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R290 R&D Report

Haier Air Conditioner

Qingdao Haier Air Conditioner Gen., Corp. Ltd

June 2013

Haier空调 无氟变频 引领时代

Content

Development Of The Industry

Evaluation of R290

1、Conditions Of Use R290

2、Safety Evaluation

3、Performance Test

4、Cost Evaluation

Haier Current R&D Process Of R290

1、Haier R290 Product R&D

2、Production Line and laboratory improvement

3、Product installation and maintenance

Development Of The Industry

The Montreal Protocol
（1987）
To Protect the ozone layer

The Kyoto protocol
（1996）
To Prevent the Earth's Greenhouse Effect

Specific Refrigerant

CFC：R11、R12

（Phase out in 1996）

HCFC：R22、R123

（Phase out in 2020 for developed countries）

Which destruct the ozone layer

Alternative Refrigerant

HFC：R32、R125、R134a

R404a

R407C=R32+R125+R134a

R410A=R32+R125

With High GWP

Natural Refrigerant

R290、CO2、NH3 etc

No destruction of ozone layer and low greenhouse effect. But there exist safety and performance problems.

Low GWP Refrigerant

HFO1234yf etc

Weak combustible and

Micro Toxicity.

Europe is claim to use low GWP Hydrocarbon refrigerant ,such as R290.

From Jan.1st 2013, Europe Standard will be classified in two energy admittance criterion as the boundary of GWP = 150. The Product , whose GWP ≤150, can get 10% low than the energy access standard.

(EU) No 206/2012

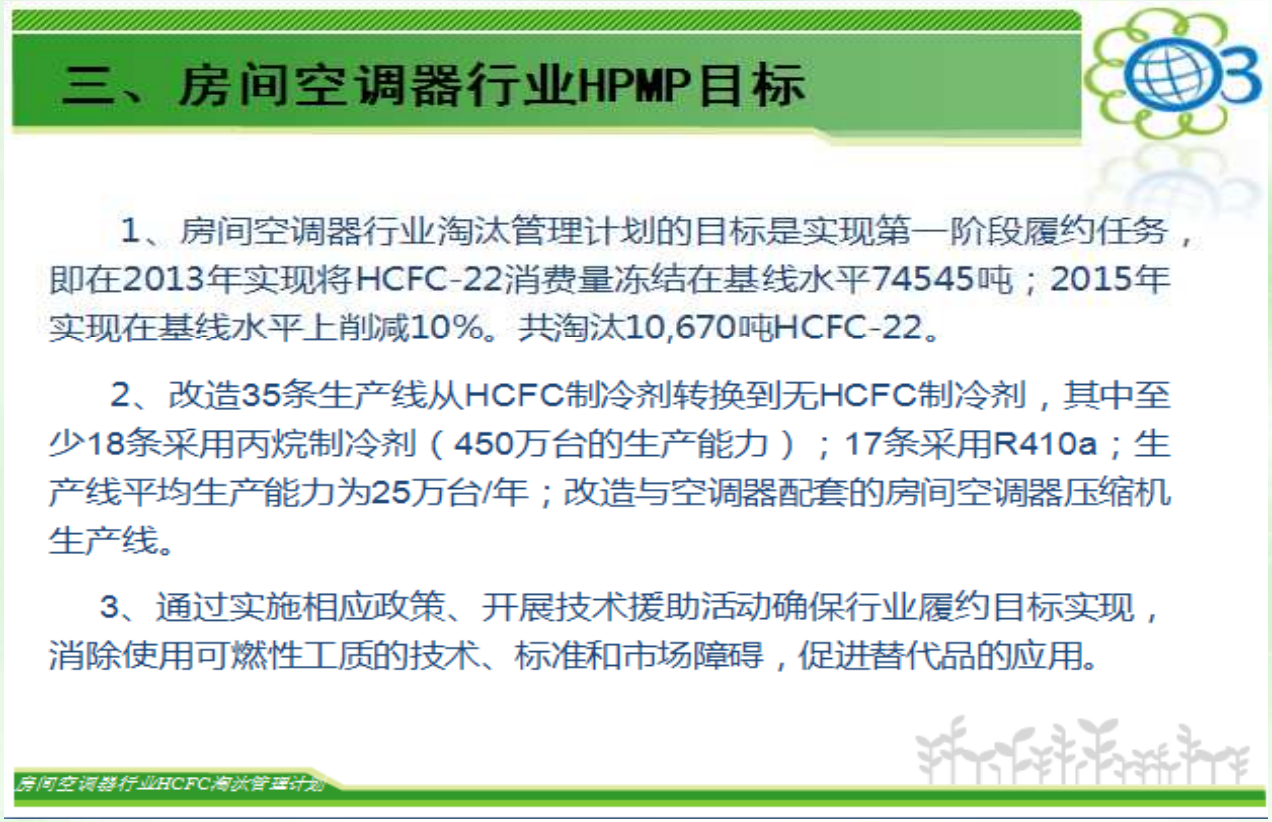
(b) From 1 January 2013, air conditioners, except single and double duct air conditioners, shall correspond to minimum energy efficiency and maximum sound power level requirements as indicated in Tables 4 and 5 below, calculated in accordance with Annex II. The requirements on energy efficiency shall take into account the reference design conditions specified in Annex II, Table 3 using the 'Average' heating season where applicable. The requirements on sound power shall relate to the standard rating conditions specified in Annex II, Table 2

Table 4

Requirements for minimum energy efficiency

	SEER	SCOP (Average heating season)
If GWP of refrigerant > 150	3,60	3,40
If GWP of refrigerant ≤ 150	3,24	3,06

In order to accelerating elimination of HCFC22, The Ministry of Environmental Protection of China and China Household Electrical Appliance Association worked out HPMP (HCFC22 Elimination Plan)for room air conditioner . And China also encouraging the low GWP Refrigerant development and production.



The new safety standard came into effect on May 1st 2013, which add the flammable refrigerants items, and speed up the usage of R290 process.

Evaluation of R290

1、 Conditions Of Use R290

Safety	Non-toxic; Low risk of combustion
Environmental	0DP=0、GWP≤150
Performance	High efficiency and good social benefits
Economic	Competitive Cost

2、Safety Evaluation

Following tests , which the air conditioner unit using R290 ,are conducted by Tianjin Fire Controlling Research Institute under The Ministry of Public Security of the People's Republic of China.

1) Leakage concentration Test

2) Combustion Test

3) Compressor with mixed air Test ,

All the above tests to evaluate the possibility and relevant results of fire or explosion accident during the air-conditioner unit operation ,installation and maintenance.

3 R290泄漏后的浓度实验

公安部天津消防研究所

3.6 R290泄漏实验结论

（1）泄漏口的位置、方向对房间内浓度的分布有很大影响。当泄漏口直吹向浓度传感器时，在泄漏过程中会达到R290的爆炸下限（2.1%）。

（2）空调室内机背部连接头泄漏一般不会对传感器直吹，因此实验过程中距离墙壁10cm的区域外、1.5m高度上较难达到R290的爆炸下限。室内机蒸发器的泄漏口有可能形成直吹，在空调器侧下方会达到R290的爆炸下限。

3 R290泄漏后的浓度实验

公安部天津消防研究所

3.6 R290泄漏实验结论

（3）空调室内机背部连接头泄漏时，R290会沿着墙壁下降，泄漏过程中地面浓度首先上升，之后上部传感器浓度上升。

（4）R290泄漏停止后，浓度会逐步下降，房间内浓度逐步趋向一致。约1小时后下降至0.5%左右，长时间静置后R290并未在地面上出现明显沉降，而是逐步扩散至浓度一致。

3 R290泄漏后的浓度实验

公安部天津消防研究所

3.6 R290泄漏实验结论

（5）蒸发器的泄漏能更快达到最大浓度。

（6）在没有直吹的情况下，房间能达到的最大浓度（Cmax）与泄漏速度没有明显的关系。浓度上升速率（dC/dt）与随泄漏时间影响的增加而减小。

1）Conclusion Of Leakage Concentration Test

It will reach the R290 explosion lowest point during the leakage. Here are the test report from Tianjin Fire Controlling Research Institute.

2）Conclusion on Combustion Test

It will combustion and explosion in the very limited space .Here are the Test report by Tianjin Fire Controlling and Research Institute.

4 燃爆实验

公安部天津消防研究所

5	HFC-161	h=0cm，$L_{空}$=42cm，$L_{管}$=68cm	383g	190s	泄漏后立即点火，之后每隔30s点火5s，持续30min	否	
6	R290	h=160cm，$L_{空}$=11cm，$L_{管}$=65cm	382g	192s	泄漏中一直点火	是	关闭气源时，出现燃爆现象，持续1-2s，见文件
7	R290	h=160cm，$L_{空}$=11cm，$L_{管}$=65cm	381g	427s	泄漏中一直点火，泄漏停止后每隔30s点火一次，持续10min	否	
8	R290	h=50cm，$L_{空}$=10cm，$L_{管}$=65cm	382g	427s	泄漏中一直点火，前4min，点火10s，停顿5s，后3min一直点火	否	

4 燃爆实验

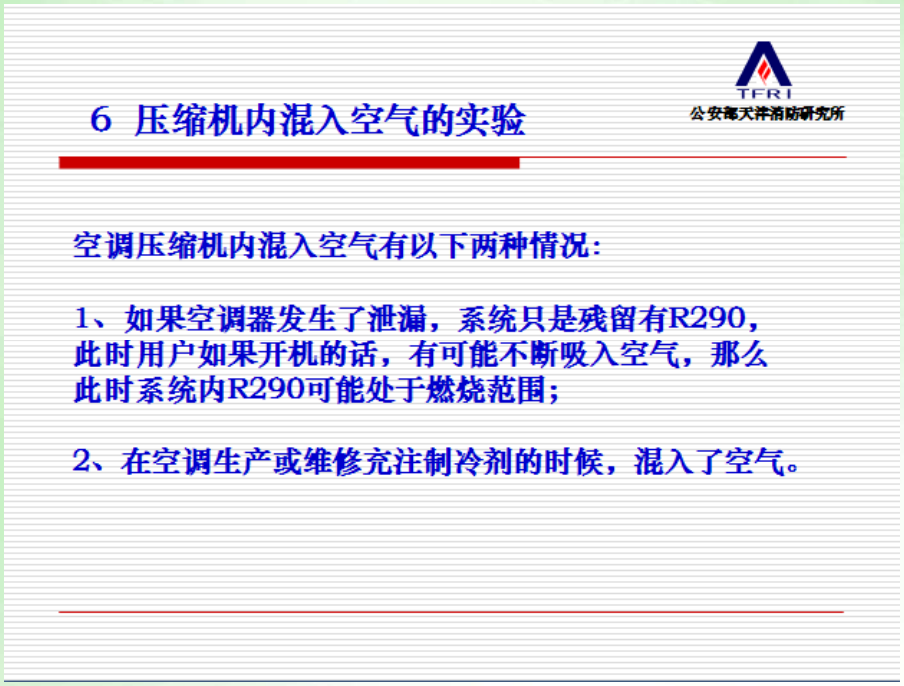
公安部天津消防研究所

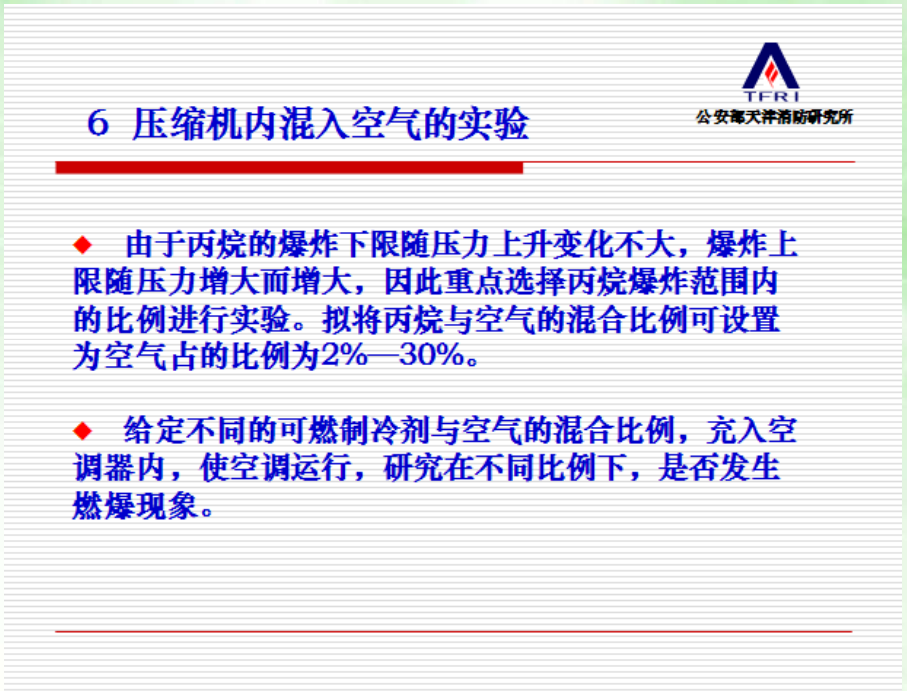
初步结论：

- 影响浓度分布的最主要因素为泄漏口朝向；
- 制冷剂泄漏后在朝向很窄范围内会超过爆炸下限；
- 如泄漏过程中不能发生燃爆，那么泄漏停止后更难发生燃爆；
- 泄漏后长时间静置，不会在地面形成明显沉降，并形成爆炸混合物；

3) Conclusion of Compressor with mixed air Test ,

The Institute have been evaluating the test with below information :

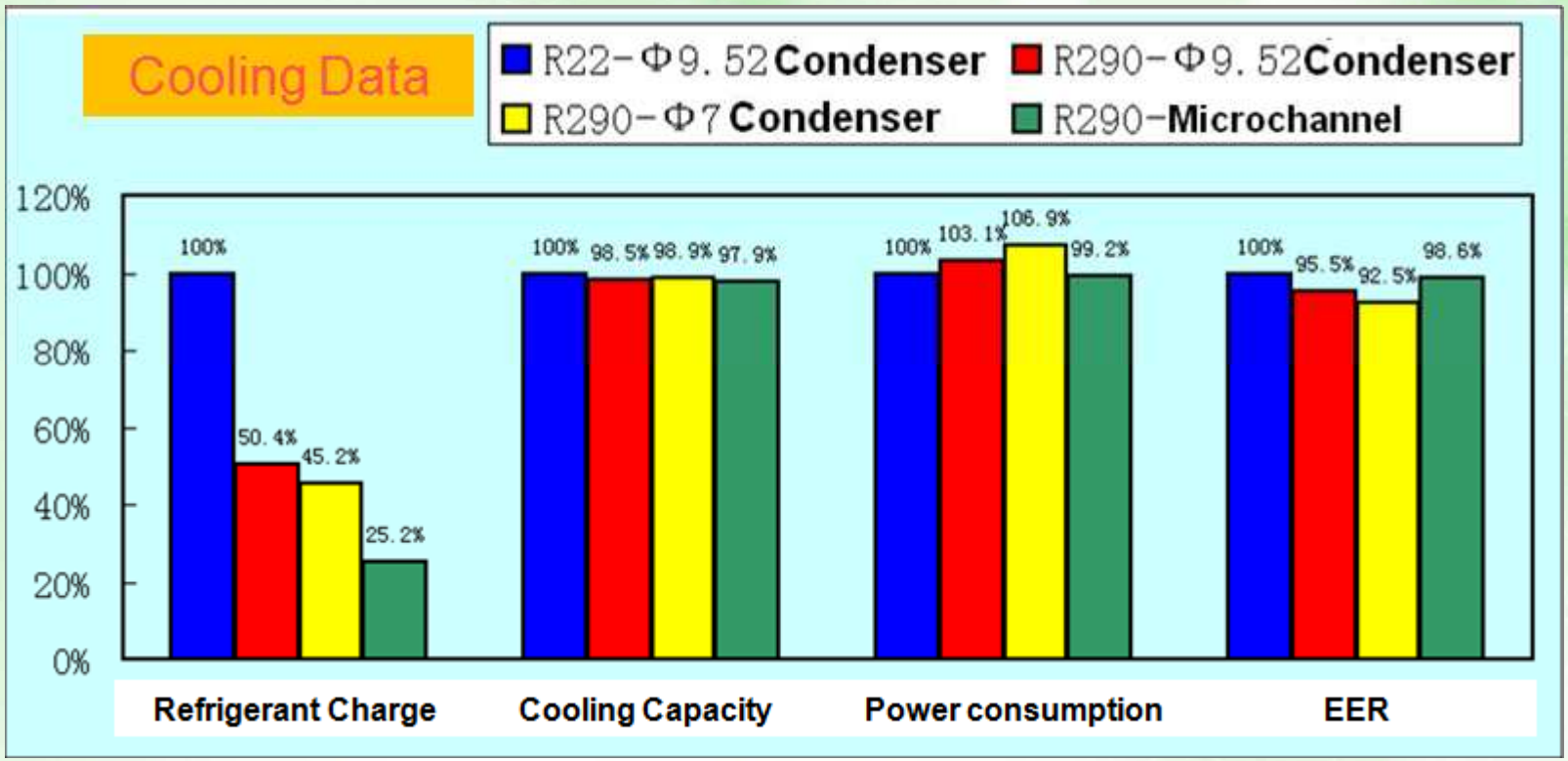




R290 might cause air conditioner fire or explosion , but still with low possibility. So which need to control the product design, production, storage、transportation and installation strictly。 And also the worker personal qualification and relevant training is necessary。

3、Performance Test

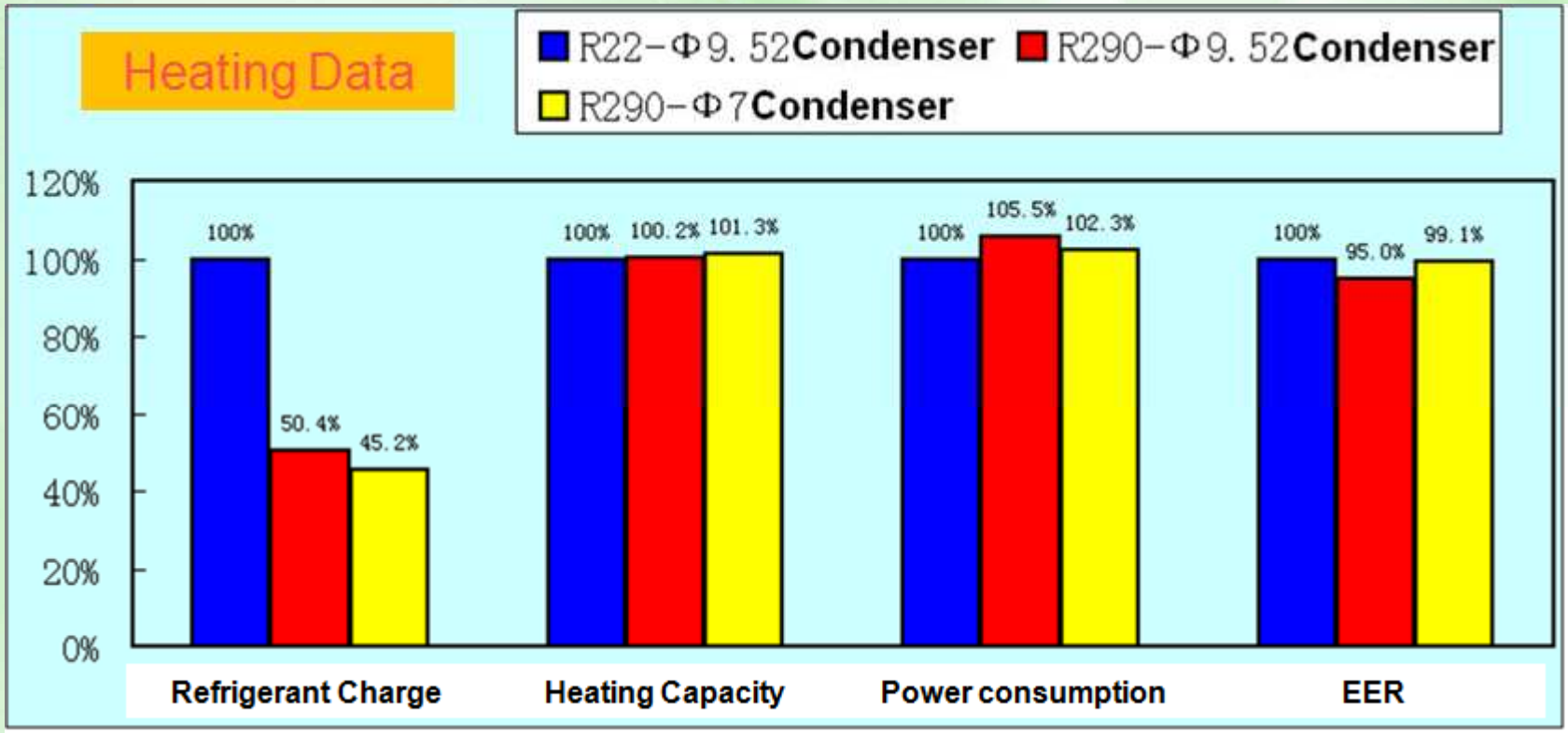
1）Test result of wall-mounted split unit 12,000BTU: Data contrast of Cooling Operating



With the same system, The Unit with R290 cooling capacity decreased around 2% and power consumption increase about 5% and EER decrease 5% if compare to R22.

Conclusion ： The cooling capacity with R290 is lower than the one with R22。

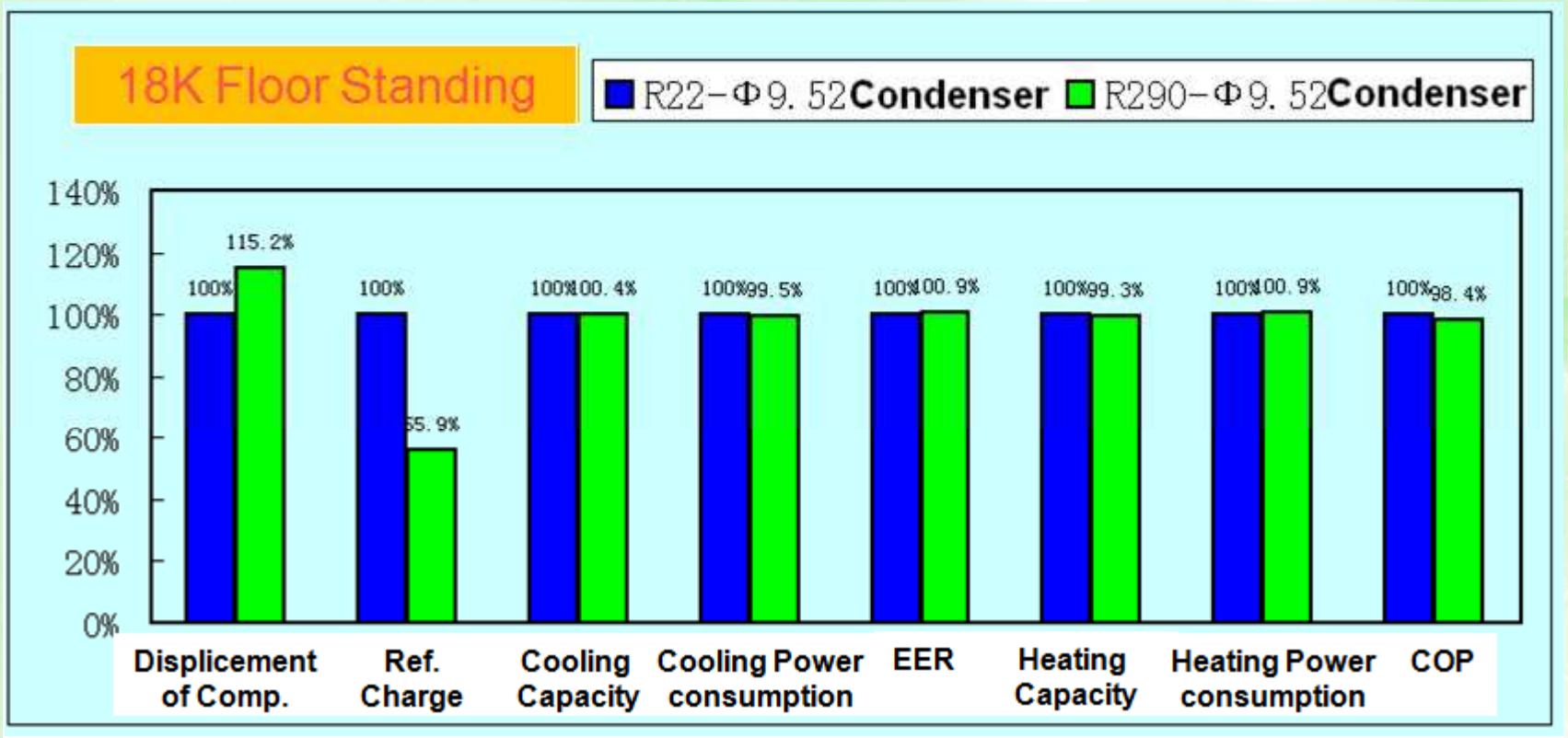
2）Test result of wall-mounted split unit 12,000BTU: Data contrast of Heating Operating



With the same system, The Unit with R290 Heating capacity almost same as R22， but power consumption increase 5% and EER decrease 5%。

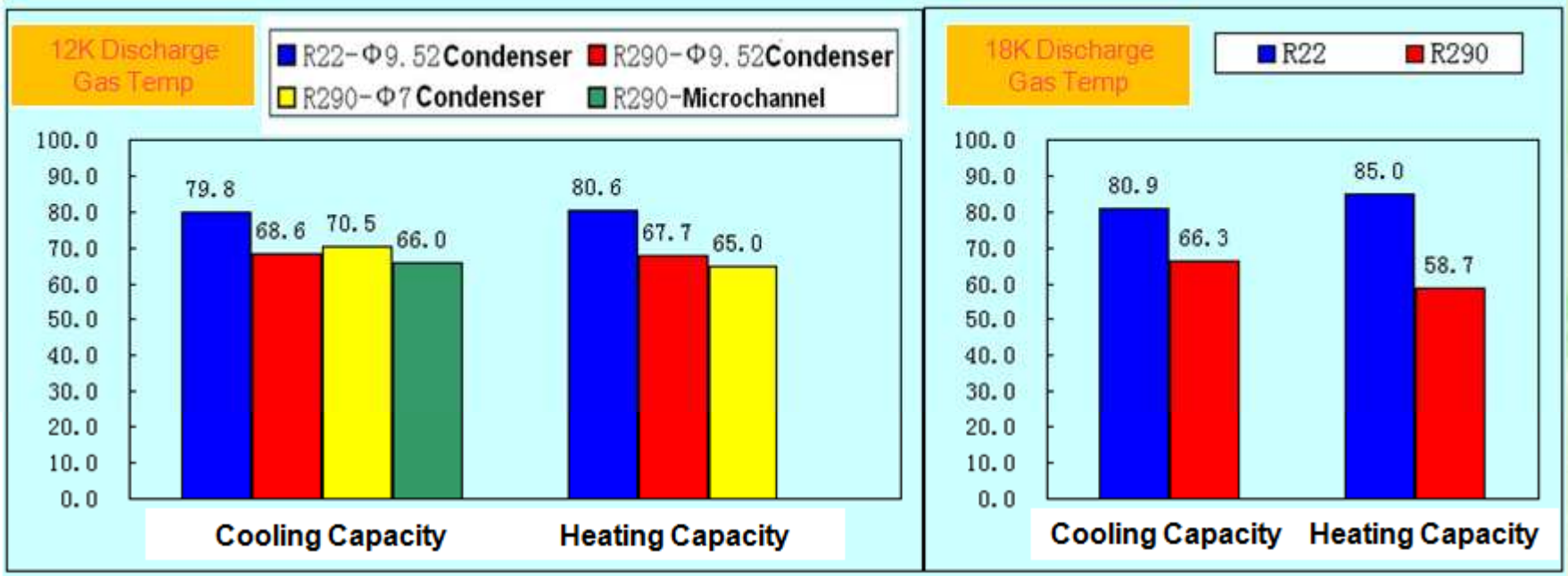
Conclusion ： The Heating capacity with R290 also lower than the one with R22。

3）Test result of Floor Standing unit 18,000BTU: Data contrast of Cooling and Heating Operating.



With the same system, The floor standing unit with R290 Heating and Cooling capacity、power consumption and EER are almost same。While according to refrigerant charging stipulated in IEC60335, The unit over 5KW can not use R290.

4）Discharge gas temp and worst working condition



The discharge gas temperature of R290 is apparently lower than R22, which better for overload operation。 Under max cooling operation condition， the discharge gas temp of 2HP with R290 is only 80.2 ℃ ,which lower 15 ℃ than the one with R22.

In the worst working condition（outside temperature over than 53 ℃），the discharge gap temperature just 84.5 ℃ and the unit with R290 still can work normally。

4、Cost Evaluation

1）、 Refrigerant Module

① Compressor：12,000BTU will increase 3.5 USD

② Condenser ： 12,000BTU will decrease 1.4 USD

③ Refrigerant： 12,000BTU will decrease 1.6 USD

2）、Electrical Module

① Sensor：new sensor for R290 cost will increase 3.5 USD

② Electrical box：add air-tight and anti-explosion structure， the cost will increase about 2.5 USD.

③ Electrical parts will use high safety standard and anti-explosion material, total cost will increase 2.5USD..

Conclusion: Total 12000BTU FG set cost will increase around 9 USD.

Haier Current R&D Process Of R290

1、Haier R290 Product R&D

① 9,000BTU and 12,000BTU cooling only non-inverter model with R290 refrigerant already finished developed

② 9,000BTU and 12,000BTU Heating non-inverter model with R290 refrigerant already finished developed

③ 9,000BTU and 12,000BTU inverter model is under developing.

Haier Current R&D Process Of R290

2、Production Line and laboratory improvement

①One RAC production line and laboratory in Chongqing manufacturing factory already completed.

②Anther two production lines and laboratories have been improving in Jiaozhou manufacturing factory

3、Product installation and maintenance

Haier already organized to formulate relevant air-conditioner installation and maintenance safety manual，according to our China standard and actual current situation。

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Thanks ！