Indoor Greenhouses

Mike Mack

Completed Unit

- **Based on 3 Shelving Units**
  - 72” Tall x 48” Wide
- **71” Shower Curtain Liner Sidewalls**
  - Held by PVC Tubing Supported off Top Shelf
- **3 mil Plastic Drop Cloth Ceiling**
  - Held in Place by Tubing Support Pieces
- **LED Tube Lights Suspended from Shelving**
- **Ultrasonic Humidifier**
- **Fans Ensure Uniform Temperature & Humidity**
- **Flooring to Insulate Cold Floor and Keep Interior Warmer**

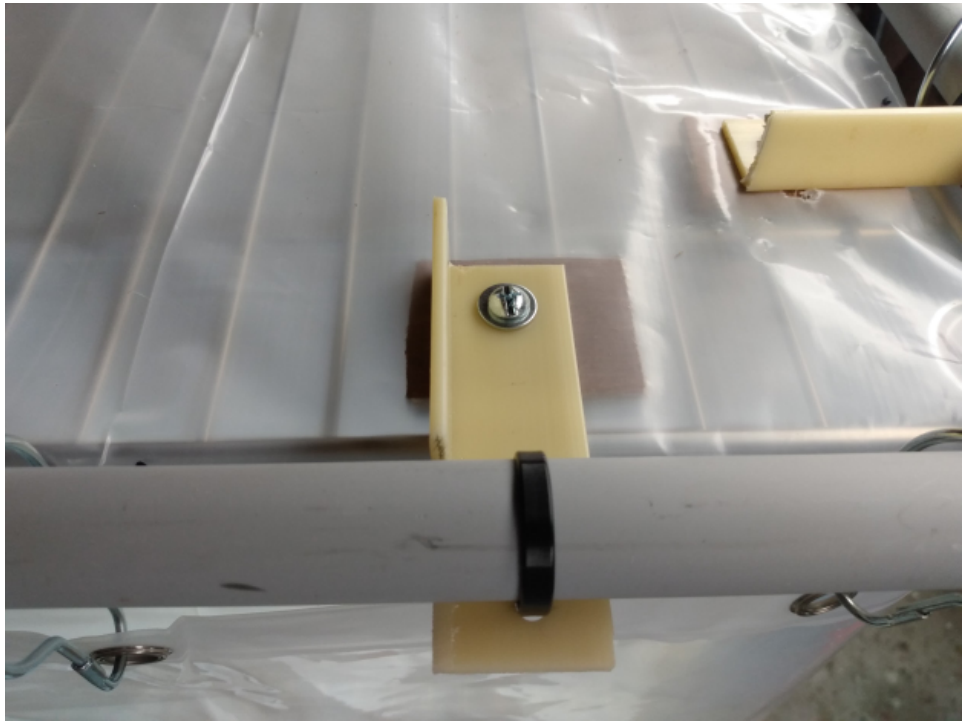
Shelving Units

- **Shelving Units**
  - Most Expensive Part of Indoor Greenhouse
  - Nominal Size 72” x 48”
    - Actual Width and Depth depend on Maker
      - Ocean State Job Lots Units made in China are 47 ¾” Wide
    - Shelf Number and Position Adjustable
      - 1” Adjustment Interval for Positions
- **Ocean State Job Lot Units**
  - Chrome Plated and depending on Store Location made in China or Taiwan
    - Up to 6 Shelves with Nominal Depth 18”
    - Price $95 - $99
- **Walmart**
  - Black or Silver Finish but Labeled for dry Area Storage
    - Up to 5 Shelves with Nominal Depth 16”
    - Price $65
    - Other Models Available

PVC Tubing Clamp

- **Angle Plastic Used to Hold ½” PVC Tubing**
  - Flat ⅛” Plastic or Metal good as well
- **½ “ Schedule 40 PVC Conduit much cheaper than Standard PVC Tubing**
  - ½” is the tubing ID
- **1 ½” x 2” Plywood ¼” Thick on each side of Shelf Wires and Through Bolted with 1” 10-32 Machine Screw**
  - Clamps Assembly to Shelving
  - 5/16” Gap between Tubing OD and Edge of Shelf Unit
- **Support Plate Drilled ¼” Diameter through on both Sides of Tubing**
  - Tie Wrap used to hold Tubing in Place

PVC Clamp also Holds Drop Cloth Ceiling in Place



Ceiling Support

- **Left over PVC Tubing**
  - Notched Lengthwise and Tie Wrapped in Place Through Holes Drilled in Ends
  - Similar Treatment for Entrance Area

Closeup of Sidewall and Ceiling Overlap

- **Close Proximity of Ceiling Drop Cloth and Sidewall Shower Liner**
  - Designed to separate Humid Inside Air from Dry Outside Air
- **Drop Cloth Overhangs 11 ½” Down Past Shelf Top**
  - 9 ½” Overlap with Sidewall Liner
- **Flexible Magnets inside and outside hold Sidewall and Ceiling Cover together**
  - Large overlap and Gap Closure by Magnets further Isolate Interior Air
  - Magnets from Amazon at $9/100
  - Magnets Stick to each other if slightly Displaced

Treatment of the Back Corners

- **¼” Thick Plywood cut to fill in the back Corners**
  - Ensures a Seal between Sidewall and Ceiling Drop Cloth there
  - ¼” Holes Drilled in Inside Edges of Plywood Tie Wrapped to top Shelf on Middle and Side Units

Outside Back Corners

Sidewall Bottom

- **Bottom Edge Less than ⅛” from Floor**
  - Use simple Shower Liner Hangers (Ace Hardware)
    - More expensive Hangers have Rollers, which will raise Liner
  - Leveling Feet on Shelving gives some Adjustment in Height as well
  - Ultrasonic Humidifier works by creating tiny droplets which evaporate and cool the Air
    - Cool humid air can fall to Bottom and go out under the Liner with too large a Gap at the Bottom Edge
      - Fans assist in preventing this

Lighting

- **Maxlite LED Tube Lights**
  - $15 each from Ocean State Job Lots
  - Less than half the Electric Consumption of Fluorescents (40 W vs >80 W)
    - Much less Heating
    - Despite their Efficiency with 9 of the 10 LIghts running the waste Heat raises Air Temperature in the Greenhouse by about 10 Degrees F
      - Fluorescents quite possibly would raise Temperature too much
  - 5000 Degree Color Temperature a good match for Plants
    - Light is very White with no bluish cast
  - Claim a 50000 hour life (11 Years at 12 hours/day)
  - Brighter than Fluorescents
    - 9-10” Space from Tubes to Leaves gives good Growth
      - Originally set up with 6” from Tubes to Leaves and experienced very poor Growth and some loss of Plants
  - Hung from Shelving

Easily Adjusted Height over Plants

Two Chains with “S” Hooks at each End

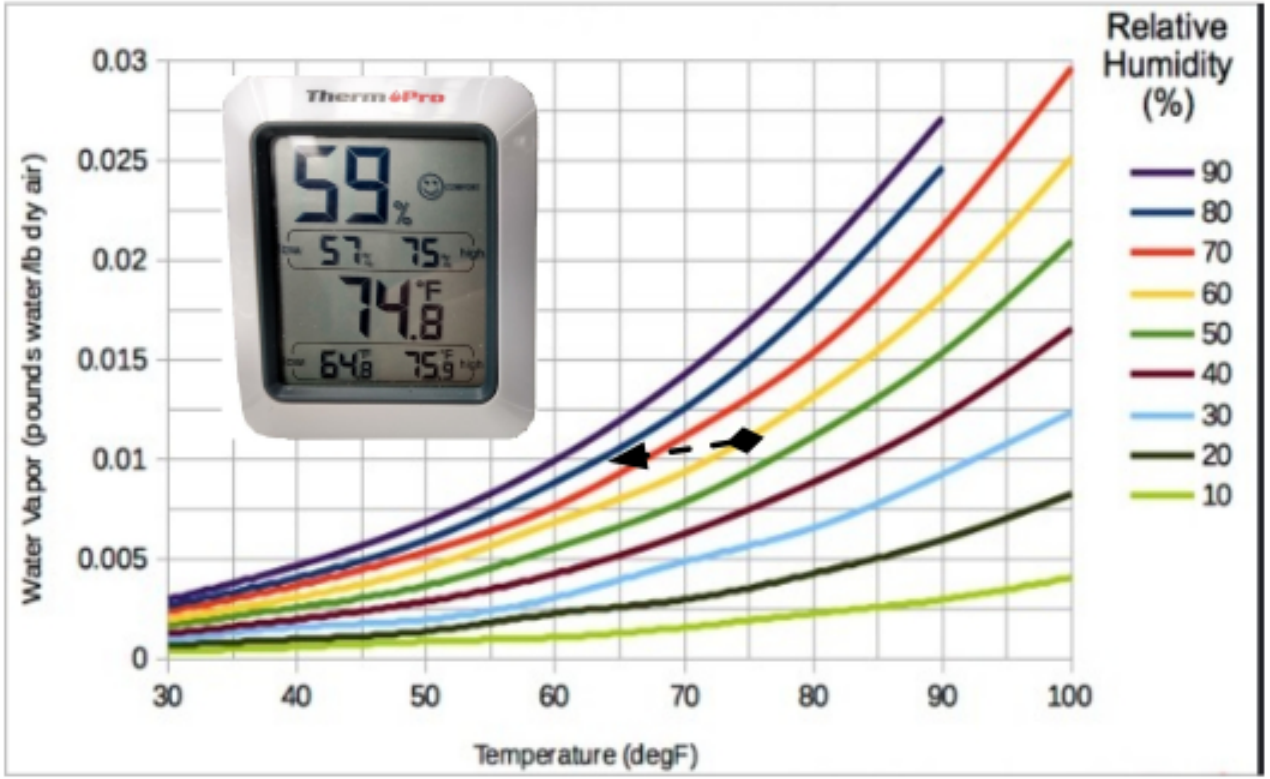
(Chain that comes with Lights cut in half and extra S Hooks added)

Humidifier

- **Humidifier**
  - TaoTronics from Amazon ($35)
  - Ultrasonic for low Power Consumption and Safety
    - 15 W on low; 30 W on high
  - 1 Gallon Reservoir
    - Use DI water ($1/Gal Market Basket)
  - Digital Relative Humidity Setting
    - Set in 5% increments
    - Looses setting if Power is shut off
      - Can’t put on Timer with everything else
      - Turn off at Night
      - Perhaps other makes might make this possible

Humidity at Night

(Humidifier set for 60%)



Fans and Flooring

- **Muffin Fans**
  - Mounted in back Corners about 8” from Floor
  - 23 CFM Mufffin Fans from Amazon ($17 each)
    - Double Ball Bearing for 67000 hour life and draw only 4 W each
  - Tilted forward and toward center to encourage circulation
- **Flooring**
  - Sold in 2’x2’ Interlocking Squares for more comfortable standing
  - Waterproof surface
  - Cut away at Shelving feet
    - Easy since at Edges of Squares
  - Ocean State Job Lots ($10/4 squares x 3)

Seedlings in Greenhouse

Larger Seedlings and Cuttings

Mature Plants

Some Indoor Greenhouse Experience: Impact of Daytime Humidity

Begonia	Minimum Humidity for Good Growth
Erythrophylla	20%
Madame Queen	20%
Tayabensis	35%
U334	35%
U632	35%
U074	45%
Barsalouxiae	45%
Black Coffee	>60%
Martha Stuart	>60%