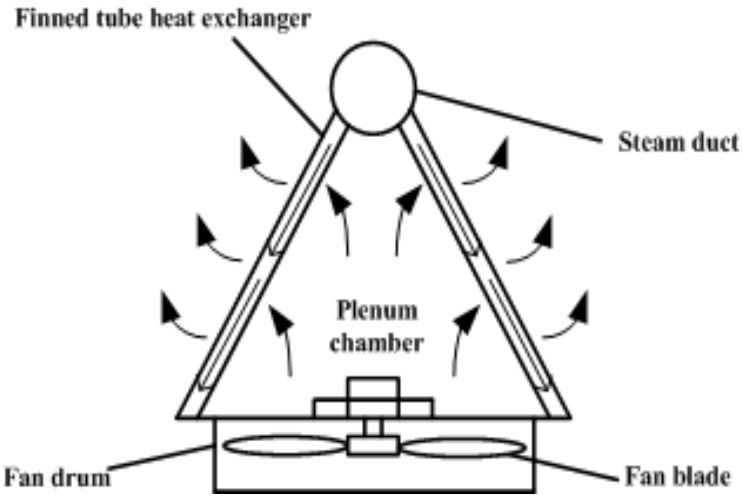


In air cooled steam condensers, turbine exhaust condensates in the finned tube exchangers, while the ambient air generated by forced draft axial fans flows outside.

Wind conditions:

wind speed
wind direction
ambient temperature

→ **Hot air recirculation**

- **Xiufeng Gao (2009)**
  - Ambient wind speed and direction, air-cooled platform height, location, terrain condition;
  - Turbine back pressure increases with the increase of wind speed and the decrease of platform height;
  - Dominant factor: hot air recirculation.

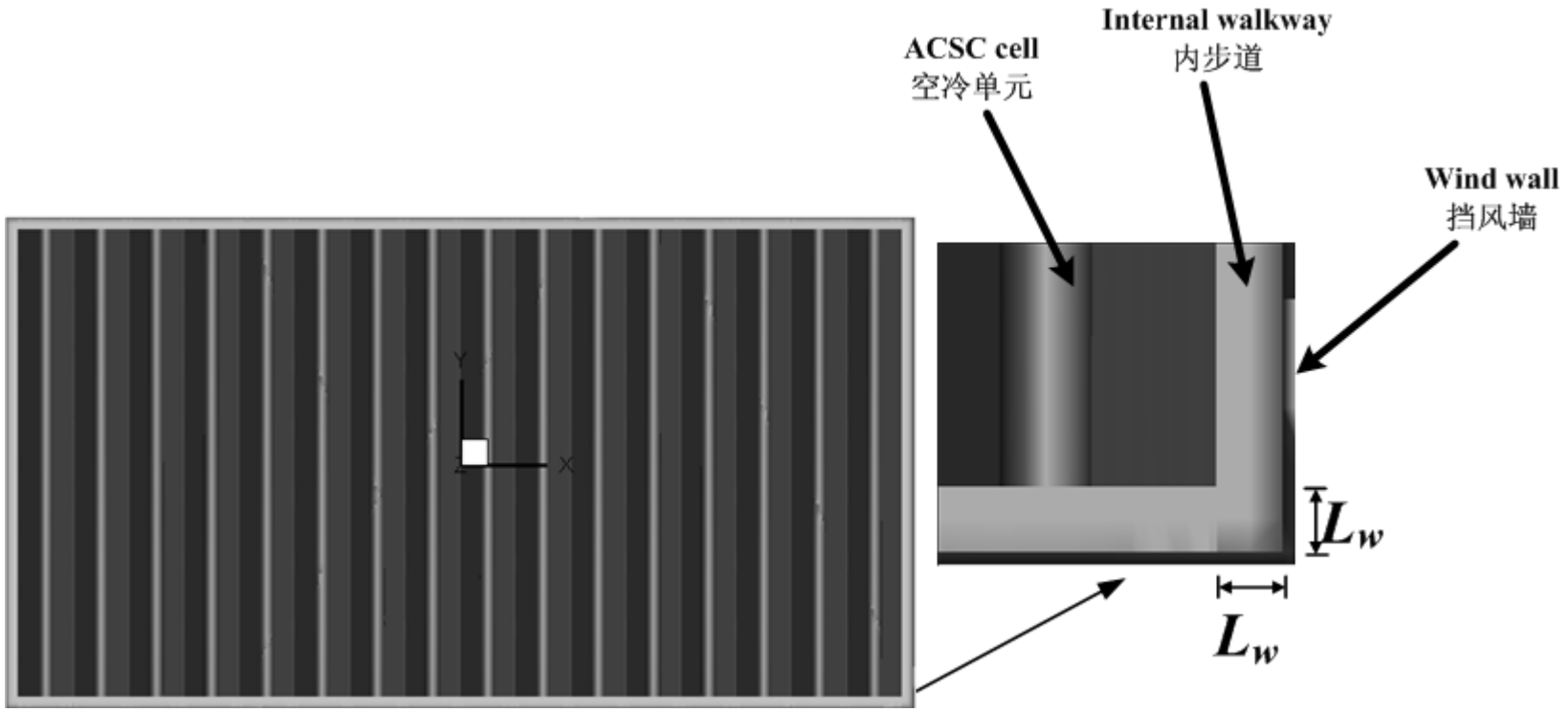
- **Weifeng He (2011)**
  - Two kinds of hot air recirculation are simulated;
  - Hot air recirculation increases the temperature of the fan inlet
  - Deteriorates the heat transfer environment.

Wind walls

- **J. A. van Rooyen1 (2008)**
  - The flow distortions and corresponding low-pressure region at the upstream edge fans;
  - Wind wall reduces the effect of hot air recirculation;

- **Peiqing Liu (2011)**
  - Hot air recirculation is more sensitive to wind direction and wind speed;
  - Increasing the wind-wall height and accelerating the rotational speed of the fans near the edge of the ACC platform.

- **Weifeng He (2011)**
  - Wind walls can prevent the hot air from being drawn back into the fan and suppressed the hot air recirculation;
  - Wind walls result in a **decrease** of the volumetric effectiveness.



- **The present study**

  - Internal walkway: the interval between the wind wall and edge heat exchangers;
  - A numerical model of a 2×600 MW power plant;
  - Purpose: the influence of internal walkway width on the ACSC performance.

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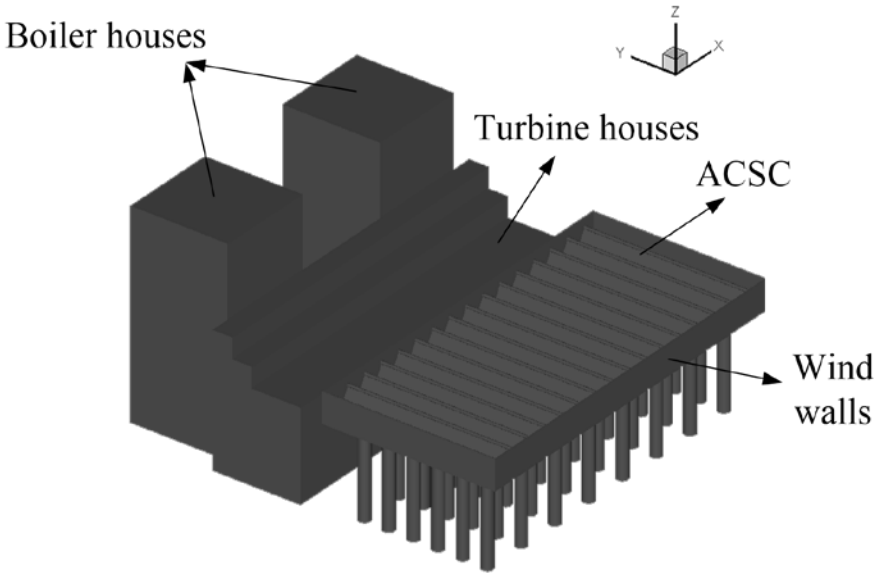


ACSC platform

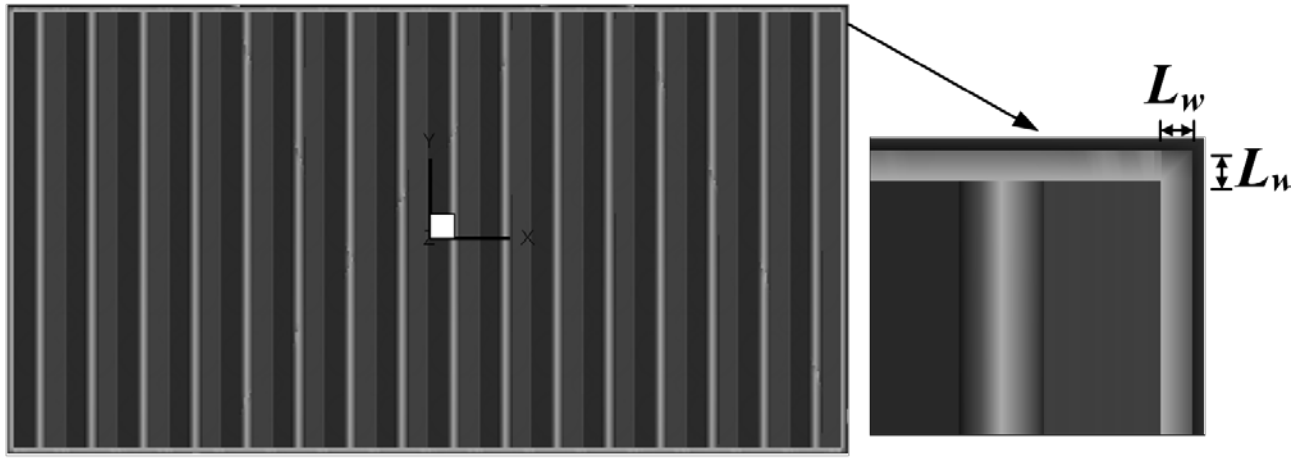
112 ACSC cells, 7 rows×16 columns

45 m in height

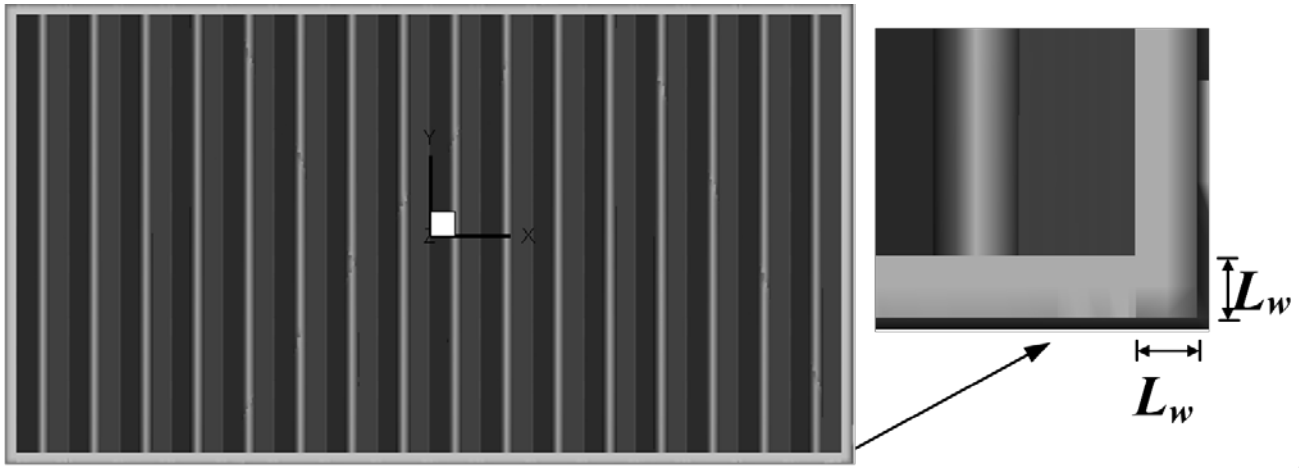
180.8 m×88.2 m

Wind walls, 15 m in height

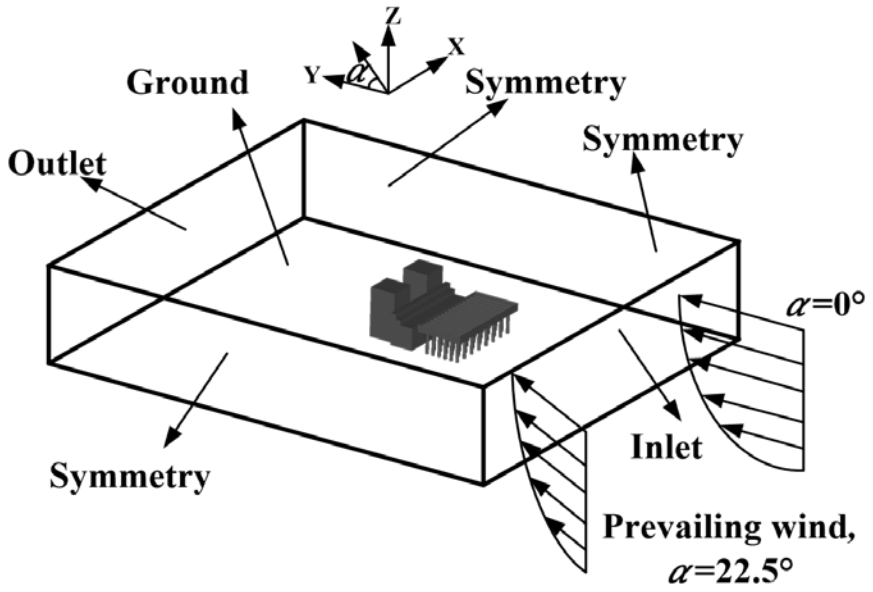
32 heat exchangers



L_w=1 m



L_w=2 m



Domain inlet	Velocity inlet
Domain outlet	Pressure outlet
Ground	Wall with ambient temperature
Side surfaces	Symmetry
Top surfaces	Symmetry

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Ambient conditions：

p_a=101,325 Pa; T_w=306 K.

Steam parameters of the ACSC under TRL mode:

Item	m_s (kg/s)	p_s (kPa)	a (%)	Δp_s (Pa)
Value	738.5	29	96.4	820

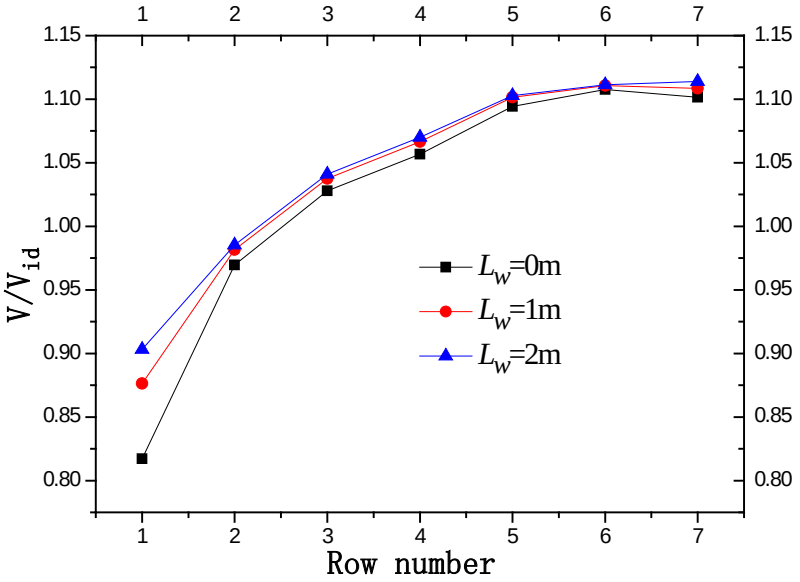
Wind conditions：

v_m = 2, 4, 6, 8, 10 m/s; α= 22.5°

Purpose:

Influences of the L_w (L_w=0,1,2 m) on the **volumetric effectiveness** (V/V_{id}), **heat transfer rate** (Q) and **back pressure** (p_b)

Fan volumetric effectiveness in row direction



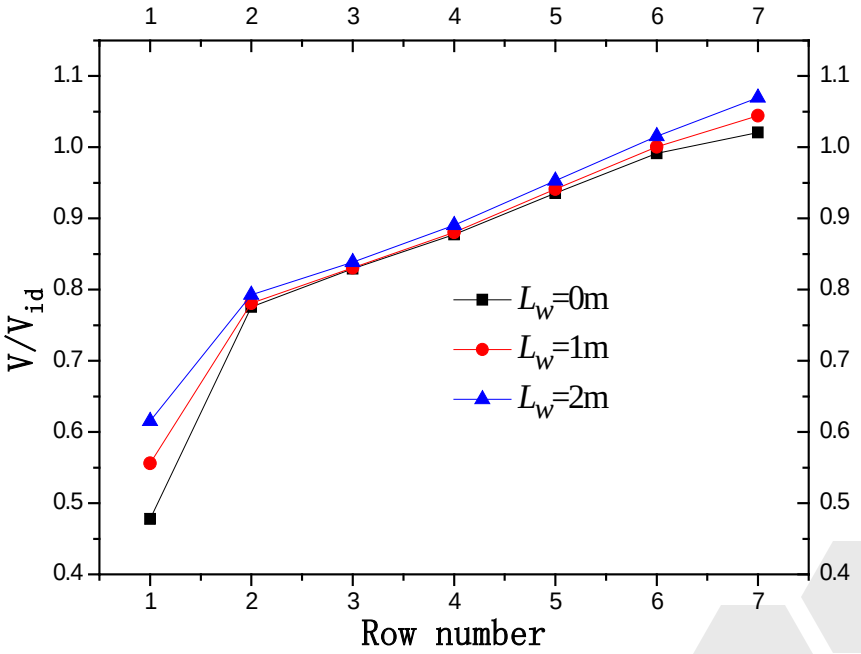
v_m= 2 m/s

a) the 1st row is the lowest;

b) increases with L_w;

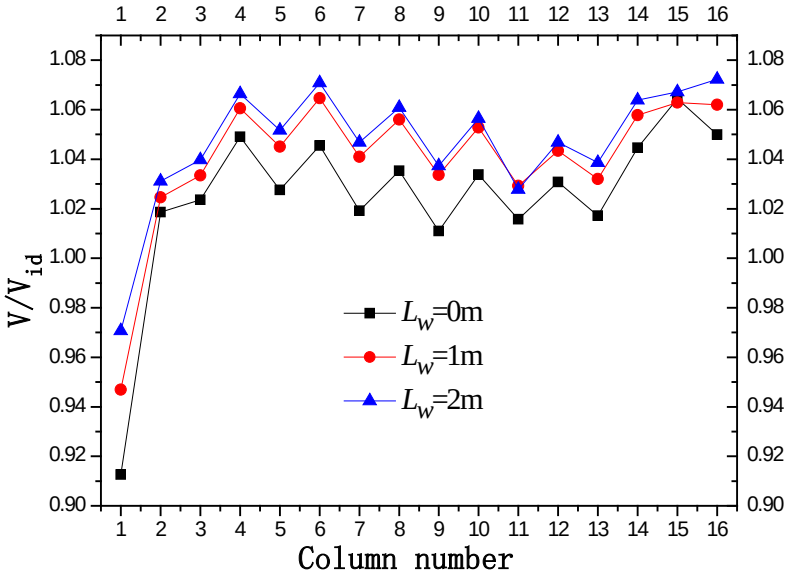
c) the 1st row volumetric effectiveness enhances more observably than other rows.

The increasing amplitude of the average row volumetric effectiveness at v_m= 10 m/s, is larger than that at v_m= 2 m/s



v_m= 10 m/s

Fan volumetric effectiveness in column direction



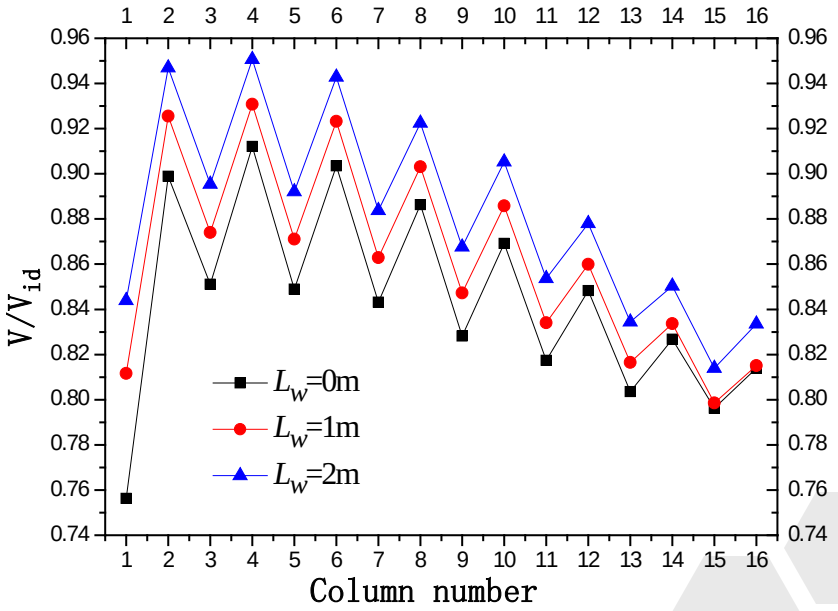
v_m= 2 m/s

a) the 1st column is the lowest;

b) increases with L_w;

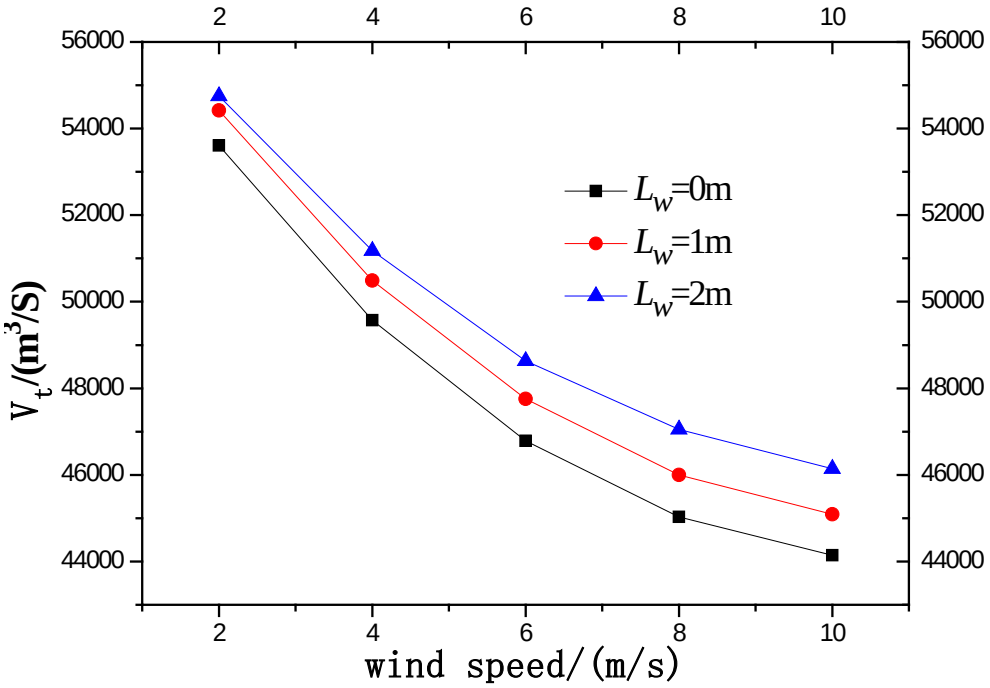
c) the 1st column volumetric effectiveness enhances more observably than other columns.

The increasing amplitude of the average column volumetric effectiveness at v_m= 10 m/s, is larger than that at v_m= 2 m/s

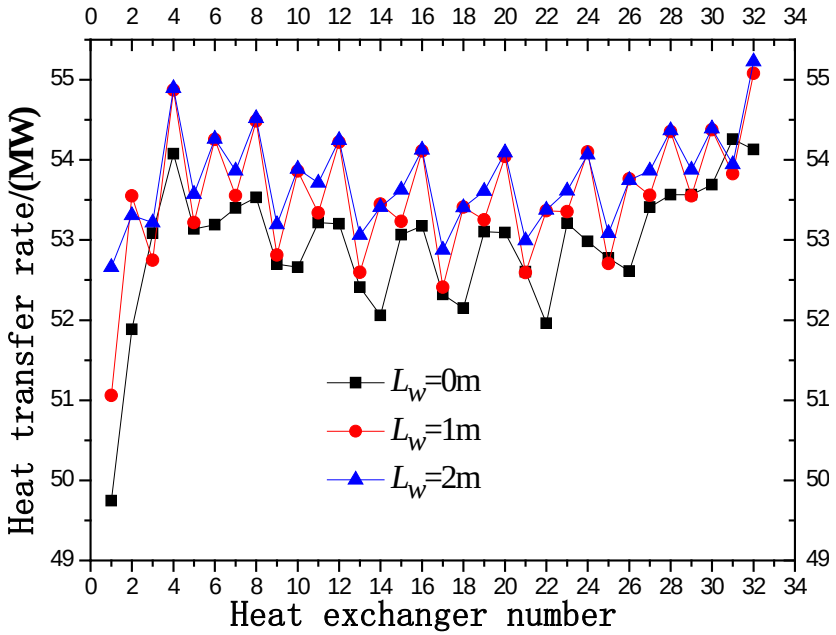


v_m= 10 m/s

Total air volume of 112 fans



Heat transfer rate



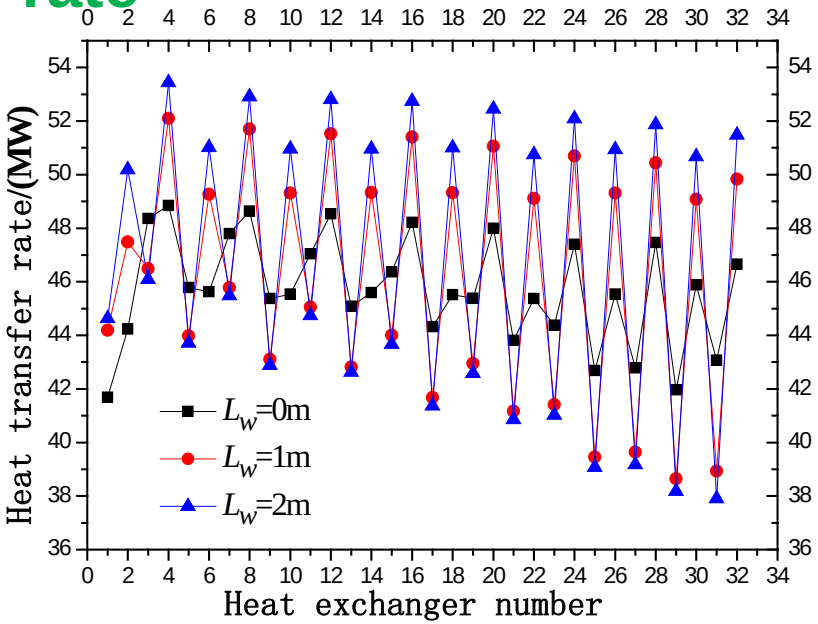
v_m= 2 m/s

a) The 1st heat exchanger' heat transfer rate **increases** with L_w;

b) Almost all heat exchangers' heat transfer rates **rises** due to the **increasing** L_w at v_m= 2 m/s;

c) A large internal walkway width could enhance the heat transfer rate of each heat exchanger at **low** wind speeds.

Heat transfer rate



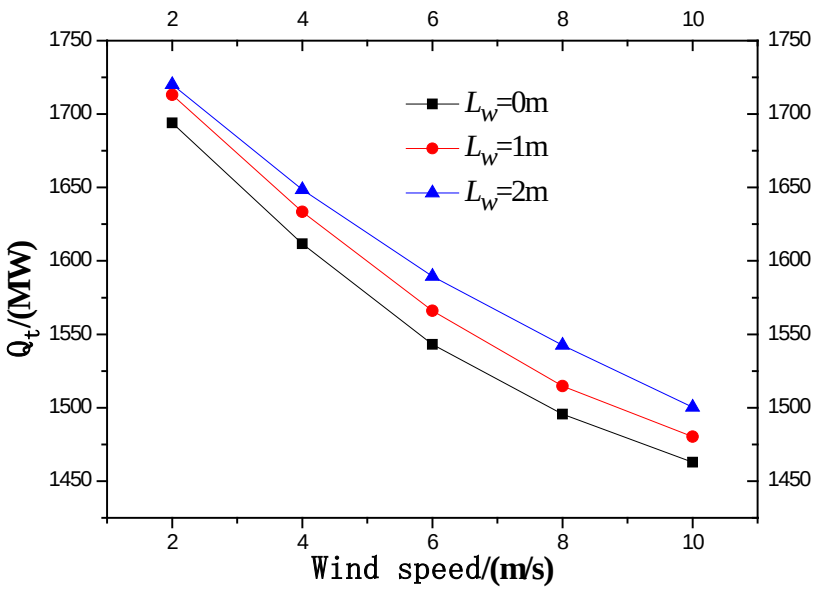
v_m= 10 m/s

a) All heat transfer rate of windward(odd number) heat exchangers except the 1st one **decreases** as L_w rises;

b) All heat transfer rate of leeward(even number) heat exchangers **increases** as L_w rises;

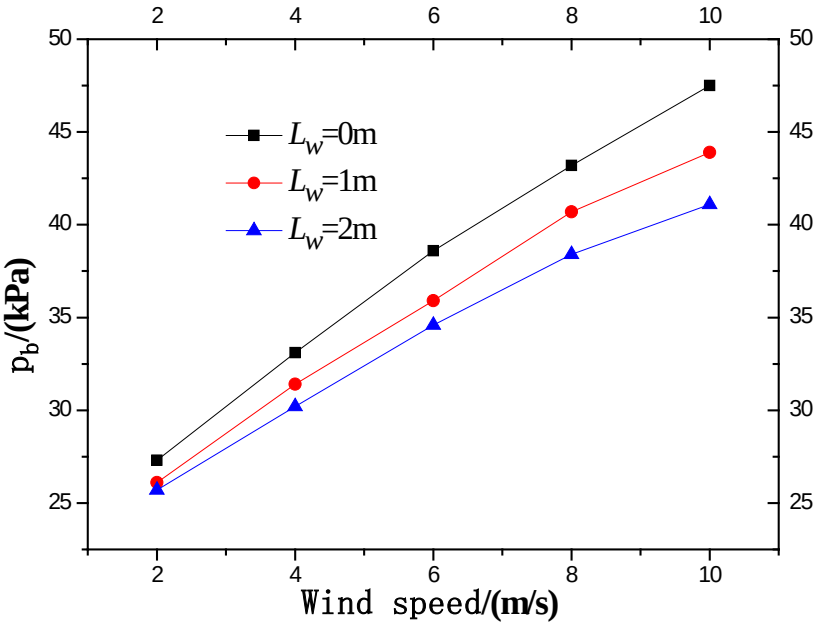
c) A large internal walkway width could enhance the heat transfer rate of whole air cooled condenser at **high** wind speeds, but not each heat exchanger's heat transfer rate.

Total heat transfer rate



Within reasonable limits, a large internal walkway width could improve the heat transfer rate of the whole air cooled condenser at both low wind speeds and high wind speeds.

Back pressure



a) p_b is achieved by iterating many times until the computational heat transfer rate is equal to the ideal heat rejection at the TRL case.

b) The back pressure will decrease with a increasing internal walkway width in a reasonable range.

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- The effect of the internal walkway width is remarkable to the volumetric effectiveness of fans, especially edge fans near wind walls.
- In a certain cope, an increase in the internal walkway width could weaken the hot air gathering effect between wind walls and edge fans, and increase the volumetric flow rate of the whole air cooled condenser.
- The volumetric effectiveness is more sensitive to the internal walkway width at high wind speeds.

- The changing law of the heat transfer rate is more complicated.
- All heat exchangers' heat transfer rates could rise at **low** wind speeds with the increasing internal walkway width.
- Only leeward heat exchangers could rise at **high** wind speeds with the increasing internal walkway width.
- In general, an increasing internal walkway width could enhance the heat transfer rate of the whole air cooled condenser at both low wind speeds and high wind speeds.
- The back pressure also could drop as the internal width rises, especially at high wind speeds.

Thank You!