

替代制冷剂应用及提高能效的方法与途径

New Refrigerant Applications and Energy Efficiency Improvements

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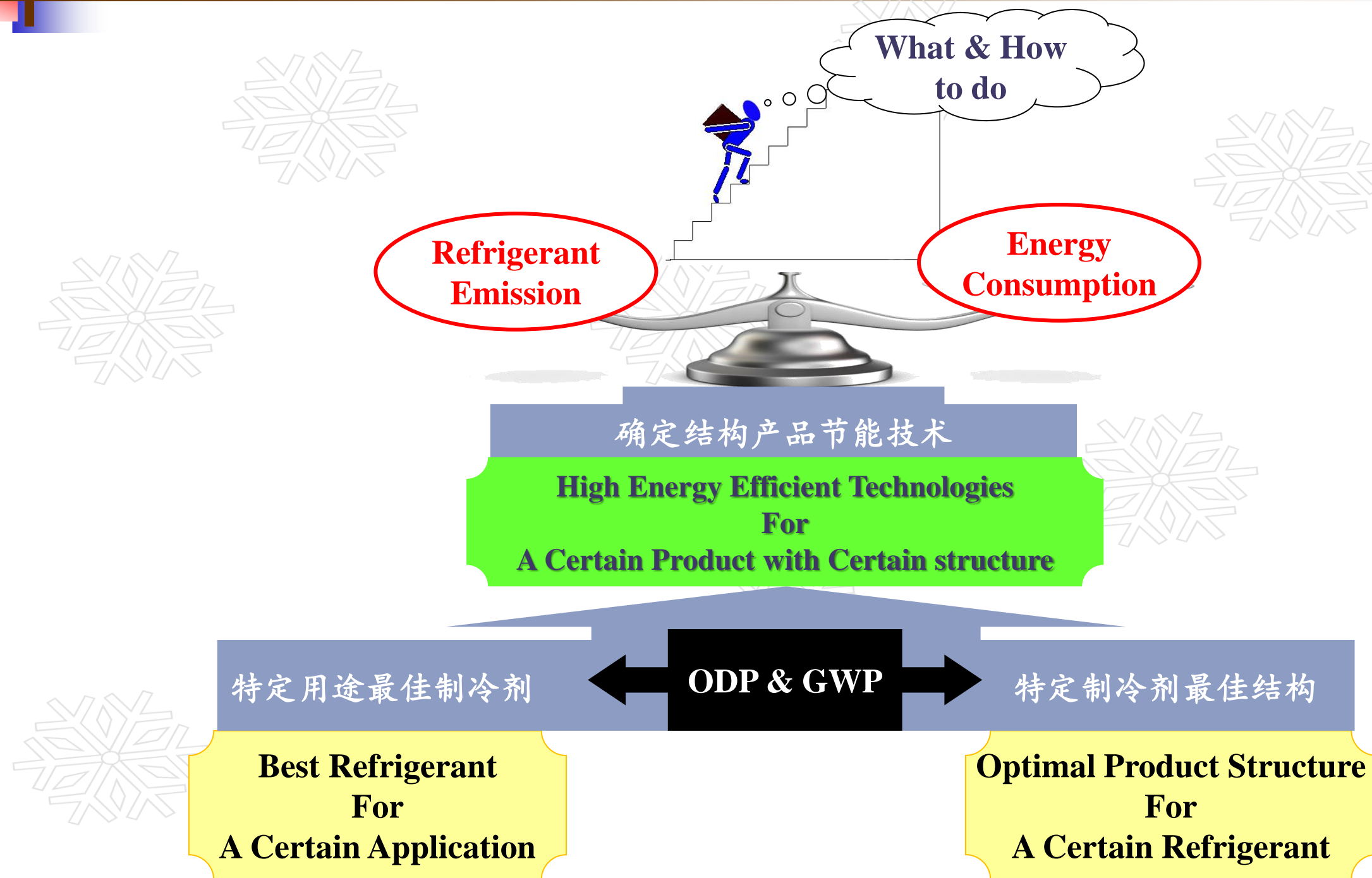
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产品结构与制冷剂的协调

Product Structures and Refrigerants



除了DDP与GWP以外

针对应用特征选择制冷剂和针对制冷剂选择产品结构是必要的

- ① 针对特定用途的制冷剂选择
- ② 针对特定用的产品结构调整

制冷剂与产品结构间的良好协调是产品性能保证的关键
The best matches of refrigerants and products are very important for the performances of products

- 制冷剂热力特性/Thermodynamic properties of refrigerants
- 用途/Usages of product
- 运行工况/Operation conditions
- 安全性/Safety
 - ☆ 可燃制冷剂更适用于封闭式结构/Flammable refrigerants prefer hermetic structures

分体空调器→窗式空调器

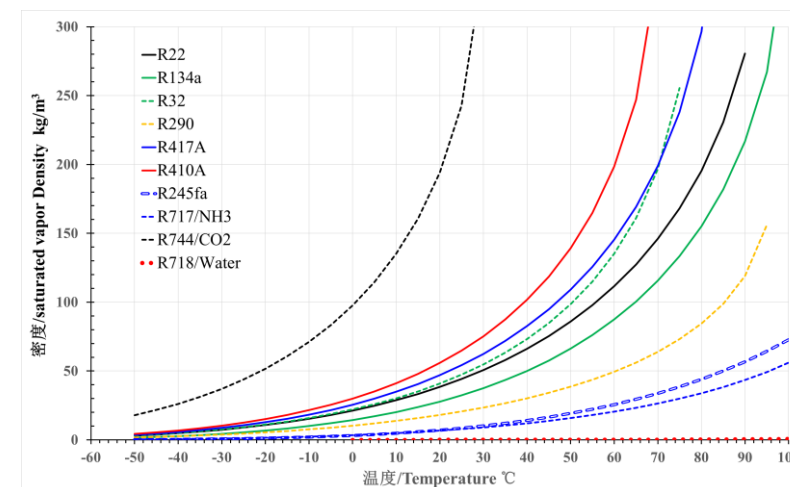
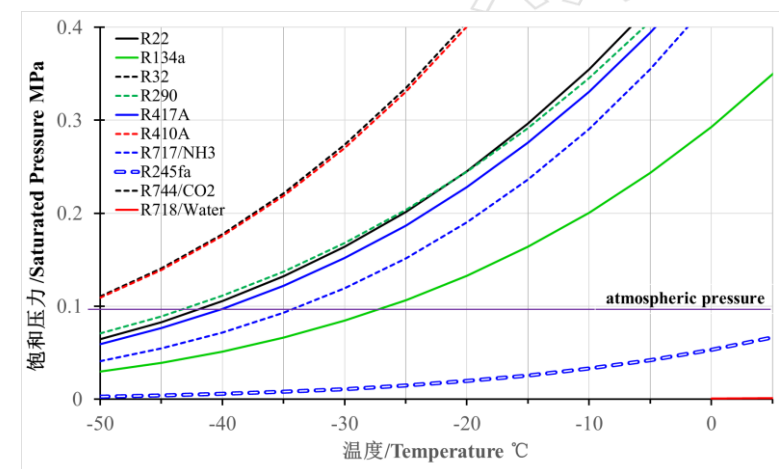
Split air-conditioners → Window type air-conditioners

多联式空调机→冷水/热泵机组

Multi-connected air-conditioning units → Water chillers/Heat pumps

Besides the essential considerations of ODP and GWP
It is important to pay attention to:

- ① Suitable refrigerant for a certain purpose
- ② Suitable product structure for a certain refrigerant

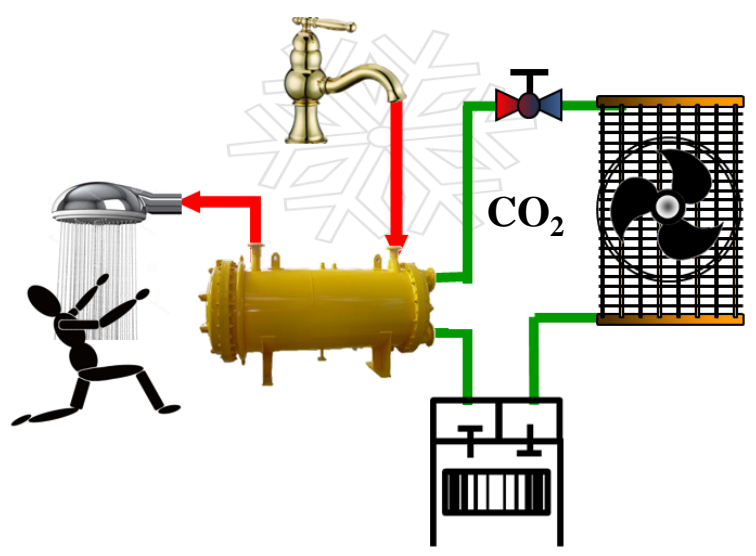


1 示例/Example

基于用途选择制冷剂

热泵热水器/Heat Pump Water Heater

最适宜制冷剂: CO₂/Best Refrigerant: CO₂



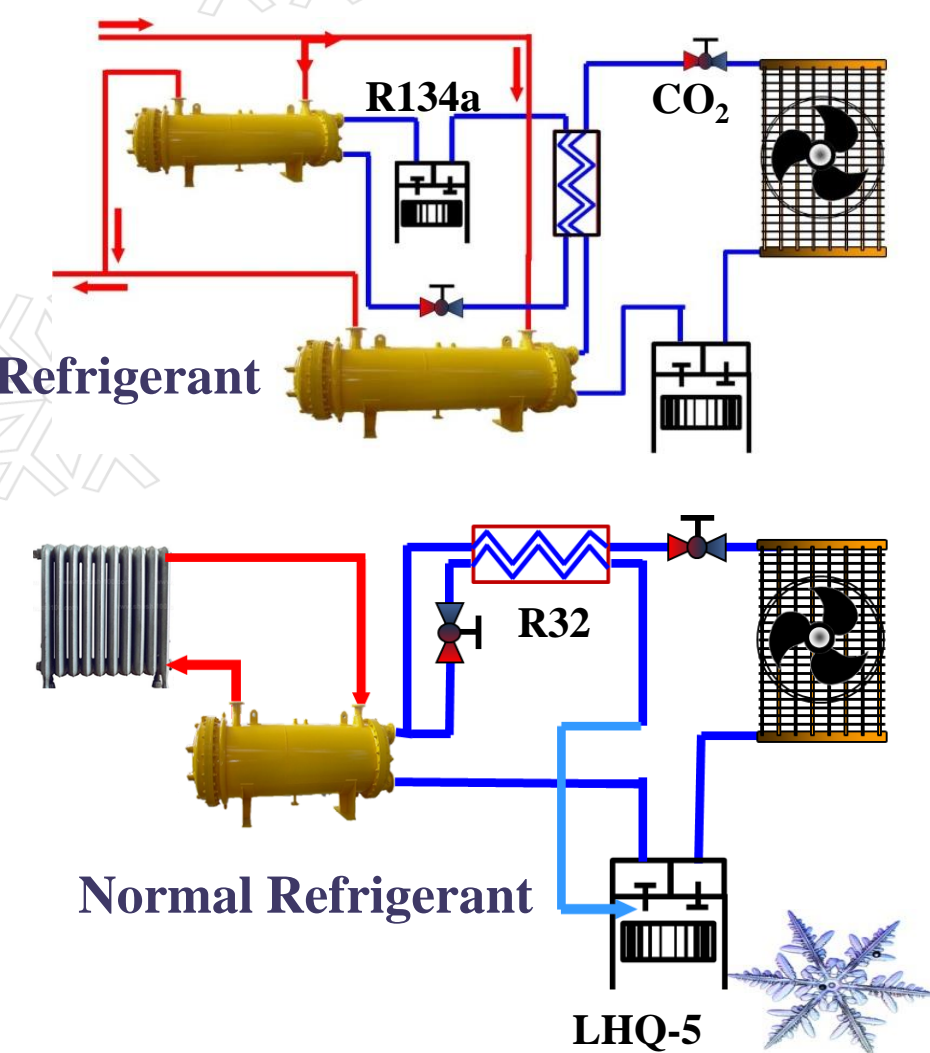
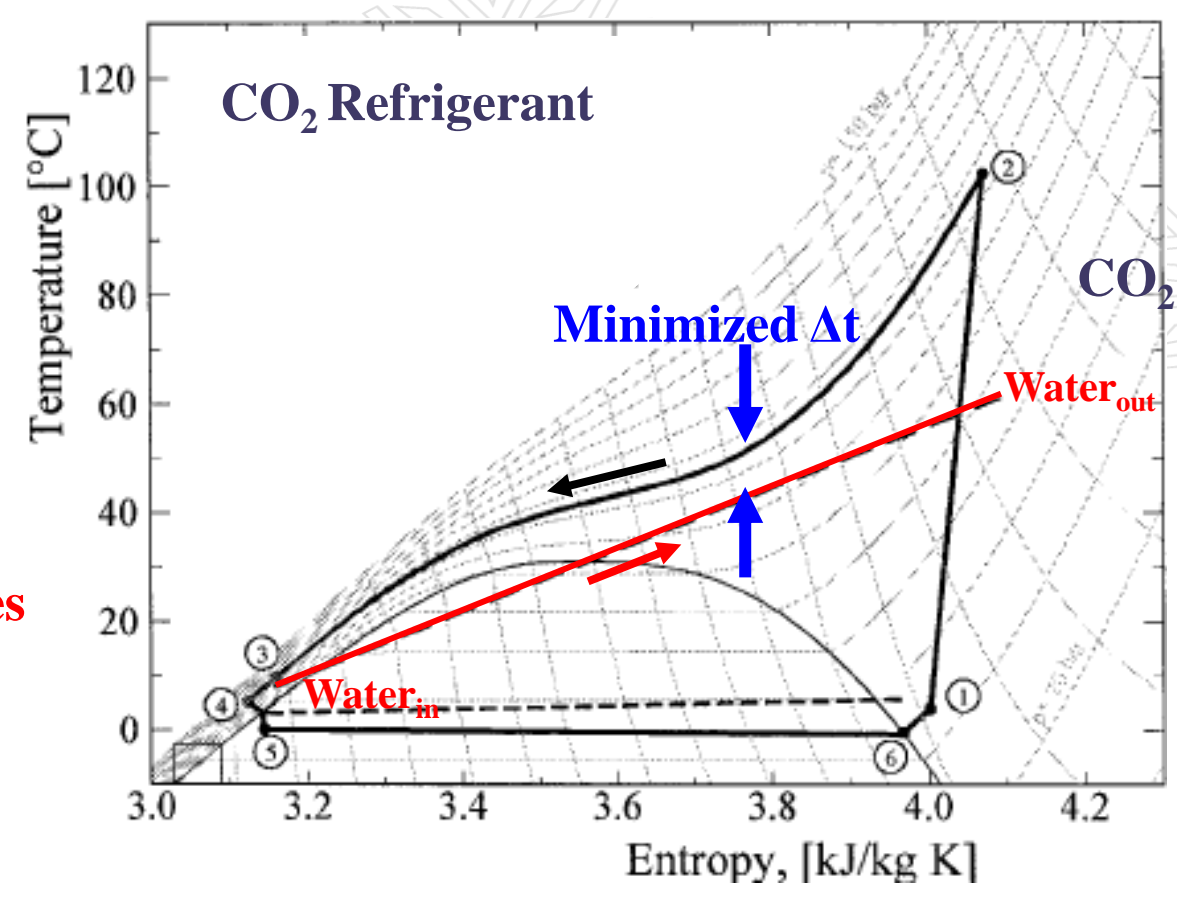
足够的经验和能力
Enough experiences and abilities
already
行业的一贯做法
We are doing it in this way

2 示例/Example

根据制冷剂确定产品结构

热泵供暖/Building Heating with CO₂ as refrigerant

最适宜结构: 复叠式/Best Structure: Cascading





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制冷空调产品及其系统节能技术

High Energy Efficient Technologies of R & AC Equipment and Systems

1. 节能技术的三个层次

3 steps to energy saving

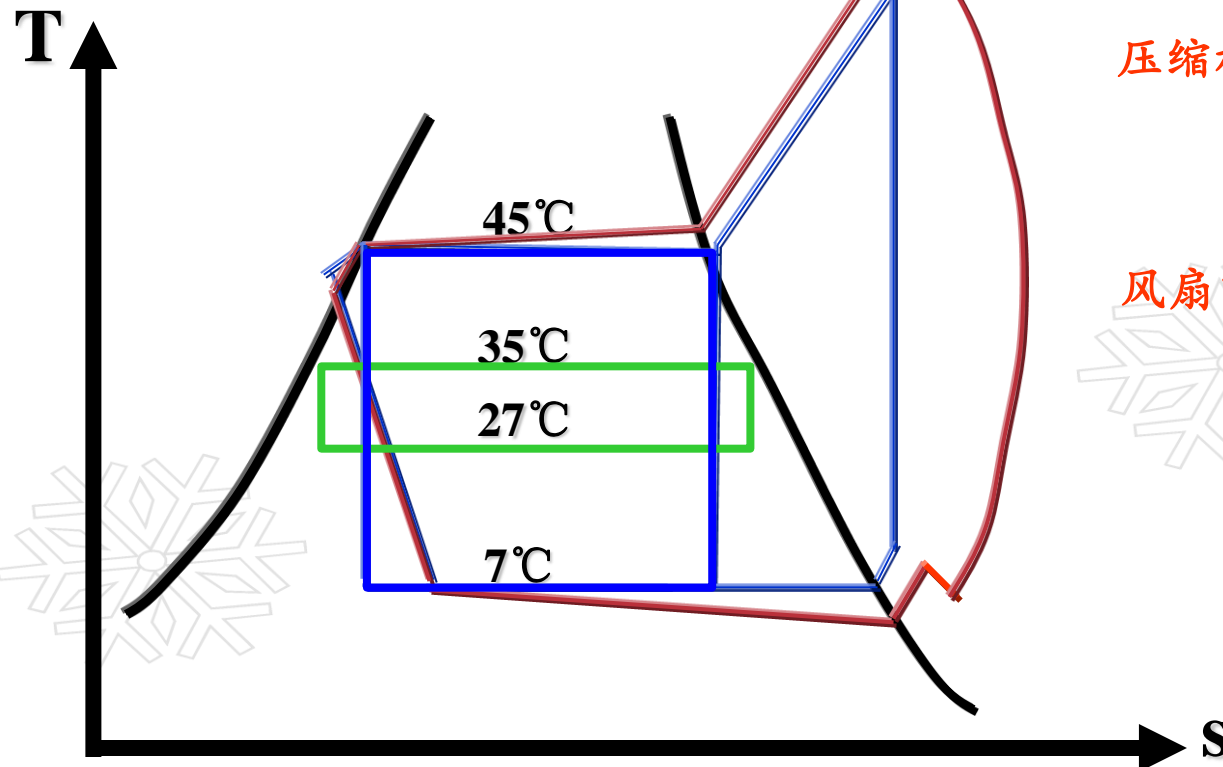
- ① 高效元器件/High EE components
- ② 系统优化设计/Optimal designs
- ③ 运行过程节能/High EE operation

2. 固定工况系统设计

System designs

- ① 设计点只能有一个

Aim at only one corking condition



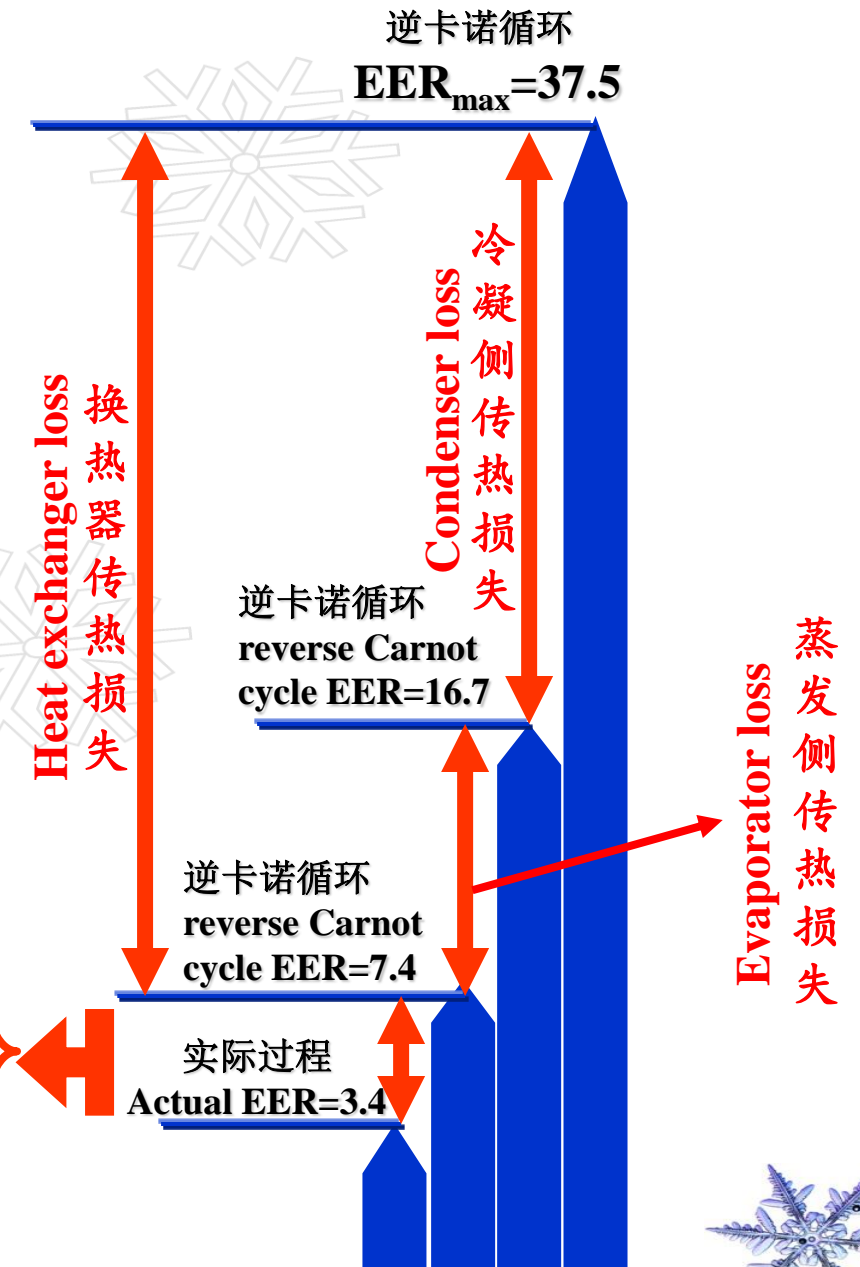
任何减少损失的措施都可以提高能效，关键在于抓住主要矛盾。

Any measure that can reduce any loss will improve performance.

The key loss recognition is most important, which changes with

- ① 不同厂家/different manufacturers
- ② 不同产品/different products
- ③ 同一产品的不同阶段/different stages of a product

压缩机损失/Compressor Loss
流动阻力损失
Flow Resistance
风扇损失/Fan Loss
风扇电机损失/Fan motor loss
吸气过热损失
Suction over-heating
表面散热损失
Surface heat transfer
电气系统能耗
Electric system loss
.....



3. 全工况系统设计

Full condition system design

- ### ① 综合考虑各方面的因素

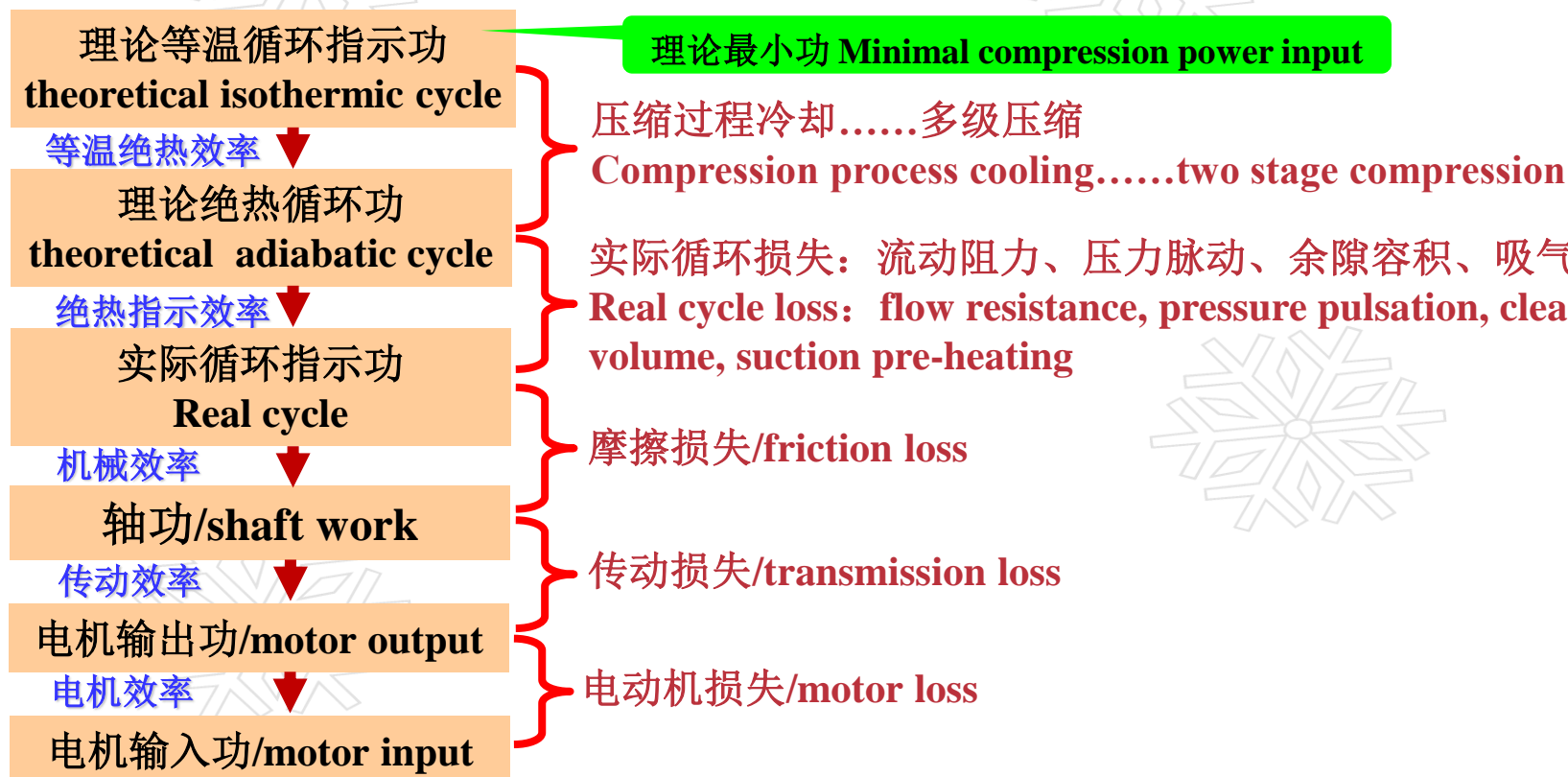
Integrated considerations of all factors

- ## ② 复杂的多变量优化问题

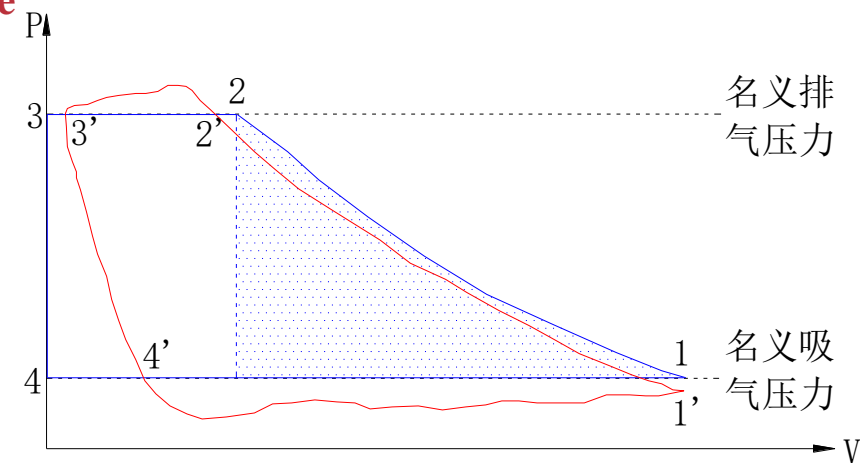
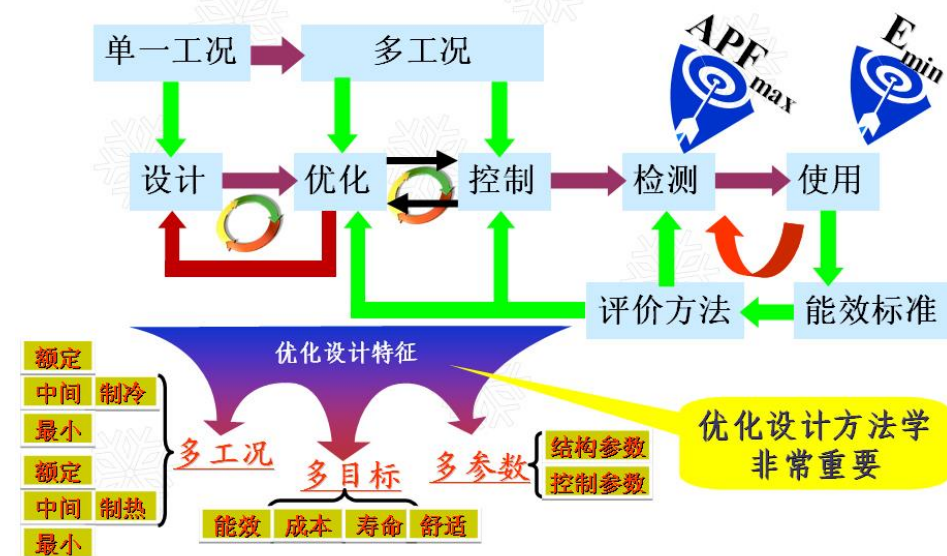
A complicated multi-parameter optimal problem

4. 部件节能/High EE components

压缩机为例/ Example: compressor



APF体系下空调器的能效与研发



4. 部件节能/High EE component
换热器为例/ Example: heat exchangers

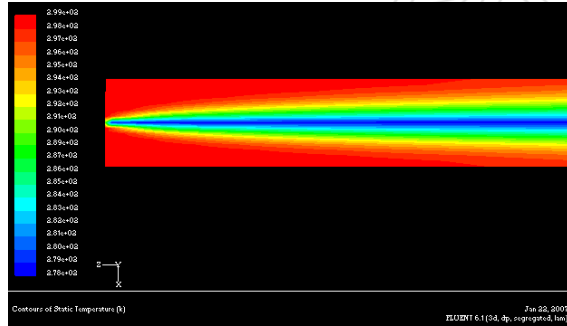
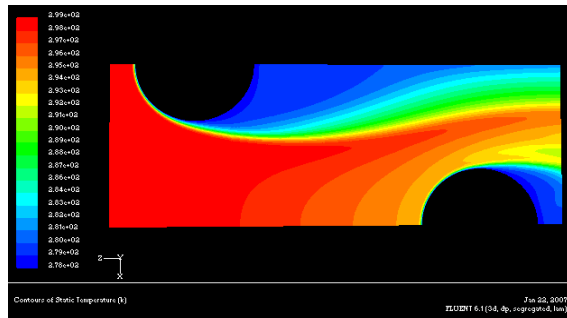
Constant $\phi = K_e \uparrow \times A_e \uparrow \times \Delta T_e \downarrow$

$$K_e = \frac{1}{\frac{1}{\alpha_1} + \frac{\delta}{\lambda} + \frac{1}{\alpha_2}}$$

制冷剂物性/Refrigerant properties
强化传热/heat transfer enhancing
微细通道换热器

Micro-channel heat exchangers

- 较高的传热系数/higher K_e
- 不增加材料消耗/less materials
- 较少的制冷剂充注量/less refrigerant charge
- 较小的流动阻力/lower flow resistance



节能技术是通用的，适用于所有制冷剂

Energy saving technologies are universal and general, no difference among refrigerants

足够的经验和能力

Enough experiences and abilities already

行业的一贯做法

We are doing it in this way

- Ø 能耗减少5%/Energy consumption decreases by 5%
- Ø 制冷剂充注量减少约30%/Refrigerant charge decreases by about 30%





5. 运行过程节能/Energy Saving in Operation

保持设备高效运行/Keep equipment Running at high Efficiency

- ① 设备安装/Equipment installation
- ② 系统设计与施工/System design & construction
- ③ 制冷剂泄漏/Refrigerant leakage
- ④ 维护保养/Servicing
- ⑤ 控制/Control
- ⑥ 运行管理/Operation management

服务行业能力与素质薄弱

Poor ability and low quality in servicing sector

目前的薄弱环节、大量的工作

Weak and short general

A long way to go

可燃制冷剂商业化应用的最大障碍

Largest barrier for the commercial applications of flammable refrigerants





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综合环境影响及评价 Integrated Environment Effect and Evaluation



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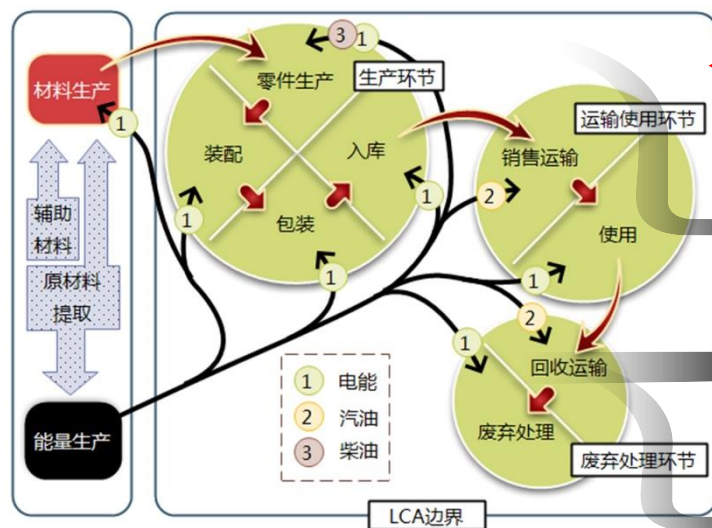
总收益
Output

使用寿命内制冷、制热总量
Total cooling & Heating amount
in life cycle

综合评价
Integrated Assessment Value

$$IAV = \frac{CSTL + HSTL}{CLA} \times 10^{-15}$$

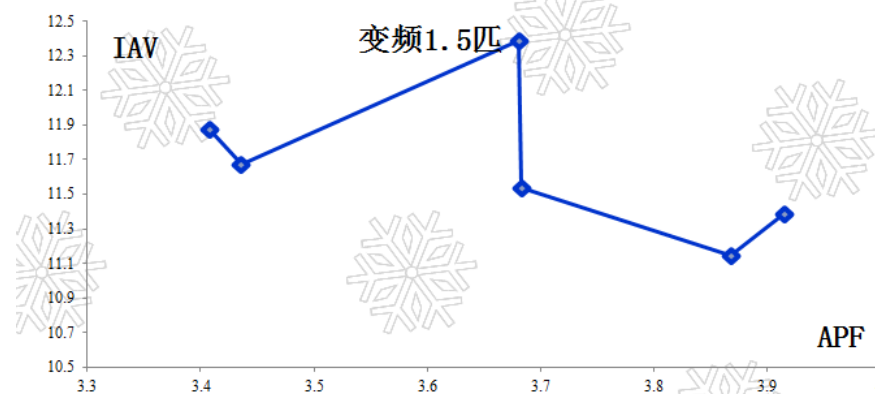
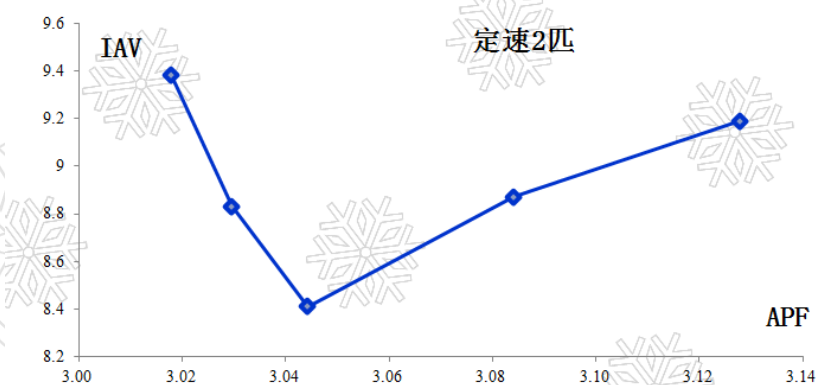
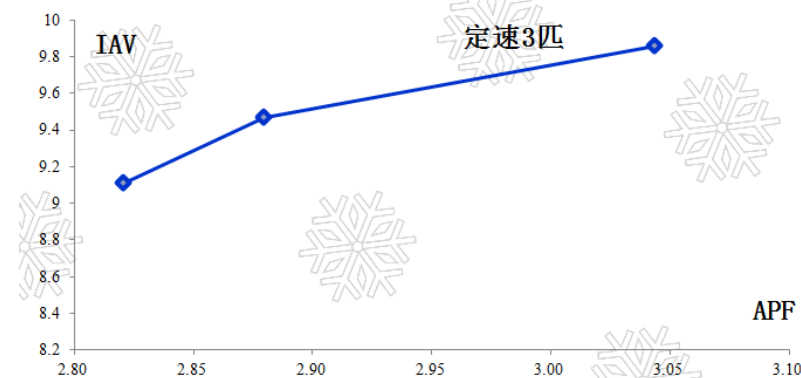
总补偿
Input



能源消耗/Energy consumption

资源消耗/Resource consumption

制冷剂/Refrigerant

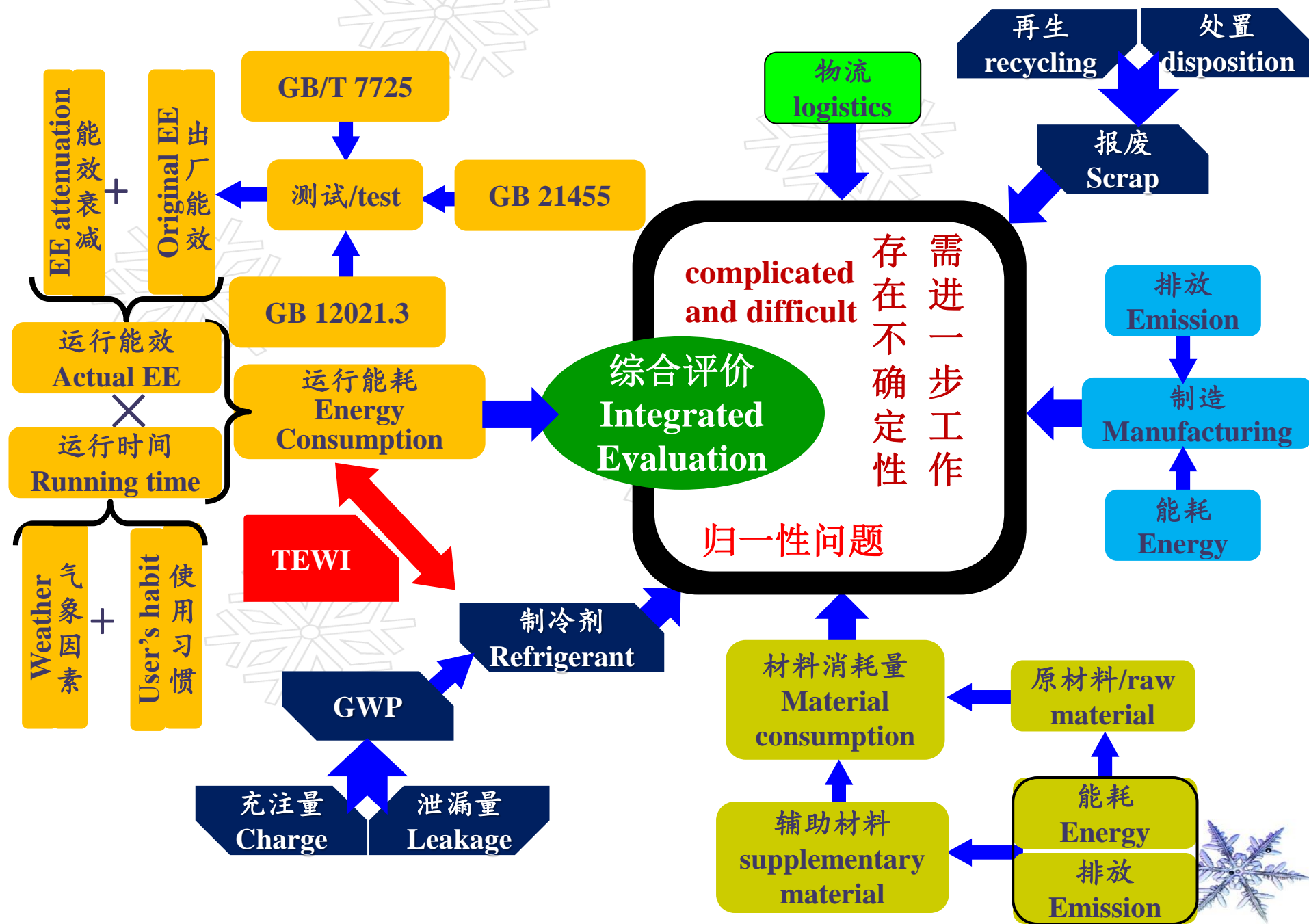


综合环境影响及评价

Integrated Environment Effect and Evaluation

综合环境影响评估 /Integrated Environment Effect and Evaluation

- ① 当前制冷空调产品能效已达到相当的程度
High EE level already
- ② 综合考虑产品全生命周期的环境影响是非常重要的
Important to evaluate overall environmental effect
- ③ 全面评估所有环境影响因素非常复杂、困难
Very complicated and difficult to cover all factors
- ④ 在制冷剂GWP和能耗方面取得平衡是可行的
But possible and necessary to set up a balance between GWP and energy consumption
- ⑤ 基于改进的TEWI评估
Evaluation based on improved TEWI method



TEWI=DE+IE

DE = GWP × [L × N + m × (1 - α)]

IE = E_{ann} × N × β = $\frac{Q}{EER} \times h \times N \times \beta$

按照固定能效和能力计算能耗不合理
unreasonable based on constant efficiency and capacity

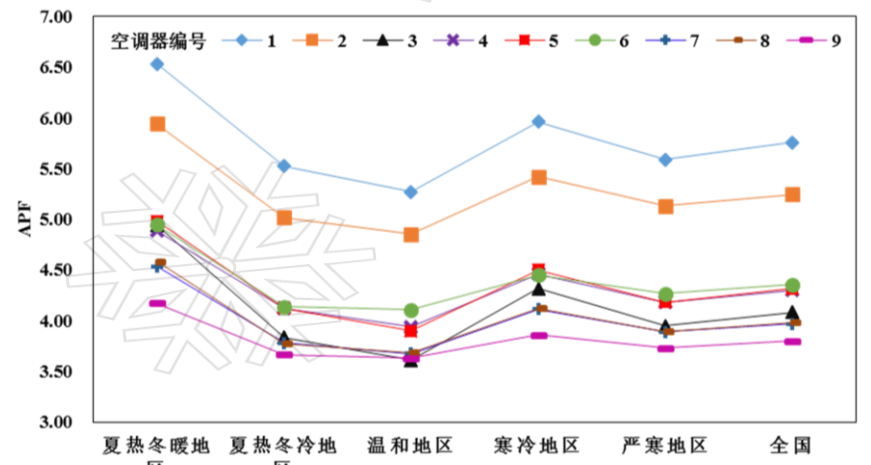


理论时间曲线APF最值

➢ APF最大差值均为夏热冬暖地区与温和地区之差，其中3号空调器最大为1.33，9号空调器最小为0.54

带来的问题

➢ 一台由全国统一的时间曲线计算APF达标的变频空调器，在个别地区实际使用时就可能会出现APF大幅下降甚至低于市场准入能效限定值，图3中的温和地区、图3中的华中地区就属于这种情况。



能耗的环境影响更大
Energy consumption usually causes more environmental effect than GWP

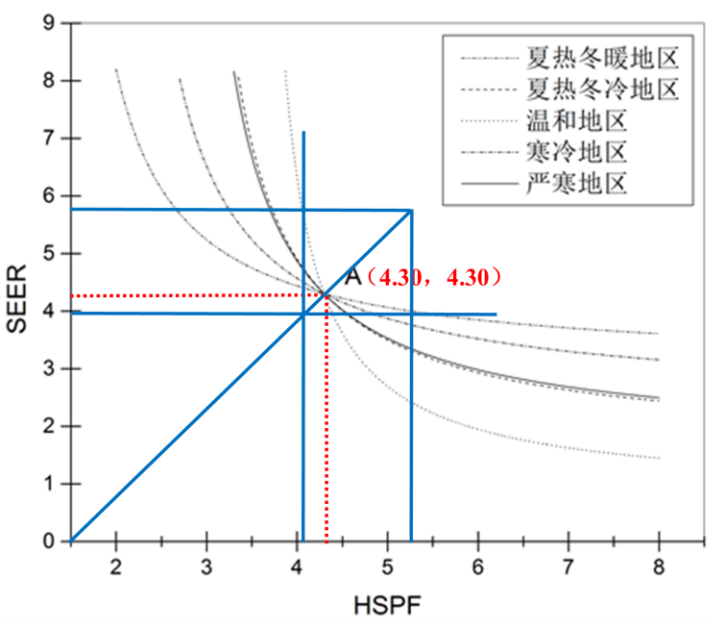


图9 理论1P机APF为4.30不同地域的SEER与HSPF关系曲线

	CSHL(kWh)	HSTL(kWh)	ATL(kWh)
夏热冬暖地区	3384.52	1399.87	4784.39
夏热冬冷地区	2207.00	3673.90	5825.90
温和地区	829.83	3535.33	4365.16
寒冷地区	1589.89	1247.27	2837.16
严寒地区	756.20	1181.23	1937.43
全国	2186.07	2658.44	4844.51
理论4号机全国APF	4.30	3.66	1.4918

SEER与HSPF的相对大小

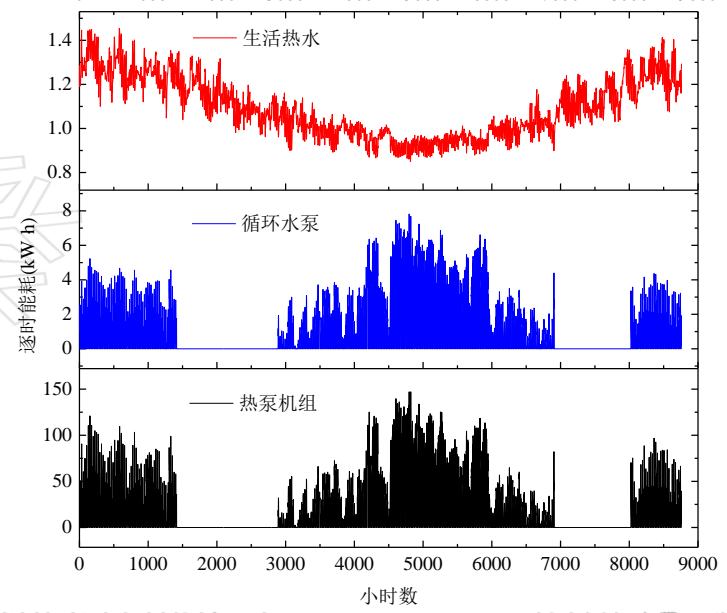
- A点上方，SEER、HSPF分别相等，HSPF、SEER值大小顺序：温和地区>夏热冬冷地区>严寒地区>寒冷地区>夏热冬暖地区
- A点下方，与上方顺序相反

形成原因

- 不同地域制冷负荷、制热负荷占全年总负荷的比例不同

对实际的指导

- 变频空调器的具体SEER和HSPF应根据生产技术现状以及成本等因素综合考虑确定。（HSPF从4.30降低至3.90降幅9.3%时，SEER从4.30飙升至7.64升幅77.7%）



该虚拟机组全年总能耗W为171471.7 kW·h，R290制冷剂充注量m为42kg。

TEWI = GWP × [L × N + m × (1 - α)] + W × N × β
= 44.1 + 1646128.32 = 1646172.42kg_{CO2}

LCCP = TEWI + (E + F) × [L × N + m × (1 - α)]
= 1646172.42 + 36.75 = 1646209.17kg_{CO2}



Refrigerant
Emission

Energy
Consumption

解决方案/solutions

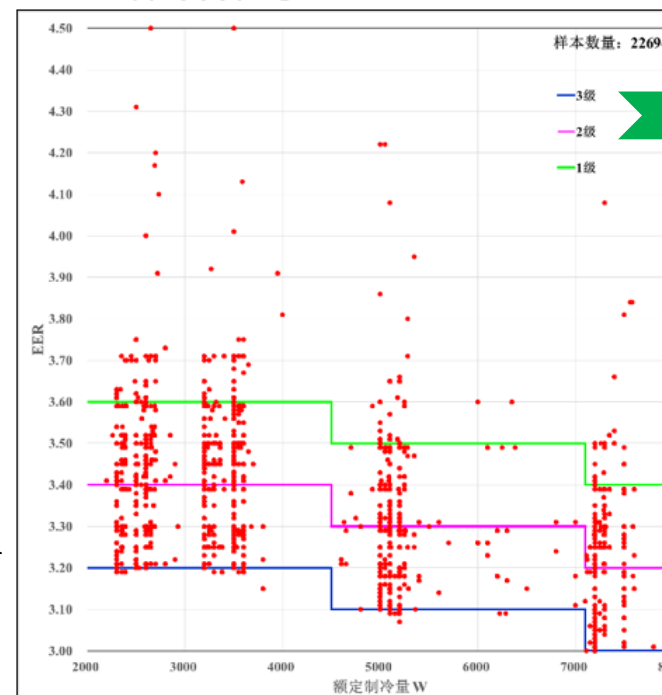
--标准改进/standard development

- ① 同时考虑制冷剂和能耗的评价方法
Cover GWP and Energy Consumption
- ② 考虑能效和能力的变化
Cover Energy Efficiency change and capacity change in product life cycle, including:
 - 气象参数（季节和地域）
meteorological conditions (season and territory)
 - 能效和能力衰减
Dropping in Energy Efficiency and

Best Way

标准巨大的推动作用

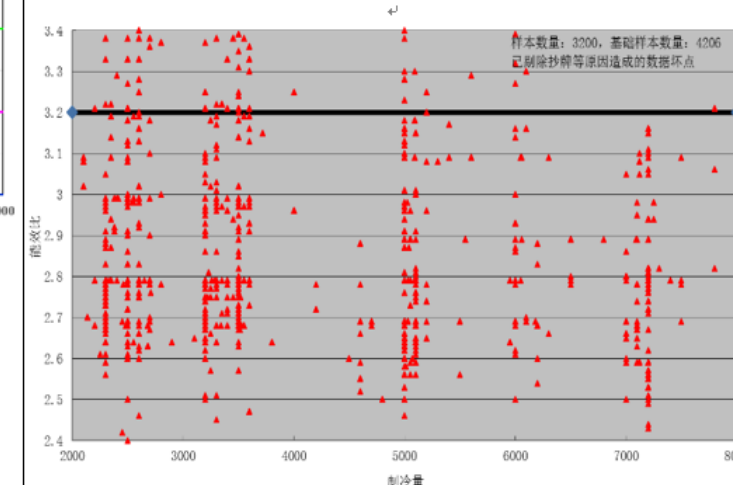
Great promotion ability of standard, example: GB 12021.3-2010



GB-12021.3-2010 实施后
After GB 12021.3-2010

More than 70% existing products then were weeded out

Before GB 12021.3-2010
GB-12021.3-2010 实施前



标准指标提升后定速空调器产品实际能效水平对比。

EE promotion of Air-conditioner EE standard, GB 12021.3-2010





谢谢、敬请赐教

Thank You!

