Ripening Facilities

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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
- Citrus fruits (degreening)

Ripening Facilities

- Room design
Construction

Citrus degreening

Conventional

Forced air

Wall Insulation

vapor barrier

outside

insulation

inside

water vapor

high humidity

low humidity
Ripening Facilities

• Room design
• Temperature management

Ripening Room Temperature

Near room temperature for most fruits. (See syllabus for specifics.)
Banana Ripening Temperature

- vent to control CO2
- soft pulp above 65°F
- 4 day cycle
- 7 day cycle
- chilling below 56°F

Cooling after Ripening

- Avocados, stonefruit, and pears need to be cooled after ripening or conditioning.
- Use a forced-air system.
- FA cooling requires more refrigeration than needed for ripening.
Temperature monitoring

Automated monitoring
Hand-held Firmness Testers

Penetrometer

Firmness During Ripening

Bartlett Pears @ 70° F

5.1 lbs in 12hrs
Ripening Facilities

- Room design
- Temperature management
- Airflow

Citrus Degreening

Diagram showing air conditioning coils and air deflector.
Forced Air Ripening

Forced Air
Transport Ripening

Air return
Conditioned air flows horizontally thru boxes
Air supply
SmartAir by Carrier
Forced-Air Ripening in a Container

Ripe.Anywhere.™ by Global Cooling

Air Flow Rate

<table>
<thead>
<tr>
<th>Air Volume</th>
<th>Static Pressure</th>
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<tbody>
<tr>
<td>• Banana, Avocado</td>
<td>0.6 - 1.9 cm w.c.</td>
</tr>
<tr>
<td>0.3 cfm/lb (m³/s-MT)</td>
<td>0.25 – 0.75” w.c.</td>
</tr>
<tr>
<td>• Oranges, etc.</td>
<td>0.1 - 0.05 cfm/lb (m³/s-MT)</td>
</tr>
</tbody>
</table>
Ripening Facilities

- Room design
- Temperature management
- Airflow
- Humidity control

Ripening Room Humidity

85% to 95% relative humidity
- Humidifiers to add water to corrugated
- Automated control available
Ripening Facilities

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

- Ripening <100 ppm
- Degreening 3-5 ppm
- Automated ethylene control systems have used 18ppm.

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.)

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**Ethylene safety**

**Continuous ventilation system**

- Ethylene cylinder
- Critical orifice
- Small fan
- Ripening Room
- Fresh air inlet
**Ethylene Sensor**

Global Cooling
0 – 20ppm or 0 - 100ppm
$1,200 - $1400

SmartRipe (Catalytic Generators)
Integrates ethylene sensor with ethylene generator to maintain controlled ethylene levels.

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**Ripening Facilities**

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

CO₂ less than 0.5%

Carbon Dioxide Venting

• Ventilate even during ethylene addition.
• For ripening - one room volume in 2 - 4 hr.
• For degreening - one room volume in 0.5 - 1 hr.
• With CO₂ sensor flow is variable depending on fruit respiration.
• With controlled ethylene release these levels will prevent explosions.
CO$_2$ Sensor

Vaisala CO$_2$ Transmitter #GMT221, 0-10%
- LCD display, remote sensing
- accuracy $<\pm 0.02\%$ CO2 $+ 2\%$ of reading
- $1,200$
- Intec CO$_2$ sensor, $500$

Ethylene Damage

[Images of ethylene damage]
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