Fruit Ripening

Start the natural ripening process by controlling:
- Fruit temperature
- Room humidity
- Carbon dioxide
and adding ethylene gas.

Fruits Commonly Ripened:
- Bananas
- Tomatoes
- Avocados
- Pears
- Mango
- Orange (degreening)
Ripening Facilities

- Room design

Construction

- Citrus degreening
  - Conventional
  - Forced air

Conventional
Forced Air

Transport Ripening

Conditioned air flows horizontally thru boxes

Air supply

SmartAir by Carrier
WALL INSULATION

- Water vapor
- Vapor barrier
- Insulation
- High humidity inside
- Low humidity outside

Ripening Facilities

- Room design
- Temperature management

Ripening Room Temperature

Near 70°F for most fruits
Automated monitoring

Hand-held Firmness Tester

Ripening Facilities
- Room design
- Temperature management
- Air flow
Citrus Degreening

Conventional Ripening Room

Forced Air Ripening
Air Flow Rate

<table>
<thead>
<tr>
<th>Air Volume</th>
<th>Static Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Banana, Avocado</td>
<td>0.3 l/s-kg 0.6 - 1.9 cm w.c.</td>
</tr>
<tr>
<td>• Oranges, etc.</td>
<td>0.1 - 0.05 l/s-kg</td>
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</tbody>
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Air Volume Static Pressure

0.3 cfm/lb 0.25 - 0.75 in. w.c.

Ripening Facilities

- Room design
- Temperature management
- Airflow
- Humidity control
Ripening Room Humidity

85% to 95% relative humidity
- humidifiers to add water to corrugated

Ripening Facilities

- Room design
- Temperature management
- Air flow
- Humidity control
- Ethylene management

Ethylene Level

- Ripening - about 100 ppm
- Degreening - 5 ppm
Ethylene Level

- Ripening - 10 to 100 ppm

Ethylene Sources

- Generator
- Gas cylinders
- Lecture bottles

Ethylene Safety

- Follow label
- Prevent accidental releases
- No ethylene cylinders in ripening rooms
- Train operators
- Measure ethylene (2800 ppm max.)
Ethylene safety

- Continuous ventilation system
- Small fan
- Critical orifice
- Ethylene cylinder
- Fresh air inlet

Ripening Room

Hydrocarbon Sensor

- Sensorex Hydrocarbon Transmitter #SX912, 0-2,000 ppm
- Approximately $1,200 installed

Ripening Facilities

- Room design
- Temperature management
- Humidity control
- Air flow
- Ethylene management
- Carbon dioxide
Carbon Dioxide

CO₂ less than 0.5%

Carbon Dioxide Venting

- For ripening - one room volume in 2 - 4 hr.
- For degreening - one room volume in 0.5 - 1 hr.
- With controlled ethylene release these levels will prevent explosions.

CO₂ Sensor

Vaisala Carbon Dioxide Transmitter GMT221, 0-10%
- LCD display, remote sensing
- Accuracy <± 0.02% CO₂ + 2 % of reading
- Approximately $1,200 installed
Ethylene Damage

Critical Levels = 0.1 to 1 ppm

Venting

6 to 8 room air changes drop ethylene to 1% of original level
Controlling Ethylene Damage

- Separate ripening and storage areas
- Reduce ethylene used in ripening
- Vent ripening rooms
- Vent cold storage
- Use scrubbers
- Eliminate engines

Eliminate Engines