Impact of Environmental Factors on Energy Efficiency of Room Air Conditioners in India

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Introduction

• Room ACs contributed 30-40% of cooling energy consumption in 2017-18, expected to rise to 50% by 2037-38

• Annual RAC sales have increased rapidly to 7.6 million in 2017 resulting in energy consumption

• RAC ownership expected to rise to 30-40% by 2037-38

• Key drivers urbanization, increasing cooling degree days, rising incomes

• Efficiency one of the cost effective solutions to curb the growing demand
Standards and Labeling Program

- **2001**
  - Energy Conservation Act launched

- **2002**
  - Enactment of the Act
  - Establishment of Bureau of Energy Efficiency (BEE)

- **2006**
  - First voluntary program for RACs launched

- **2009-2016**
  - RAC made mandatory and revision in 2012, 2014 and 2016
  - Voluntary inverter AC launched
  - Transition from EER to ISEER metric

- **2018**
  - Revision & common rating plan

*23 appliances under labeling, of which 10 under mandatory phase*
Rationale for the study

• Products are tested under standard testing conditions in test labs to participate in the program

• In real life conditions, ACs are exposed to adverse climatic conditions

• **Objective**
  
  To assess the impact of environmental factors on the efficiency of RACs, expose the products to climatic conditions

• **Scope**
  
  Unducted single split/window AC units including fixed and variable capacity
Approach and Methodology

- Identify national/international test standard for environmental and energy performance testing
- Identify a nationally accredited test lab for testing
- Prepare sampling plan comprising of major brands, categories, types, capacities and heat exchangers
- Following a stepwise approach for testing:

  Establish baseline efficiency

  Subject samples to environmental conditions (such as corrosive, dusty and saline)

  Conduct performance tests again and assess change from baseline
Environment and Efficiency Test Standards

Environmental Tests

• IS 9000 part XII for dust test
• IS 9000 part XI as per procedure 3 for salt mist test
• IS 9000 part VI (10 cycles) Composite temperature/humidity cyclic test

Efficiency Tests

• IS 1391 part 1 for unitary ACs
• IS 1391 part 2 for split ACs
## Sampling plan

<table>
<thead>
<tr>
<th>Type of test</th>
<th>Type of AC</th>
<th>Heat Exchanger</th>
<th>No of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dust test</td>
<td>Window</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (fixed speed)</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (Variable speed)</td>
<td>Aluminum</td>
<td>2</td>
</tr>
<tr>
<td>Salt mist test</td>
<td>Window</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (fixed speed)</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (Variable speed)</td>
<td>Aluminum</td>
<td>2</td>
</tr>
<tr>
<td>Composite temperature/humidity cycle test</td>
<td>Window</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (fixed speed)</td>
<td>Copper</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Split (fixed speed)</td>
<td>Aluminum</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total Number of Samples</strong></td>
<td></td>
<td></td>
<td>18</td>
</tr>
</tbody>
</table>
Efficiency Variation Based on Heat exchanger

ISEER variation for copper heat exchanger
ISEER variation -3% to +2%

ISEER variation for aluminium heat exchanger
Efficiency Variation Based on Environmental Factors

Humidity Test

Dust Test

Salt Mist

ISEER variation -3% to +2%

All environmental tests
Overall Efficiency Variation

Overall ISEER variation -3% to +2%

Variation in ISEER (in percent)

Sample Number

Percentage

-4.00
-3.00
-2.00
-1.00
0.00
1.00
2.00
3.00

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Test Results Analysis

• Reduced cooling capacity ranged from -3.79% to 0.57%, with an average of -1.28%.
• Reduced power ranged from -5.03% to 0.76%, with an average of 0.98%.
• Reduced ISEER ranged from -2.78% to 1.95%, with an average of -0.30%.

All these variation in the values are insignificant and within the tolerance limits prescribed in BEE’s labeling schedule for all ACs
Conclusions and way forward

- RACs performance in India not affected by short-term exposure to environmental conditions (dust, salt mist, and composite humidity) simulated in the test laboratory irrespective of the
  - type of AC
  - type of heat exchanger
  - type of tests
- Could be due to some quality measures taken by manufacturers safeguarding against environmental factors
- Can be further expanded to expose the samples to salt mist test for a prolonged duration
- Samples from the field across various climatic conditions can be tested to assess the impact on energy performance in real life situation