Slow Release Fragrance and Disinfectant for Carpets

ChE 4273 Capstone

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Overview

- Background
- Design
- Utilities
- Production Process
- Economics

The Case for a Clean Carpet

- Dust Mites
- Mold
- Mildew
- Bacteria

Dust Mites

- Microscopic arachnids
- Dust mite’s dead remains and fecal matter are invisible cause respiratory problems
- Remains are suspended in the air for extended periods of time

Dust Mites: Ideal Environment

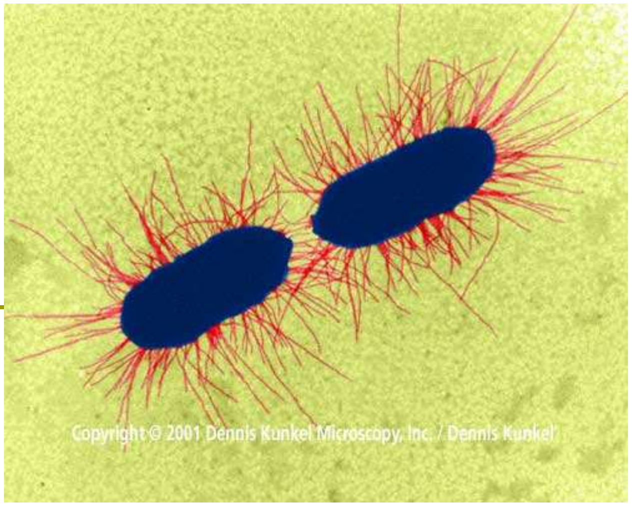
- Feed on dead human skin cells

- > 55% humidity
- 72°-79° F
- < 50% humidity, most die within 7-10 days

Mold & Mildew

- Moist, warm, poorly ventilated places
- Quickly mature
- Produce floating spores
- Cause discomfort and allergies

Bacteria



- Gram negative
- Anaerobic
- Require wet environment
- Live in latex backing of carpet
- Produce butyric acid – foul smell

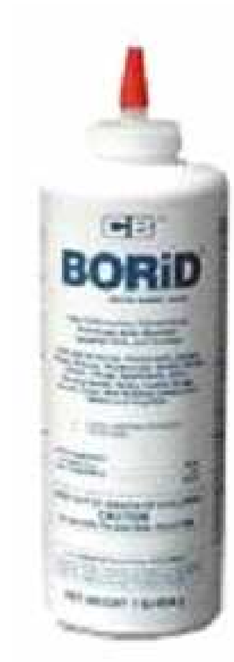
Wet Cleaning Problems

- Cause mildew growth
- Up to 20% water absorption
- Analogous to shampooing hair without rinsing
- Soapy, sticky residue

Current Products

- Arm&Hammer
- Borid
- Capture Clean

www.churchdwight.com



www.pestproducts.com

www.captureclean.com

Challenge

Freshen and Disinfect

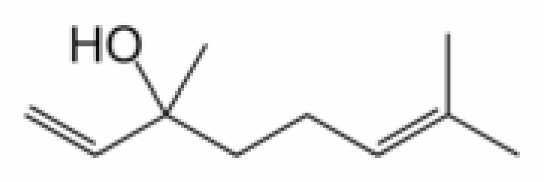
– With Powders

- Slow release fragrance
- Small particles (biodegradable)
- Disinfectant

Problem	Potential Solution
Dust Mites	**boric acid**, tannic acid
Mold	**boric acid**, sodium propinoate
Bacteria	neutralize butyric acid odor with **baking soda**
Mildew	**boric acid, baking soda**

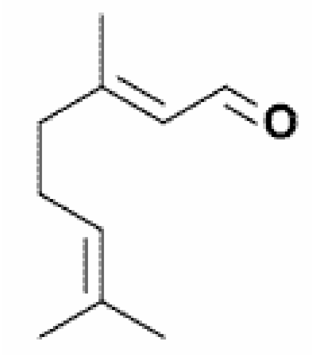
Natural Fragrances

Linalool



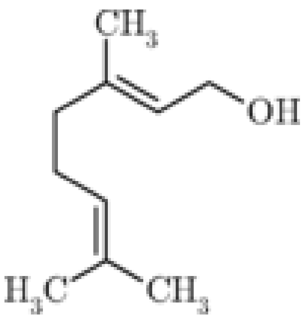
Lily

Citral



Lemon

Geraniol



Rose

Design

- Baking Soda
- Boric acid
- Linalool in PLGA for *extended duration*

Sodium bicarbonate

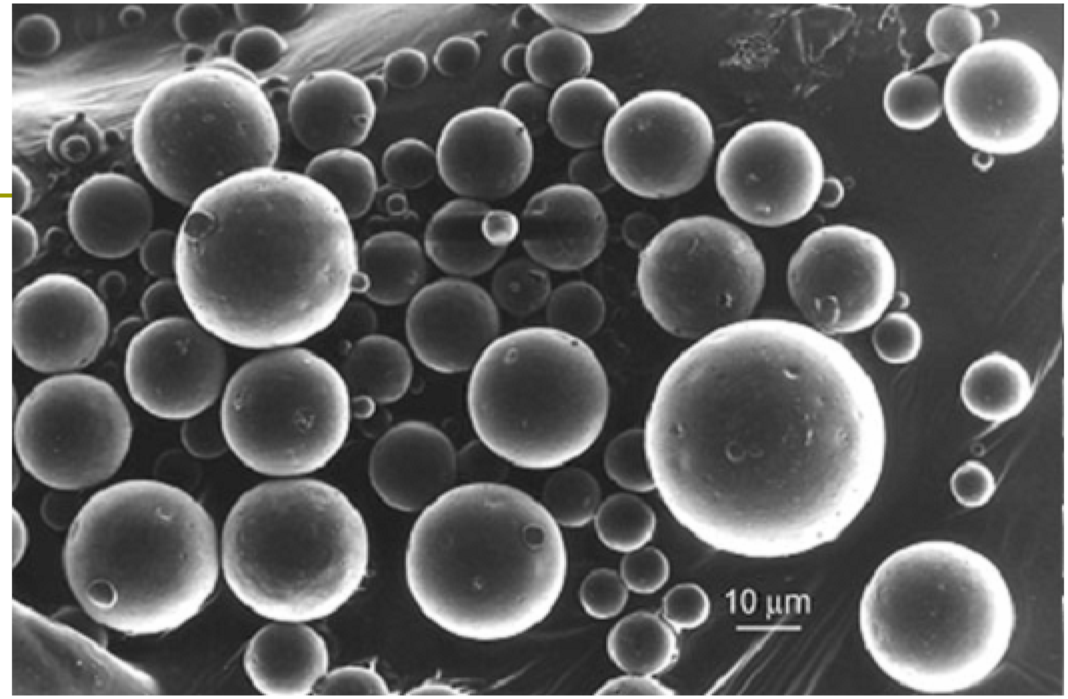
- Absorbs moisture
- Non-toxic

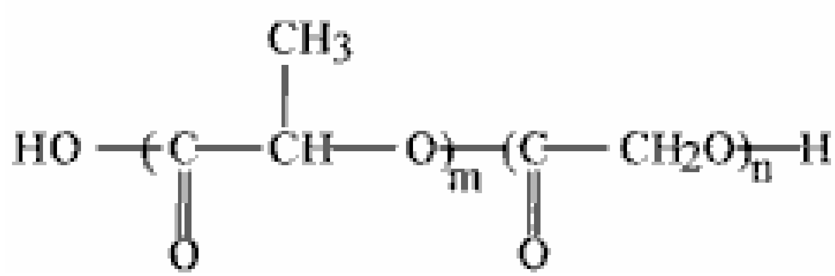
Boric Acid

- Kill dust mites
  - crystal coats food source
- Neutralize allergens
- Inhibit mold, mildew, bacteria, and fungi growth
- Kill cockroaches, beetles, and ants by chemical burns

PLGA

- Poly(lactic-co-glycolic acid)
- Biodegradable
- Degrades by hydrolysis of ester linkages





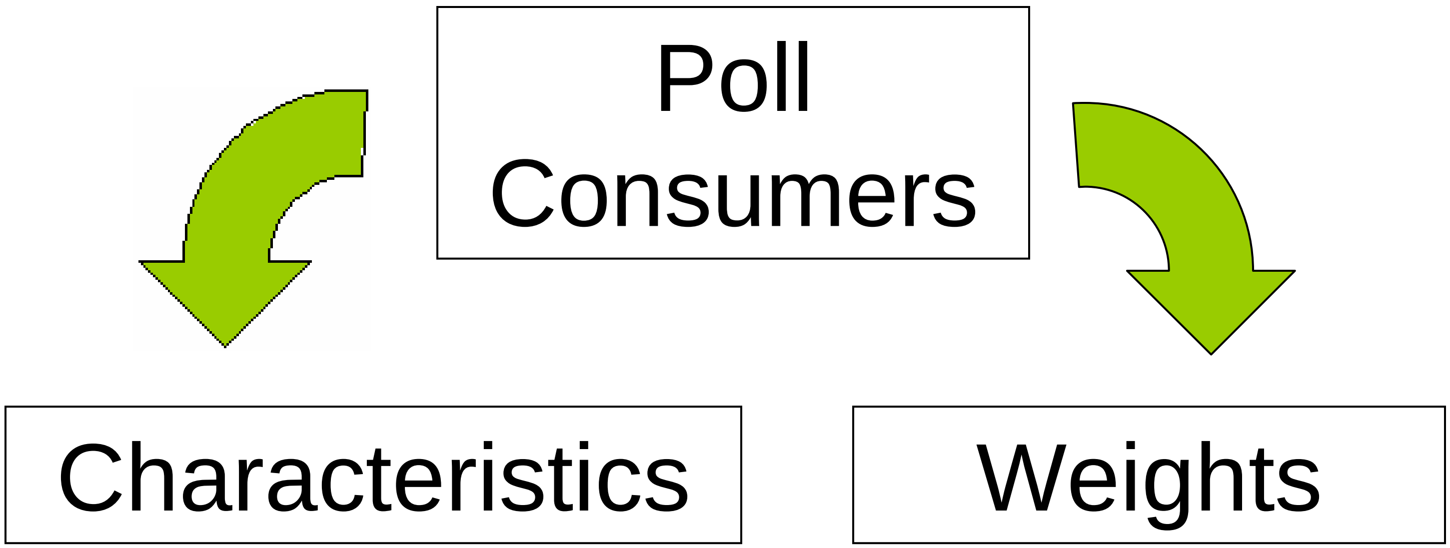
Utility Function Method

$$U = \sum U_i w_i$$

U = utility   w = importance weight

i = characteristic

Utility Function Method



$$\sum \text{weights} = 1$$

Characteristic	Weight
Disinfectant Effectiveness	0.21
Scent Intensity	0.22
Fragrance Duration	0.19
Toxicity	0.09
Odor Elimination	0.15
Scent Type	0.14

Utility Function Method

Consumer Tests

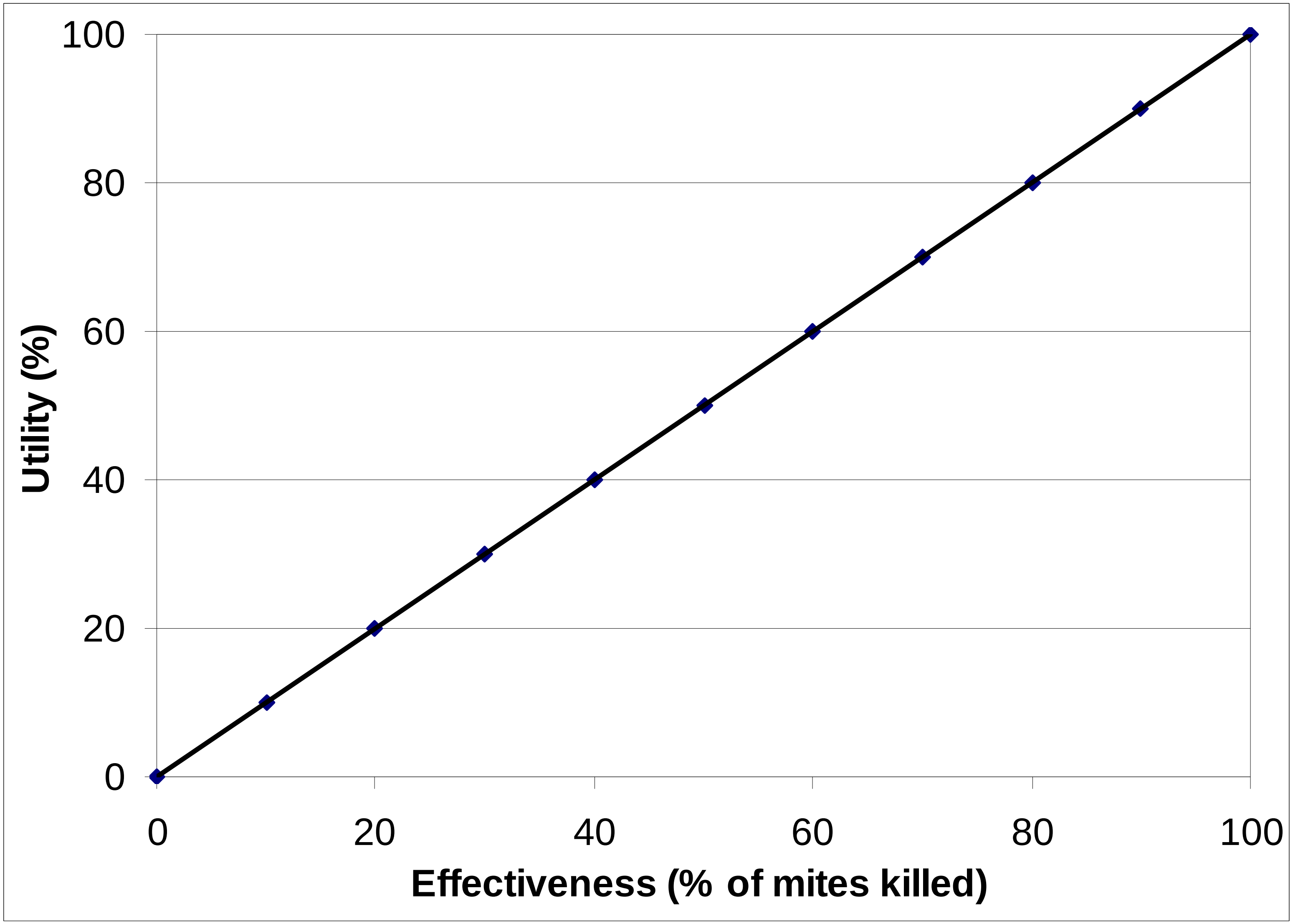
measure preference

Relate characteristics to physical property

Disinfectant Effectiveness relates

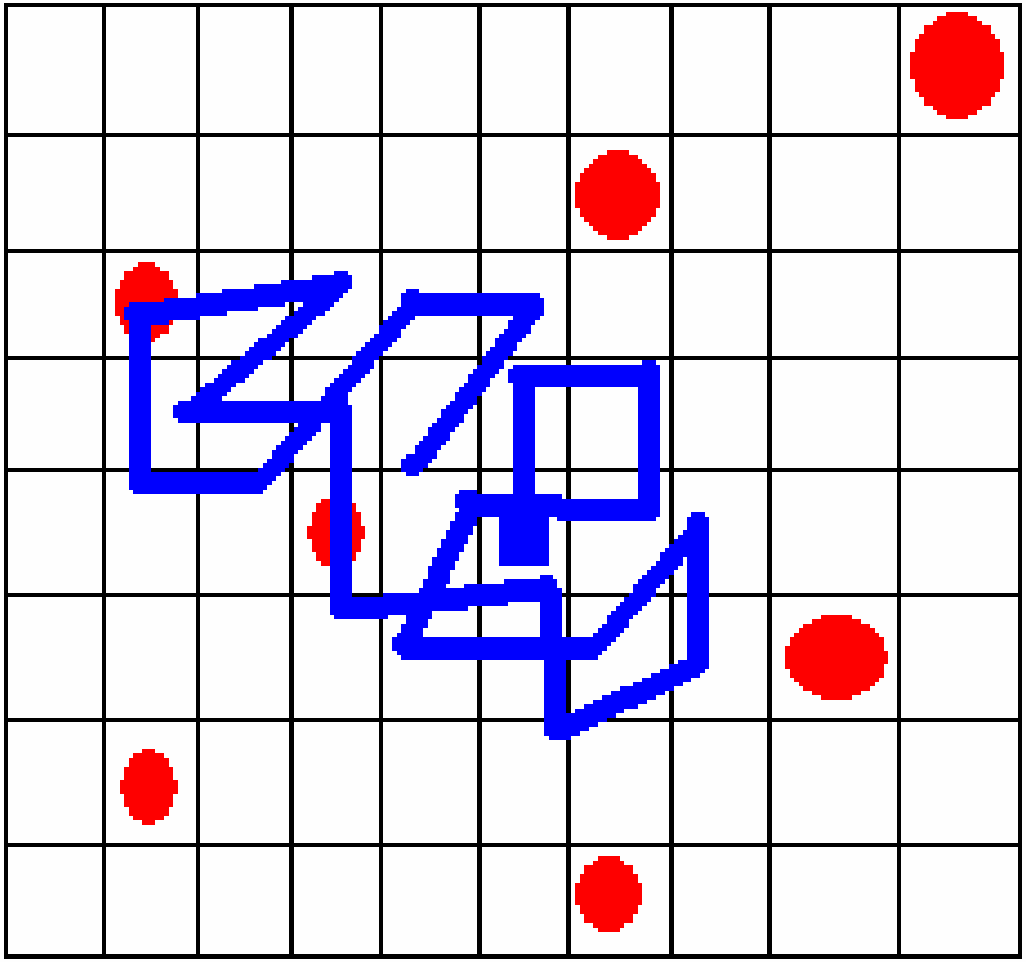
- % of mites killed
- Amount of boric acid per unit area

Disinfectant Effectiveness

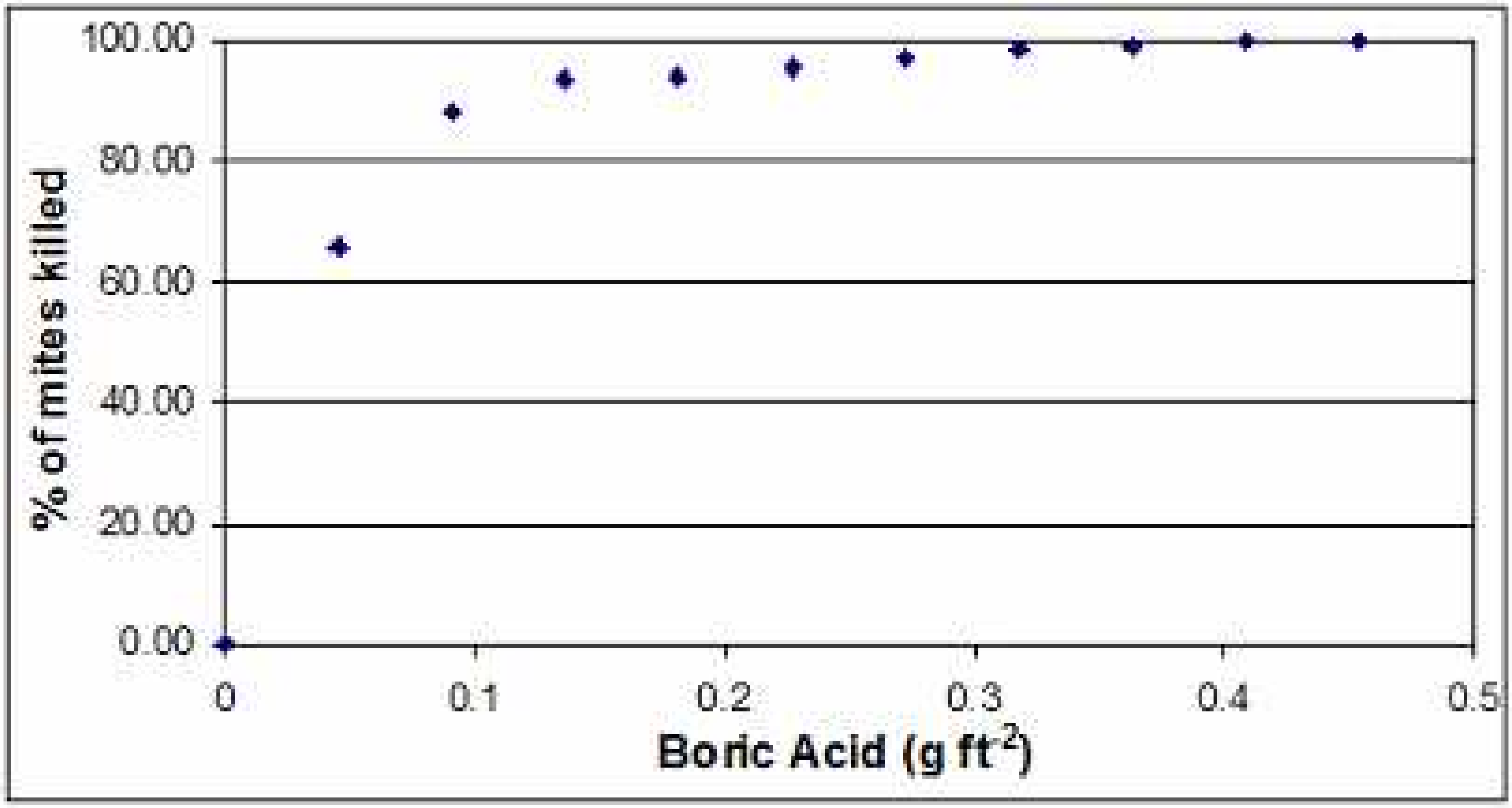


Disinfectant Effectiveness

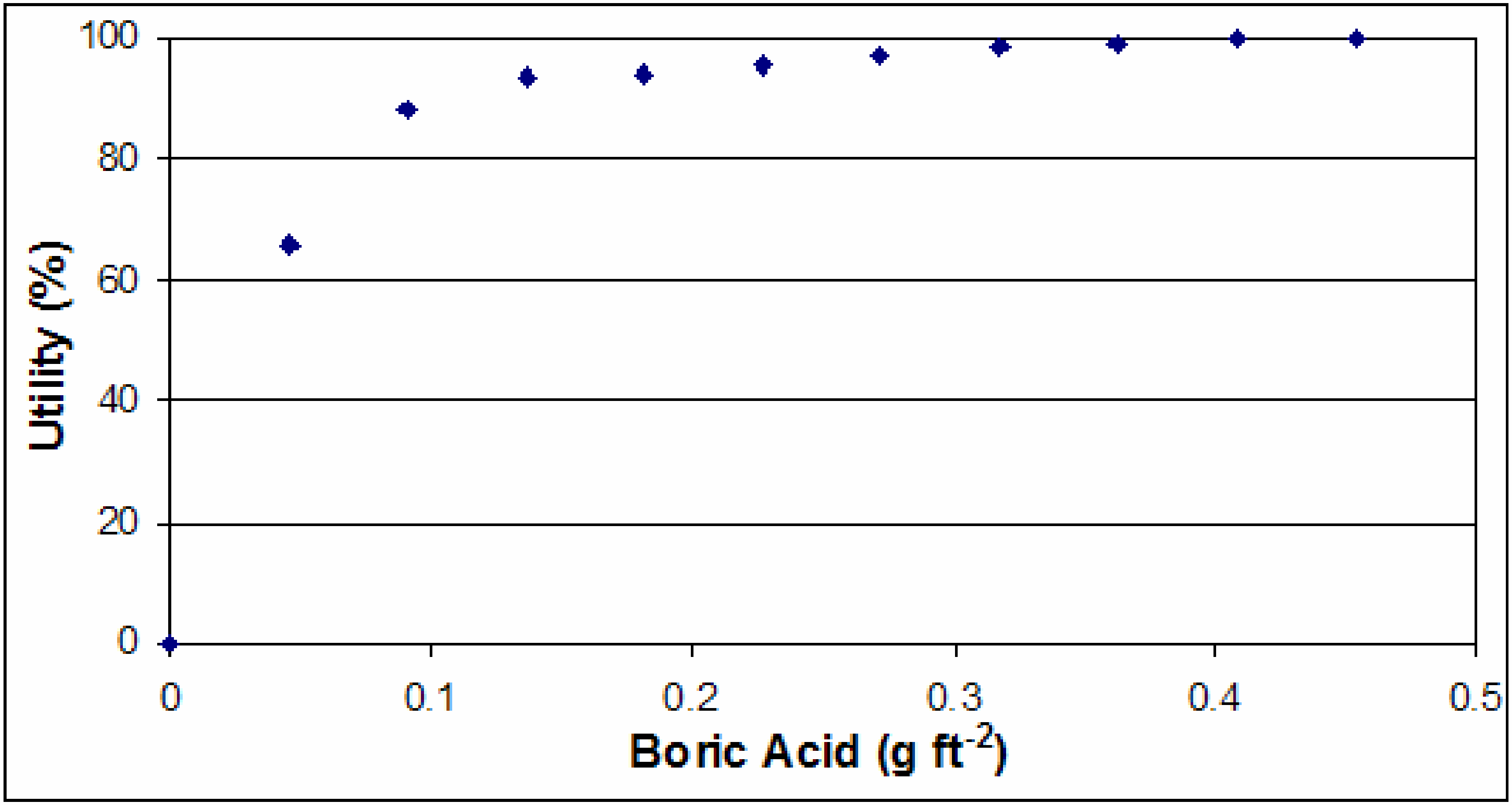
Random Walk



Disinfectant Effectiveness

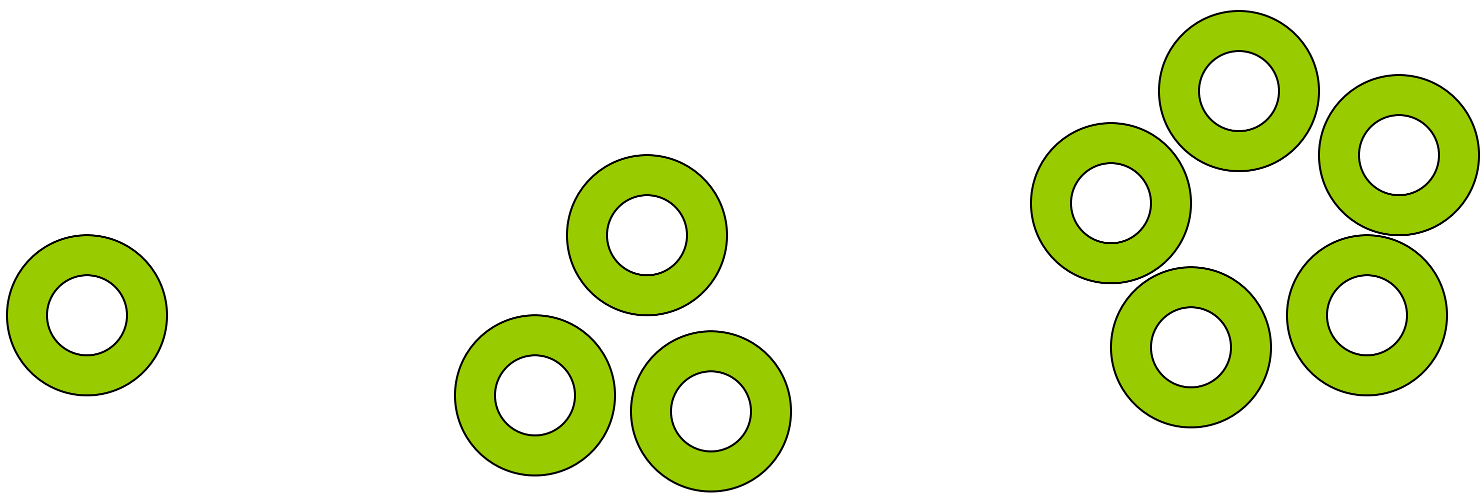


Disinfectant Effectiveness

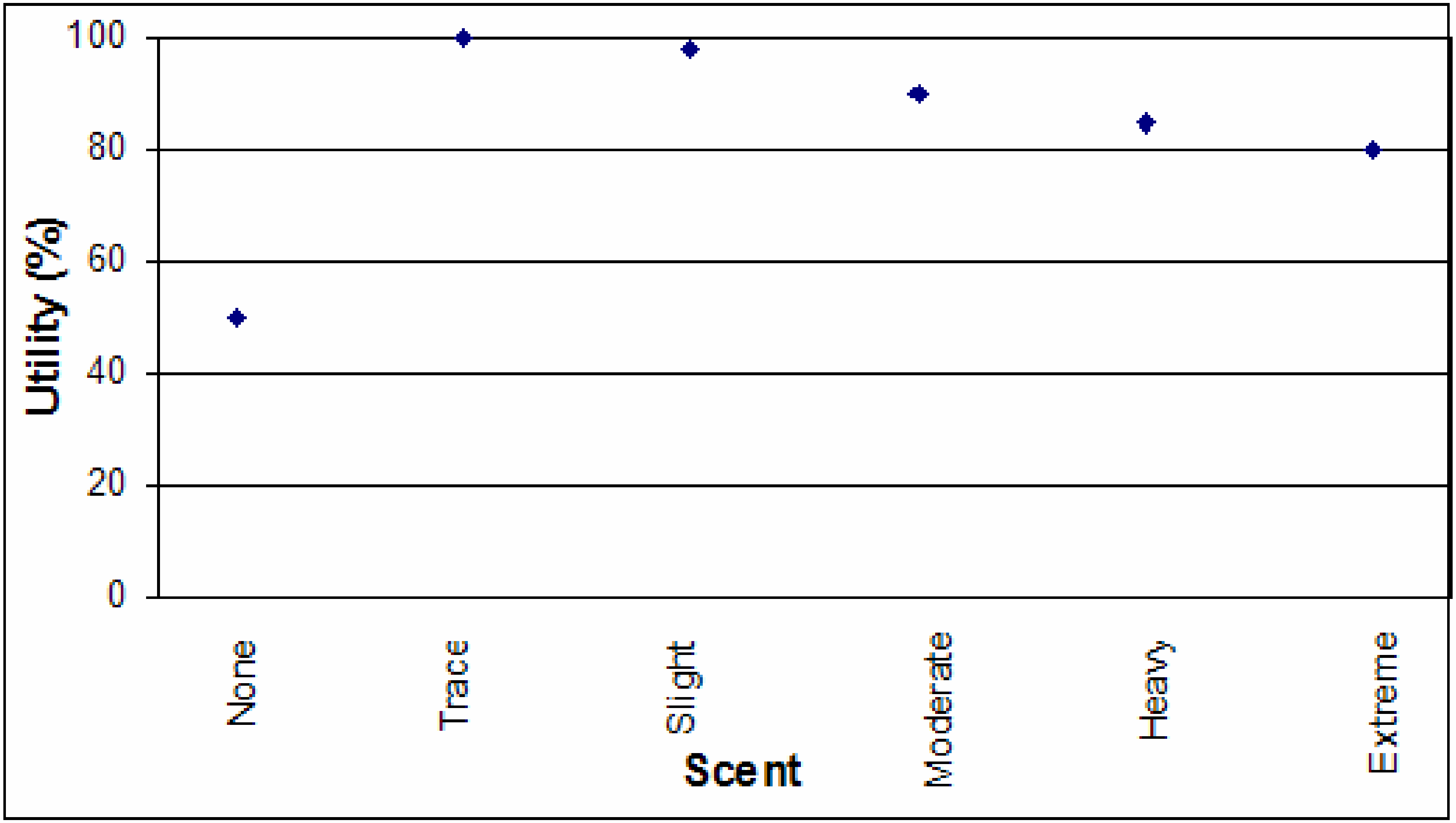


Scent Intensity relates

- Fragrance intensity
- Number of particles per unit area (n)



Scent Intensity



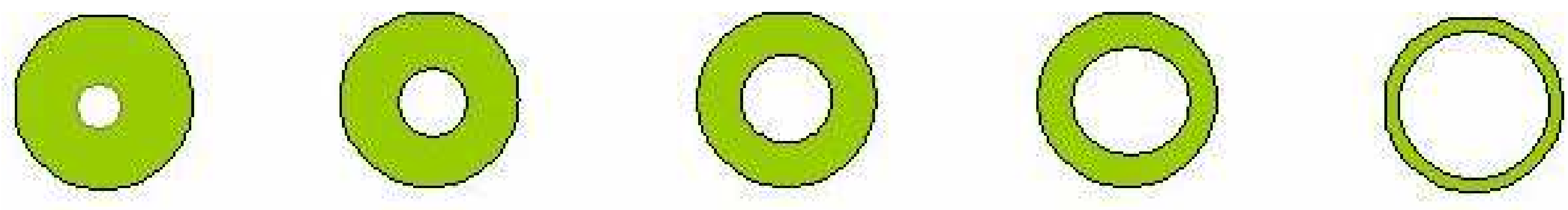
Quantifying Consumer Preference

- Journal of Food and Science
  - various amounts of linalool
  - human subjects determined scent intensity
  - 1.5 feet away from the sample
  - 25 minutes after the sample was prepared

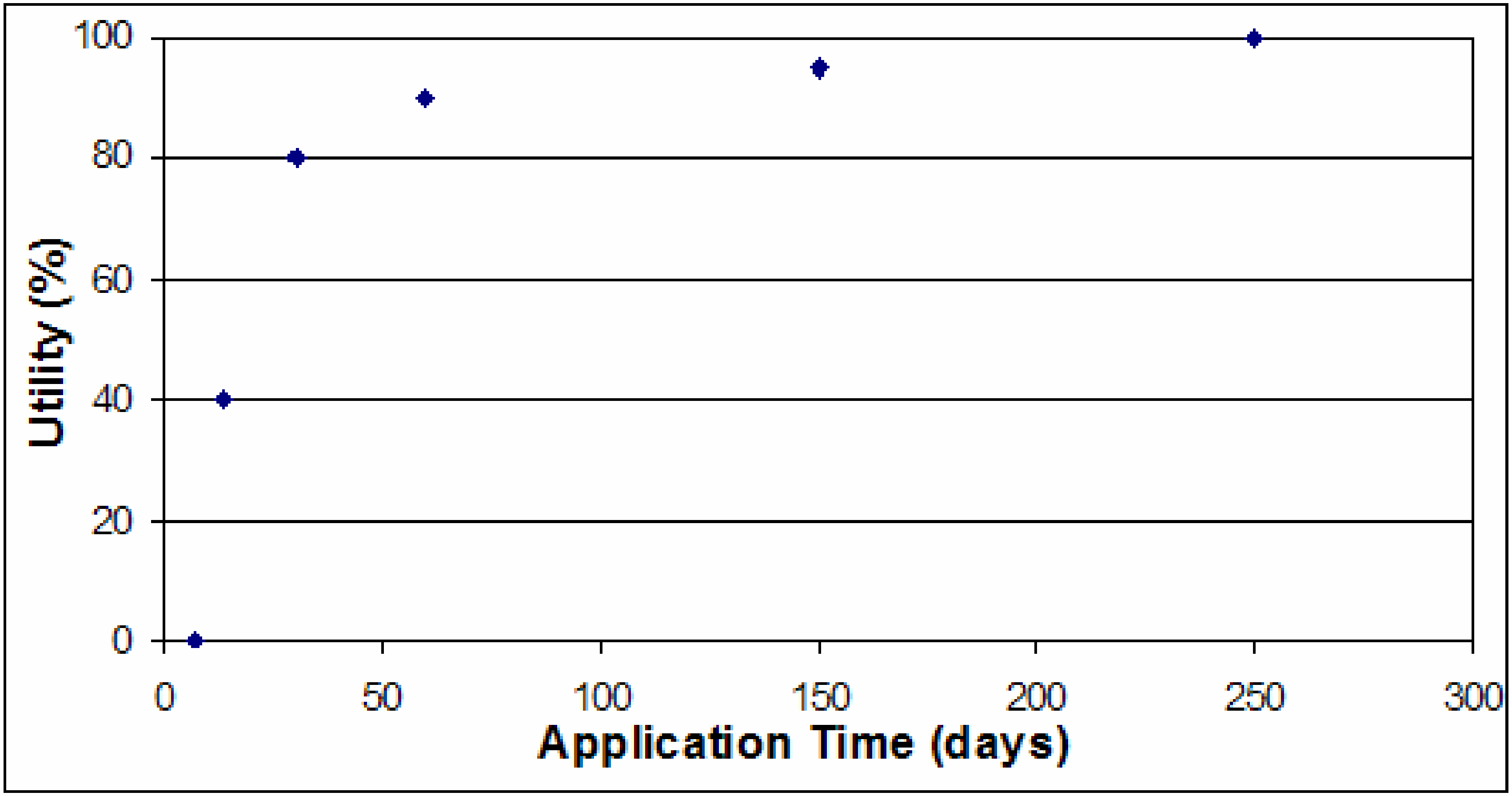
Linalool (ppm)	Strength	Utility
0	none	50
0.5	none - trace	70
2.5	**trace**	100
12.5	trace - slight	99
62.5	moderate	90
312.5	heavy	82.5

Fragrance Duration relates

- Application frequency
- Amount of linalool in particles (L)



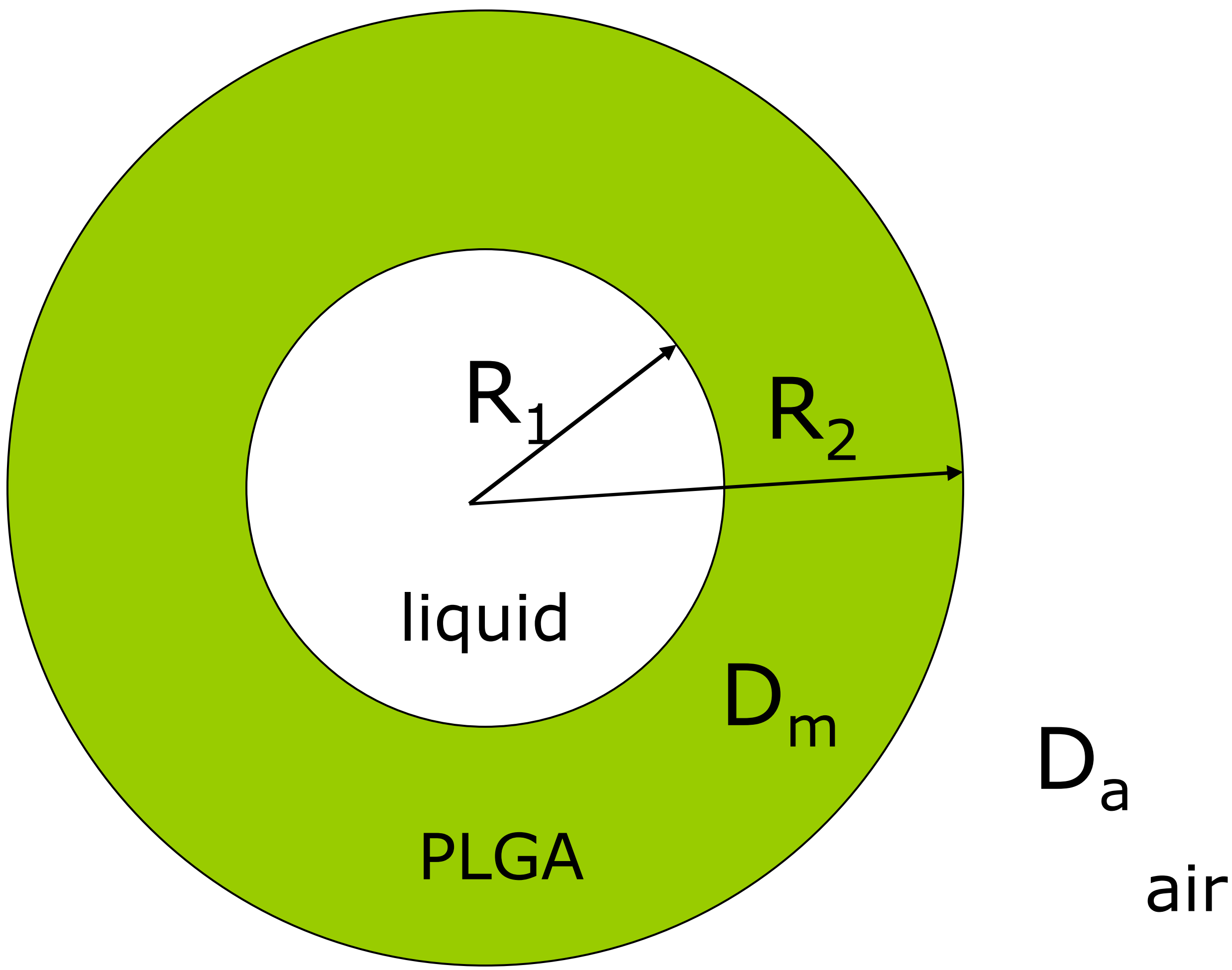
Fragrance Duration



Mass Transfer quantifies

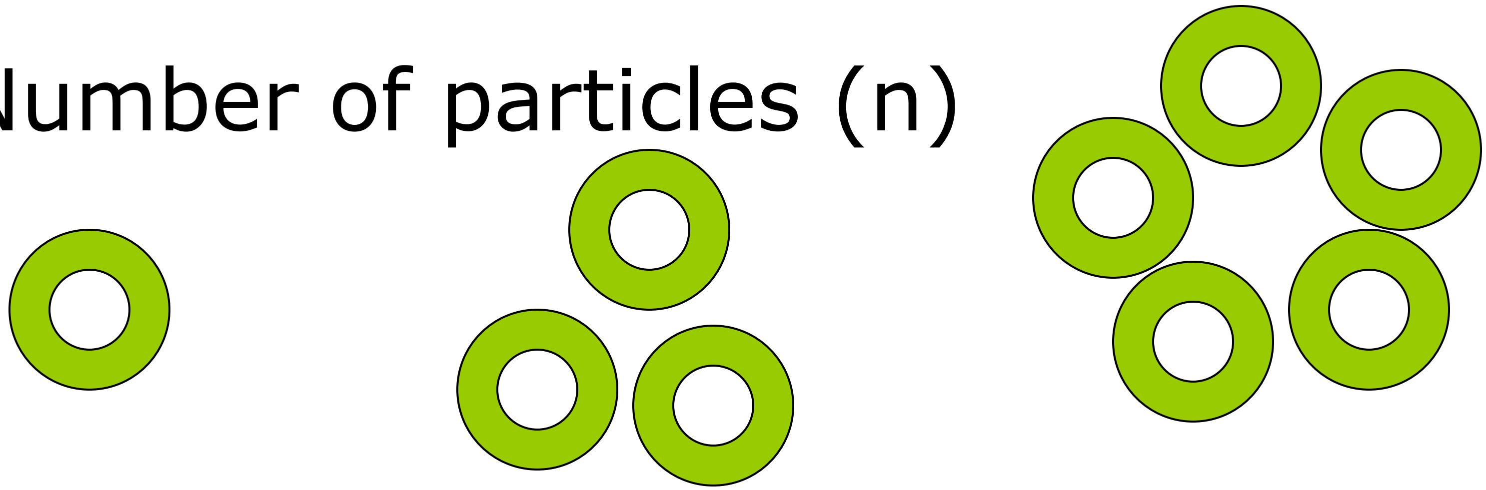
- Scent Intensity
- Fragrance Duration

Fragrance Particle Schematic

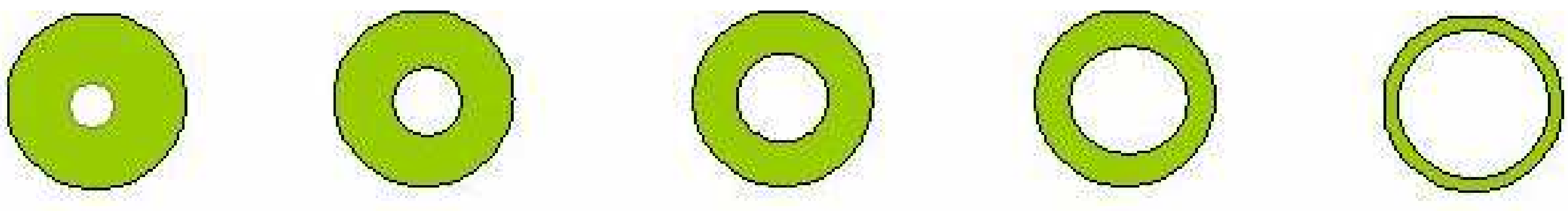


Design Parameters

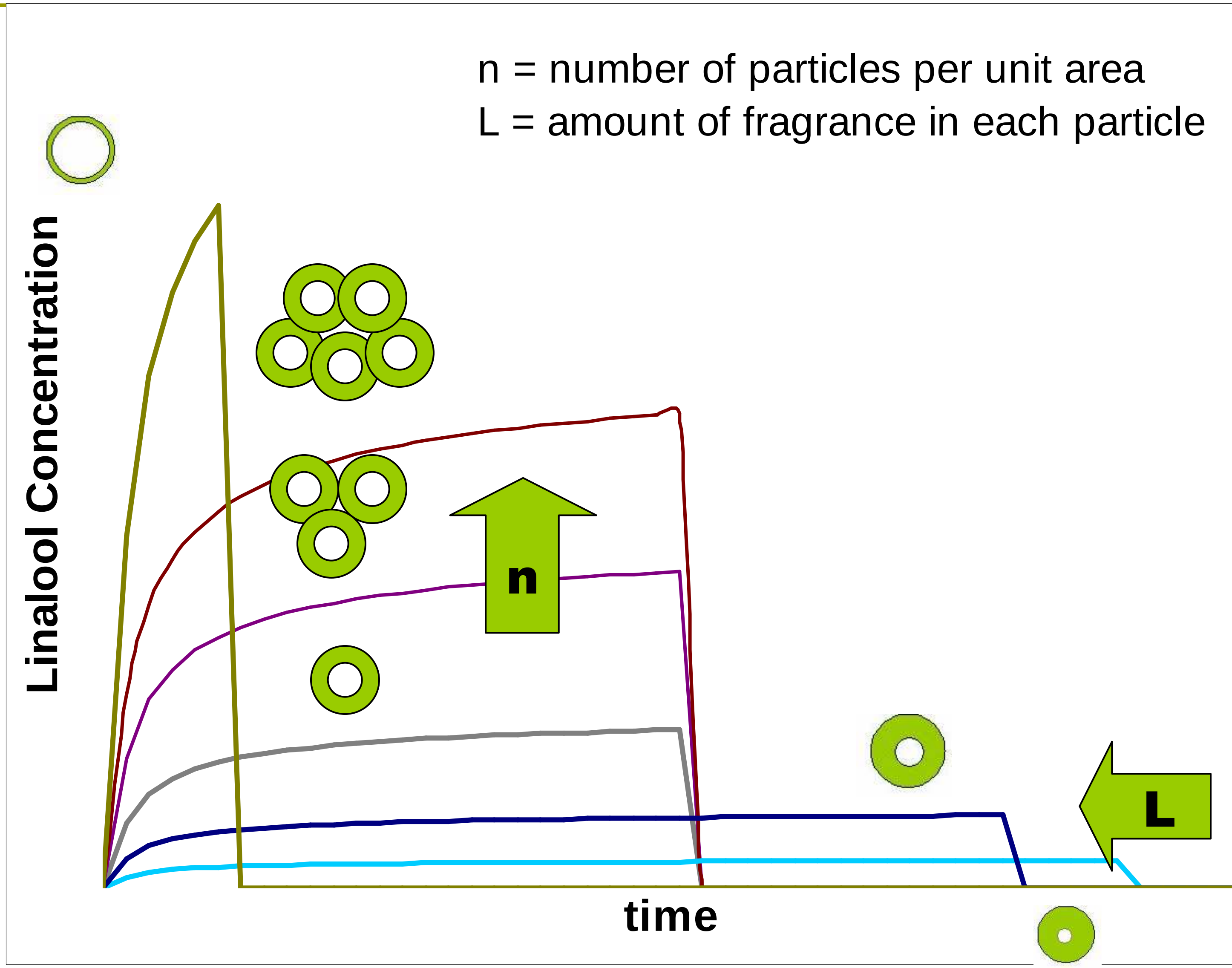
- Number of particles (n)



- Amount of linalool in particles (L)



Expected Trends



Assumptions

- Radial symmetry
- Air is semi-infinite
- No degradation inside particle
- Polymer degradation slower than fragrance diffusion

Equation Development

$$\frac{d}{dr}\left(r^2 \frac{dC}{dr}\right) = 0$$

$$C = b - \frac{a}{r}$$

Welty et al., “Fundamentals of Momentum, Heat, and Mass Transfer,” 2001.

Boundary Conditions

- $C = c^{sat} \quad at\ r = R_1$

- $$D_m \frac{dC}{dr}\Big|_{r=R_2} = D_a \frac{dC^*}{dr}\Big|_{r=R_2}$$

- r > R_2

$$C^* = C^*_\infty + (C^*(R_2) - C^*_\infty)\frac{R_2}{r}\,erfc\left(\frac{r-R_2}{2\sqrt{D_a t}}\right)$$

Linalool Concentration

$$C(r) = c^{sat} - \frac{R_2}{R_1}\frac{D_a}{D_m}C(R_2) + \frac{R_2}{r}\frac{D_a}{D_m}C(R_2)$$

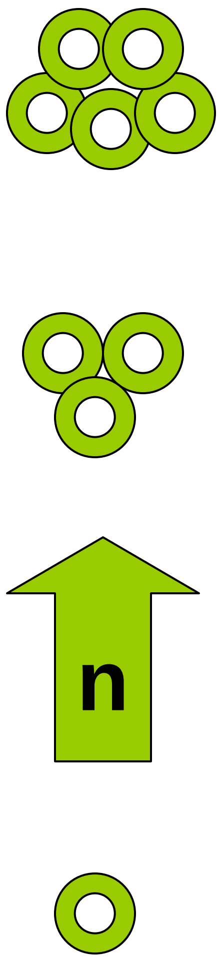
$$C(R_2) = \frac{c^{sat}}{1 + \frac{R_2}{R_1}\frac{D_a}{D_m} - \frac{D_a}{D_m}}$$

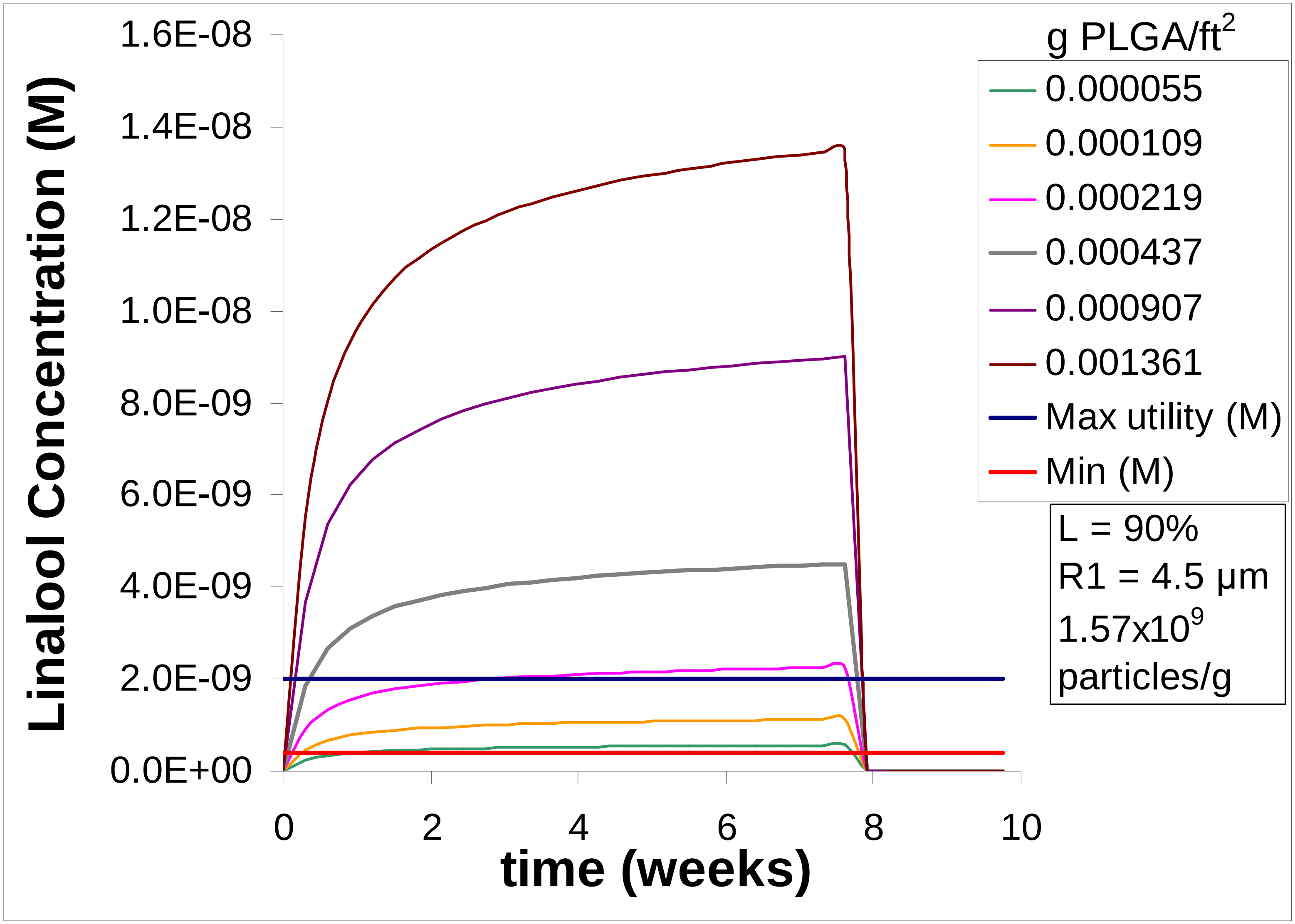
Scent Intensity

- Relates
  - Odor intensity
  - Number of particles per unit area (n)

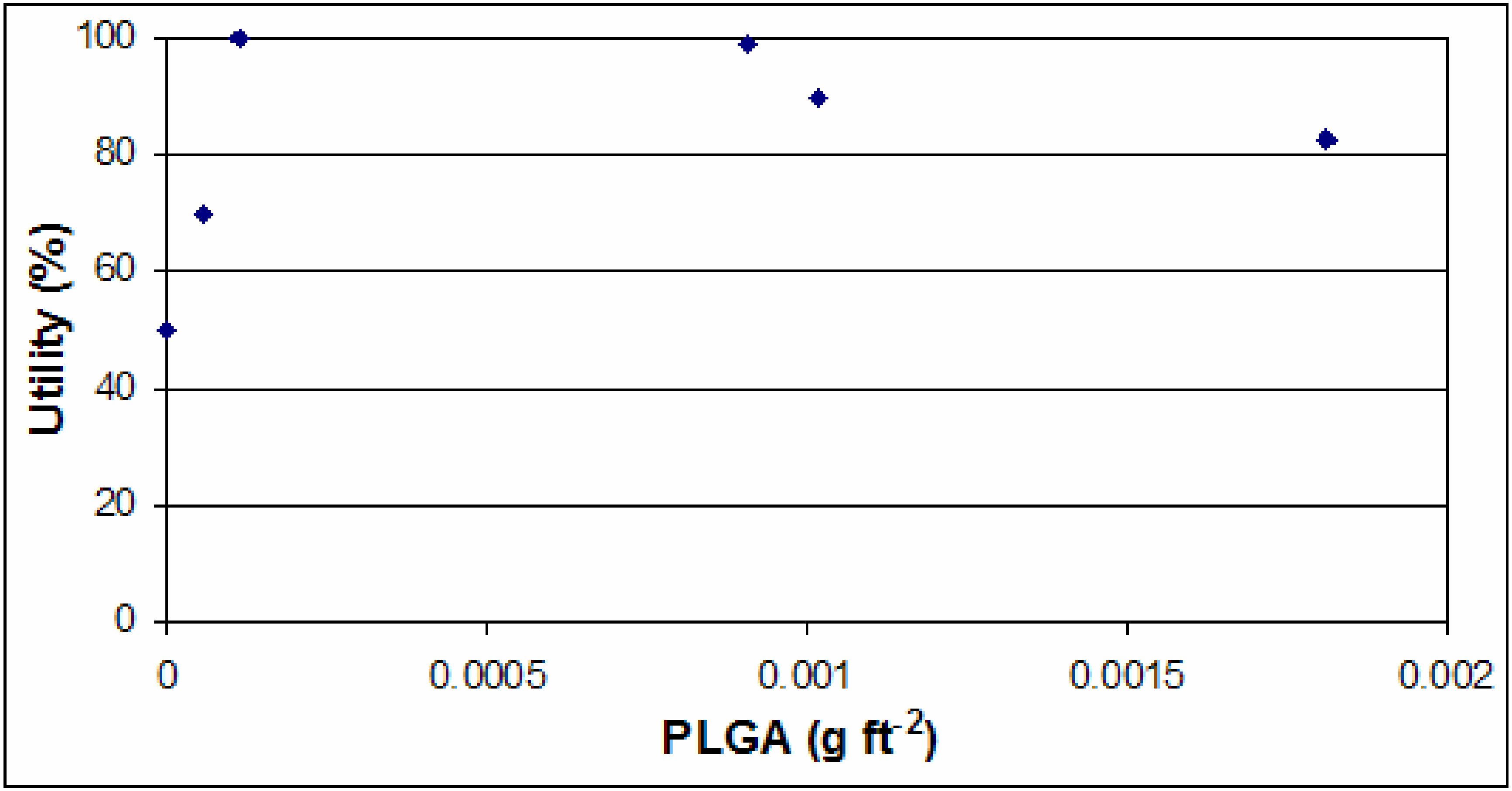
- Assuming
  - 10 micron particle diameter
  - Fixed amount of linalool in particles (L) to 90% linalool

Scent Intensity: Concentration at 5 ft





Scent Intensity



Fragrance Duration

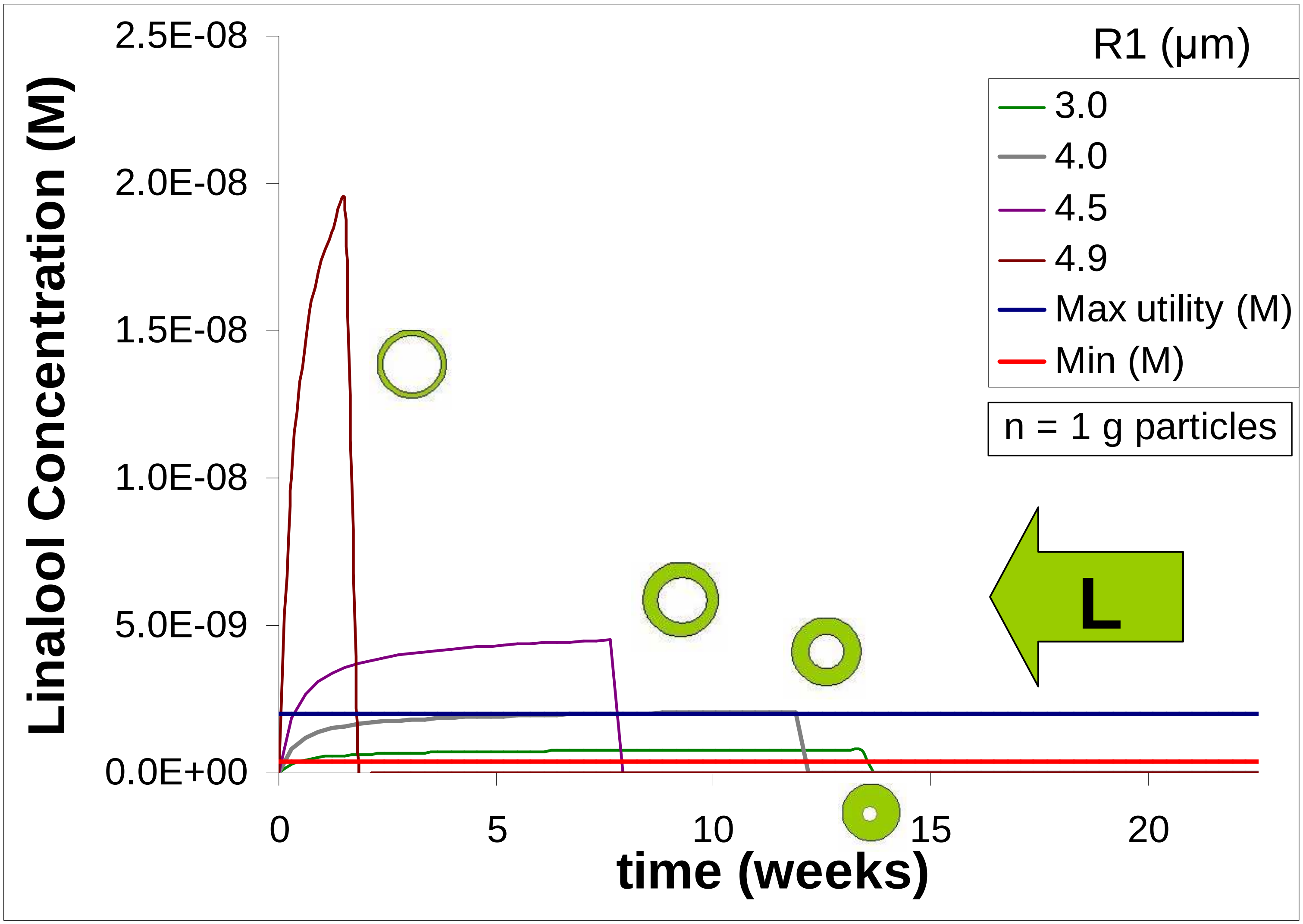
$$\int_0^{t^*} D_m \frac{dC}{dr} = m$$

$$t^* = \frac{c_o R_1^3}{3 D_a C(R_2) R_2}$$

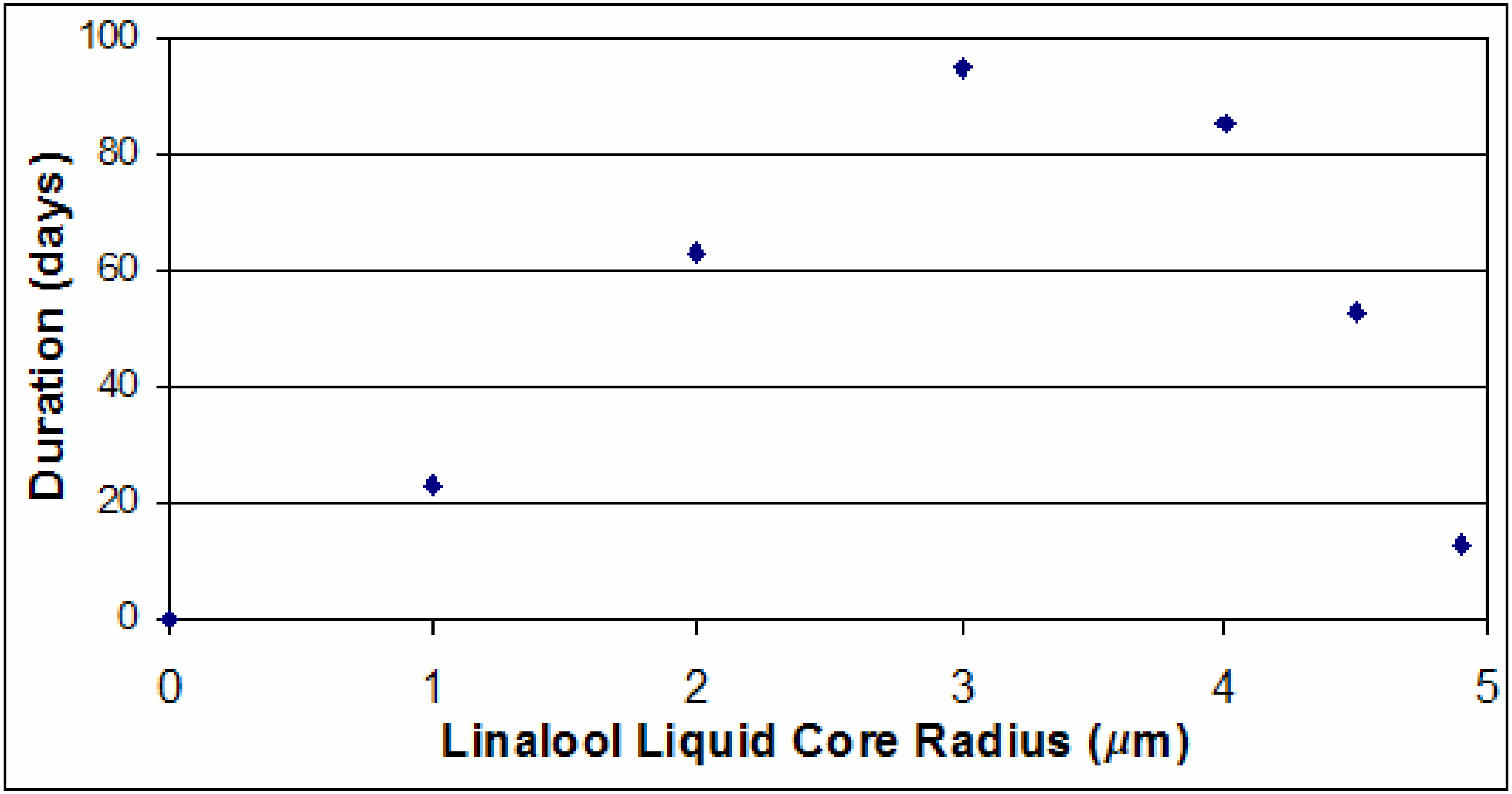
Fragrance Duration

- Relates
  - Application frequency
  - Amount of linalool in particles (L)
- Assuming
  - 24 hours to concentration threshold
  - Fixed number of particles (n)

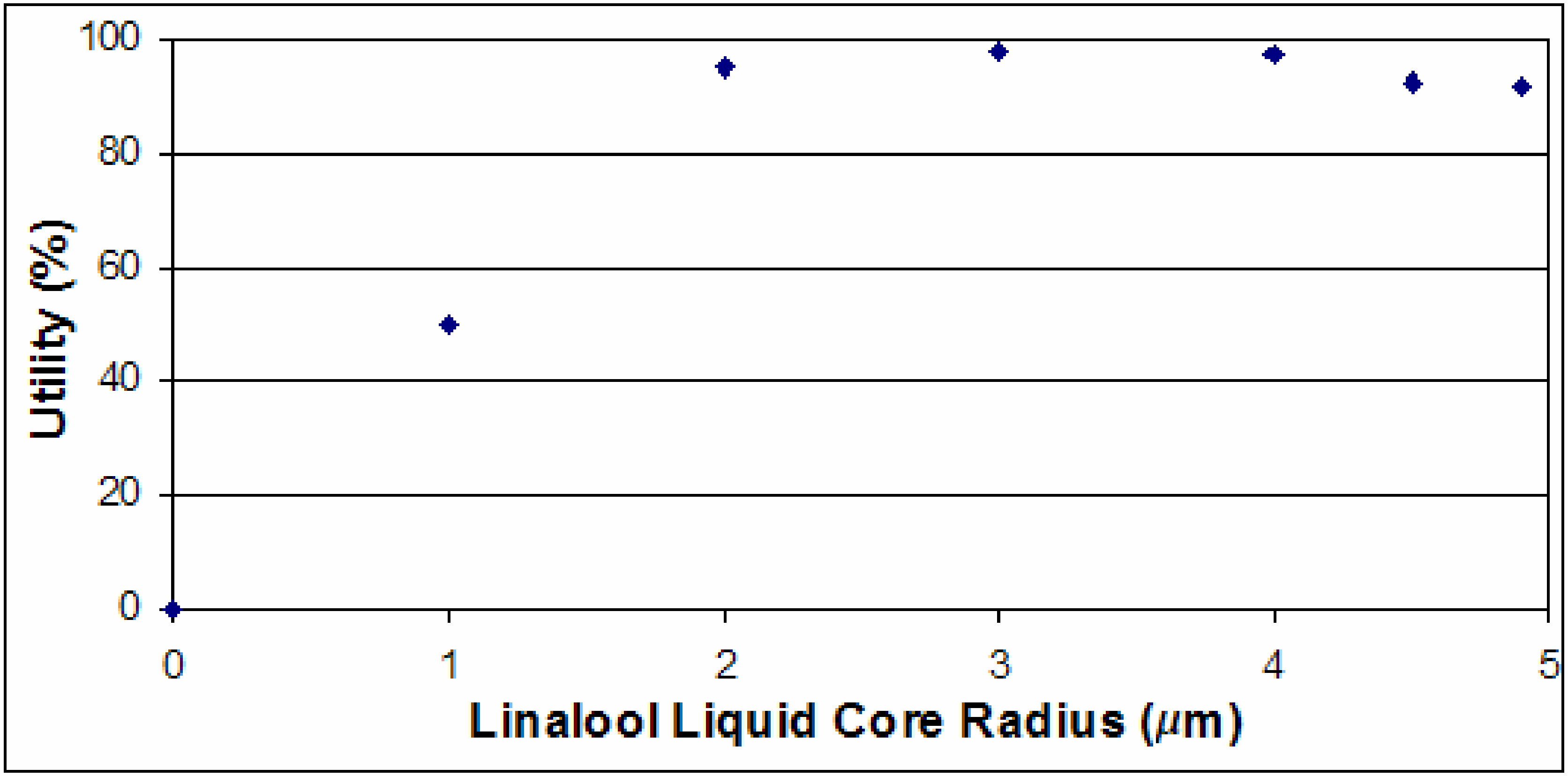
Fragrance Duration: Concentration at 5 ft



Fragrance Duration



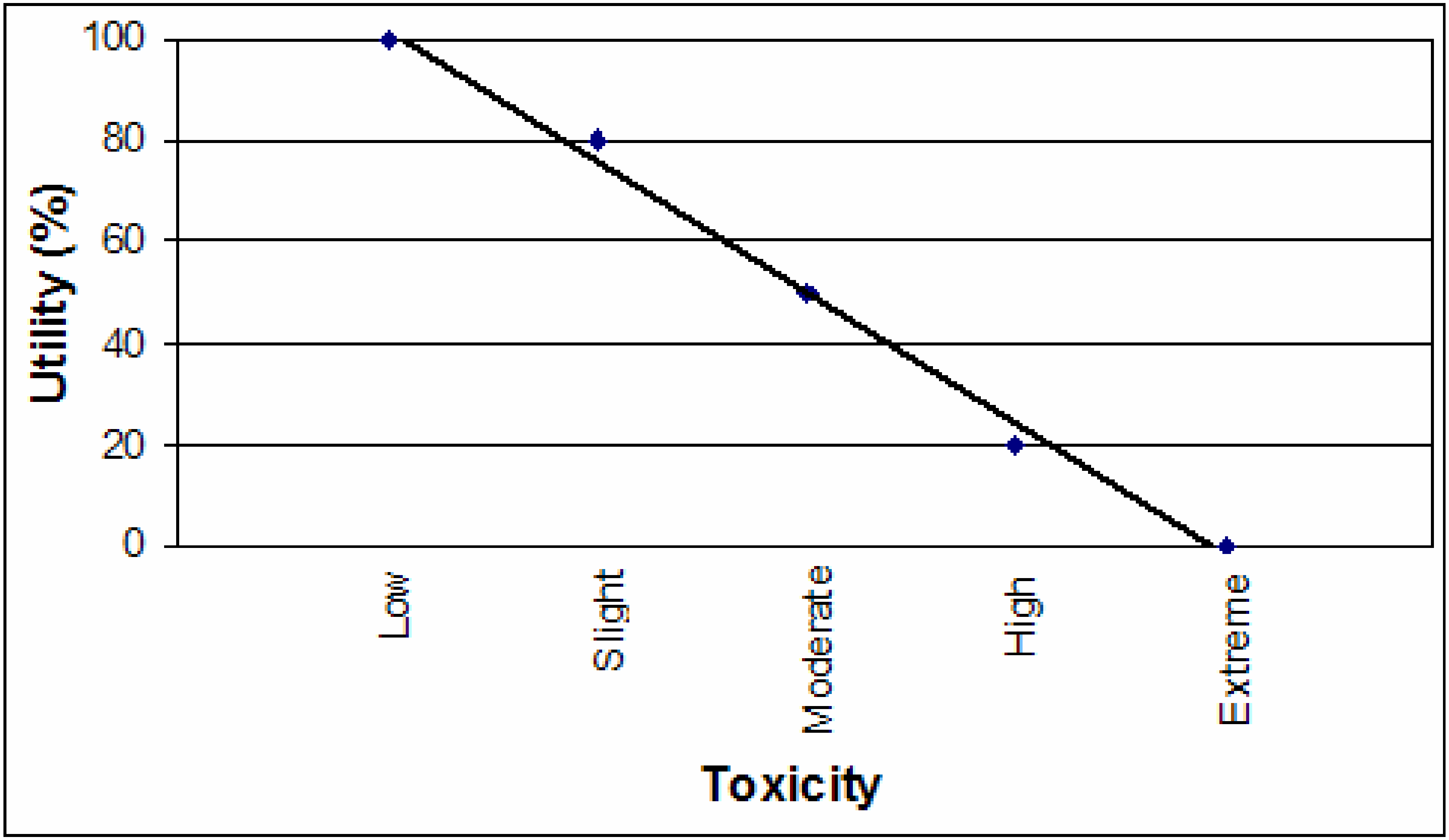
Fragrance Duration



Toxicity relates

- Toxicity
- Amount of boric acid per unit area

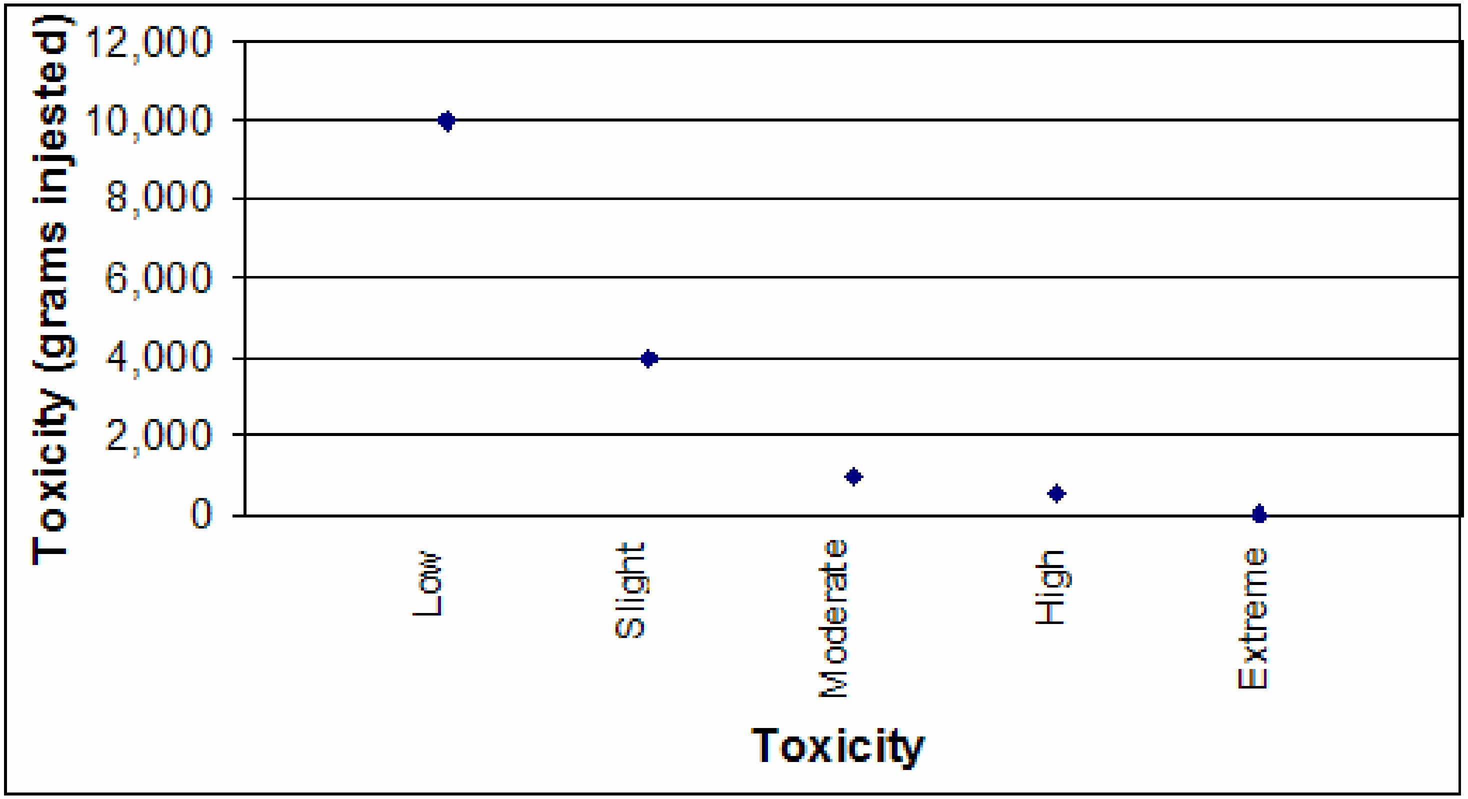
Toxicity



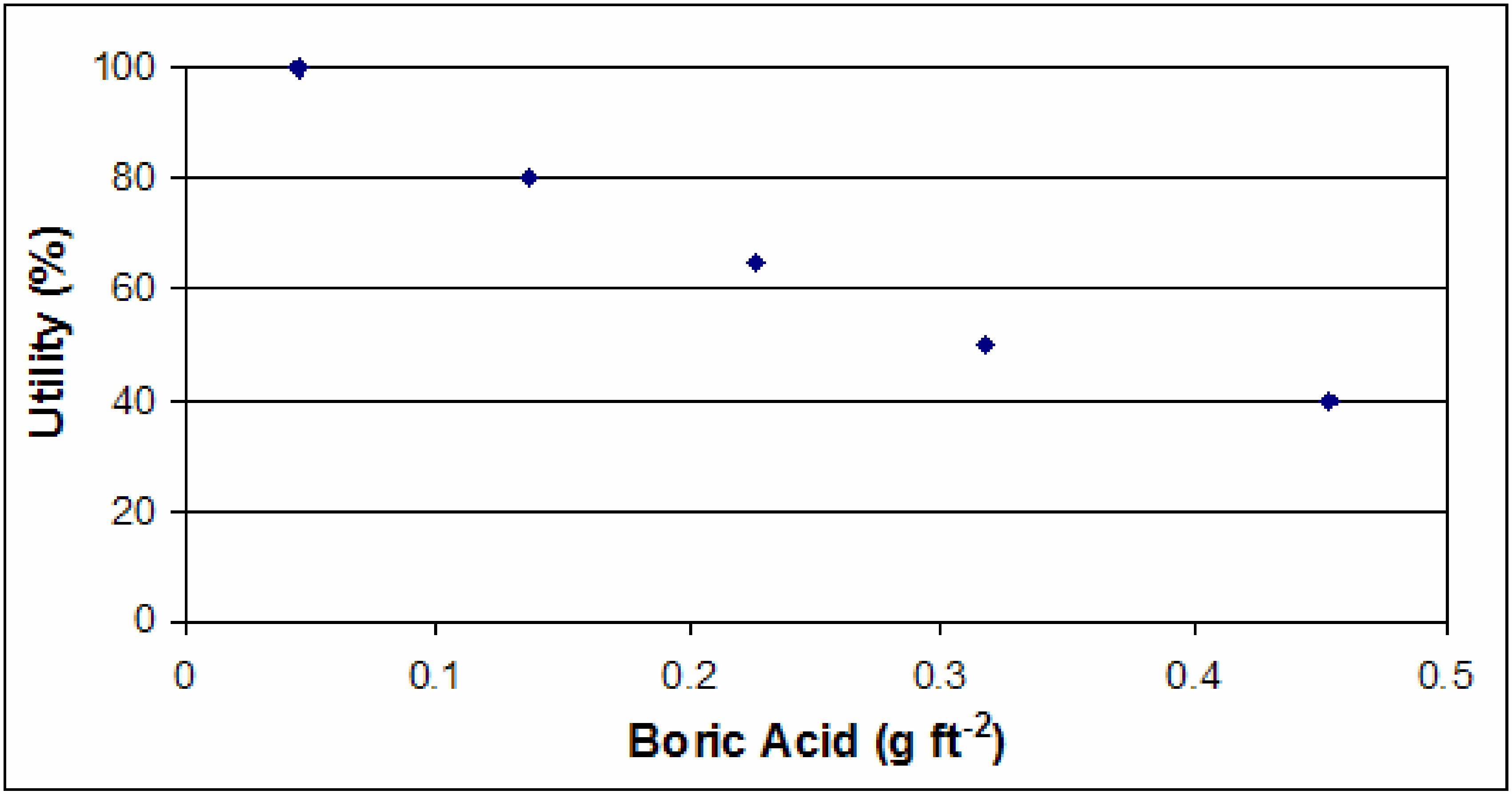
100
80
60
40
20
0
Utility (%)
Low
Slight
Moderate
High
Extreme
Toxicity

Toxicity

- Components are fixed
- Toxicity is the same as the competitor



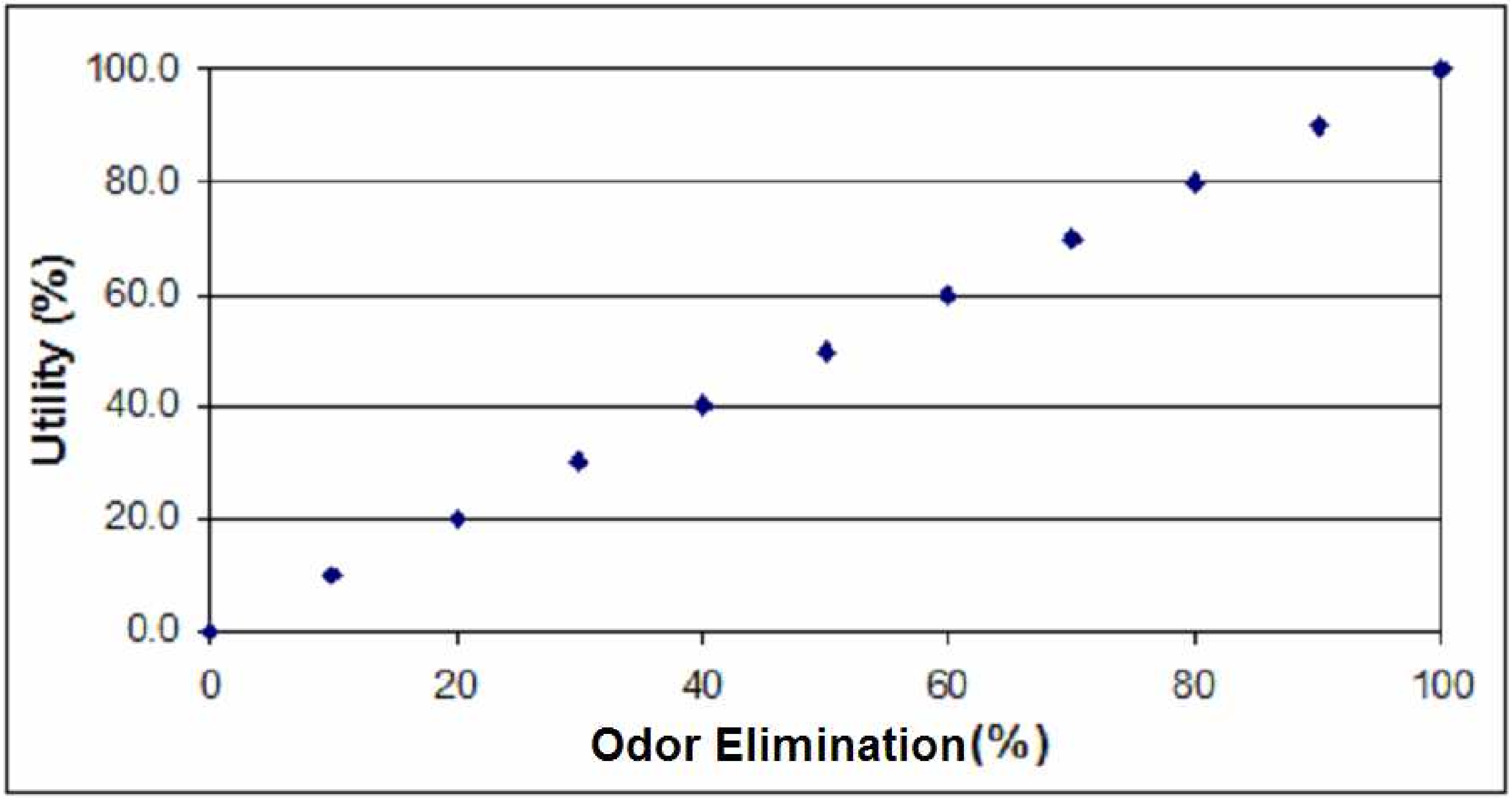
Toxicity



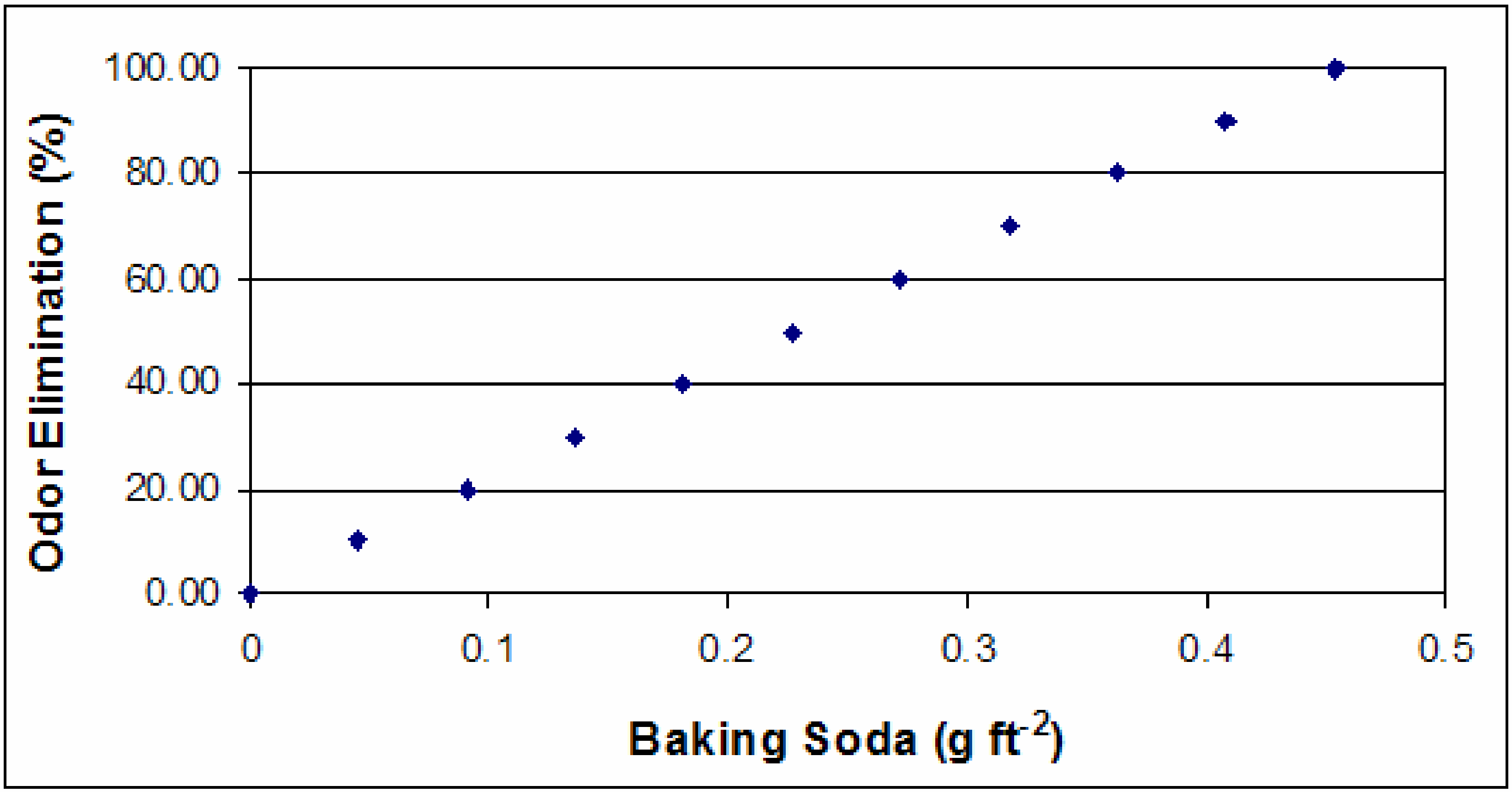
Odor Elimination relates

- Odor Eliminated (Freshness)
- Amount of baking soda per unit area

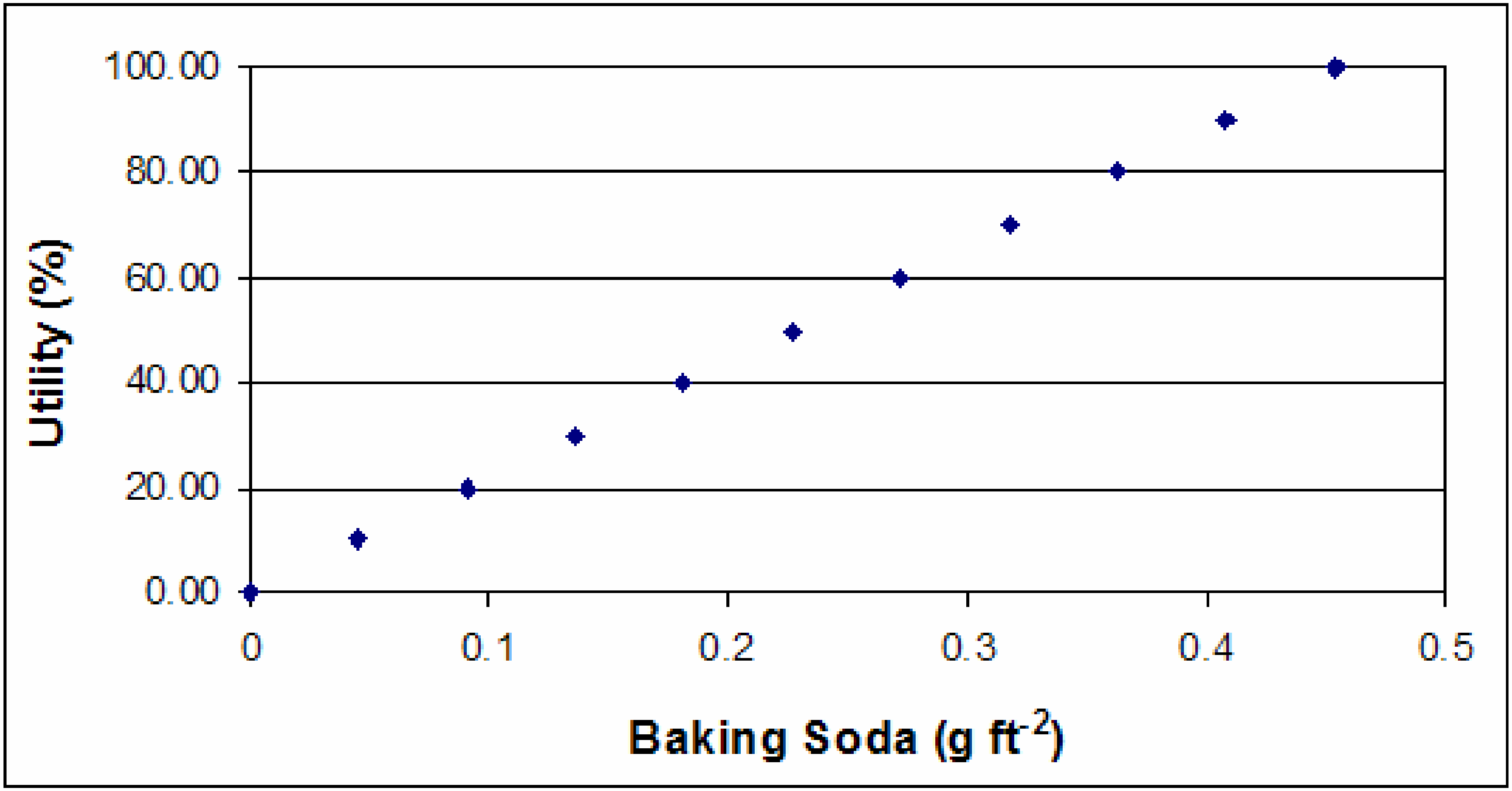
Odor Elimination



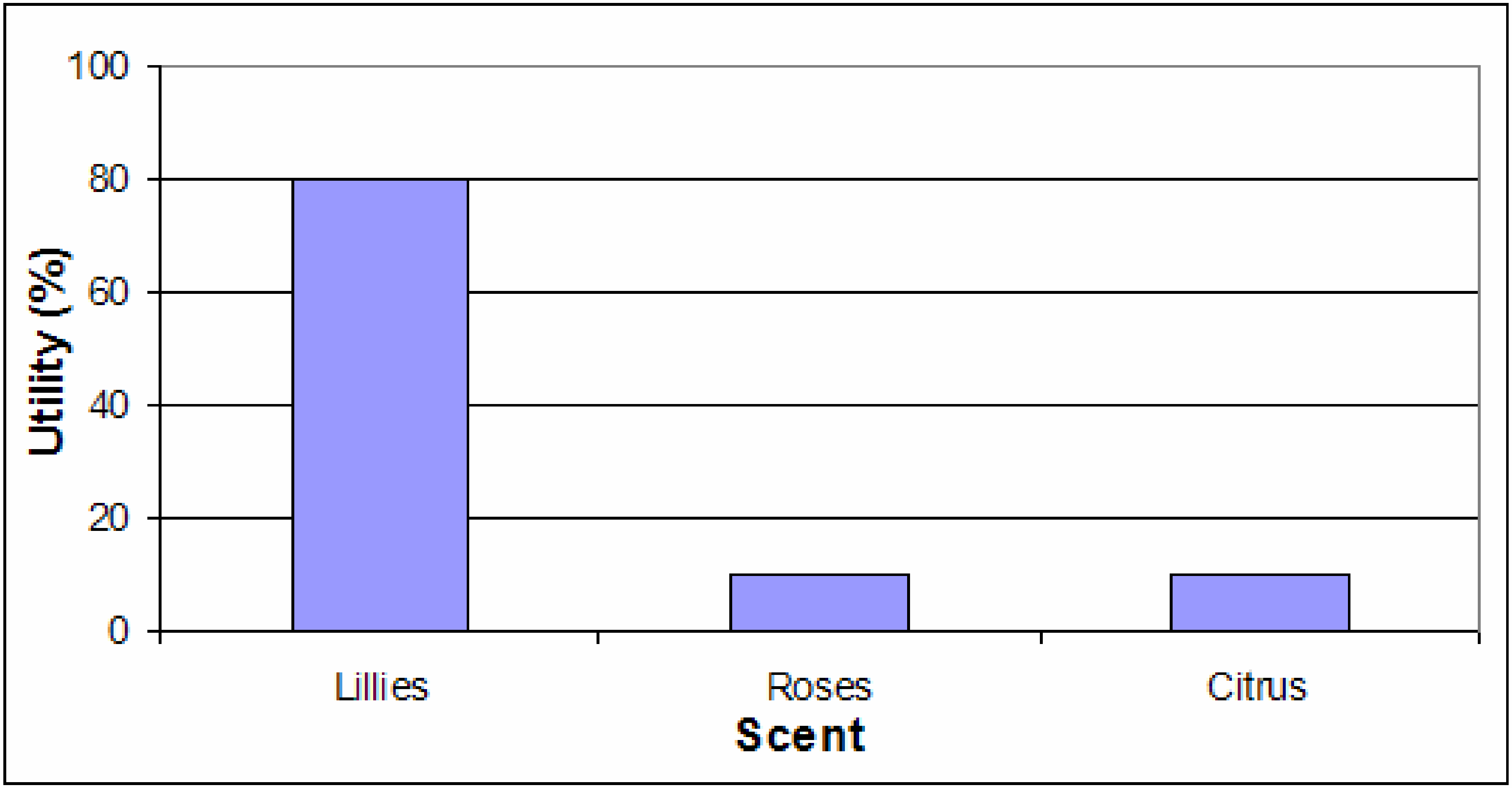
Odor Elimination



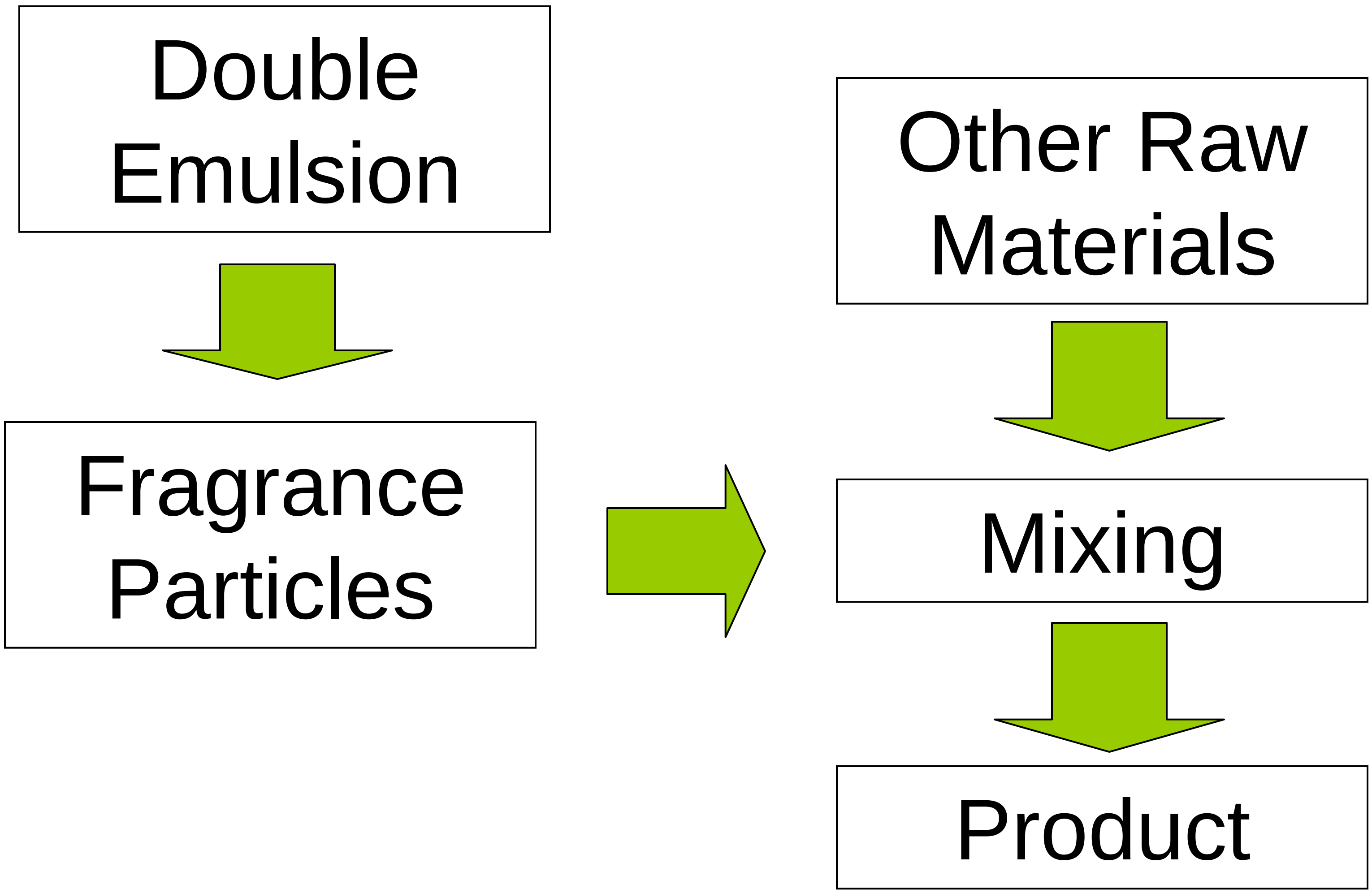
Odor Elimination



Scent Type

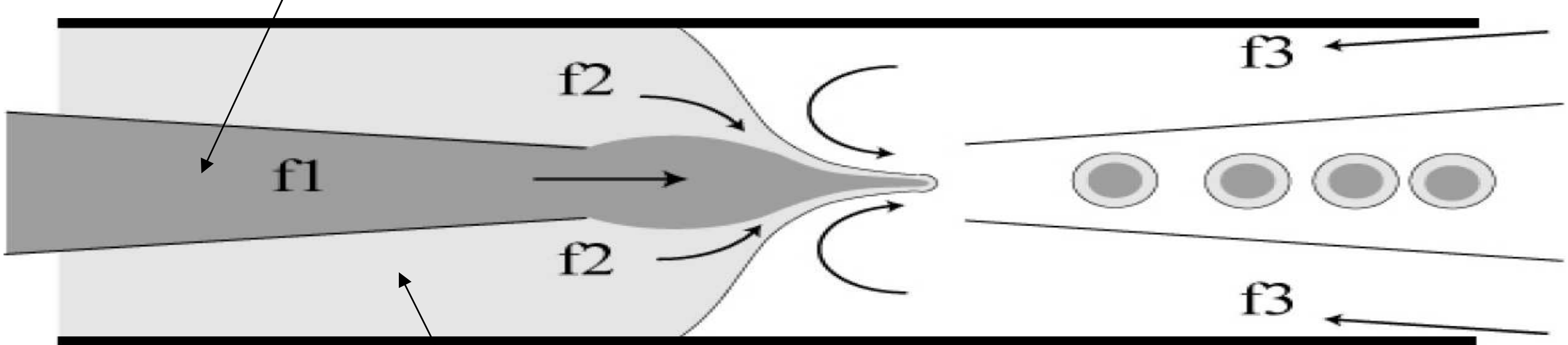


Production Process



Water/Oil/Water Double Emulsion

Aqueous linalool



Methylene
chloride/PLGA solution

Double Emulsion

- Mix by sonication

Sonicator

www.2spi.com

Double Emulsion

Linalool

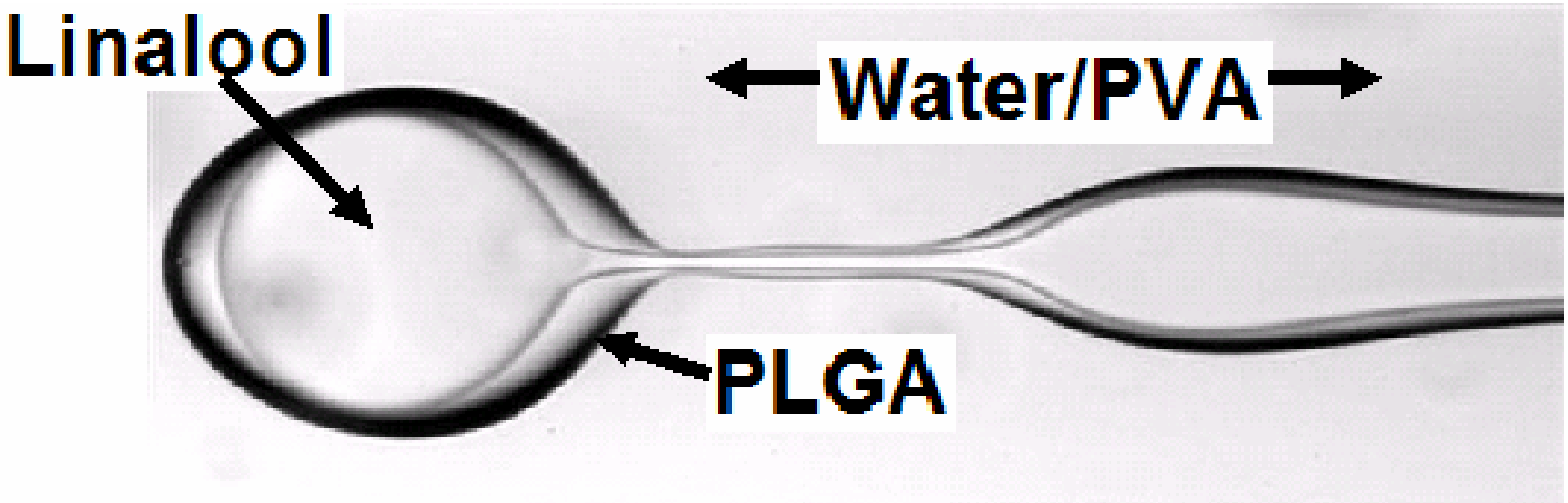
in methylene chloride/PLGA

H_2O and PVA

(emulsifying agent)

Double Emulsion

- PVA ensures small colloids stay small



Double Emulsion

- Remove organic solvent

Rotary Evaporator

aironline.com/equipment

Double Emulsion

- Collect microspheres

Centrifuge

aironline.com/equipment/

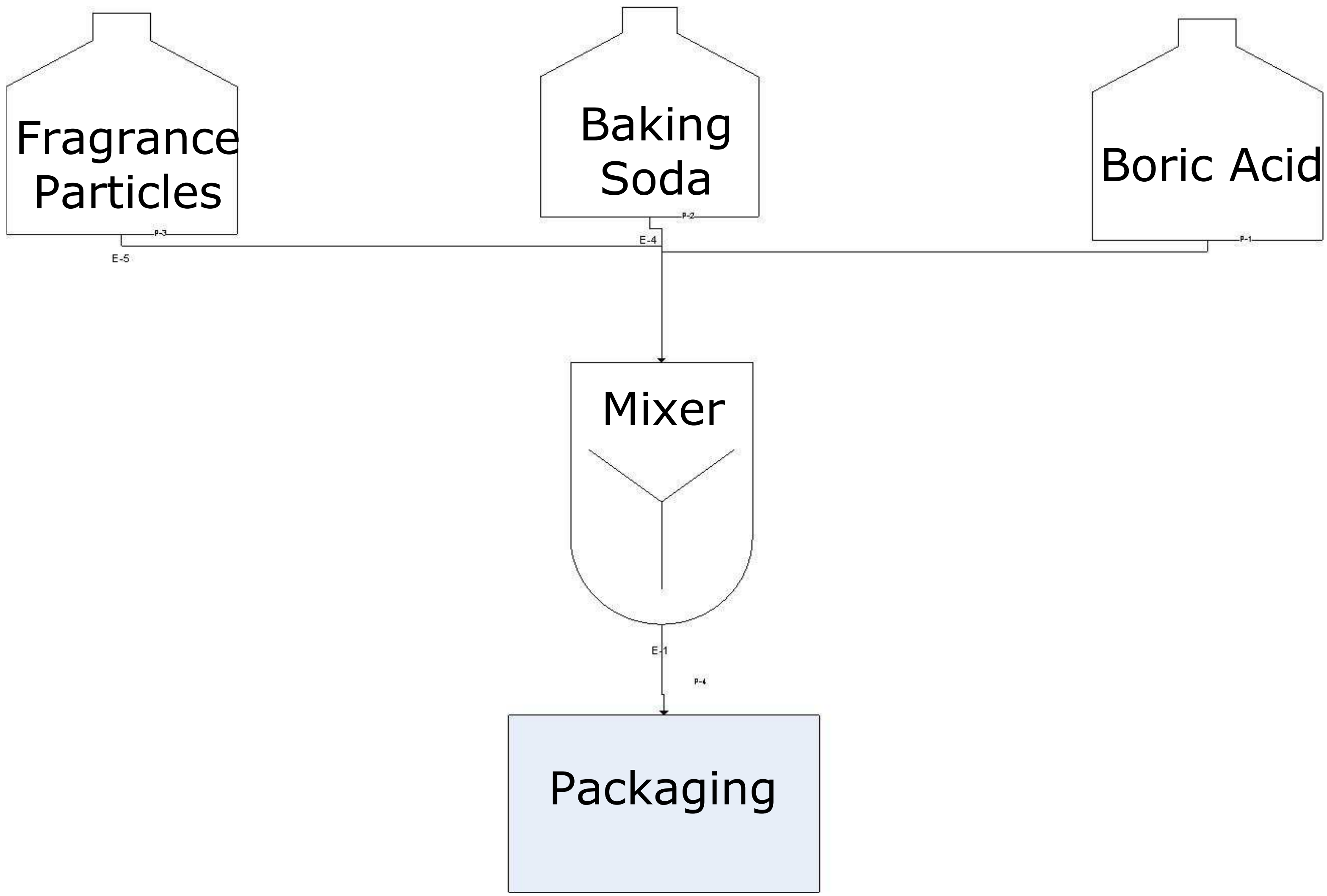
Double Emulsion

- Prepare for mixing

Freeze Dryer

www.labx.com

Production Process: Mixing



Cost Analysis

- TCI and FCI
- Price and Demand Model
  - Maximized Utility
  - Maximized NPW
- Shipping Costs
- Advertising Costs
- Risk
  - Strauss Plots
  - Monte-Carlo Simulations

Price and Demand

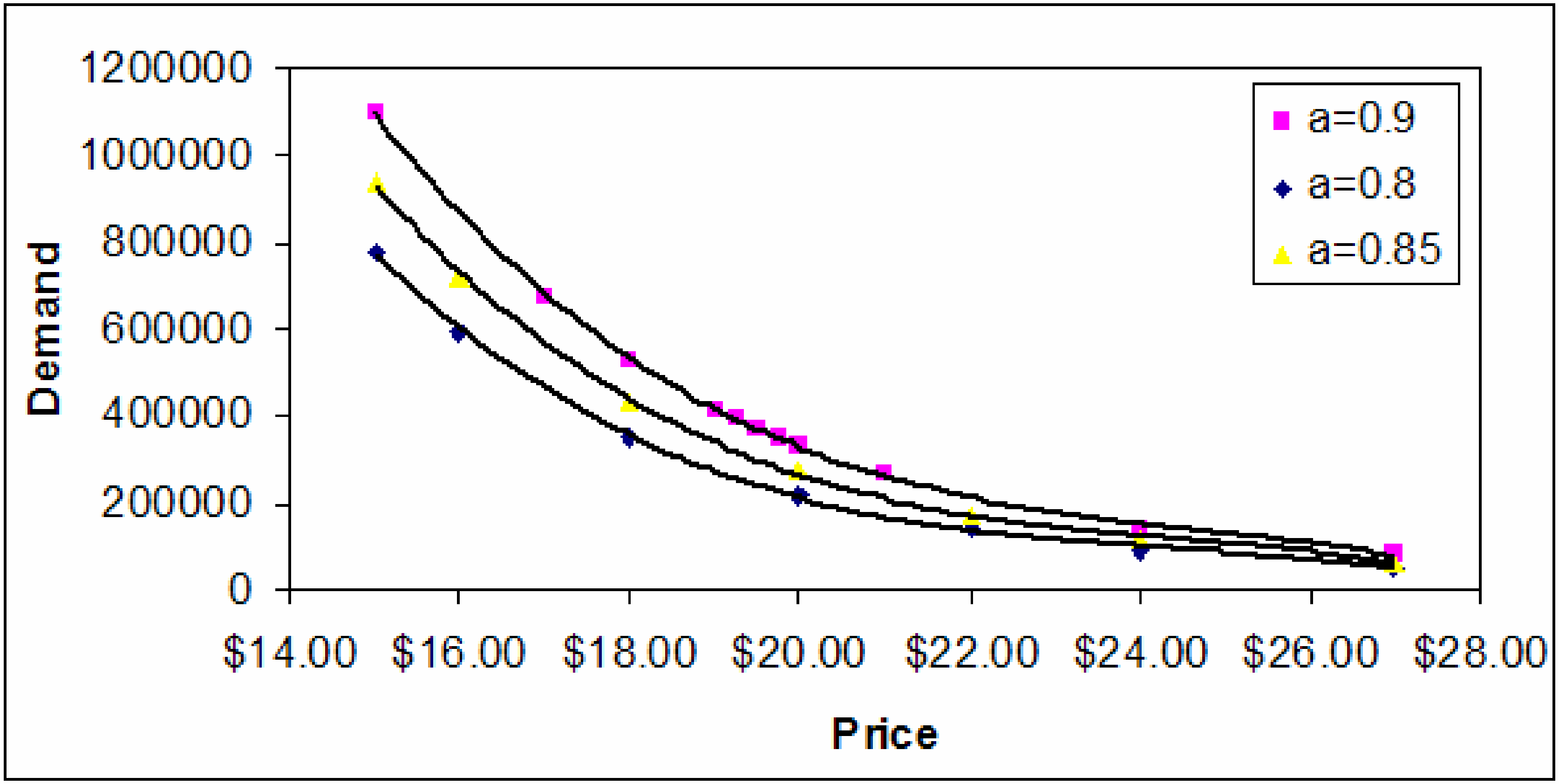
$$0 = P_1 D_1 - \left(\frac{\alpha}{\beta}\right)^{\rho} P_2 \left(\frac{Y - P_1 D_1}{P_2}\right)^{1-\rho} D_1^{\rho}$$

α	= consumer awareness
β	= competitor utility/our utility
ρ	= diminishing marginal utility (concave <1)
Y	= budget constraint
P	= price
D	= demand
	1 = ours, 2 = competition

P_2=10$

U_2=62

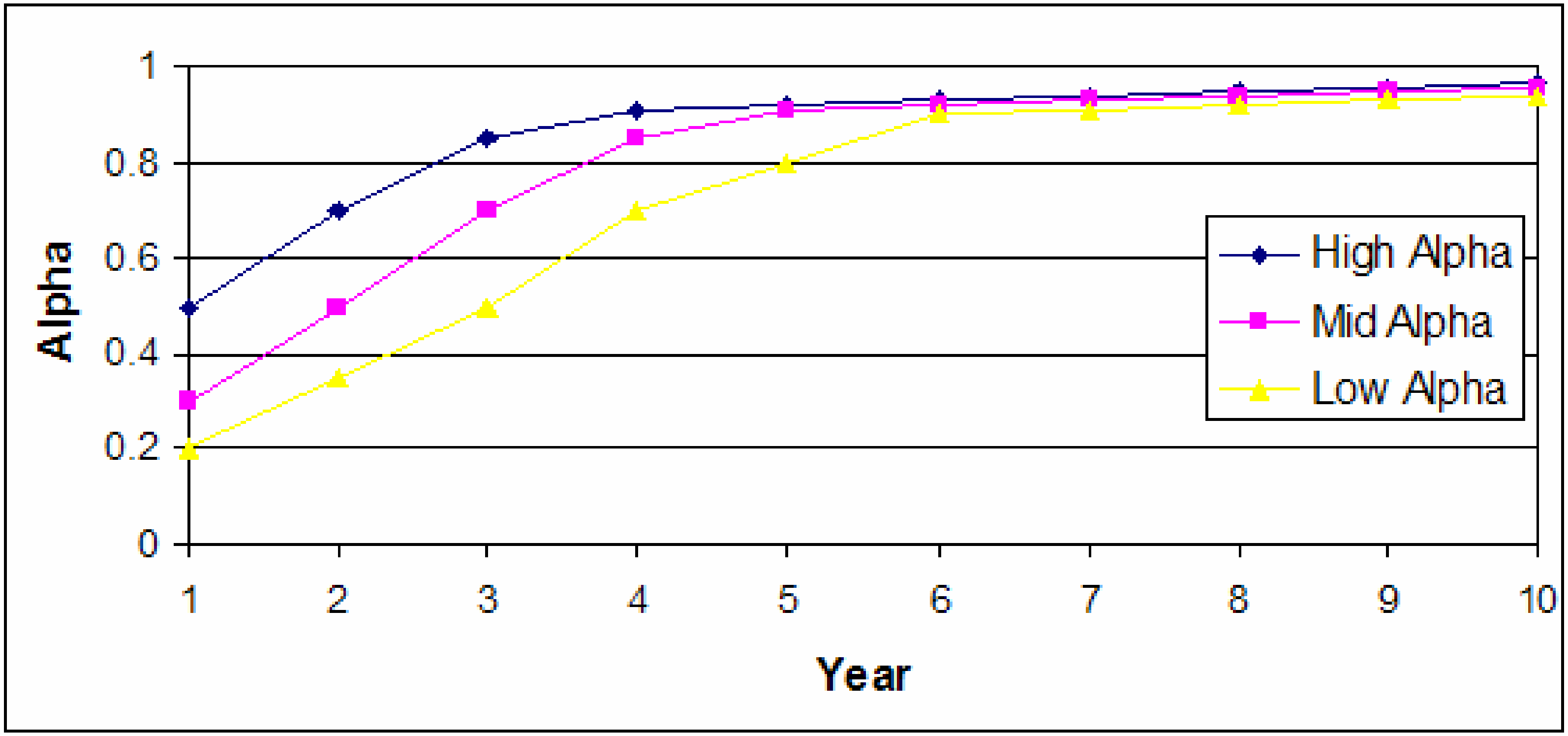
Price and Demand



Budget Constraint = 54 million

Alpha

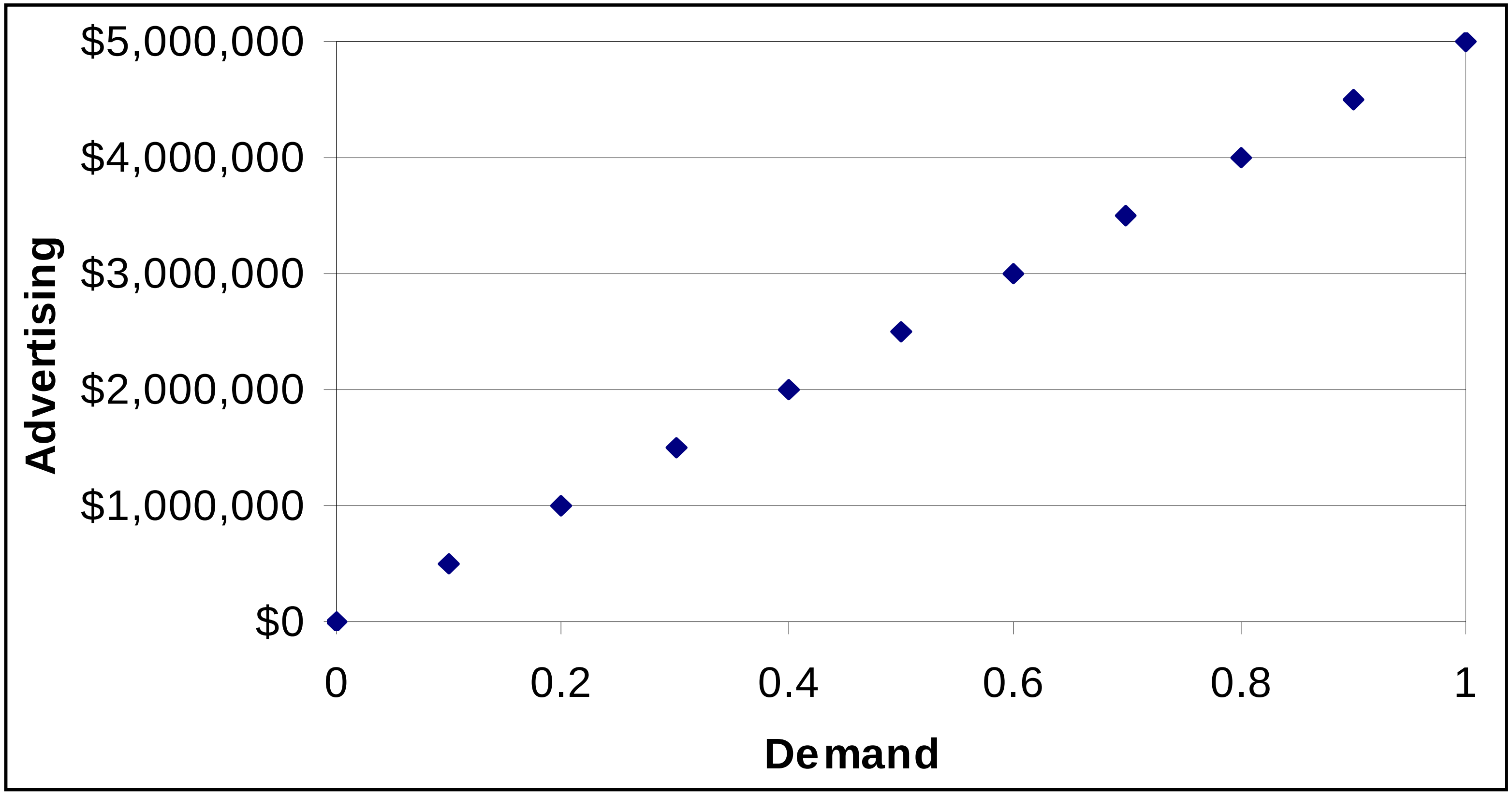
- α is a function of advertising and time



- Preliminary estimates based on α = 0.9

Advertising

- Directly proportional to demand
- $5 million for 100% demand



Shipping

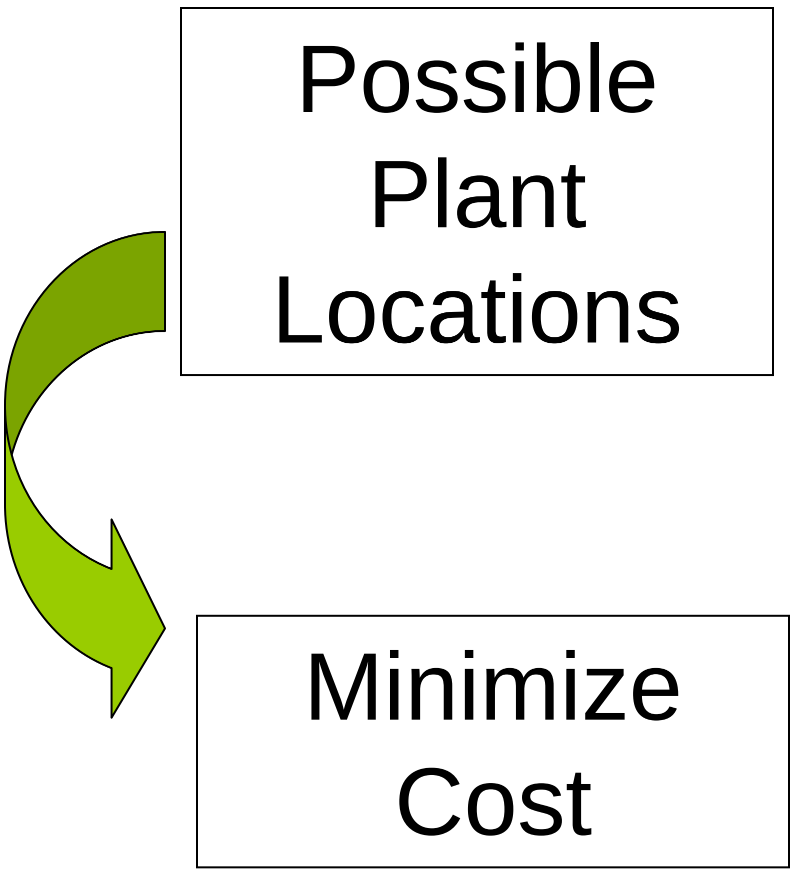
Choose Distribution Centers

throughout USA

Assign Weights

population and humidity

Shipping



high productivity

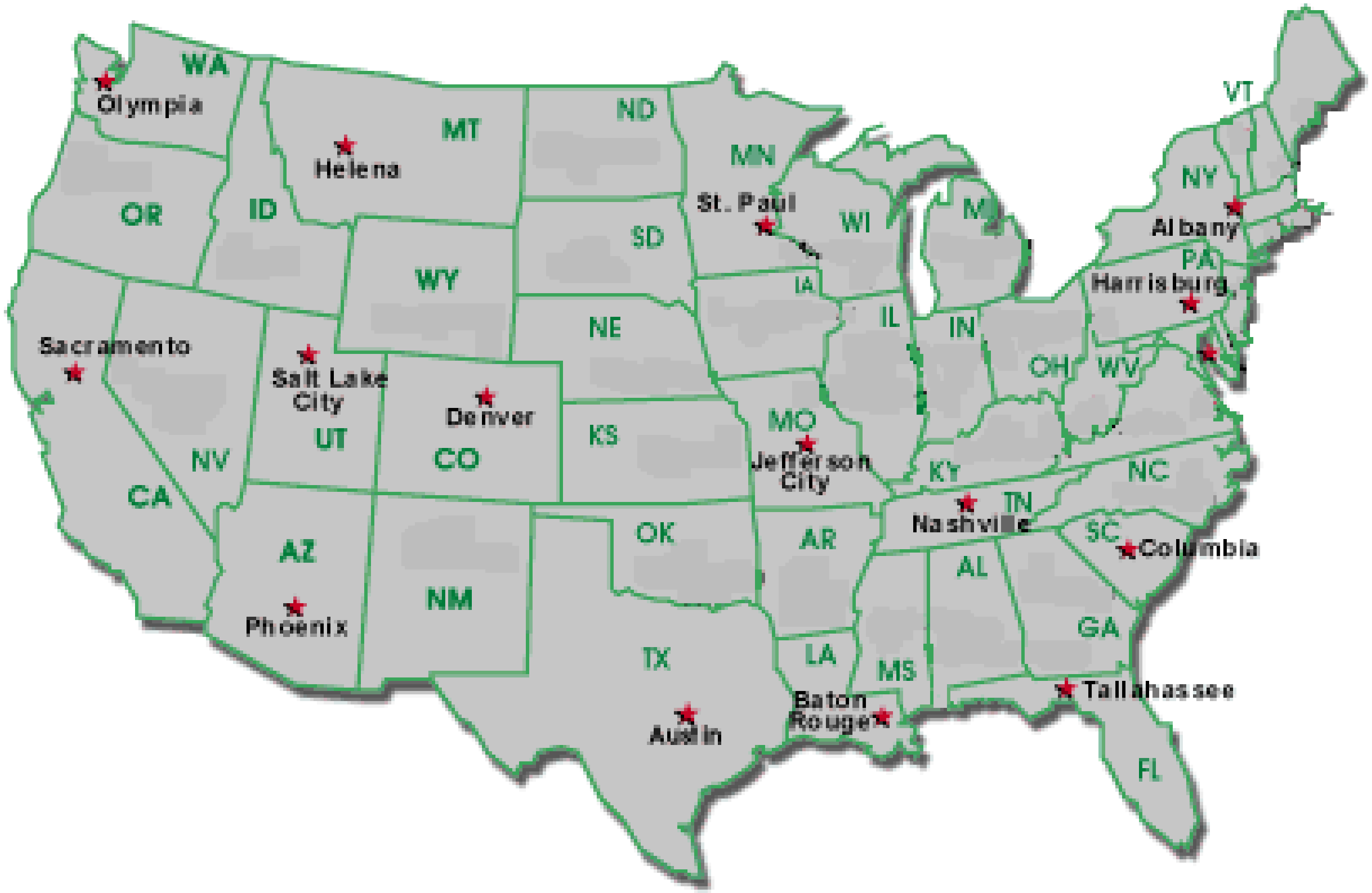
Shipping Assumptions

- Ship by truck
- Constant product composition
- Uniform price in all regions
- Uniform budget constraint in all regions

Distribution Centers

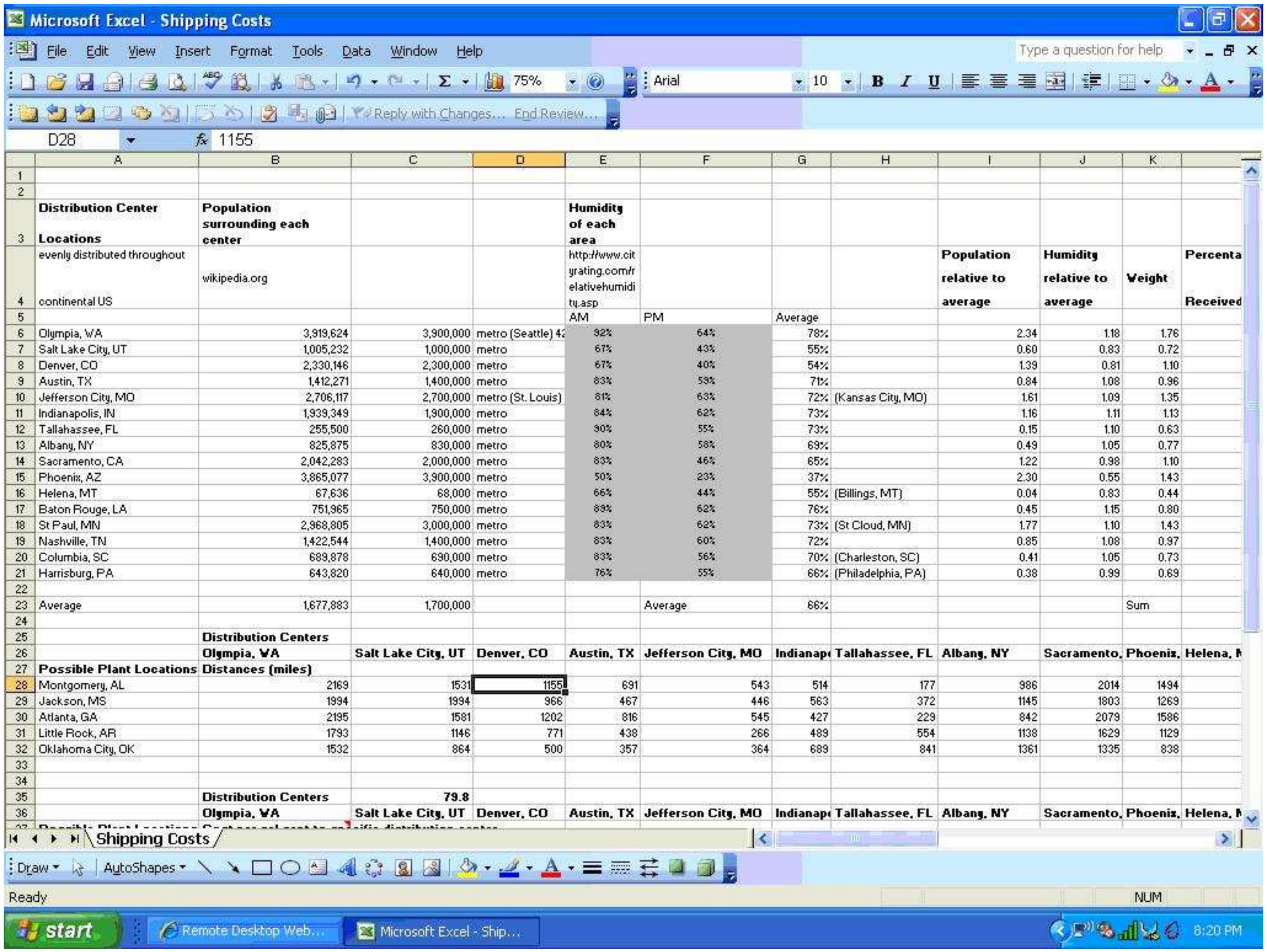
Olympia, WA	Sacramento, CA
Salt Lake City, UT	Phoenix, AZ
Denver, CO	Helena, MT
Austin, TX	Baton Rouge, LA
Jefferson City, MO	St Paul, MN
Indianapolis, IN	Nashville, TN
Tallahassee, FL	Columbia, SC
Albany, NY	Harrisburg, PA

Distribution Centers



50states.com

Shipping Calculations

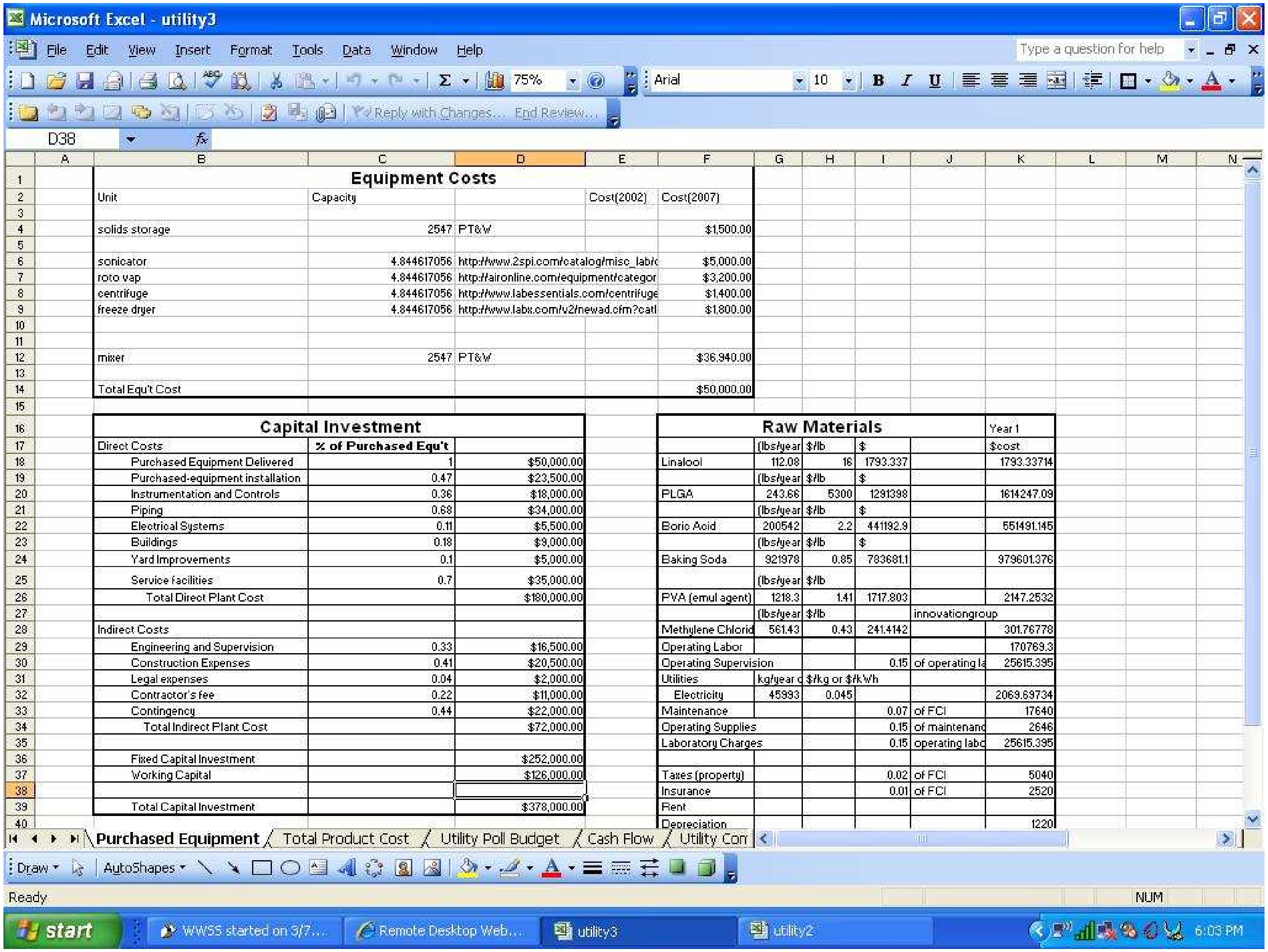


	A	B	C	D	E	F	G	H	I	J	K	
1												
2												
3	**Distribution Center Locations**	**Population surrounding each center**			**Humidity of each area**							
4	evenly distributed throughout continental US	wikipedia.org			http://www.cityrating.com/relativehumidity.asp				**Population relative to average**	**Humidity relative to average**	**Weight**	**Percenta Received**
5					AM	PM	Average					
6	Olympia, WA	3,919,624	3,900,000	metro (Seattle) 42	92%	64%	78%		2.34	1.18	1.76	
7	Salt Lake City, UT	1,005,232	1,000,000	metro	67%	43%	55%		0.60	0.83	0.72	
8	Denver, CO	2,330,146	2,300,000	metro	67%	40%	54%		1.39	0.81	1.10	
9	Austin, TX	1,412,271	1,400,000	metro	83%	59%	71%		0.84	1.08	0.96	
10	Jefferson City, MO	2,706,117	2,700,000	metro (St. Louis)	81%	63%	72%	(Kansas City, MO)	1.61	1.09	1.35	
11	Indianapolis, IN	1,939,349	1,900,000	metro	84%	62%	73%		1.16	1.11	1.13	
12	Tallahassee, FL	255,500	260,000	metro	90%	55%	73%		0.15	1.10	0.63	
13	Albany, NY	825,875	830,000	metro	80%	58%	69%		0.49	1.05	0.77	
14	Sacramento, CA	2,042,283	2,000,000	metro	83%	46%	65%		1.22	0.98	1.10	
15	Phoenix, AZ	3,865,077	3,900,000	metro	50%	23%	37%		2.30	0.55	1.43	
16	Helena, MT	67,636	68,000	metro	66%	44%	55%	(Billings, MT)	0.04	0.83	0.44	
17	Baton Rouge, LA	751,965	750,000	metro	89%	62%	76%		0.45	1.15	0.80	
18	St Paul, MN	2,968,805	3,000,000	metro	83%	62%	73%	(St Cloud, MN)	1.77	1.10	1.43	
19	Nashville, TN	1,422,544	1,400,000	metro	83%	60%	72%		0.85	1.08	0.97	
20	Columbia, SC	689,878	690,000	metro	83%	56%	70%	(Charleston, SC)	0.41	1.05	0.73	
21	Harrisburg, PA	643,820	640,000	metro	76%	55%	66%	(Philadelphia, PA)	0.38	0.99	0.69	
22												
23	Average	1,677,883	1,700,000			Average	66%				Sum	
24												
25		**Distribution Centers**										
26		**Olympia, WA**	**Salt Lake City, UT**	**Denver, CO**	**Austin, TX**	**Jefferson City, MO**	**Indianap**	**Tallahassee, FL**	**Albany, NY**	**Sacramento,**	**Phoenix,**	**Helena, M**
27	**Possible Plant Locations**	**Distances (miles)**										
28	Montgomery, AL	2169	1531	1155	691	543	514	177	986	2014	1494	
29	Jackson, MS	1994	1994	966	467	446	563	372	1145	1803	1269	
30	Atlanta, GA	2195	1581	1202	816	545	427	229	842	2079	1586	
31	Little Rock, AR	1793	1146	771	438	266	489	554	1138	1629	1129	
32	Oklahoma City, OK	1532	864	500	357	364	689	841	1361	1335	838	
33												
34												
35		**Distribution Centers**	**79.8**									
36		**Olympia, WA**	**Salt Lake City, UT**	**Denver, CO**	**Austin, TX**	**Jefferson City, MO**	**Indianap**	**Tallahassee, FL**	**Albany, NY**	**Sacramento,**	**Phoenix,**	**Helena, M**

Plant Location	Population	Avg. Humidity	Fraction of Production
Olympia, WA	3.9 million	78%	0.11
St. Paul, MN	3 million	73%	0.09
Baton Rouge, LA	750,000	76%	0.05

Plant Location	Cost per gal
Montgomery, AL	$ 304
Jackson, MS	$ 289
Atlanta, GA	$ 304
Little Rock, AR	$ 260
Oklahoma City, OK	$ 250

TCI Calculations



Equipment Costs

Unit	Capacity		Cost(2002)	Cost(2007)
solids storage	2547	PT&W		$1,500.00
sonicator	4.844617056	http://www.2spi.com/catalog/misc_lab/c		$5,000.00
roto vap	4.844617056	http://aironline.com/equipment/categor		$3,200.00
centrifuge	4.844617056	http://www.labessentials.com/centrifuge		$1,400.00
freeze dryer	4.844617056	http://www.labx.com/v2/newad.cfm?catl		$1,800.00
mixer	2547	PT&W		$36,940.00
Total Equ't Cost				$50,000.00

Capital Investment

Direct Costs	% of Purchased Equ't	
Purchased Equipment Delivered	1	$50,000.00
Purchased-equipment installation	0.47	$23,500.00
Instrumentation and Controls	0.36	$18,000.00
Piping	0.68	$34,000.00
Electrical Systems	0.11	$5,500.00
Buildings	0.18	$9,000.00
Yard Improvements	0.1	$5,000.00
Service facilities	0.7	$35,000.00
Total Direct Plant Cost		$180,000.00
Indirect Costs		
Engineering and Supervision	0.33	$16,500.00
Construction Expenses	0.41	$20,500.00
Legal expenses	0.04	$2,000.00
Contractor's fee	0.22	$11,000.00
Contingency	0.44	$22,000.00
Total Indirect Plant Cost		$72,000.00
Fixed Capital Investment		$252,000.00
Working Capital		$126,000.00
Total Capital Investment		$378,000.00

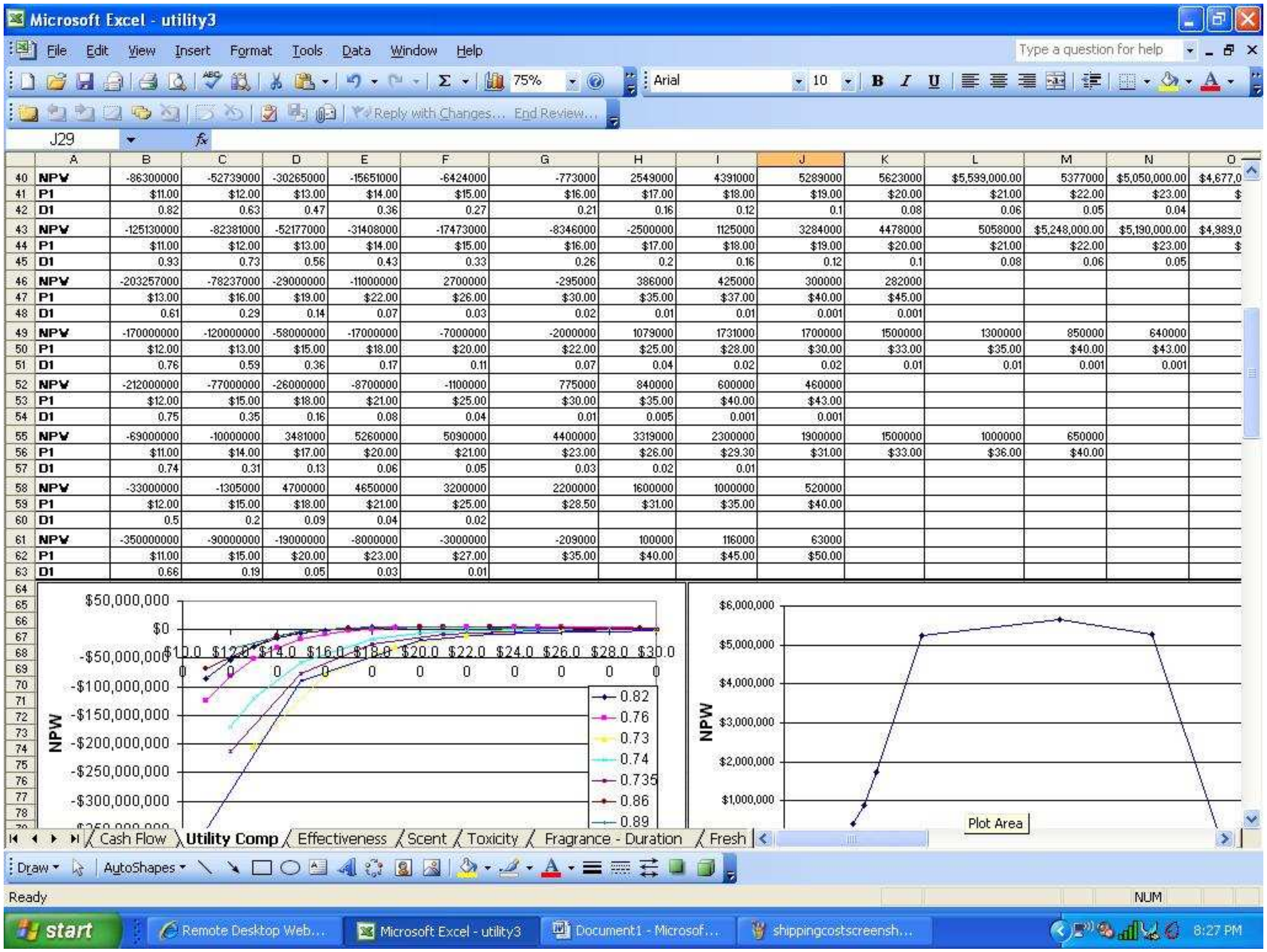
Raw Materials

					Year 1
	(lbs/year	$/lb	$		$cost
Linalool	112.08	16	1793.337		1793.33714
	(lbs/year	$/lb	$		
PLGA	243.66	5300	1291398		1614247.09
	(lbs/year	$/lb	$		
Boric Acid	200542	2.2	441192.9		551491.145
	(lbs/year	$/lb	$		
Baking Soda	921978	0.85	783681.1		979601.376
	(lbs/year	$/lb			
PVA (emul agent)	1218.3	1.41	1717.803		2147.2532
	(lbs/year	$/lb		innovationgroup	
Methylene Chlorid	561.43	0.43	241.4142		301.76778
Operating Labor					170769.3
Operating Supervision			0.15	of operating la	25615.395
Utilities	kg/year c	$/kg or $/kWh			
Electricity	45993	0.045			2069.69734
Maintenance			0.07	of FCI	17640
Operating Supplies			0.15	of maintenanc	2646
Laboratory Charges			0.15	operating labo	25615.395
Taxes (property)			0.02	of FCI	5040
Insurance			0.01	of FCI	2520
Rent					
Depreciation					1220

TCI Calculations

FCI	$350,000
Working Capital	$175,000
TCI	$525,000

NPW Calculations



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
40	NPW	-86300000	-52739000	-30265000	-15651000	-6424000	-773000	2549000	4391000	5289000	5623000	$5,599,000.00	5377000	$5,050,000.00	$4,677,0
41	P1	$11.00	$12.00	$13.00	$14.00	$15.00	$16.00	$17.00	$18.00	$19.00	$20.00	$21.00	$22.00	$23.00	$
42	D1	0.82	0.63	0.47	0.36	0.27	0.21	0.16	0.12	0.1	0.08	0.06	0.05	0.04	
43	NPW	-125130000	-82381000	-52177000	-31408000	-17473000	-8346000	-2500000	1125000	3284000	4478000	5058000	$5,248,000.00	$5,190,000.00	$4,989,0
44	P1	$11.00	$12.00	$13.00	$14.00	$15.00	$16.00	$17.00	$18.00	$19.00	$20.00	$21.00	$22.00	$23.00	$
45	D1	0.93	0.73	0.56	0.43	0.33	0.26	0.2	0.16	0.12	0.1	0.08	0.06	0.05	
46	NPW	-203257000	-78237000	-29000000	-11000000	2700000	-295000	386000	425000	300000	282000				
47	P1	$13.00	$16.00	$19.00	$22.00	$26.00	$30.00	$35.00	$37.00	$40.00	$45.00				
48	D1	0.61	0.29	0.14	0.07	0.03	0.02	0.01	0.01	0.001	0.001				
49	NPW	-170000000	-120000000	-58000000	-17000000	-7000000	-2000000	1079000	1731000	1700000	1500000	1300000	850000	640000	
50	P1	$12.00	$13.00	$15.00	$18.00	$20.00	$22.00	$25.00	$28.00	$30.00	$33.00	$35.00	$40.00	$43.00	
51	D1	0.76	0.59	0.36	0.17	0.11	0.07	0.04	0.02	0.02	0.01	0.01	0.001	0.001	
52	NPW	-212000000	-77000000	-26000000	-8700000	-1100000	775000	840000	600000	460000					
53	P1	$12.00	$15.00	$18.00	$21.00	$25.00	$30.00	$35.00	$40.00	$43.00					
54	D1	0.75	0.35	0.16	0.08	0.04	0.01	0.005	0.001	0.001					
55	NPW	-69000000	-10000000	3481000	5260000	5090000	4400000	3319000	2300000	1900000	1500000	1000000	650000		
56	P1	$11.00	$14.00	$17.00	$20.00	$21.00	$23.00	$26.00	$29.30	$31.00	$33.00	$36.00	$40.00		
57	D1	0.74	0.31	0.13	0.06	0.05	0.03	0.02	0.01						
58	NPW	-33000000	-1305000	4700000	4650000	3200000	2200000	1600000	1000000	520000					
59	P1	$12.00	$15.00	$18.00	$21.00	$25.00	$28.50	$31.00	$35.00	$40.00					
60	D1	0.5	0.2	0.09	0.04	0.02									
61	NPW	-350000000	-90000000	-19000000	-8000000	-3000000	-209000	100000	116000	63000					
62	P1	$11.00	$15.00	$20.00	$23.00	$27.00	$35.00	$40.00	$45.00	$50.00					
63	D1	0.66	0.19	0.05	0.03	0.01									

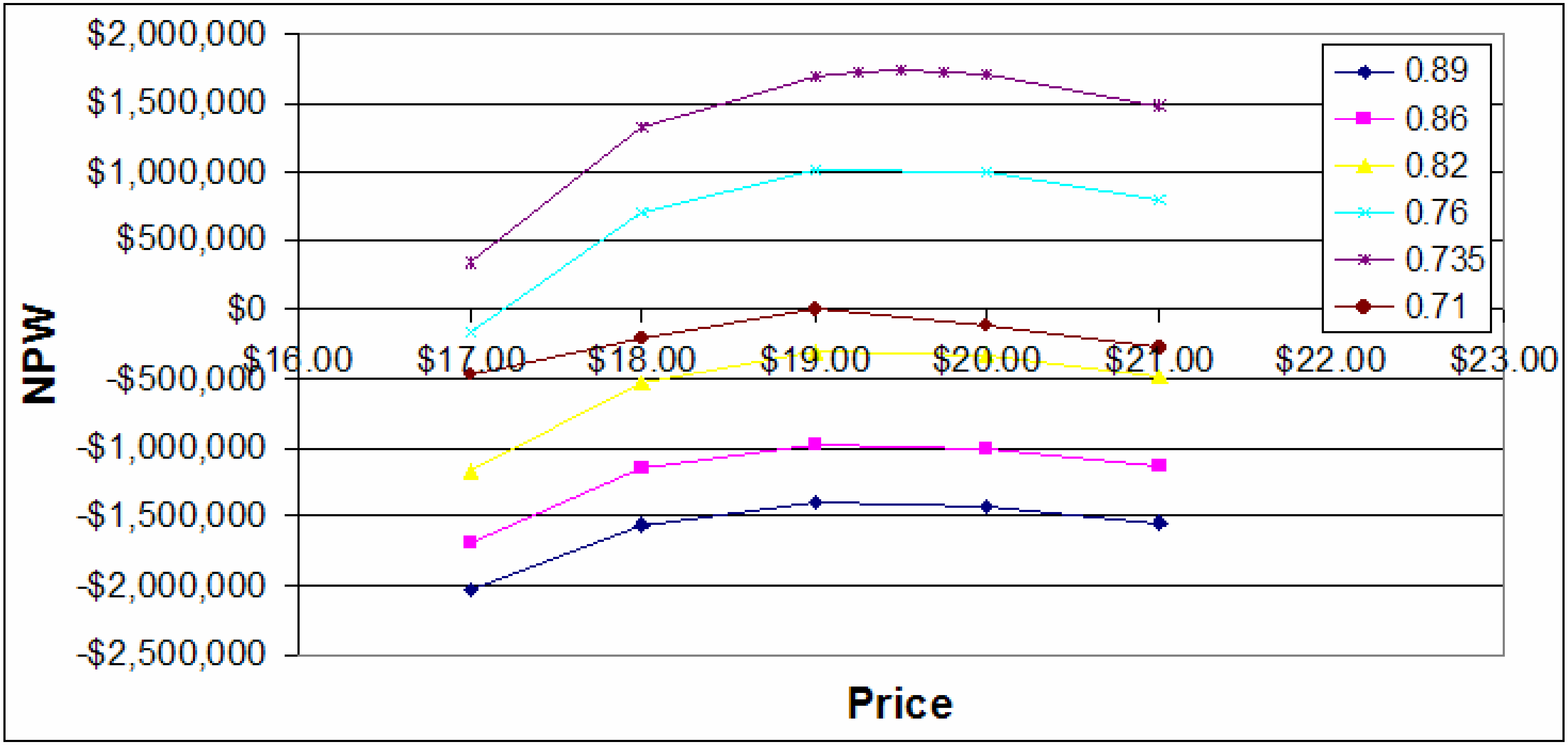
Maximum Utility

- Composition
  - 0.1% Linalool
  - 0.2% PLGA
  - 20.6% Boric Acid
  - 79.1% Baking Soda

- Cost per 16 oz container to have + NPW
  - Unrealistic, you get a –NPW at any price

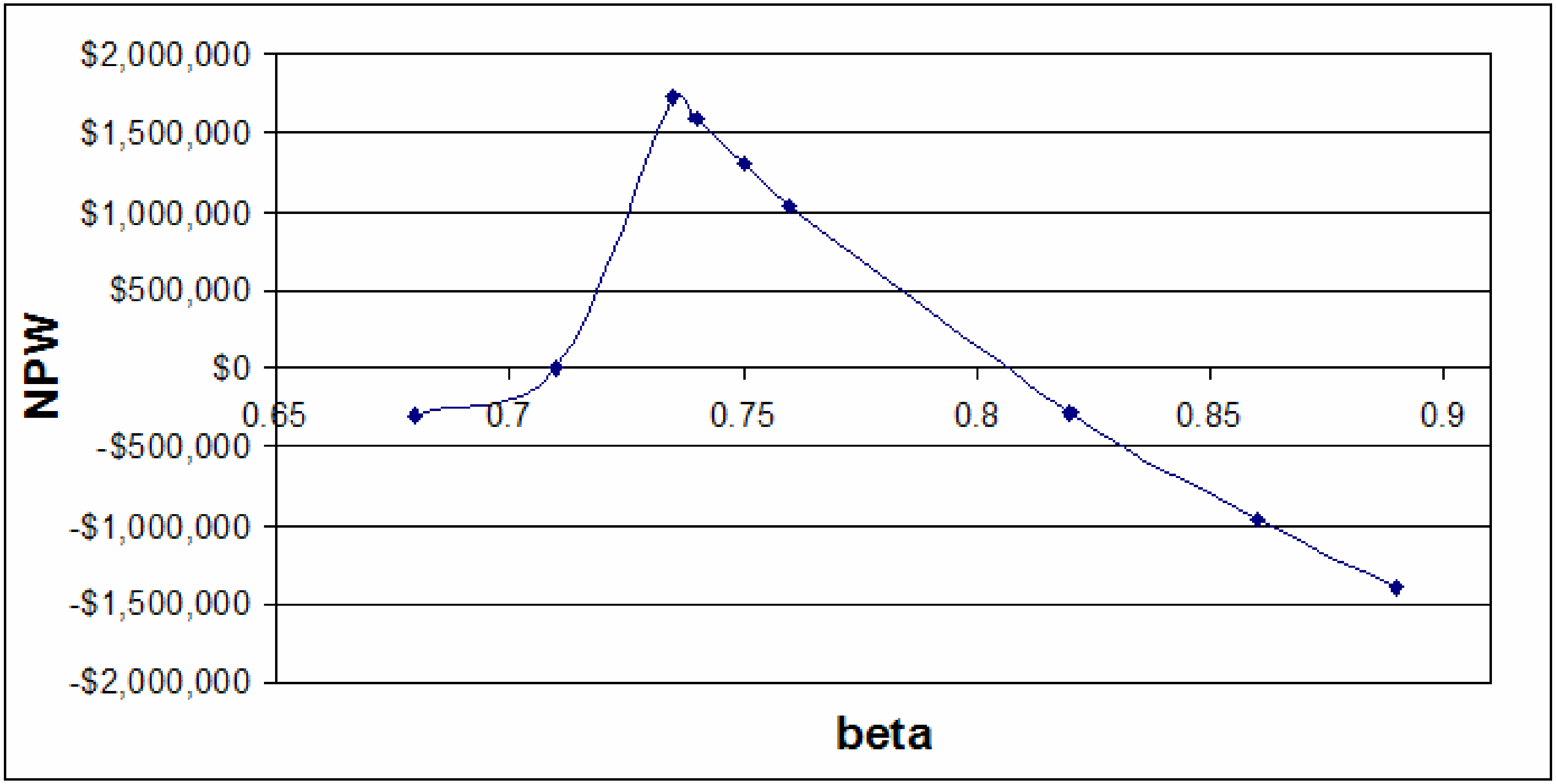
Maximum NPW Product

- Varied Composition – which varied utility



Maximum NPW Product

- Maximum NPW Utility β =0.735 Price=$19.44



- Composition – 0.01% Linalool, 0.02% PLGA, 17.9% Boric Acid, 80% Baking Soda

Revised Budget Constraint

- All calculations have been based on disinfectant market only
- Y=54 million
  - Max NPW is $1,730,000 – lowest approximation
- If the air freshener market (98 million) is taken into account
  - Max NPW is $13,300,000 – highest approximation
- Actual budget constraint most likely would fall in the middle
  - A novel idea is to poll consumers
  - How much would they pay extra than just disinfectant
    - Shown below

16oz - 10$ container	
2x Duration	$2.14
More Effective	$2.03
Fresher	$1.58
Safer	$1.23
Better Scent	$1.01
Increase	$17.99
Initial Demand	5400000
New Budget Constraint	$97,000,000.00

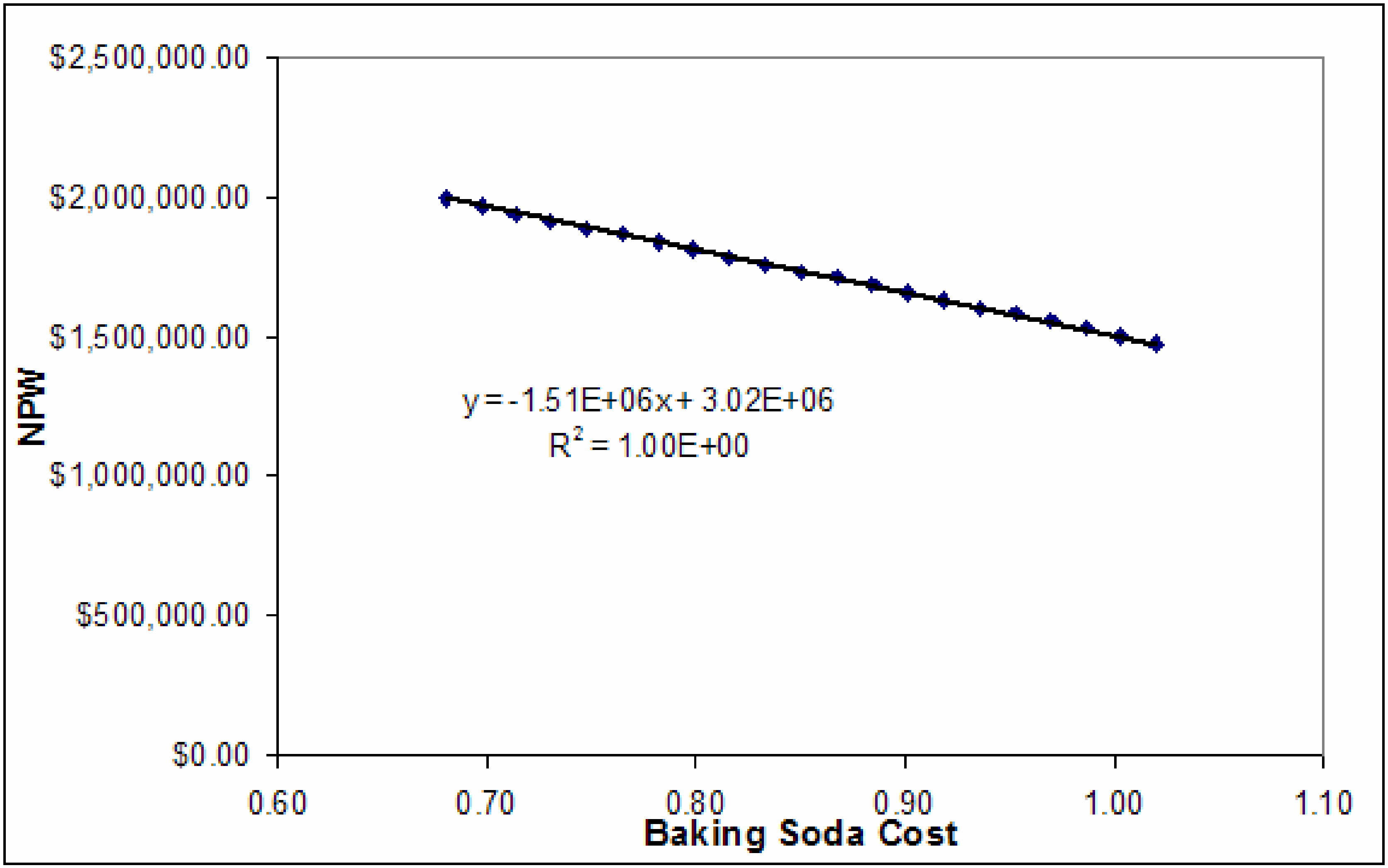
New Y=97 million

Max NPW = $6,800,000

Risk

- Strauss Plots
  - Varied all raw materials 20% of 2007 selling price
- Monte Carlo Simulations
  - Varied all raw materials 20% of 2007 selling price

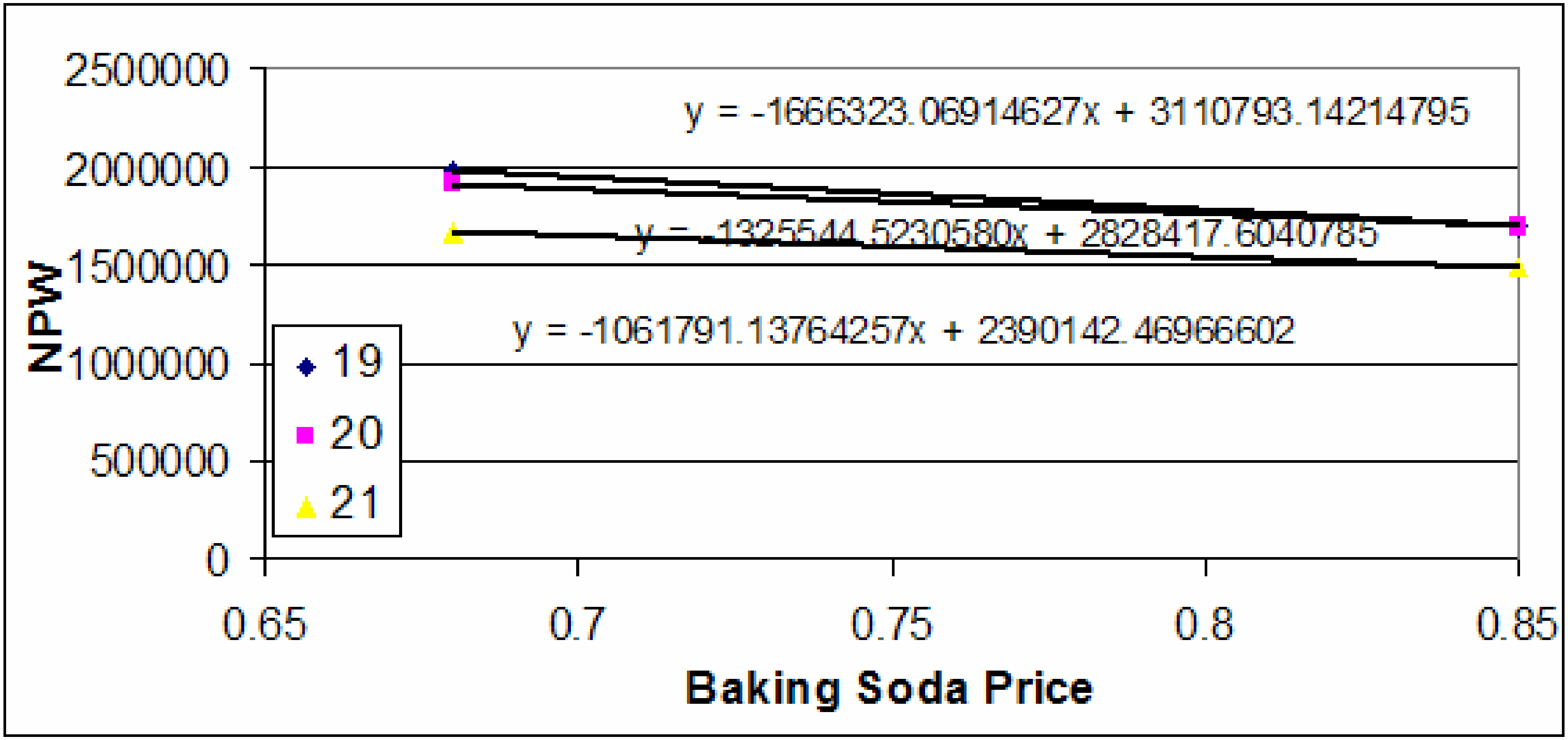
Strauss Plots



Cost	Strauss Plot Slope
Linalool	-150
PLGA	-400
Boric Acid	-3e5
Baking Soda	-1e6

Strauss Plots

- Sensitivity to Price



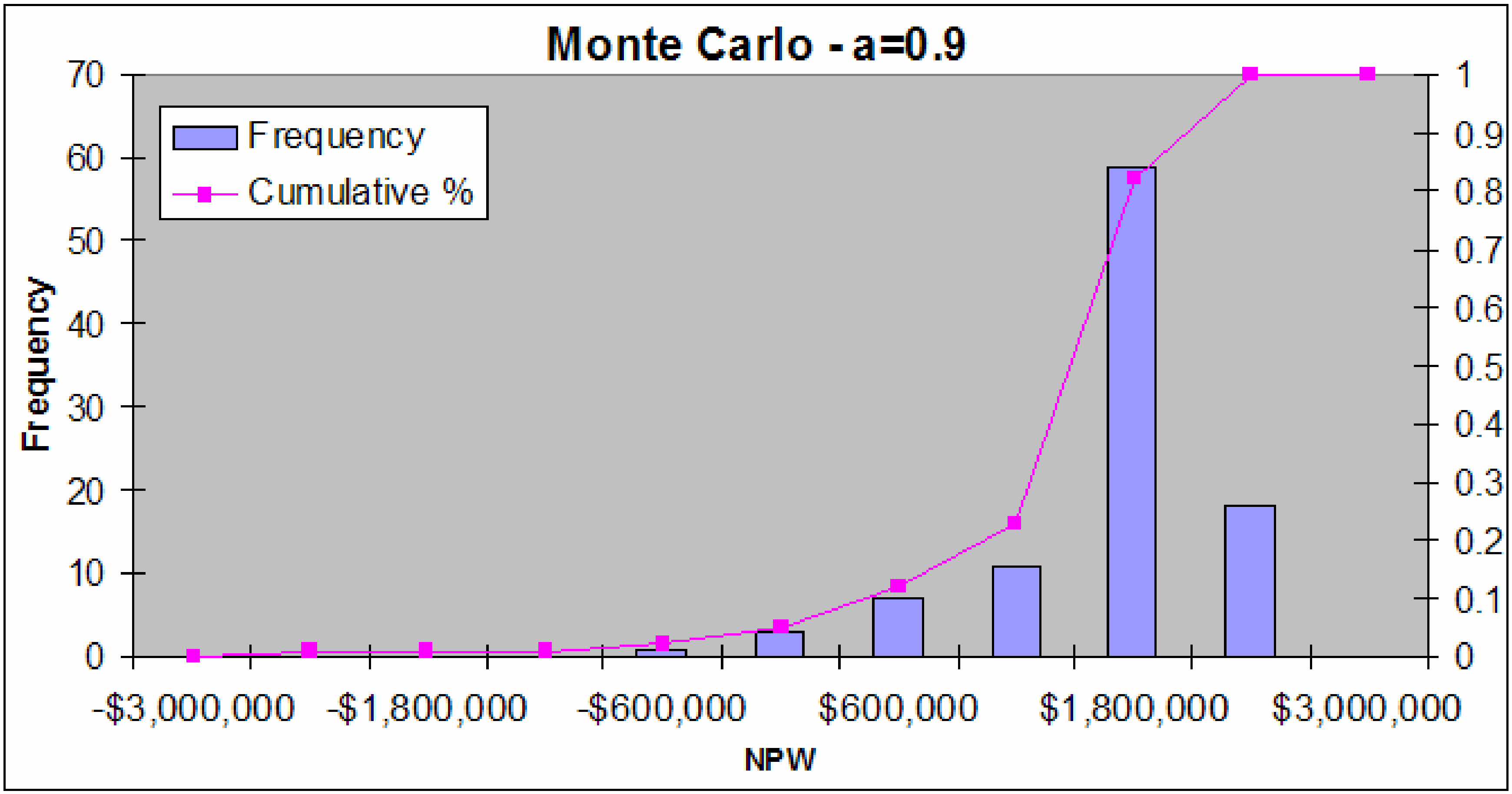
- Lower the price, higher the demand, and higher sensitivities

Strauss Plot Slopes

Price per container	Linalool	PLGA	Boric Acid	Baking Soda
$19	-440	-162	-3.6e5	-1.6e6
$20	-350	-129	-2.9e5	-1.3e6
$21	-280	-123	-1.3e5	-1.0e6

As price goes down, demand goes up the NPW is a stronger function of the raw materials

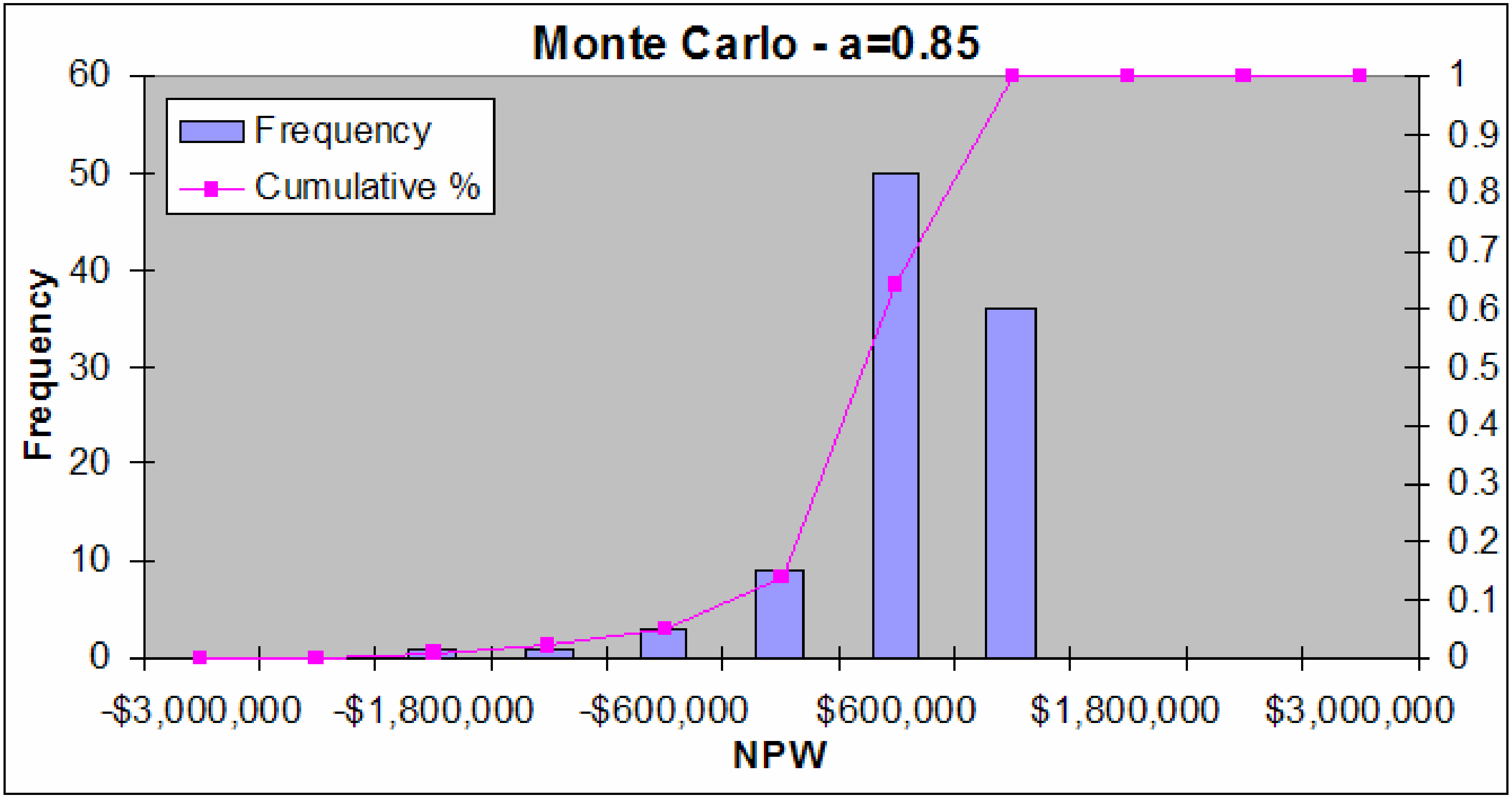
Monte Carlo Simulations – Y=54mill



5% of losing money

95% of making money

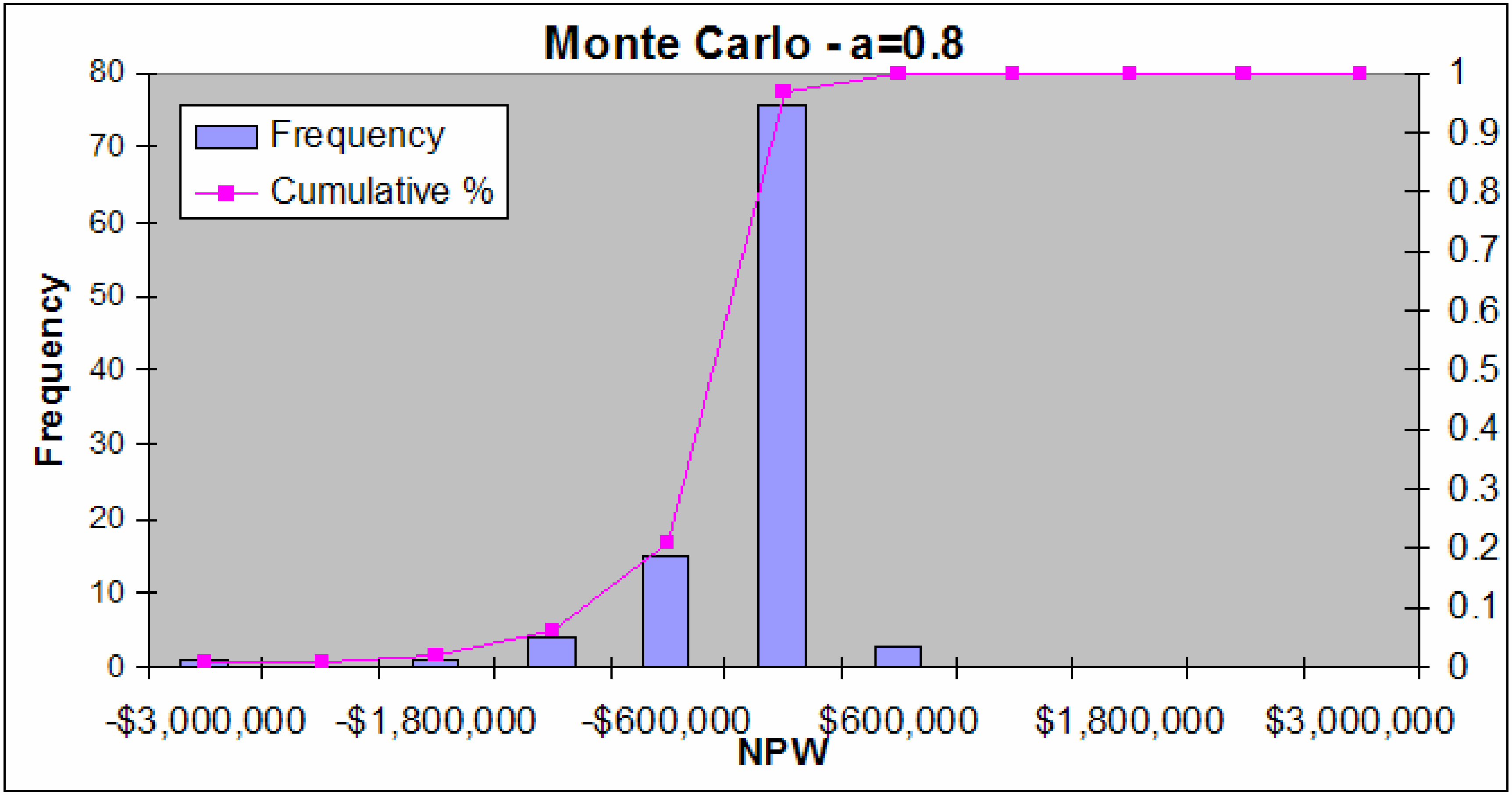
Monte Carlo Simulations – Y=54mill



14% of losing money

86% of making money

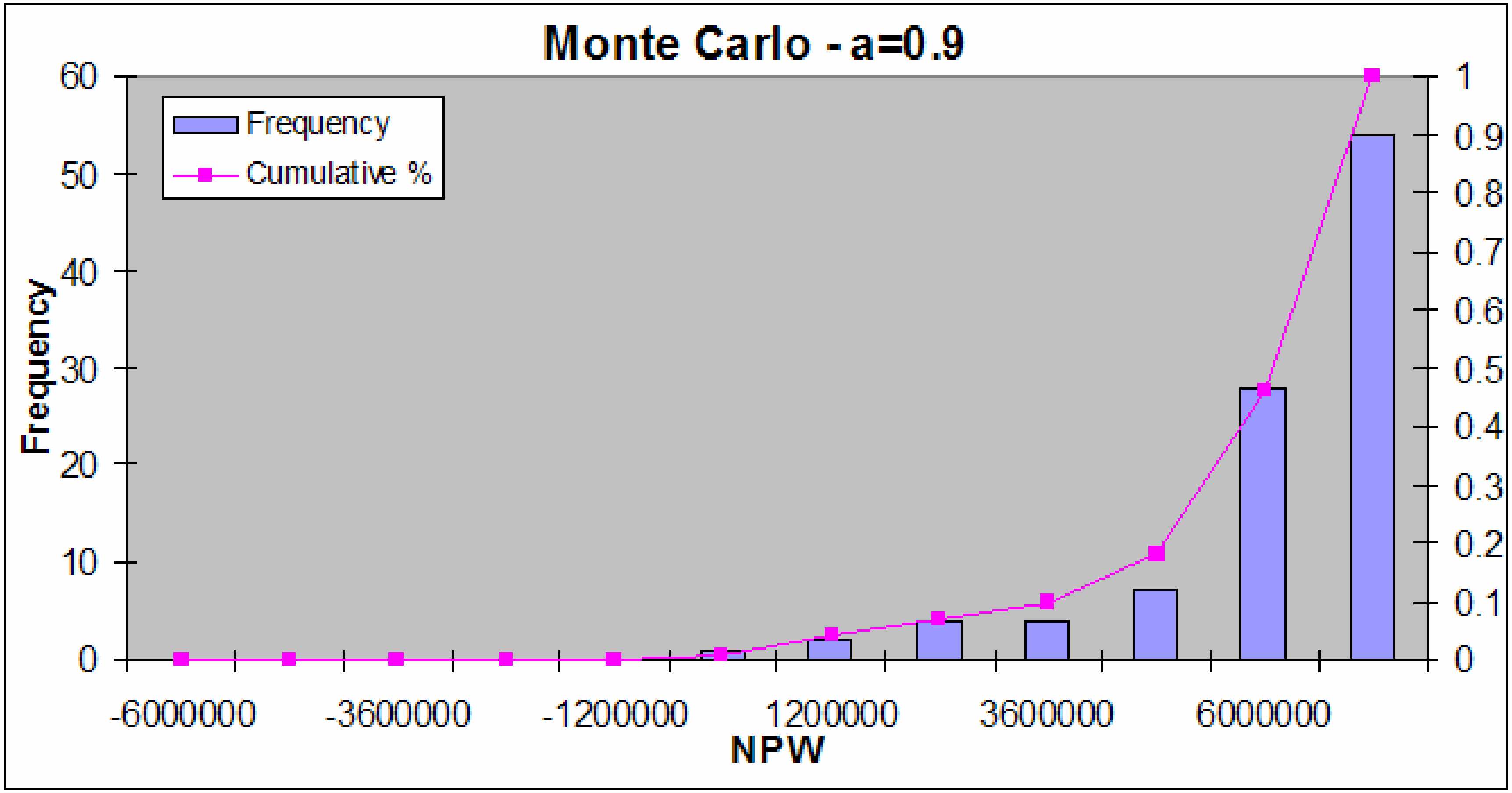
Monte Carlo Simulations – Y=54mill



97% of losing money

3% of making money

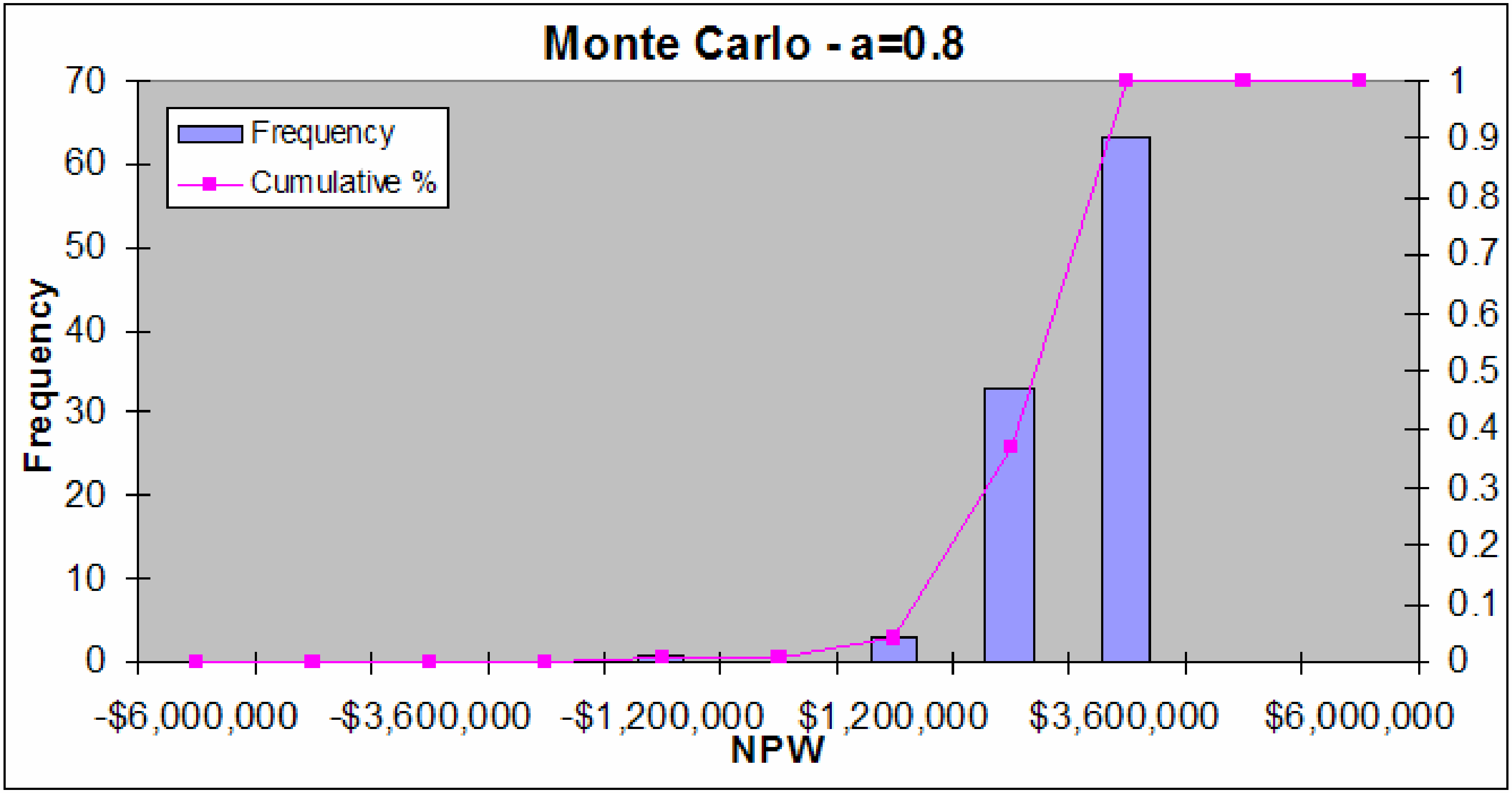
Monte Carlo Simulations – Y=97mill



1% of losing money

99% of making money

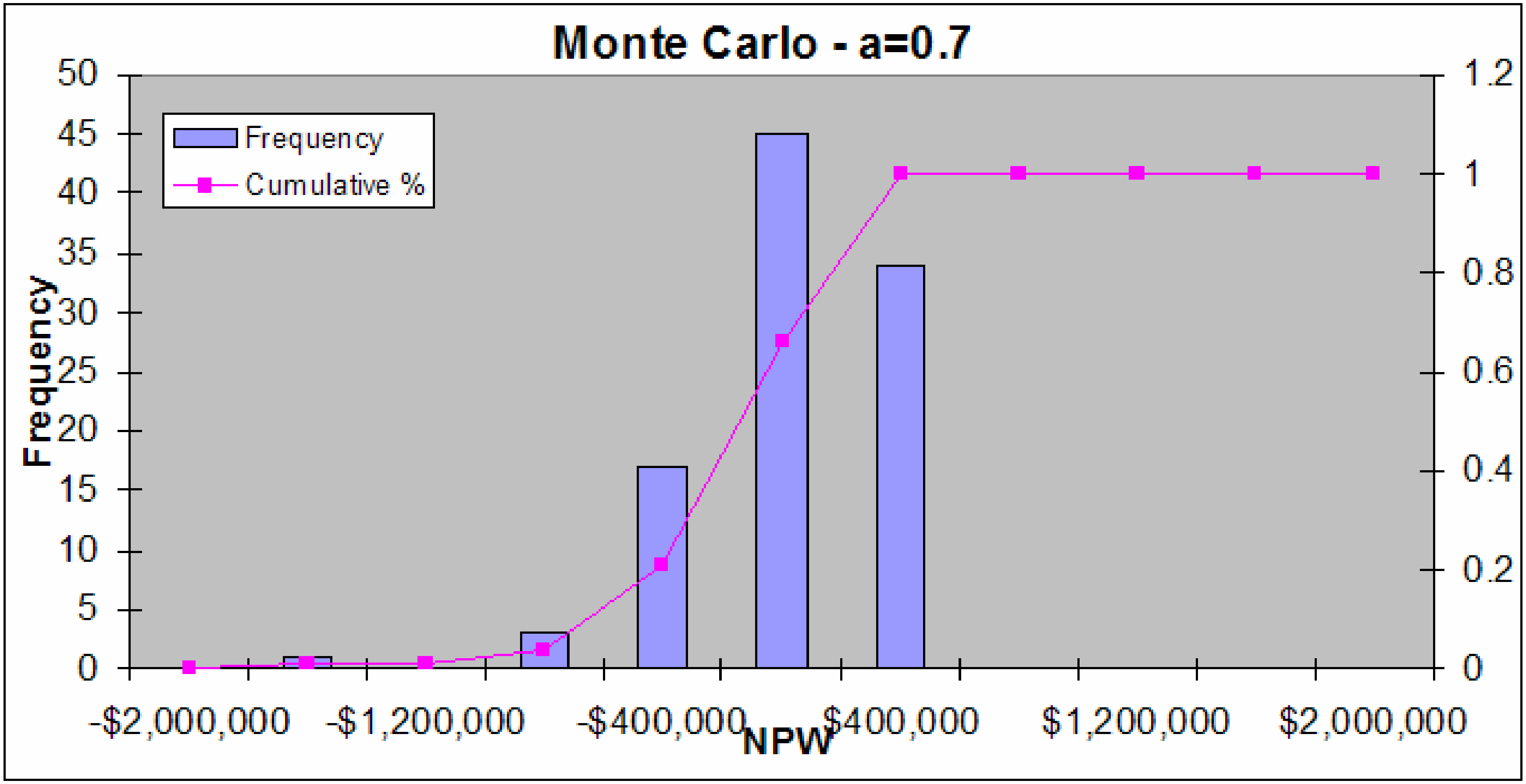
Monte Carlo Simulations – Y=97mill



1% of losing money

99% of making money

Monte Carlo Simulations – Y=97mill



66% of losing money

34% of making money

Questions

Utility Questions

Utility	Wt.	U_{ours}	U_{theirs}	$U_{theirs\ should\ be}$
Duration - Linalool	0.19	13.90	9.50	0
Toxicity	0.09	7.50	7.50	7.5
PLGA-Scent Strength	0.22	16.40	11.00	0
Boric Acid	0.21	18.00	19.95	19.95
Baking Soda	0.15	14.90	7.30	7.3
What Scent	0.14	13.00	7.00	7
		83.70	62.25	41.75
		$\beta =$	0.73	0.50
		NPW	$1,730,000	$12,000,000

This table breaks down our conservative approach for the utility. When polled consumers stated for our product their would be a 0 utility for a product that had no duration and no scent, yet we felt that to be conservative we should give our competitor 50% of the utility so that we would not be making unrealistic amounts of money. This table shows how much we make with the conservative approach and how much we would have made if the competitor would have had a 0 utility for both. Another implication of our model being conservative with the utility for the fragrance of the competitor is that is gave us the freedom to look into the fragrance market also, which is very important. It would be like comparing apples and oranges if we would have excluded that.

Equipment Costs

Equipment Costs		
Unit	Capacity (lbs)	Cost(2007)
solids storage	850	$780.00
sonicator	1.62	$5,000.00
roto vap	1.62	$3,200.00
centrifuge	1.62	$1,400.00
freeze dryer	1.62	$1,800.00
mixer	850	$20,152.00
Total Equ't Cost		$32,000.00

TCI, FCI, Working Capital

Capital Investment		
Direct Costs	% of Purchased Equ't	
Purchased Equipment Delivered	1	$32,000.00
Purchased-equipment installation	0.47	$15,040.00
Instrumentation and Controls	0.36	$11,520.00
Piping	0.68	$21,760.00
Electrical Systems	0.11	$3,520.00
Rent		$60,000.00
Buildings	0.18	$5,760.00
Yard Improvements	0.1	$3,200.00
Service facilities	0.7	$22,400.00
Total Direct Plant Cost		$175,200.00
Indirect Costs		
Engineering and Supervision (2 Eng 70K)		$140,000.00
Construction Expenses	0.41	$13,120.00
Legal expenses	0.04	$1,280.00
Contractor's fee	0.22	$7,040.00
Contingency	0.44	$14,080.00
Total Indirect Plant Cost		$175,520.00
Fixed Capital Investment		$350,720.00
Working Capital		$175,360.00
Total Capital Investment		$526,080.00

ROI and PBP questions

Yr	Sales	Costs	Annual Cash Flow	d	r	[(er-1)/r]e-rj	Present Worth
1	$7,300,396.28	$6,809,171.87	$320,076.67	$780.80	$0.00	0.93	$299,439.14
2	$7,519,408.17	$7,013,423.60	$329,670.77	$780.80	$0.00	0.81	$268,157.45
3	$7,744,990.42	$7,223,802.89	$339,552.69	$780.80	$0.00	0.71	$240,144.35
4	$7,977,340.13	$7,440,493.55	$349,731.08	$780.80	$0.00	0.61	$215,058.22
5	$8,216,660.33	$7,663,684.93	$360,214.81	$780.80	$0.00	0.53	$192,593.16
6	$8,463,160.14	$7,893,572.05	$371,013.06	$780.80	$0.00	0.46	$172,475.25
7	$8,717,054.95	$8,130,355.79	$382,135.25	$780.80	$0.00	0.40	$154,459.20
8	$8,978,566.59	$8,374,243.04	$393,591.11	$780.80	$0.00	0.35	$138,325.36
9	$9,247,923.59	$8,625,446.91	$405,390.64	$780.80	$0.00	0.30	$123,877.05
10	$9,525,361.30	$8,884,186.89	$417,544.16	$780.80	$0.00	0.27	$110,938.14
10end	$0.00	$0.00	$0.00	$0.00	$24,192.00	0.24	$5,806.08
						Sum	$1,921,273.42
			NPW				
			$1,735,801.42				
	16 oz cont	**Revenue**		**TCI**	**FCI**	**ROI=Np,avg/TCI**	**PBP (yrs)**
	375000	$19.47		$403,328.00	$350,720.00	86.00%	1.01