I PRO 344

Inflatable Greenhouses
Current Greenhouses

- Use lots of energy
- Young plants need a narrow range of temperature to thrive in
- Excessive volume
- Structure
- Pest Control
Structures
Structures

1. Why plastic?
2. Structural Concept
3. Fabrication
Why PLASTIC? (PolyEthylene)

- Plastic is much cheaper construction than stand and glass structures that are currently used.
- The amount of UV transmitted is nearly the same as glass.
- The greenhouse when constructed can be deflated and moved to suit different locations.
- Plastic is light weight, making it easy to inflate; this way the air become the major structural element
- Creating connections with plastic is easily accomplished through ironing or light welding.
Structures

STRUTURAL CONCEPT

+ =

[Images of inflatable structures and a hot air balloon]

[Images of inflatable structures on a landscape]
STRUCTURAL CONCEPT (SECTIONAL VIEW)

BEFORE LATERAL PRESSURE

ADD LATERAL PRESSURE

SUSTAIN LATERAL PRESSURE
W/ WEIGHTED BLOCKS
THE PROBLEM WITH LATERAL TUBES IS THAT “PINCHING” OCCURS.
Structures

Fabrication

To alleviate that vertex point, longitudinal tubing gives many more places to “pinch” making it more flexible.
Pest Control
Experimental Setup
Experimental Design

Note: Not drawn to scale
Results

- Insect incapacitation within 30 seconds
- Death within 3 hours
Application in Greenhouses

Max $\text{CO}_2$ Allowed for Greenhouse of Given Size

$\text{CO}_2$ Volume ($\text{ft}^3$)

3% ratio of curing container to greenhouse volume

Volume of Greenhouse ($\text{ft}^3$)
Temperature Control

- Several Options Available
  - Misters
  - Foggers
  - Fans
  - Plastic Coatings
Thermal Analysis
Mister

Misters attach to hose via attachment
- Cheap
- No pumps required; use water pressure to generate mist

Misters with pumps
- User defined temperature settings
- More expensive
Foggers

- Cools greenhouse by generating a cooling fog
- More complex and expensive than misters
  - Price: $25-$250/unit
  - Modular units require no tubing
  - Pool of water required
Fans

- All cooling options require a fan
- Serves a double purpose
  - Circulates air within greenhouse
  - Keeps greenhouse inflated
- Size of fan dependent upon size of greenhouse
- Typical circulation in a greenhouse is 1 total air exchange per minute
Plastic Coatings

- Solarflair™ 870 is a pigment that offers a way to absorb the “Photosynthetic Active Light” (PAR) which has a wavelength of around 400-800nm. Designed by EMD Biosciences.

- Offers a way to reflect some of the UV and IR wavelengths that supply unnecessary heat for the greenhouse.
LIGHT RED/DARK RED RATIO

- For optimum plant growth more red and blue is desired.

- The positive light red/dark red ratio of 1.4 : 1 was intended to affect the length growth of plants in a way that the internodal distance (the distance between the base of leaves) is decreased and thus the plant has more energy available for photosynthesis.
Business Plan
Economic Advantage

of Inflatable Greenhouse

- Reducing Initial Capital
- Energy efficient
- Suitable for Organic
Reducing Initial Capital

Initial cost of Inflatable Greenhouse
- Structure = $3,425.44
- Film = $520
- Cooling and Heating System = $6,581 \( \downarrow \frac{1}{2} \)
- Growing Media = $1,794.50
- Equipment = $1,665 \( \downarrow \frac{1}{2} \)

Installation Cost = $1,348.75

Total Cost = $15,334.69 \( \downarrow \)

TOTAL SAVINGS IN INITIAL CAPITAL = $7,604

* Assumption
  
  Size: 6ft x 41.5ft = 250 ft\(^2\), 250 ft\(^2\) X 8 = 2000 ft\(^2\)
  
  Location: Illinois, Moderate Climate
Reducing Initial Capital

Structure of Initial Cost

- Heating & Cooling: 43%
- Growing Media: 12%
- Equipment: 11%
- Installation: 9%
- Structure: 22%
- Film: 3%

Half of Initial Cost!
Energy Efficient

Operation cost of Conventional Greenhouse

- Labor Cost
- Seed and Fertilizer
- Fuel Cost: Electricity, Natural gas
- Pesticide

Savings opportunities
Energy Efficient

Width 6 ft
Length 41.5 ft

Width 20 ft
Length 100 ft

Surface Area
1526.04 ft²

3,516.8 ft²

Required Heating
177,631,056 Btu/yr

409,355,520 Btu/yr

Required Cooling
45,094,482 Btu/yr

103,921,440 Btu/yr

Assumption: 90% energy efficiency

Gas price = 23$/MBtu

Electricity: 3412.8 Btu = 1kWh

0.1$/kWh

Cost of Heating
$ 4,539.46/yr

$ 10,461.09/yr

Cost of Cooling
$ 1321.33/yr

$ 3045.05/yr

TOTAL SAVINGS IN ENERGY COST = $ 6,945.35
Suitable for Organic

Not using pesticide
- Reducing operations cost
  $ 169 / 6 month → $ 340 / yr
Assumption: Tomato Farm

Using alternative Material for organic
- Producing high quality goods

Enhanced profit!
Total Savings

Savings in Initial Cost
$ 7,943.44

Savings in Energy Cost
$ 6,945.35 / yr

Savings in Pesticide
$ 340 / yr

Savings by years

Initial year
$ 15,228.79

3 year
$ 29,799.49

5 year
$ 44,370.19

10 year
$ 80,796.94
Green Greenhouses

- Saves Energy
- Structure
- Selective Cooling
- Pest Control
Conclusion

- Questions