Seasonal Applicability of Refrigerant Release Technology in Room Air Conditioner

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- Principle of suction gas release
- Experimental performance at the rated conditions
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Background: working conditions

- Summer: AC always works in a lower outdoor temperature.
- Winter: AC works in a lower and higher outdoor temperature environment at most of time.

Annual outdoor temperature of four cities of China

Design Temperature of cooling

Design Temperature of heating
AC: system compression ratio & capacity needed

- **Summer:**
  - load < rated capacity
  - system compression ratio < inner compression capacity

- **Winter:**
  - load <> rated capacity
  - system compression ratio <> inner compression capacity
Loss and efficiency of scroll compressor

Under/over compression loss due to mismatch of inner / system compression ratio is the main factor decreasing seasonal performance of air conditioner using scroll compressor

Adjusting ICR is the key of seasonal performance enhancement!
One of solutions

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Intermediate gas bypass (release)

- **Discharge gas bypass**
  - Release to the high pressure side
  - For IVR adjustment
  - Using simple reed valve
  - No change to capacity
  - Applied

- **Suction gas bypass**
  - Release to the low pressure side
  - For capacity modulation
  - Complex control mechanism
  - Also can change the IVR
  - Still not applied

*IVR: inner volume ratio*
Suction gas release

Method

Part refrigerant in compression chamber return to inlet of compressor
Working principles

- Effective refrigerant in the system $\downarrow$ $\rightarrow$ Heating and cooling capacity $\downarrow$
- Release before compression $\downarrow$ $\rightarrow$ Power consumption of compressor $\downarrow$
- Inner discharge pressure (end pressure in compressor chamber) $\downarrow$ $\rightarrow$ Over-compression loss $\downarrow$
Experiments: working points

- Heating and cooling capacity decreased 26.6% and 31.4%
- Heating and cooling efficiency ↑ by 41.8% and 45.4%
- More efficient for small system compression ratio conditions
How about the seasonal performance?

Method

Input building, weather, etc info

Calculate the hourly load

Operation and control strategy

Build the model of air conditioner without release

Build the model of air conditioner with release

System model

Compare

Seasonal performance of AC without release

Seasonal performance of AC with release
Operation and control strategy

➢ For regular air conditioner:
  ✓ No release refrigerant under any conditions
  ✓ On-off control to match the capacity and load

➢ For air conditioner with suction gas release function:
  ✓ Adjust the opening of the valve to change the inner compression ratio to match the system compression ratio
  ✓ On-off control to match the capacity and load
Seasonal performance: working hours

(a) cooling

(b) heating

Operation hours of the air conditioner in different buildings
Seasonal performance: energy consumption

Seasonal energy consumption of air conditioner with and without refrigerant release

(a) cooling

(b) heating
Seasonal performance: energy saving

Annual energy saving ratio
Remarks

✓ Suction gas release can unload the capacity of the scroll compressor and decrease the over-compression loss
✓ Room air conditioner needs to decrease the capacity and inner compression ratio at the same time during the working season
✓ Suction gas release is quite suitable for room air conditioner and should be considered in the energy-saving of RAC
Thanks! Questions?