General Idea of the New Annex Project: Indirect Evaporative Cooling

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Outline

- Background
- Indirect evaporative cooling(IEC) technology
- Key problems needed to be studied for IEC technology
- Objectives of the new Annex
- Intended target audience
- Sub-tasks discussion

Background

- Buildings account for nearly 1/3 of the total energy consumption, **20-30% of building energy is used for air conditioning and maintaining indoor thermal comfort in hot seasons.**
- As predicted, **many regions are going to change from non-air conditioning temperate zones to air conditioning zones, when there is a 2 °C lift** of the average global temperature due to climate change. Especially **for Europe, Southeast Asia, the Middle East, and South America**, as UNEP predicted.
- **Changing the mode of air conditioning is one of the important solutions** to meet the cooling demand without increasing electricity consumption and carbon emission.

Figure 15 • World CO_2 emissions associated with energy use for air conditioning in buildings by source

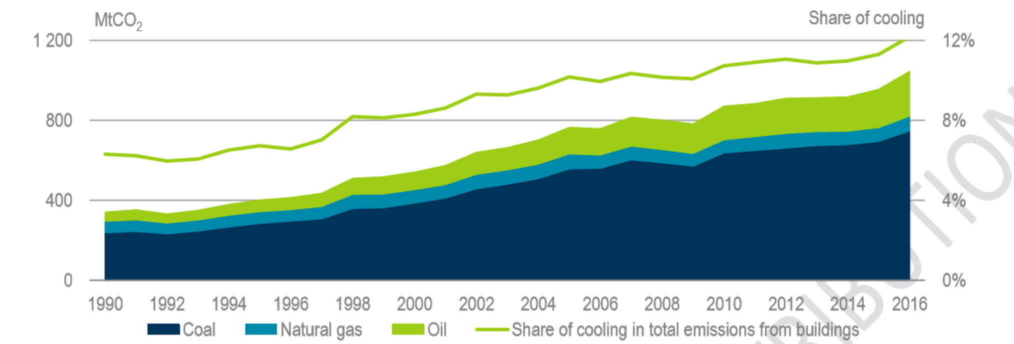


Figure 8 • World energy consumption for air conditioning in buildings by fuel type

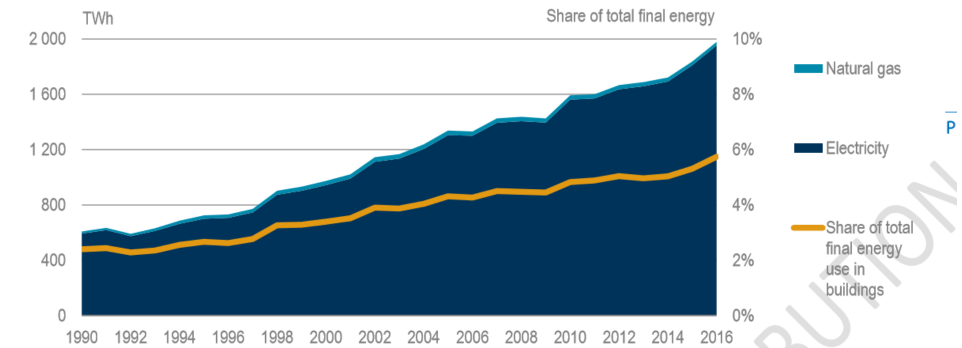


Figure 32 • Cooling capacity of air conditioning equipment in the commercial sector in the Reference Scenario by region

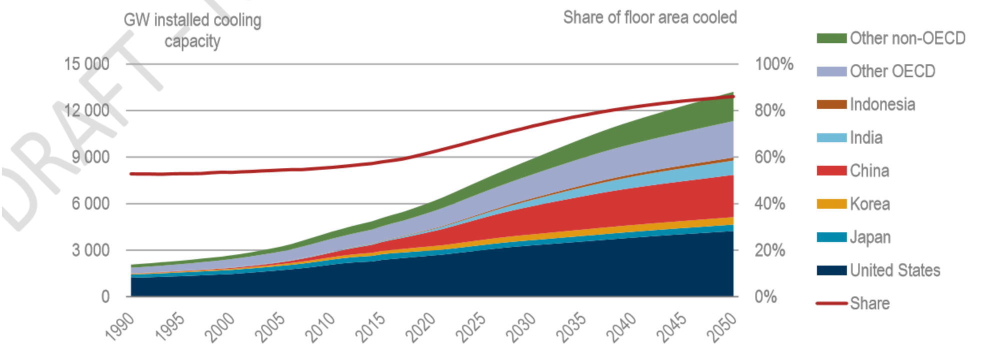
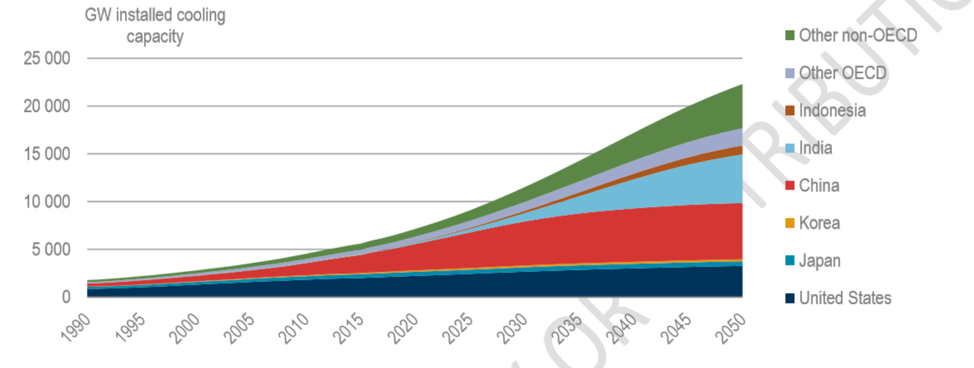


Figure 31 • Cooling capacity of residential air conditioning units in the Reference Scenario by region



Background

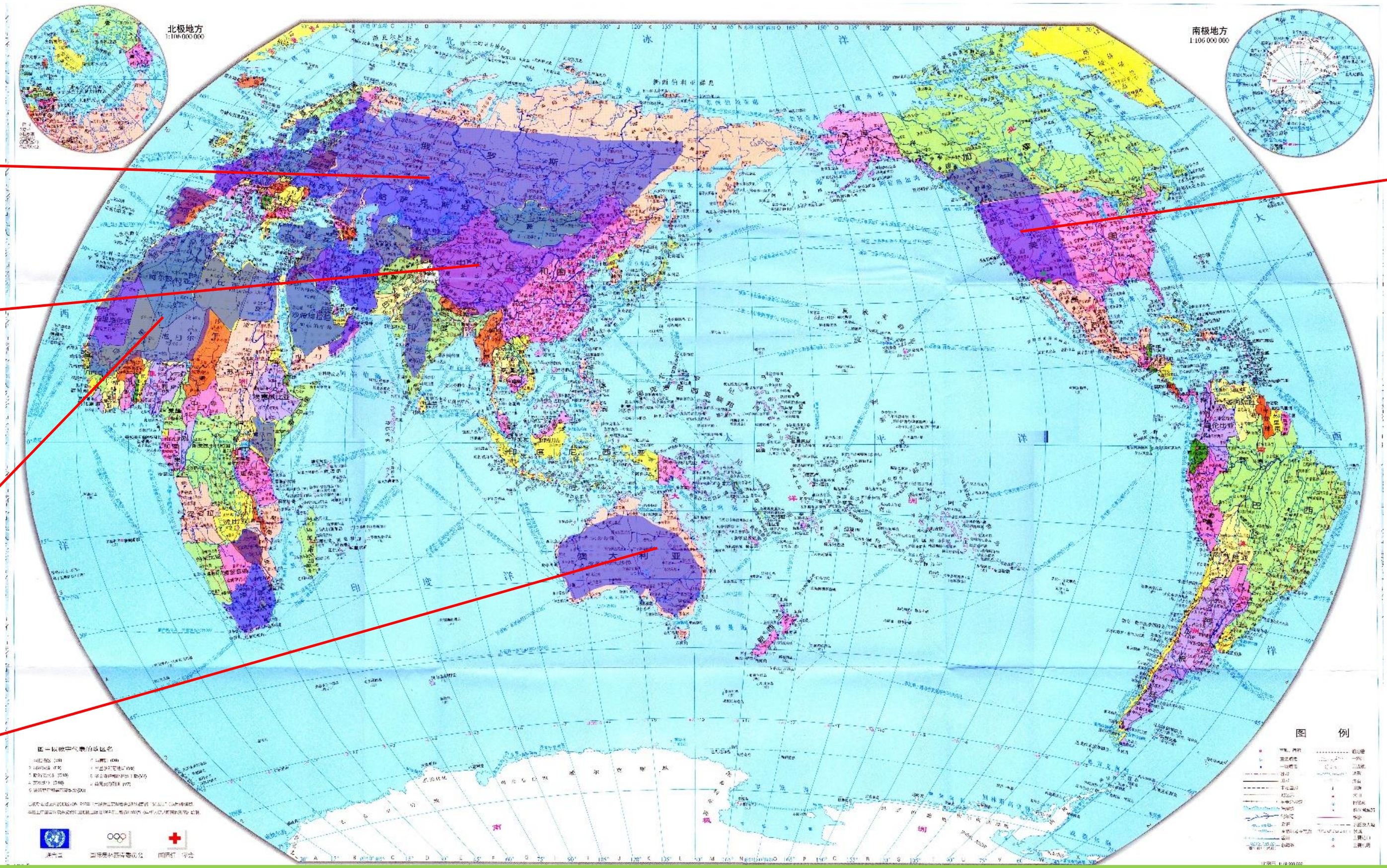
- Although over 85% of cooling around the world is achieved by mechanical refrigeration, more than 40% buildings of the regions where cooling is needed can be cooled by evaporative cooling instead mechanic, due to the dry climates.

Countries in Europe: North France, Germany, Holland, most part in Russia

Asia: North west of China, Mongolia, Saudi Arabia, Kazakhstan, middle of india

North of Africa

Australia

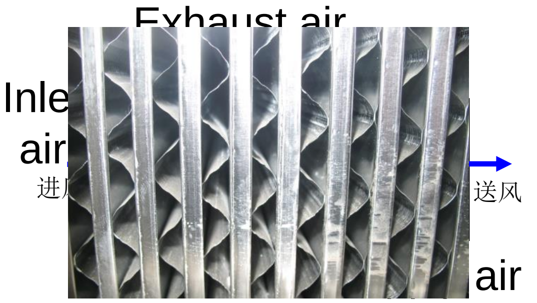
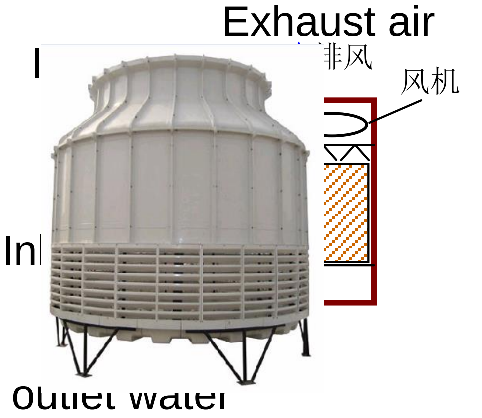
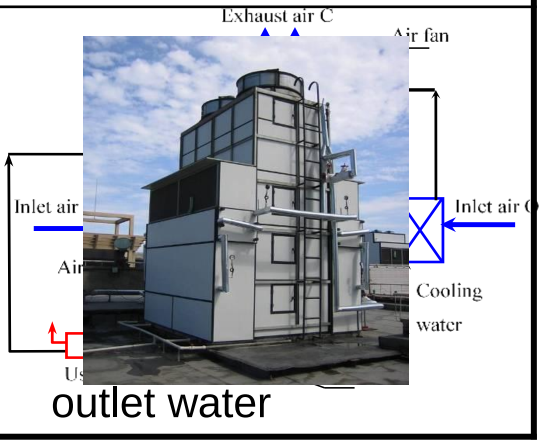


West of the U.S., South west of Canada

To study the feasibility and provide the roadmap of using indirect evaporative cooling technology in different dry regions of the world is the main focus of the proposed project.

Evaporative cooling technologies

- Evaporative cooling is to make water directly or indirectly contact with air of low relative humidity, thus water evaporated to realize cooling effect.

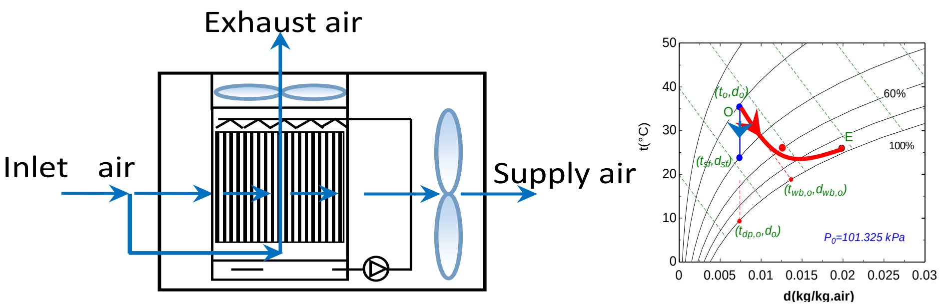
	Direct Evaporative Cooling (DEC) **Limit is inlet wet bulb temperature**	**Indirect Evaporative Cooling (IEC)** **Limit is inlet dew point temperature**
To produce cooling air		
To produce cooling water		

- Using IEC technology, the output temperature of water or air can be 6-10K lower than using DEC technology, and 3-5K lower than the inlet wet bulb temperature, reaching around 14-18℃ at ambient temperature of 35℃-38℃ and relative humidity of 20%-25%.
- Using IEC technology, electricity consumption can be reduced by 40%~70% compared with common mechanical chiller system, and no CFCs used.

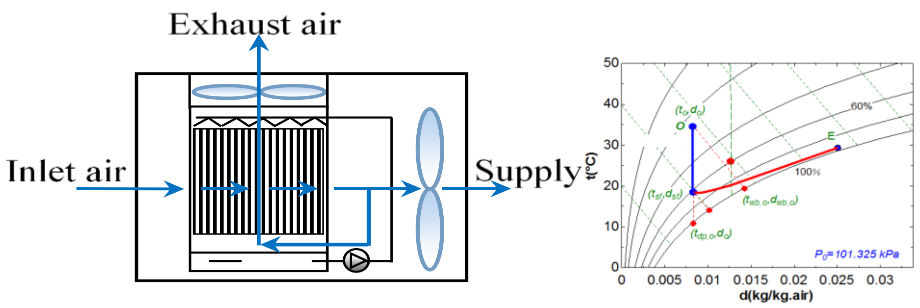
Current situations of IEC technology: IEC air coolers

- **Various kinds of processes:**
  - Different second air conditions
  - Different heat and mass transfer process: Internal three-stream heat and mass transfer and external two-stream heat and mass transfer; countercurrent or crosscurrent;
  - Different process structure: single stage or multi stage;

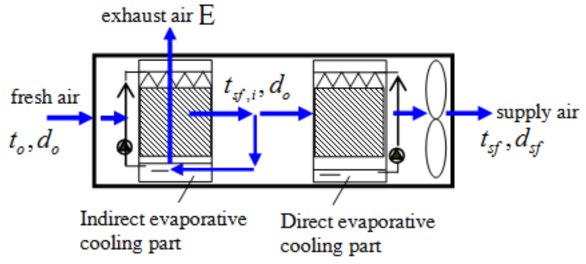
Different processes, with different cooling performance and different outlet cooling air temperature;



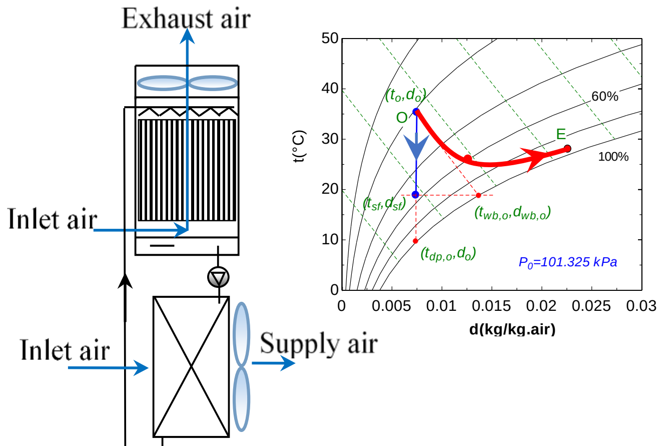
***Internal IEC** air coolers with inlet air as secondary air*



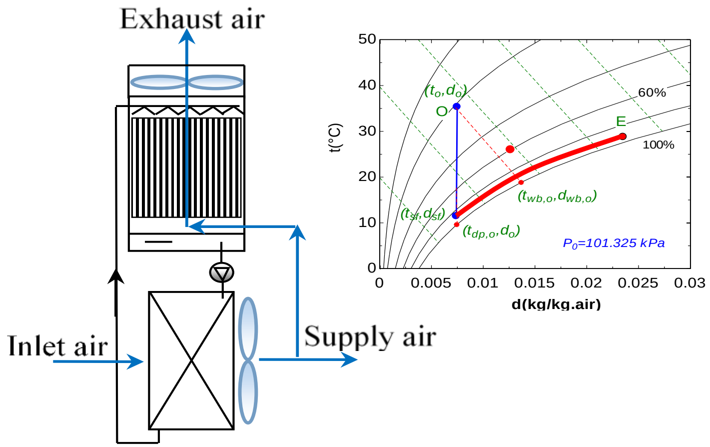
***Internal IEC** coolers with one part of outlet air as secondary air*



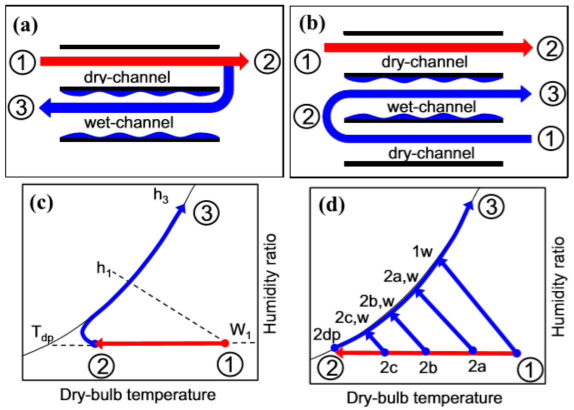
Multi-stage processes



***External IEC** coolers with inlet air as secondary air*



***External IEC** coolers with one part of supply air as secondary air*



M-Cycle IEC air coolers

Current situations of IEC technology: IEC air coolers

- Different technical structures with:
  - different heat and mass transfer forms
  - different heat and mass transfer coefficients
  - different cost of heat transfer area;
  - different size, including the volume and specific surface area

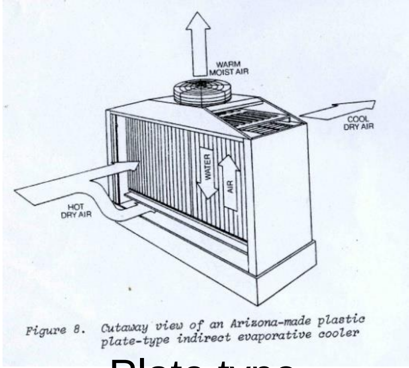
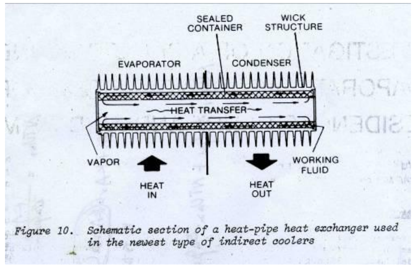
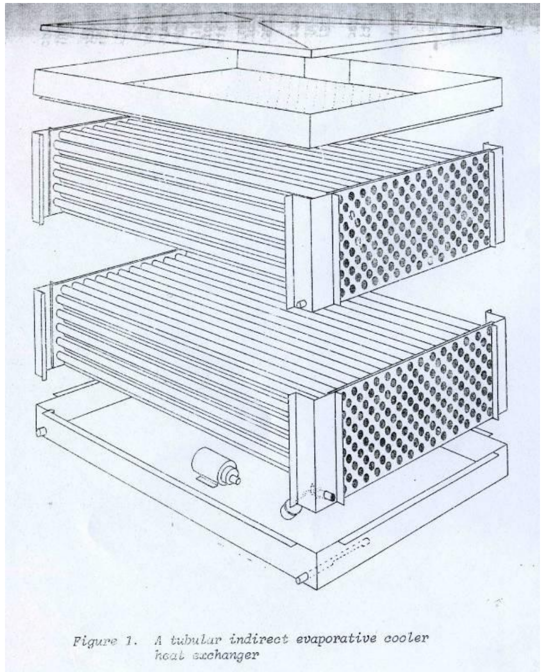


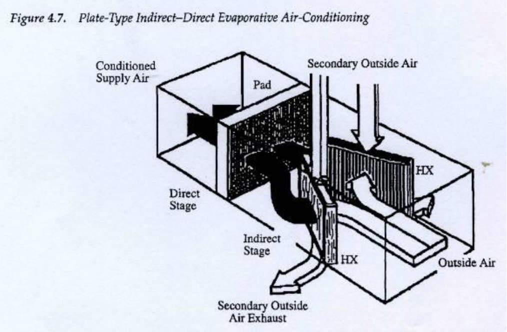
Plate type



Heat pipe type



Pipe type IEC air cooler



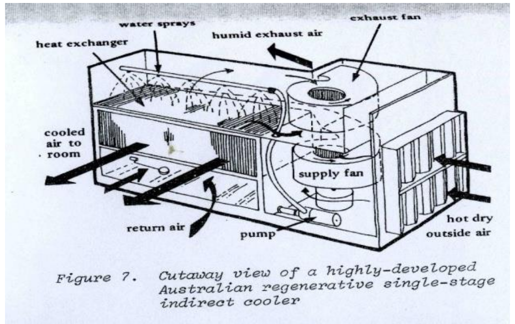
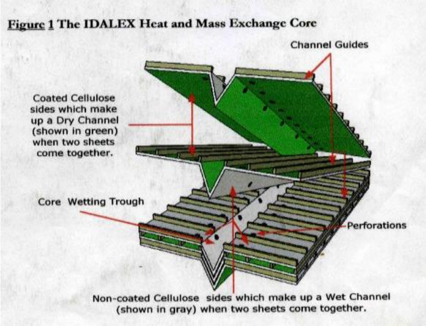
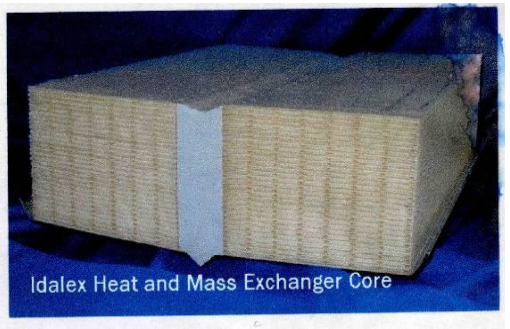
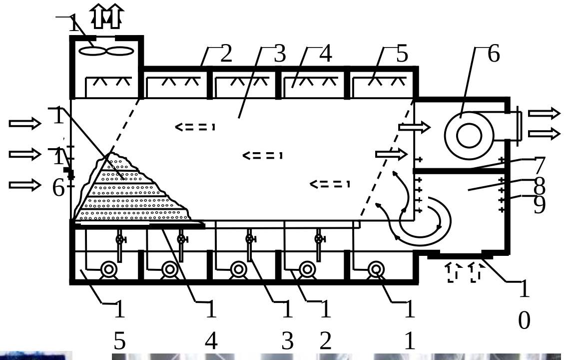


Plate type





M-Cycle core



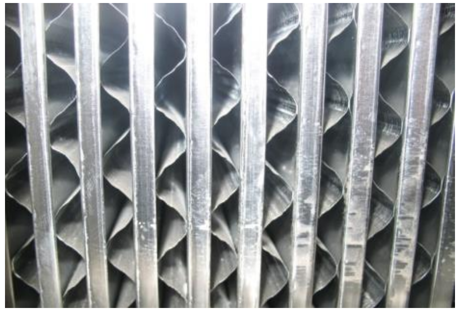


Plate type, internal IEC core

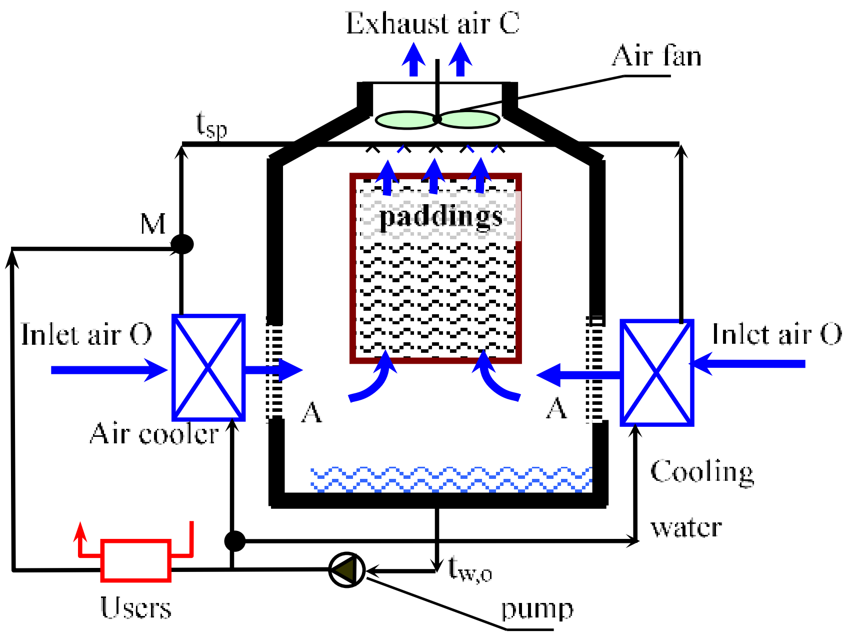
IEC Technology: Applications of IEC air coolers

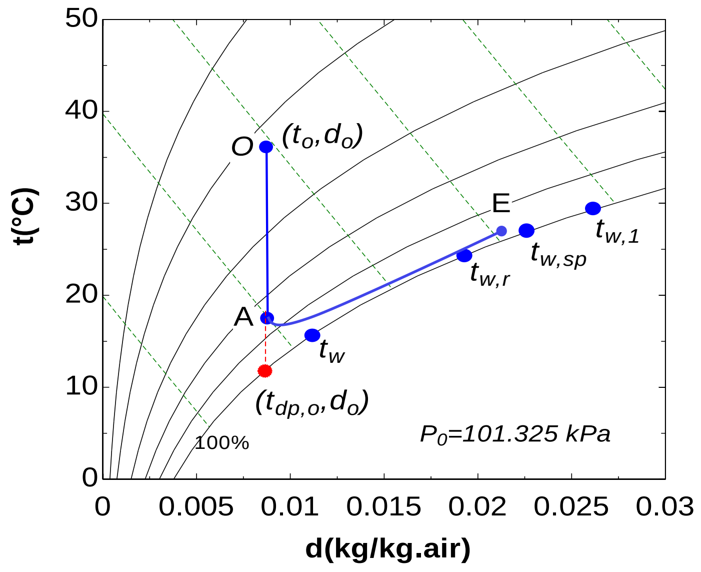
Country	City	type of IEC process	Size(m^2)	Application buildings	air flow rate(m3/h)	wetbulb temperature efficiency
India	Delhi	IEC + DEC, 3 stages		public buildings	13600~68000, total 4730000(52 projects)	1.15
India	Maharashtra	IEC+DEC	650	exhibition hall	70560	
India		IEC+DEC	650300	plants	67200000	
India		IEC	371.6	plants	23520	
India	Nagpur	IEC+DEC		plants	53760	
India	Pimpri	IEC+DEC	65030	large public building		
Australia	Adelaide	M-cycle IEC		commercial building	19.7kW	1.06
Australia	Adelaide	IEC	4225			
Australia	Roxby, downs	M-cycle IEC	140	resential buildings	10.5kW	1.24
Australia	New South wales	M-cycle IEC				
China	Urumqi	Multi stage IEC	2,000,000	hospital building, high-speed railway station, office building, exhibition centers	20,000,000	1.0~1.2
China	Gansu	Multi stage IEC+DEC	1,700	office building		0.927
China	Xian	Multi stage IEC+DEC	300	plants	30,000	1.29

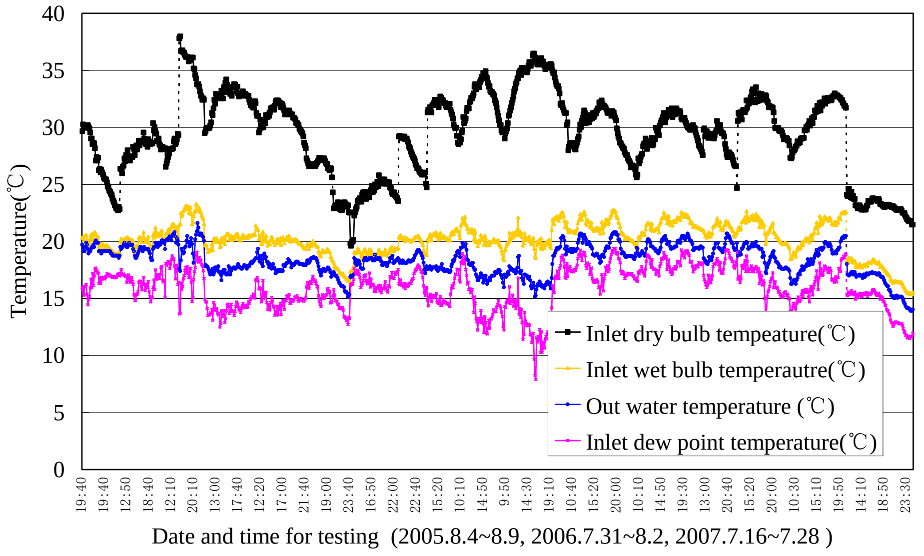
Country	City	type of IEC process	Application buildings	wetbulb temperature efficiency
The United States	Colorado	M-cycle IEC	single house	1.2
The United States	Arizona	M-cycle IEC	single house	1.2
The United States	California	M-cycle IEC	single house	1.2
The United States	Utah	M-cycle IEC	hosipital	1.2
The United States	California	M-cycle IEC	hosipital	1.2
The United States	Watchington	M-cycle IEC	hosipital	1.2
Mexico	Mexicali	M-cycle IEC	food plant	1.2
South Africa	Bloemfontein	M-cycle IEC	restarant	1.2
Kuwait		IEC+DEC		0.9~1.2
Iran	Teheran	IEC+DEC		1.1

Current situations of IEC technology: IEC water chiller

- To produce the cooling water by near reversible process, with limit out water temperature to be outdoor dew point temperature.



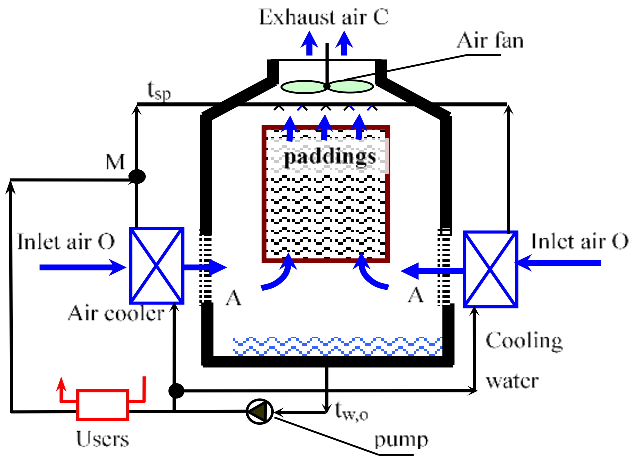




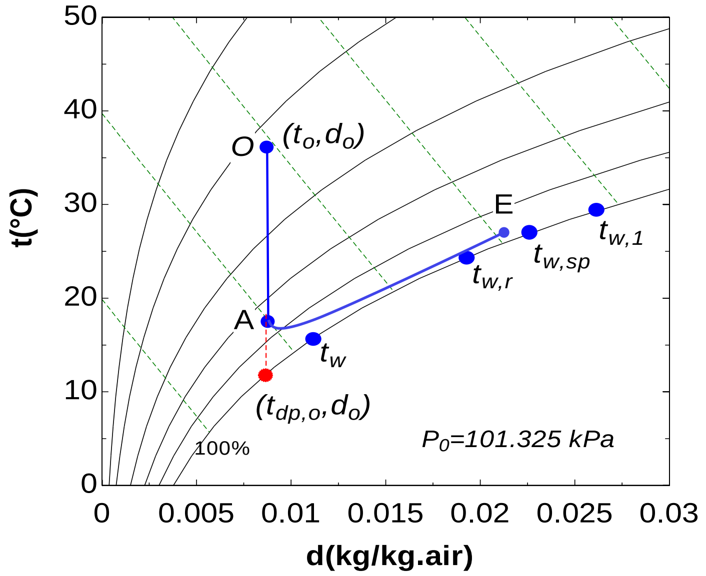
- **Key processes:**
  - to cool the inlet air to make it near the saturation line through a countercurrent air cooler by part of the produced cooling water;
  - to produce cold water by a counter current padding tower;
  - flow rate ratio matching design for each of the heat transfer or heat and mass transfer process.

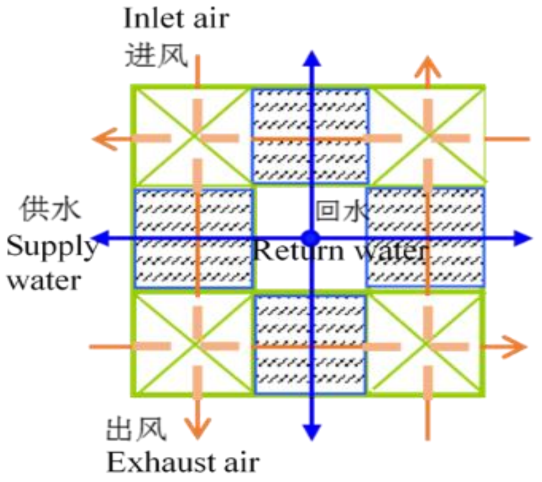
Current situations of IEC technology: IEC water chiller

- Different process structure of IEC chiller
- IEC chiller I:
  - The limit outlet water temperature is outdoor dew point temperature
  - The total cooling energy produced by the padding tower is higher than the output cooling energy;
- IEC chiller II:
  - The limit outlet water temperature is higher than outdoor dew point temperature
  - The total cooling energy produced by the padding tower is equal to the output cooling energy;

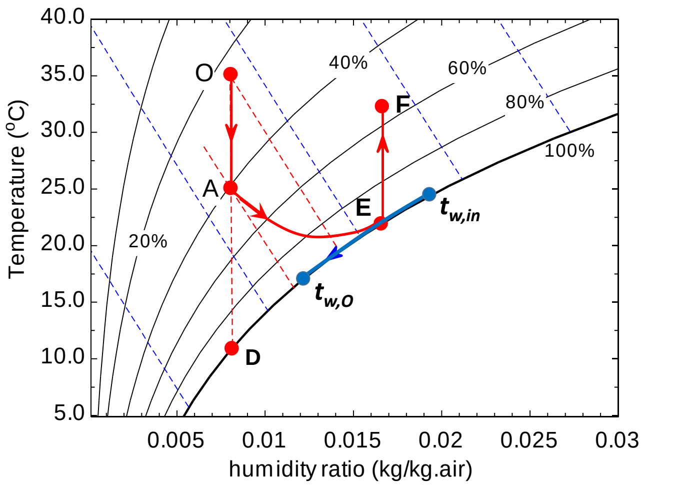


IEC chiller I





IEC chiller II



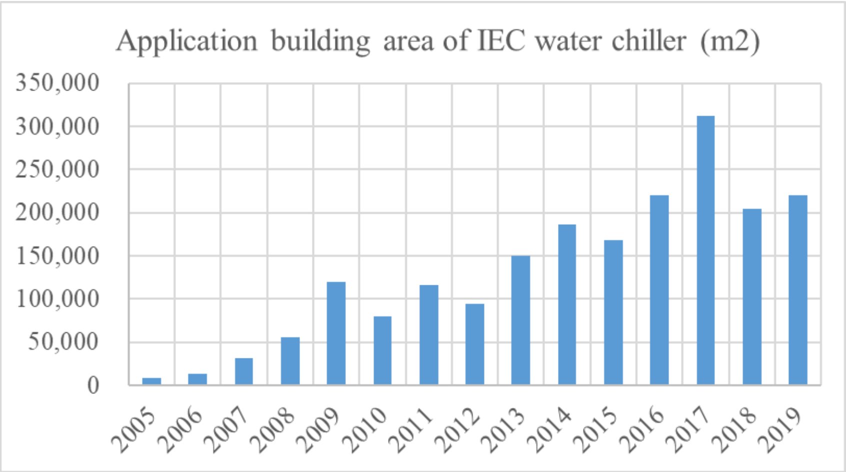
IEC Technology: Applications of IEC water chiller

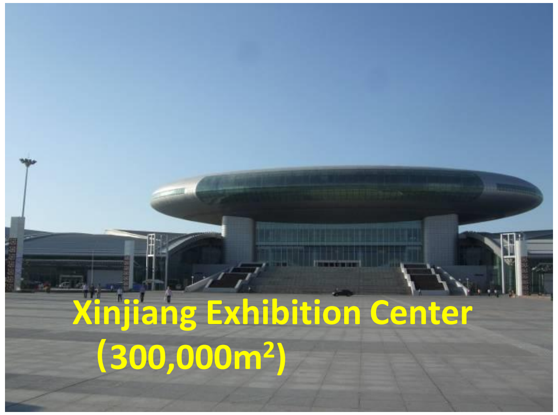
- Mainly applied in northwest of China, totally more than 2,000,000m^2, as the cooling source for large public buildings, instead of mechanical chillers.

Shihezi Kairui Building (3000m^2)

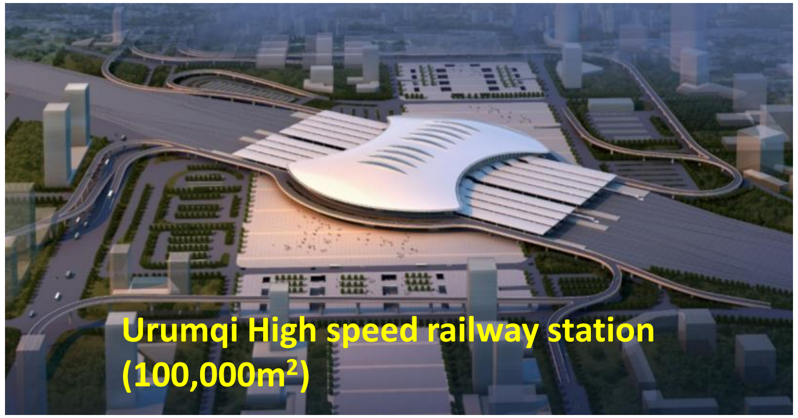
Xinjiang Traditional Medicine Hospital (13000m^2)

Urumqi Air Force hospital (17231.4m^2)





Xinjiang Exhibition Center (300,000m^2)

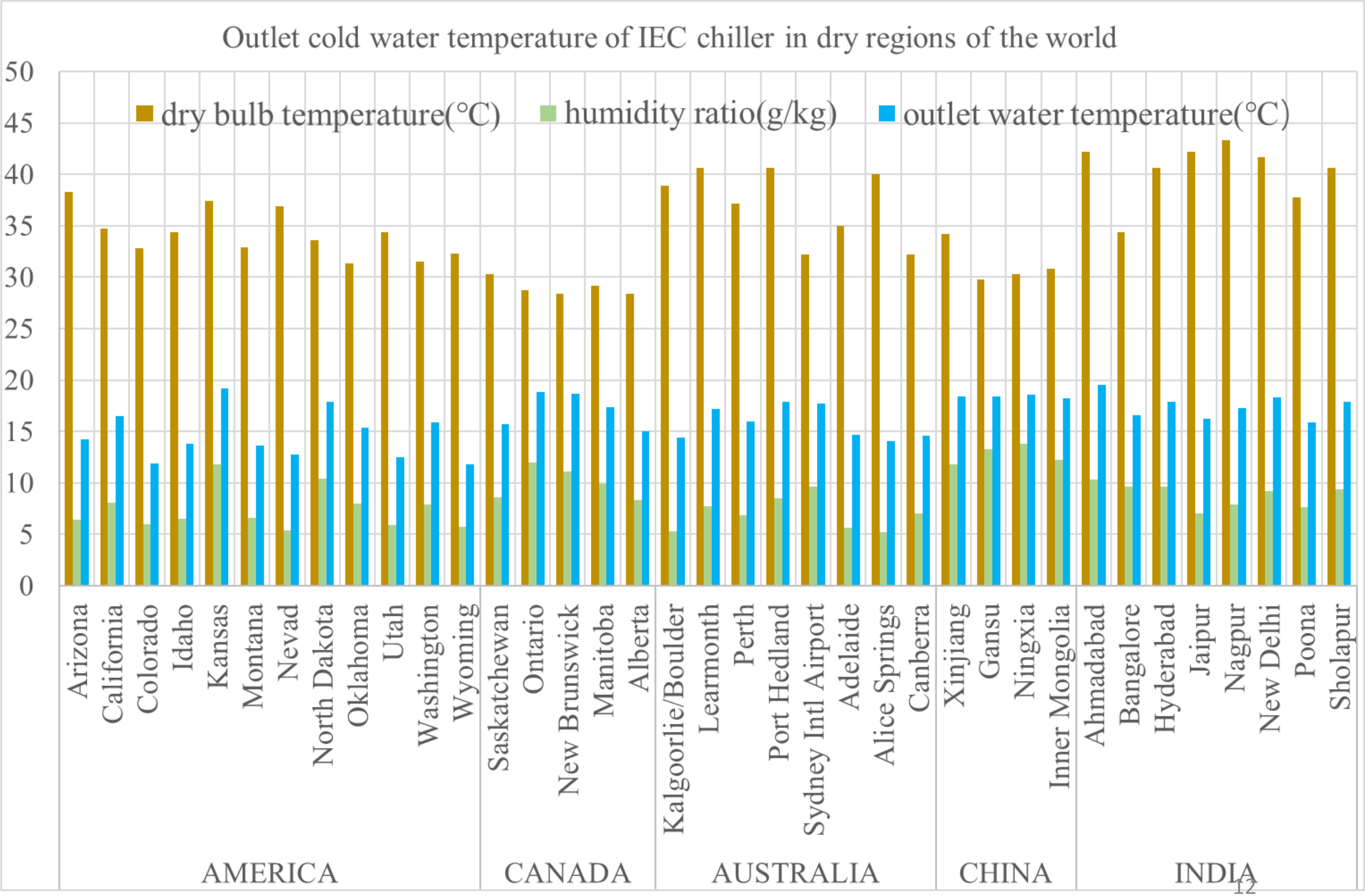


Urumqi High speed railway station (100,000m^2)

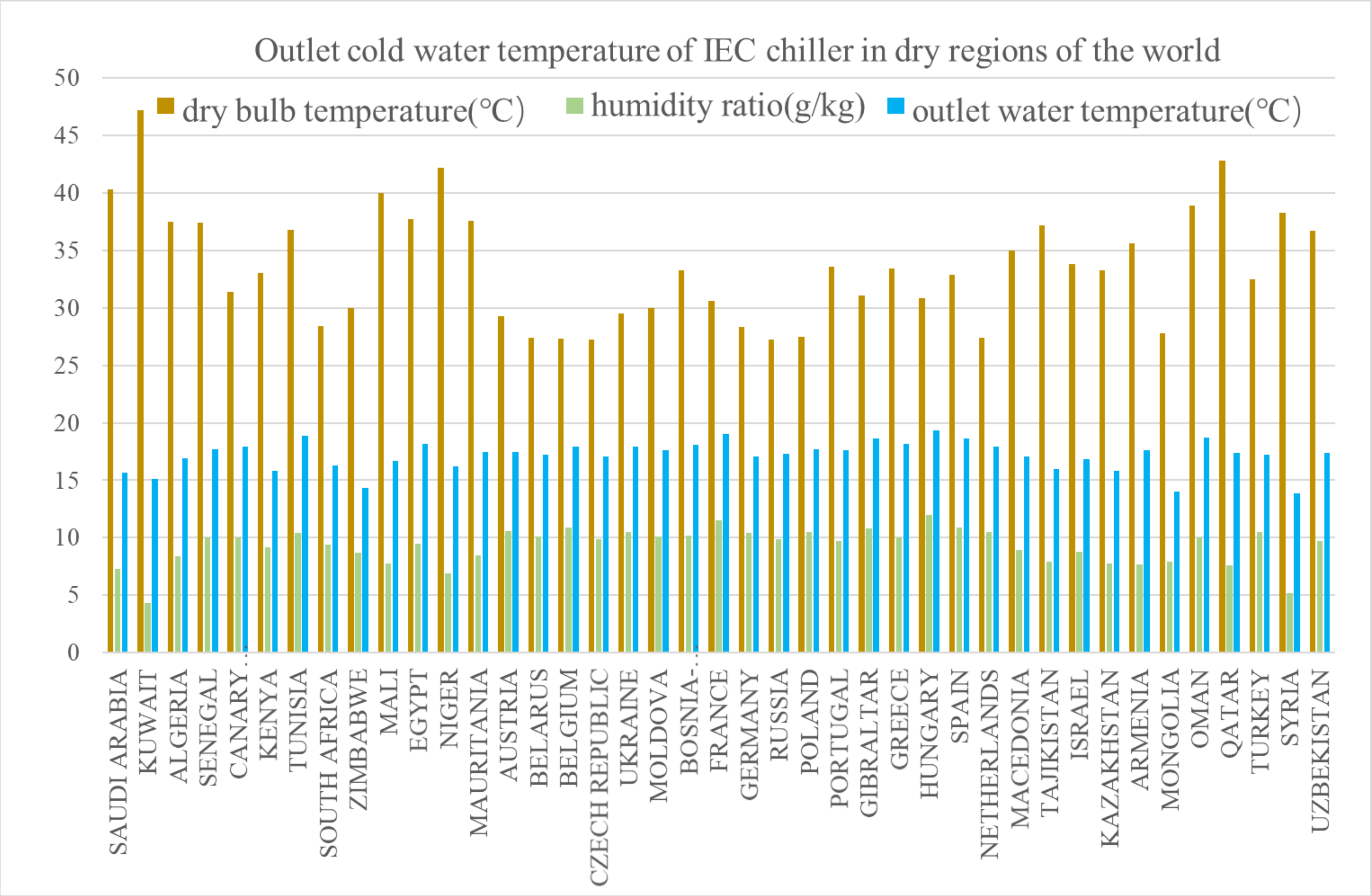
An office building in Davis, CA, the U.S.

The preliminary performance analysis of IEC technology applied in the world

- Take the IEC technology to produce cooling water, called IEC chiller for example, the outlet water temperature is shown as the right figure.



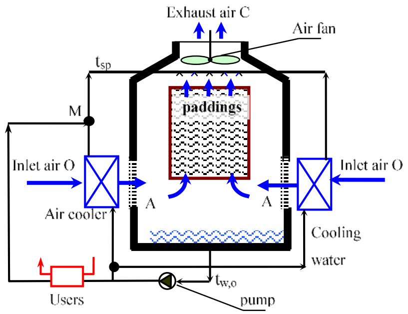
IEC Technology

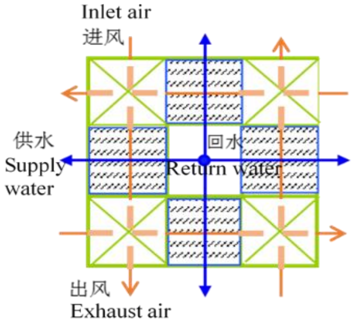


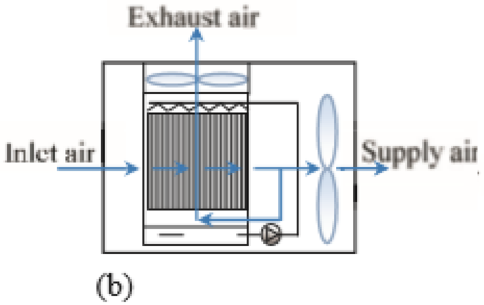
Huge potential to use IEC technology to substitute mechanical cooling and significantly reduce the energy use for cooling.

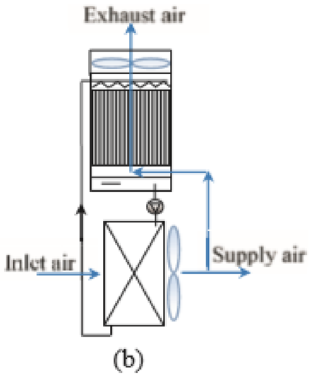
Key problems for wide applications of IEC technology

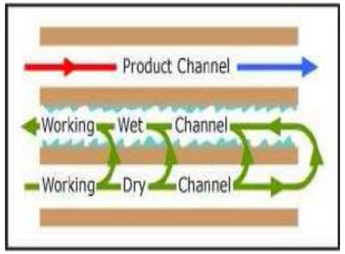
- The reasons why the IEC not be widely applied in dried regions in the world:
  - Lack of investigation of existing IEC systems in different regions of the world.
  - Lack of feasibility analysis of using IEC technologies for different types of buildings in different dry climates.
  - Lack of fundamental studies of heat and mass transfer processes with various IEC systems and components, and optimized process of IEC air coolers and IEC chillers.
  - Lack of analysis of water consumption and methods to consider both water and electricity consumption together.

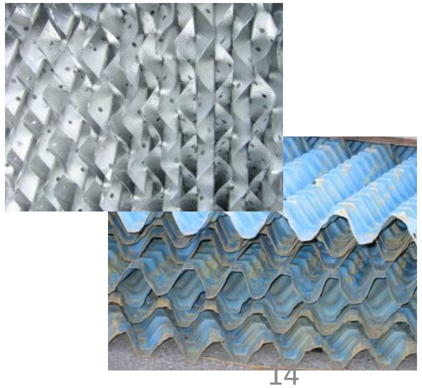








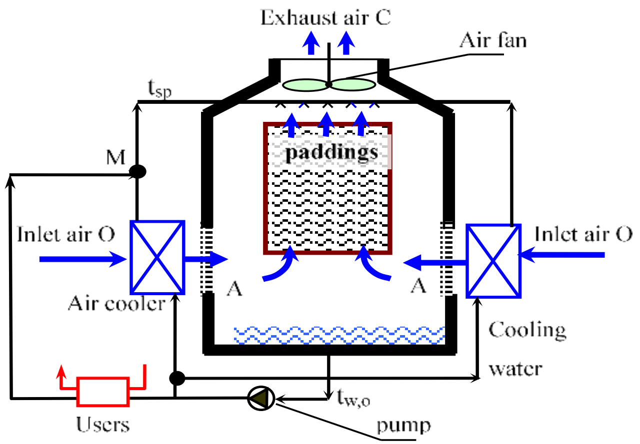




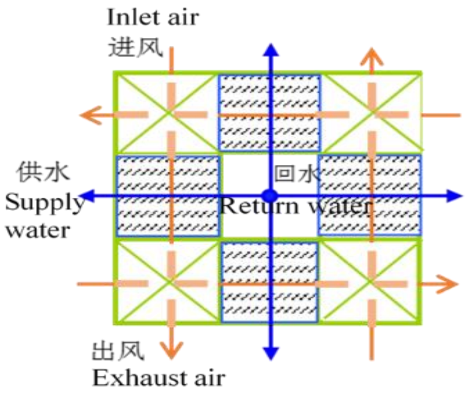
Key problems 1. The cooling performance—Feasibility study

- **How low the outlet cooling water/air temperature could be, for IEC air coolers and IEC water chillers?** which determine the feasibility of the application of IEC technologies.
- **How to identify the cooling capacity of each kind of IEC process?**

For example, for IEC water chillers, two efficiencies could be used to express the outlet water temperature, the evaporative cooling efficiency and the sensible cooling efficiency



η_{ev}, 0.6~0.8; η_C, 0.7~0.9



Hc, 0.3~0.4; η_{ev}, 0.8~0.9

$t_{w,o}=t_{wr}-\boldsymbol{\eta_{ev}}[t_{wr}-(t_{sO}-\boldsymbol{\eta_c}(t_{sO}-t_{dpO}))]]$

$\boldsymbol{\eta_c}=(t_{sO}-t_{sA})/(t_{sO}-t_{dpO})$

$\boldsymbol{\eta_{ev}}=(t_{wr}-t_w)/(t_{wr}-t_{sA})$

Total output cooling energy;

$Q_w=G_w c_{pw}(t_{w,in}-t_{wo})$

Cooling capacity for unit inlet air flow rate;

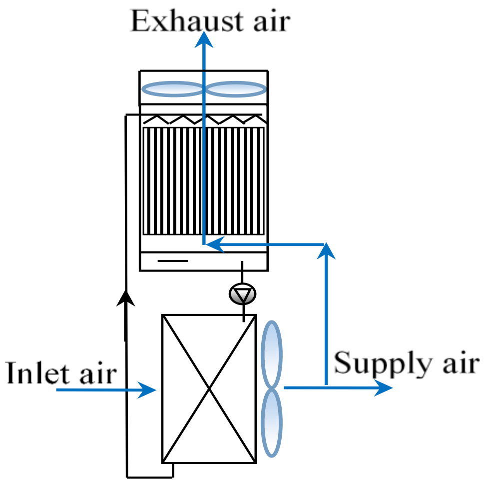
$q_w=G_w c_{pw}(t_{w,in}-t_{wo})/G_a$

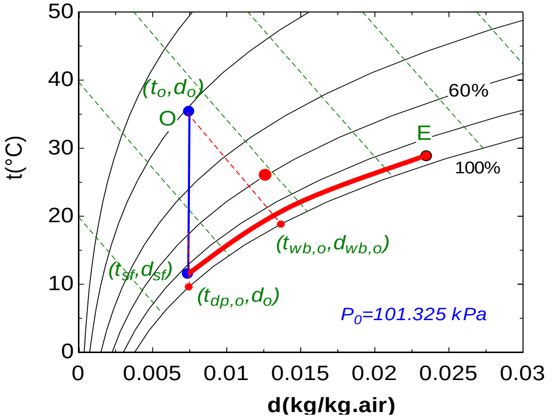
What are the main factors to influence the defined efficiencies?
What about other IEC chiller with different processes?

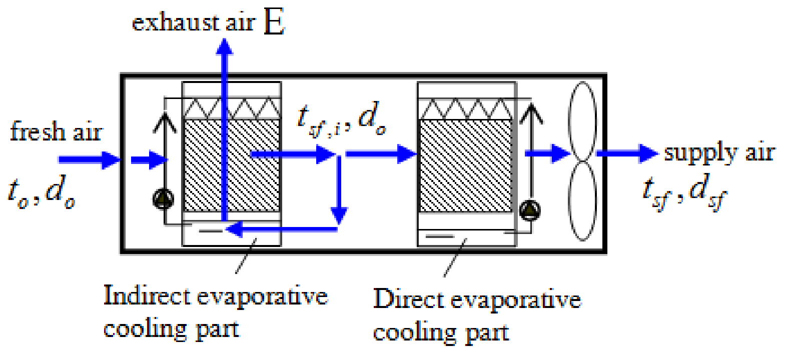
A unified method is needed to identify and then compare the cooling performance of different IEC processes.

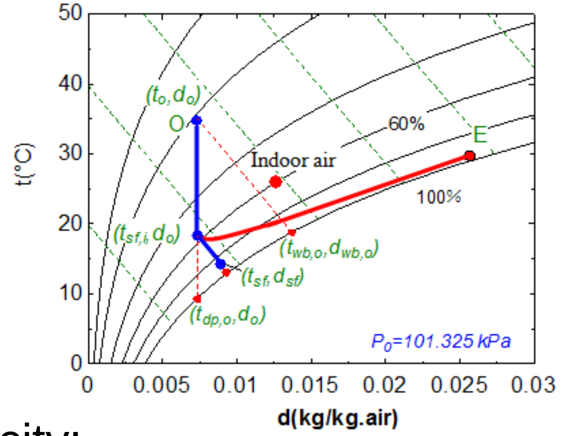
Key problems 1. The cooling performance—Feasibility study

- **What about the IEC air coolers? How to identify the outlet cooling air temperature and the cooling capacity?**









The supply air temperature:

$$t_{sf} = t_O - \eta_{dp}(t_O - t_{dp,O}) - \varepsilon_{d-t}\eta_{dec}(1-\eta_{dp})(d_{wb,O} - d_O)$$

IEC efficiency $\eta_{dp}=(t_o-t_{sf,i})/(t_o-t_{dp,o})$

DEC efficiency for DEC stage $\eta_{dec}=(d_o-d_{sf})/(d_o-d_{wb,sf,i})$

The cooling capacity:

The process produced cooling energy:

$$Q_{cp} = G_a\,(h_{a,in} - h_{a,O})$$

The indoor heat removed by the supply air:

$$Q_{indoor} = G_a\,(h_{indoor} - h_{a,O})$$

$$Q_{cp} \neq Q_{indoor}$$

Different processes, different efficiency;
What about other IEC air coolers with different processes, such as M-cycle process, multi-stage process? A Unified method is needed.

The target cooling energy is Q_{indoor}, which is needed to be clarified.

Key problems 1. The cooling performance—Feasibility study

- **A unified characterization method is needed for kinds of IEC processes**, to identify the outlet water or outlet air temperature, and the output cooling capacity.
- Using the unified characterization method, to **analyze the factors to influence the outlet cooling water/air temperature and the cooling capacity**, **to compare the cooling performance of different processes**, and **to obtain the performance of IEC processes** under different working conditions at different regions of the world.

- Theoretical analysis
- Simulation analysis
- Field testing of real projects

What we need to do

→

Finally, A unified characterization method is given, and the feasibility of different IEC technologies in different regions of the world is obtained.

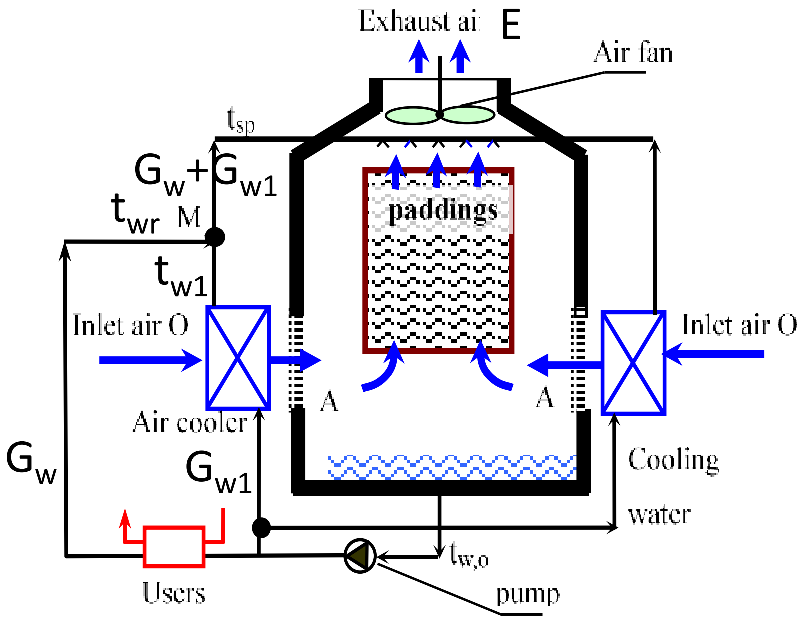
The objectives

Key problems 2. Water consumption——Economics Analysis

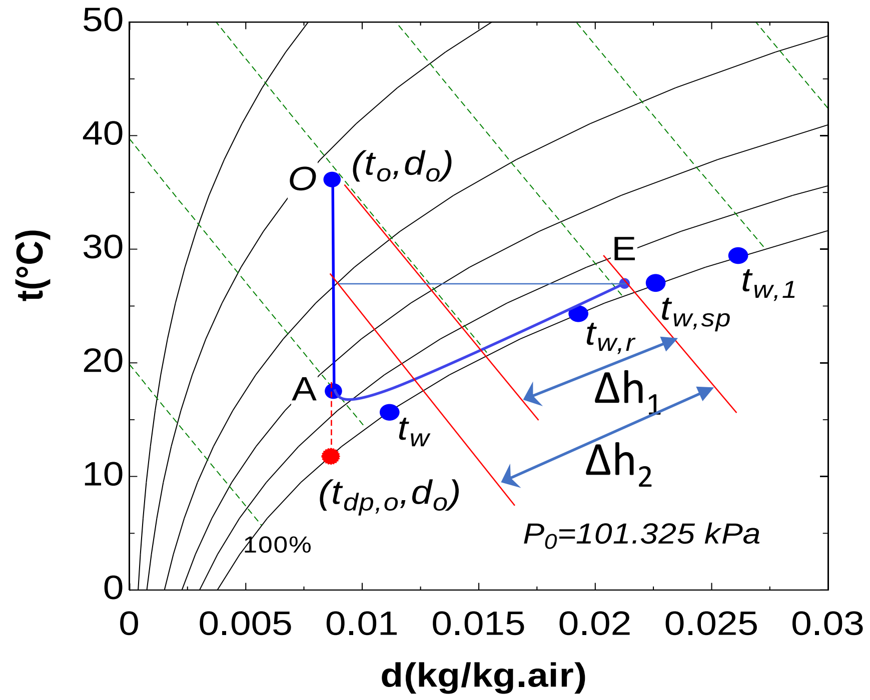
- The water consumption analysis for different kinds of IEC processes:
- How to calculate and identify the total quantity of consumed water?
- What are the main factors to influence the water consumption?
- What is the most principal factor to influence the water consumption, the process produced cooling energy, the cycled water flow rate or other parameters?
- How to evaluate the water consumption, when considering both water consumption and electricity consumption, to compare with common mechanical chiller?

Key problems 2. Water consumption——Economics Analysis

- Take the IEC water chiller for example.



Air: O→E; Water: t_{wr} → t_w



What is the principal parameter to influence η_w ?

- The higher the exhaust air enthalpy, the higher η_w
- The higher the return water temperature, the higher η_w
- The higher the evaporative cooling efficiency, the higher η_w
- The larger NTU of the tower, the higher η_w

What about different process structure?

From energy balance, the out put cooling energy:

$$Q_w= G_w c_{pw}(t_{wr}-t_w)=G_a(h_E-h_O)=G_a\Delta h_1$$

The water consumption:

$$W= G_a(d_E-d_O)=G_a\Delta h_2/r_0$$

r_0 : latent heat of vaporization

An efficiency to describe the water consumption could be defined, to identify the effective water consumption:

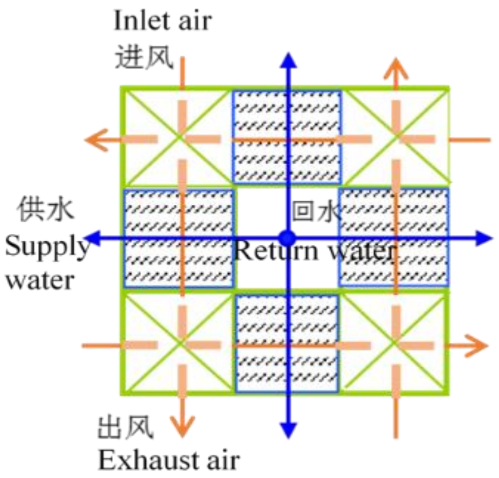
$$\eta_w= Q_w/r_0 W= \Delta h_1/ \Delta h_2$$

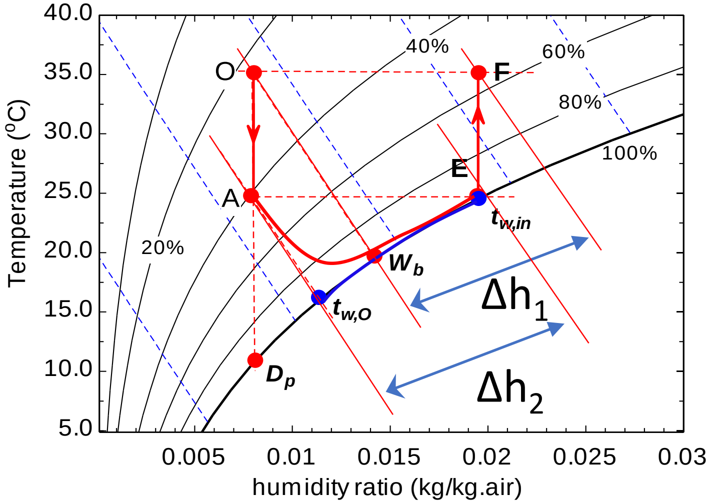
The higher the η_w, the lower the water consumption by water vaporization.

The water consumption efficiency could also be used for water vaporization consumption analysis of IEC air coolers.

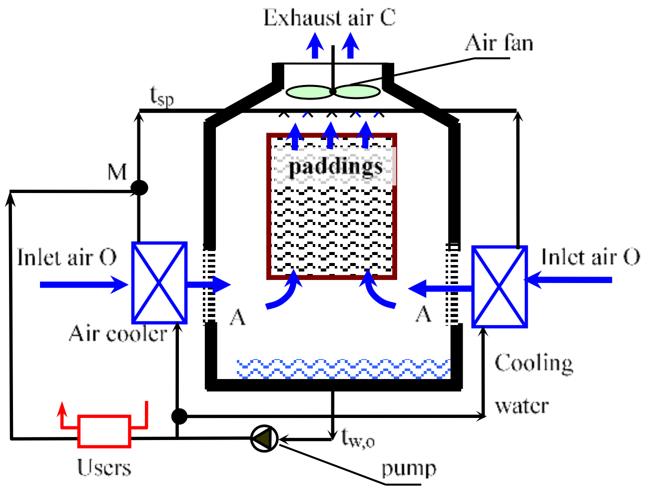
Key problems 2. Water consumption——Economics Analysis

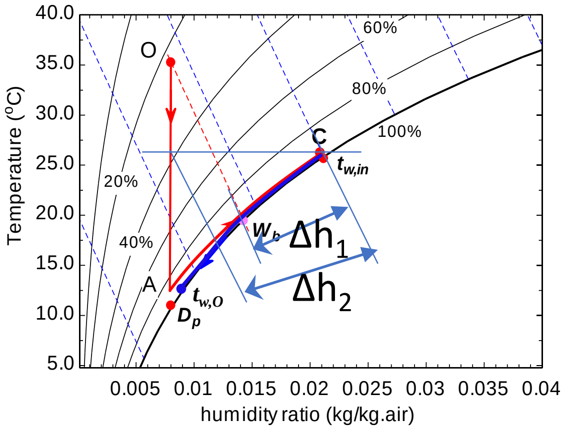
- Take the IEC water chiller for example.





Process II





Process I

When totally heat recovery between the inlet air and exhaust air, and the evaporative cooling efficiency equals to one,

$\eta_w = Q_w / r_0 W = \Delta h_1 / \Delta h_2 = 1$

Even the sensible cooling efficiency and the evaporative cooling efficiency equals to one,

$\eta_w = Q_w / r_0 W = \Delta h_1 / \Delta h_2 < 1$

For the same return water temperature t_{wr} from the users, why the difference of η_w for different processes?

For process I, the sensible cooling process of inlet air O also consume water;

While, for process II, the sensible cooling process is realized by temperature difference and don't need water vaporization

What about different IEC air coolers? The water consumption analysis is also needed to be studied.

Key problems 2. Water consumption——Economics Analysis

- **Water consumption performance for kinds of IEC processes, including IEC water chillers and IEC air coolers, is needed to be analyzed.**
- To evaluate the water consumption and electricity consumption together, the electricity consumption to produce pure water, such as by seawater desalination, need to be studied.
- Real projects investigation, to get the real water consumption, including vaporization water, drifting water, and the regular drain off water to reduce the hardness of water.

What we need to do

- Investigation of water resource in different regions of the world
- Theoretical analysis of water consumption for IEC processes
- Simulation analysis
- Field testing of real projects for water consumption

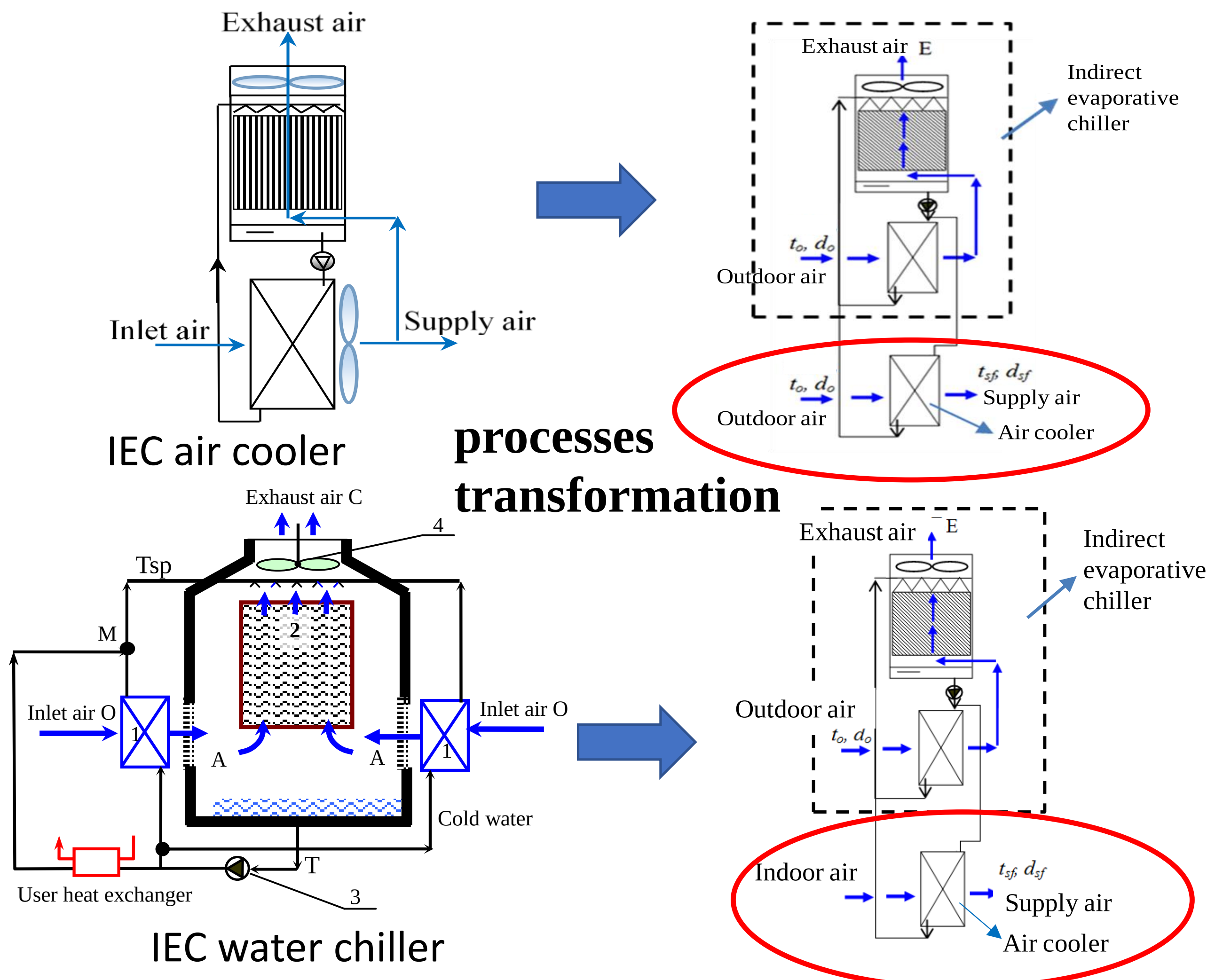
The objectives

- Give the identification method of water consumption
- Give the equivalent method between water consumption and electricity consumption
- Compare the different IEC processes, and compare IEC process and mechanical chiller process

Key problems 3. System design, cooling air and cooling water

- For the IEC cooling system to remove indoor sensible heat, choose the IEC cooling air system or IEC water chiller system, which one is better?

Theoretical research of the process:



To remove the same quantity of indoor heat:

- The process produced cooling energy IEC air cooler is larger than IEC water chiller, when outdoor air is hotter than indoor air, the difference is the outdoor air heat load of IEC air cooler.
- Thus, larger heat transfer area and larger cost when using IEC air cooler to remove indoor sensible heat.

When considering all kinds of IEC air coolers and IEC water chillers, what about the comparison result?
When considering the various outdoor conditions?
For buildings with different function, the better system?

Key problems 3. System design, cooling air and cooling water

- Investigation of the real projects using IEC technologies needs to be carried out, to get a overview of the using system;
- Comparison between different IEC processes, by simulation under all working conditions.
- Cases design for different type of buildings.

- Investigation of real projects and comparison between real projects using different IEC processes
- Theoretical analysis
- Simulation analysis
- Cases design
- Comparison by real performance of projects

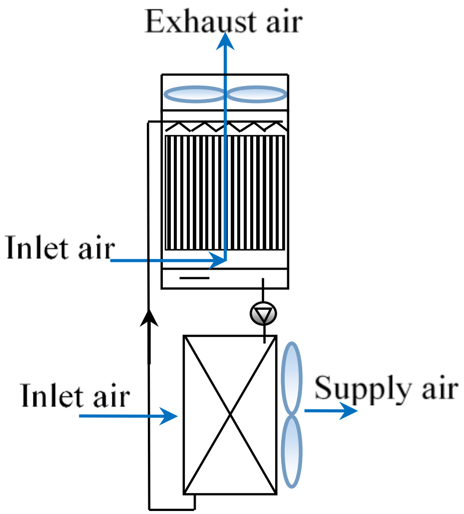
What we need to do

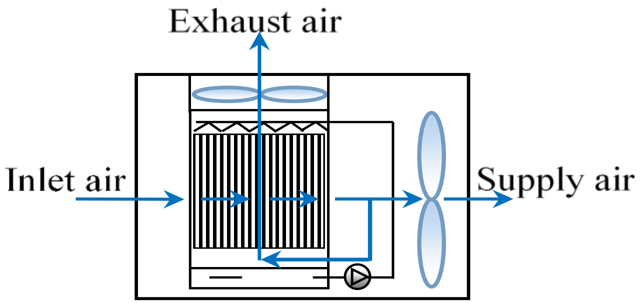
- Give system design guideline for different types of buildings.
- Give the suitable application conditions of different system structure.

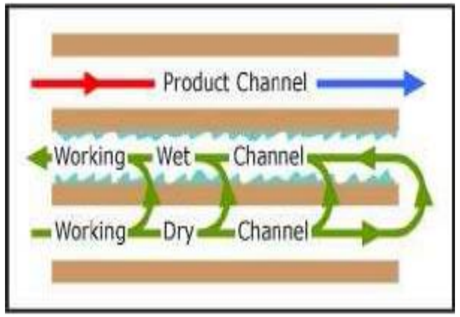
The objectives

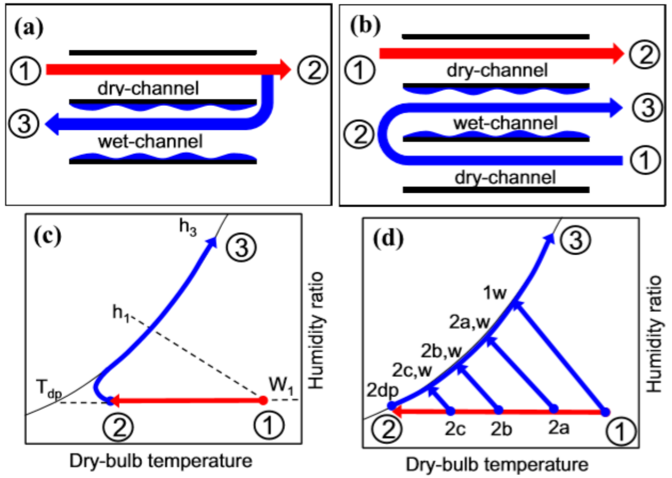
Key problems 4. IEC equipment, IEC air cooler and IEC chiller

- How to compare different IEC air coolers with different process structure?
- How to compare different IEC water chillers with different process structure?





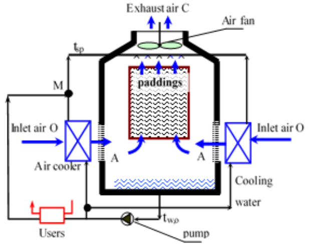
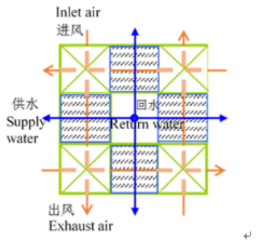
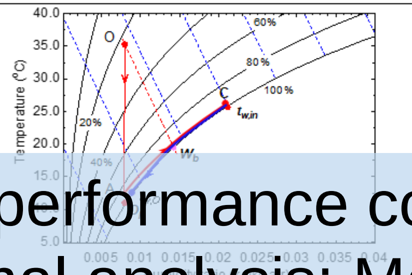
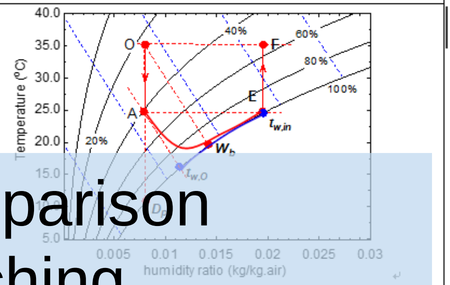


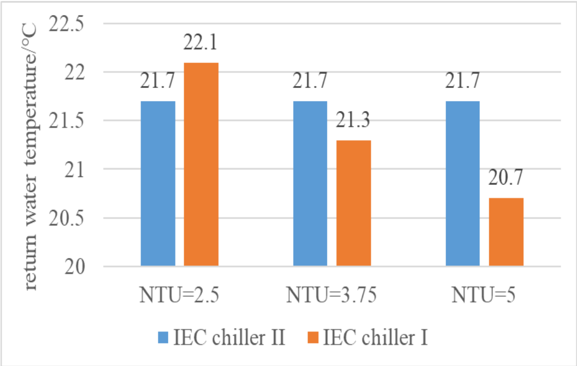


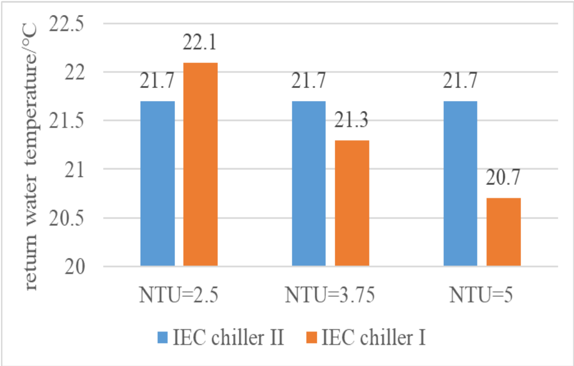
- Single stage or Multi-stage?
- Internal structure or External Structure? Three-stream heat and mass transfer or two-stream heat and mass transfer?

Key problems 4. IEC equipment, IEC air cooler and IEC chiller

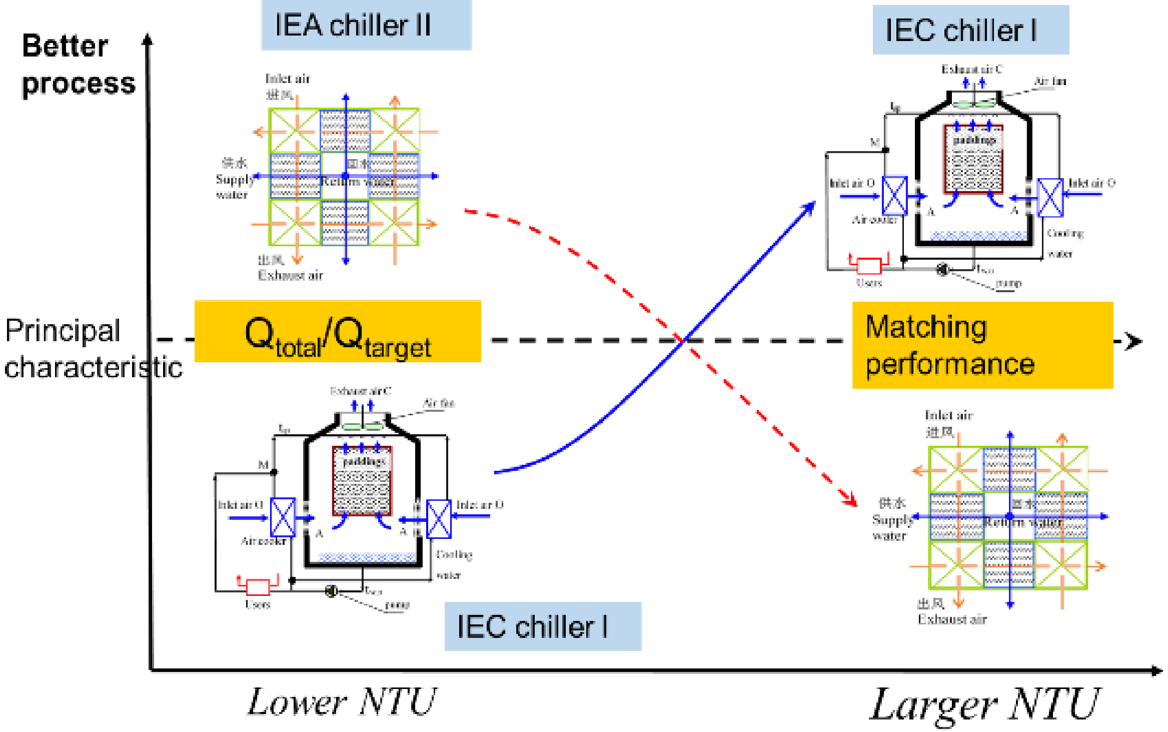
- Ideal performance comparison
- Thermal analysis: Matching performance, heat exchange loops, mixing loss;

Two different indirect evaporative chiller processes	 IEC chiller process I	 IEC chiller process II
Performance under ideal working conditions: infinite heat transfer area	 ➢ The outlet temperature is near outdoor dew point temperature $t_{w,O}=t_{dp,O}$; ➢ The output cooling energy capacity for unit of inlet air flow rate: $q_{wI}=r_0a(t_{w,in}-t_{dpO})$ where a represents the slope of the saturation line, a=Δt/Δd; ➢ $\frac{Q_{total}}{Q_{target}}=1+\frac{c_{pa}}{r_0 a}(\frac{t_O-t_{dp,O}}{t_{w,in}-t_{dp,O}}+1)$	 ➢ The outlet temperature is higher than outdoor dew point temperature; ➢ The output cooling energy capacity for unit of inlet air flow rate: $q_{wII}=r_0a(t_{w,in}-t_{dpO})$ Where a represents the slope of the saturation line, a=Δt/Δd; ➢ $\frac{Q_{total}}{Q_{target}}=1+\frac{c_{pa}}{r_0 a}(\frac{t_O-t_{dp,O}}{t_{w,in}-t_{dp,O}}-1)$
Matching performance	➢ Better than process II ➢ Flow rate matching could be satisfied for each internal process; ➢ Inlet parameter matching could be satisfied for evaporative cooling process;	➢ Flow rate matching could be satisfied for each internal process; ➢ Inlet parameter matching could be satisfied for evaporative cooling process;
Heat exchange loops: Q_{total}/Q_{target}	➢ Larger than process II	➢ Lower than process I
Mixing Performance	➢ one mixing process of two flows of water with different temperature	➢ no mixing process





With the same output cooling energy



Key problems 4. IEC equipment, IEC air cooler and IEC chiller

- Different processes need to be compared, to give deep understanding of different structures by thermal analysis, and to choose the suitable structure under different outdoor conditions, NTU conditions.
- Research on the process construction principle, to direct design of new structures.

- Thermal analysis: internal losses analysis, matching analysis, heat exchangers loops, the optimization rules
- Simulation analysis, to verify the theoretical analysis.
- Comparison of lots of different IEC air coolers and different IEC water chillers.

What we need to do

→

- Give the comparison method of different process through thermal analysis.
- Give the optimization rules for design of new process structure.
- Give the suitable conditions for different process structure.

The objectives

Key problems 5. Application conditions and application area of the world

- From the climate conditions all over the world, where are the regions suitable for using evaporative cooling technology, and separately for DEC and different IEC technologies?
- In different suitable regions, the most suitable IEC system for different type of buildings?
- To give the feasibility analysis of application of IEC technologies all over the world, then to give the design guideline of IEC systems.

- **Investigation** of climate data all over the world, the building types, running mode of building air conditioners, building indoor conditions, building cooling load and so on.
- **Theoretical analysis**
- **Simulation analysis**
- **Cases design**

What we need to do

→

- Give the comprehensive feasibility analysis of using IEC technologies all over the world: the suitable application regions.
- Give the most suitable system design for different type of buildings, in different suitable regions.

The objectives

Main tasks

Key problem 1:
Cooling performance —feasibility study.

Key problem 2:
Water consumption —economic study.

Key problem 3:
System design—produce cooling air or cooling water.

Key problem4:
IEC equipment, different processes structure comparison

Key problem5:
Application conditions and application area of the world

Investigation
Climate data
Water resource
Building feature
Application projects

Theoretical analysis
Cooling efficiency
Water consumption efficiency
System comparison

Thermal analysis
processes structure comparison
optimization of structure and parameters

Simulation analysis
Design tool
Help to verify the theoretical analysis

Cases design
Different systems design for different buildings in different regions

Field testing
Cooling performance,
Water and electricity consumption,
Running problems;

Give a unified characterization method for cooling performance

Give the identification method of water consumption, the equivalent method between water consumption and electricity consumption

Give system design guideline for different types of buildings, the suitable application conditions of different system structure.

Give the comparison method of different process, the optimization rules for new process structure, the suitable conditions for different process structure.

Give the comprehensive feasibility analysis of using IEC technologies all over the world, the most suitable system for different type of buildings different suitable regions

Import tips

- **Not Included:** Passive evaporative cooling technologies
- **COP is not used to identify the basic performance of IEC processes**. For different processes, using the comparison method, the difference is concerned, for example, water consumption difference, electricity consumption difference of different IEC processes.

Objectives of the new Annex

Field study	(1) Carry out field testing of existing IEC systems applied in different climates to obtain real-world running data. Existing projects can be found in northwest of China, western U.S., Europe, Australia, and other dry regions. Analyze the data and provide guidance for system improvement or optimization.
Fundamental Study	(2) Develop the general theoretical analysis method of IEC processes, to guide the design of different IEC systems used in different dry climates. (3) Evaluate the water and electricity consumption of IEC processes.
Simulation tool	(4) Set up the system simulation model and tool for different kinds of IEC processes and systems used in different kinds of buildings under different dry climates.
Guideline	(5) Develop a guideline for designing the IEC systems for different types of buildings under different dry climates and water resource conditions.

The 'step change' target of the proposed Annex

Innovation Aspects of IEC processes

Include not only fundamental understanding of the IEC processes from thermodynamics viewpoint, but also simulation models, optimizing tools, and design guide for better utilization of this technology.

Provide a feasible approach to realize near-free cooling in dry climates

Providing a feasible and economical approach to obtain nearly-free cooling in dry climates to realize low energy consumption and low greenhouse gas emission.

To respond to the sharp increase of cooling demand;

Real-world operation data collected

1. Aimed at responding to the sharp increase of cooling demand in the world.
2. Real-world operating data will be collected and compared with counterpart technologies

Intended target audience

- The design and planning practitioners who focus on cooling system design and selection of real projects
- The scientific communities who focus on study of cooling or evaporative cooling processes
- The government officials who are responsible for formulating energy saving policies in respond to the climate change
- The manufactures who make indirect evaporative cooling equipment or products.

Main tasks discussion: the 5 key problems

1. **Cooling performance—feasibility study**, to give a characterization method for cooling performance for all kinds of IEC processes.
2. **Water consumption—economic study,** to give the identification method of water consumption, the equivalent method between water consumption and electricity consumption.
3. **System design—produce cooling air or cooling water,** to give system design guideline for different types of buildings, the suitable application conditions of different system structure.
4. **IEC equipment, different processes structure comparison**, to give the comparison method of different process, the optimization rules for new process structure, the suitable conditions for different process structure.
5. **Application conditions and application area of the world,** to give the comprehensive feasibility analysis of using IEC technologies all over the world, the most suitable system for different type of buildings different suitable regions.

Sub tasks discussion

Sub-task 1: Definition & Field study

(1) Investigation in the world, for the existed projects using IEC technologies;
(2) Field testing of some of the projects; (including some typical cooling tower projects)
(3) Life of the equipment and products.
(4) Projects cases collecting.
(5) Investigation of climate data of the world, including extremely hot conditions, the building feature, the running mode of air conditioning, indoor design parameters and heat load.

Sub-task 2: Feasibility study

(1) Water consumption performance analysis. (including cooling towers)
(2) Cost analysis: including initial cost, running cost(electricity consumption cost), maintenance cost, life-cycle cost.
(3) Electricity consumption, and the equivalent method of water consumption to electricity consumption.
(4) Environmental impacts (compactness, risk associated to water system (aging, dirtiness, scale), noise, legionella, and so on)
(5) The application Feasibility of IEC systems for different type of buildings in suitable regions of the world.
(6) The cooling tower application feasibility.

Sub-task 3: Fundamental Study

(1) For system design, comparison of IEC cooling air system and IEC cooling water system
(2) Different process structures comparison, through thermal analysis.

Sub-task 4: Simulation tool and Guideline

(1) Set up the system simulation model and tool for different kinds of IEC processes and systems used in different kinds of buildings under different dry climates.
(2) Develop a guideline for designing the IEC systems for different types of buildings under different dry climates and water resource conditions. (including the indoor design temperature set up, how to ensure the indoor conditions when using the IEC processes with cold water temperature higher than common chillers)

Sub tasks discussion

- Belgium
  - Belgium ATIC organization, Sylvano Tusset, sub-task 4 and 1;
  - University of Liège, Jean Lebrun, sub-task 4;
- Denmark
  - Aalborg University, Michal Pomianowski, Depend on funding. Now applying for two projects. If all be granted, would join all 4 subtasks. If only the smaller project, then subtask-1 and subtask-3. For sure by the end of the year.
- Australia
  - CSIRO Energy Center, Stephen White, CSIRO will not necessarily be participating. There are other institutions that may want to be subtask leaders.
  - University of South Australia, Frank Bruno, all of the sub-tasks, Not sure if can be subtask leader depending on funding. Can find out in the coming weeks.
  - University of Melbourne too. Lu Aye
  - Seeley International, Jon, attending all of the sub-tasks, not the leader;
- China, Tsinghua Unversity, all of the sub-tasks
- The U.S., Oak Ridge National Lab, Xiaobing Liu, Depends on funding. Do not have active project in this area.
- Egypt, Zewail City of Science and Technology
- France, LOCIE, Lasie, cETHIL, sub-task 4; simulation tools, and sub-task 3;

Sub-task 1 Definition& Field study

Sub-task 2: Feasibility study

Sub-task 3: Fundamental Study

Sub-task 4: Simulation tool and Guideline

The full proposal is prepared considering all the comments from the participants, and then send to the participants for modification, and then submit to the IEA EBC;

The after plan

- The sub-tasks and the corresponding leaders determination.
- Develop a full EBC Annex proposal in the form of a draft Annex Text (2020.4~2020.6).

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Thanks for your attention.

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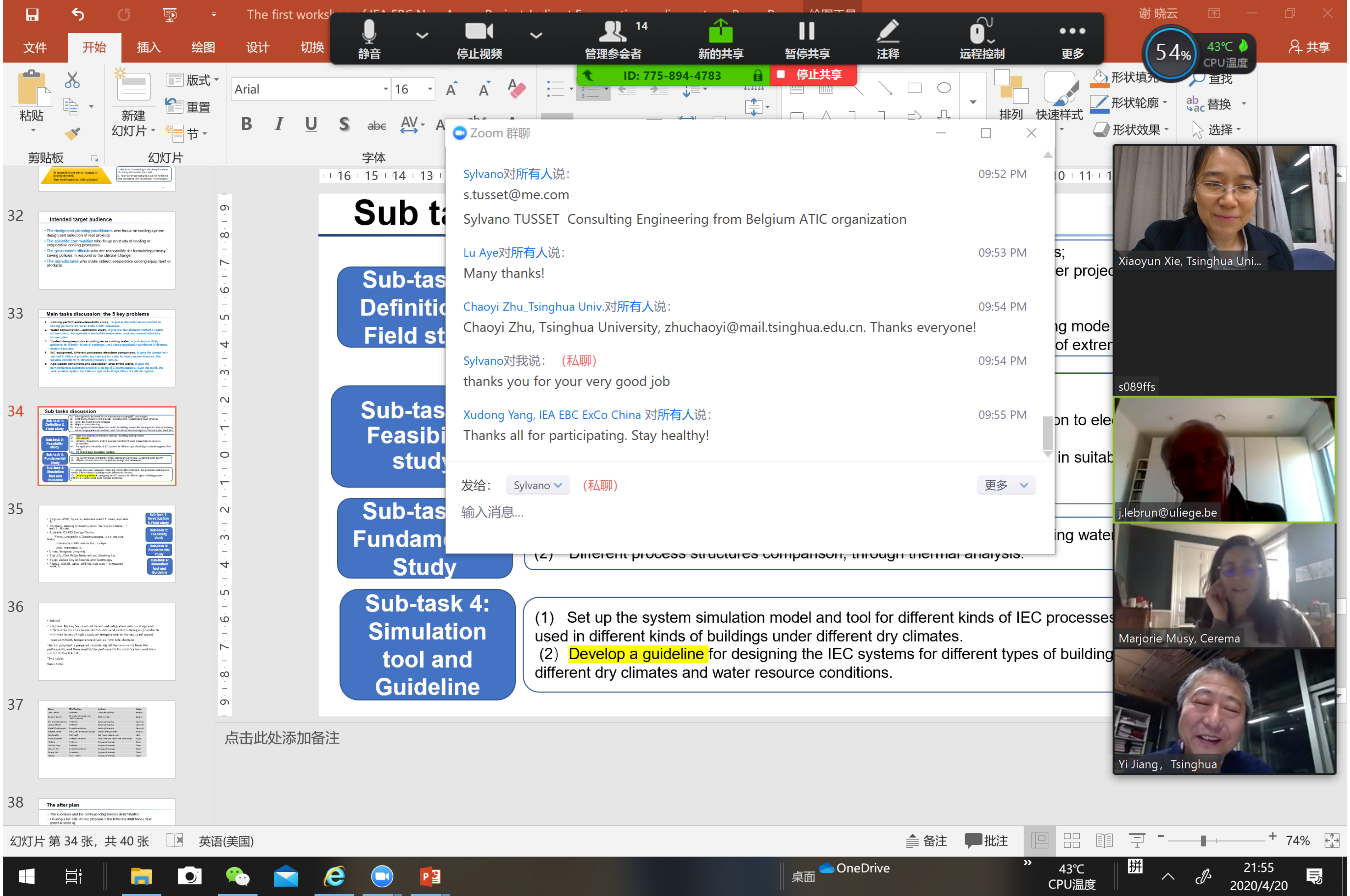
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Sylvano TUSSET Consulting Engineering from Belgium ATIC organization
Lu Aye对所有人说： 09:53 PM
Many thanks!
Chaoyi Zhu_Tsinghua Univ.对所有人说： 09:54 PM
Chaoyi Zhu, Tsinghua University, zhuchaoyi@mail.tsinghua.edu.cn. Thanks everyone!
Sylvano对我说： （私聊） 09:54 PM
thanks you for your very good job
Xudong Yang, IEA EBC ExCo China 对所有人说： 09:55 PM
Thanks all for participating. Stay healthy!
发给： Sylvano （私聊）
输入消息...
Sub-task 4: Simulation tool and Guideline
(1) Set up the system simulation model and tool for different kinds of IEC processes used in different kinds of buildings under different dry climates.
(2) Develop a guideline for designing the IEC systems for different types of building different dry climates and water resource conditions.
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