

Indiana Winery Design

Anna Alsman, Jessica Lobo, Xiaoda Yuan

Spring 2007



Objective

To design a zero discharge, minimum energy start-up winery located in Indiana with capabilities to process multiple wine types and ability to expand capacity while remaining both aesthetically appealing and functional.

Purpose

In 2005, the U.S. was the 4th largest wine producer and the 3rd largest consumer of wine. 90% of the wine produced in the U.S. comes from California and only 5% from the Midwest. Along with the steady increase in U.S. wine consumption at 1% each year for the past 25 years, the Indiana grape and wine industry has exploded in the past few years, and is a good model for new crops industry. The Purdue Wine Grape Task Force is a cooperation between the Indiana Wine Grape Council and Purdue University. They serve the state's vintners and growers and help propel the Indiana wine/grape industry into world-class competitiveness. As a part of the promotion of Indiana wineries, we have investigated the possibilities and features of a start-up local winery.

Red Wine Process Information

Grapes - Reisling, Chambourcin

Capacity - 12,500 gallon/year

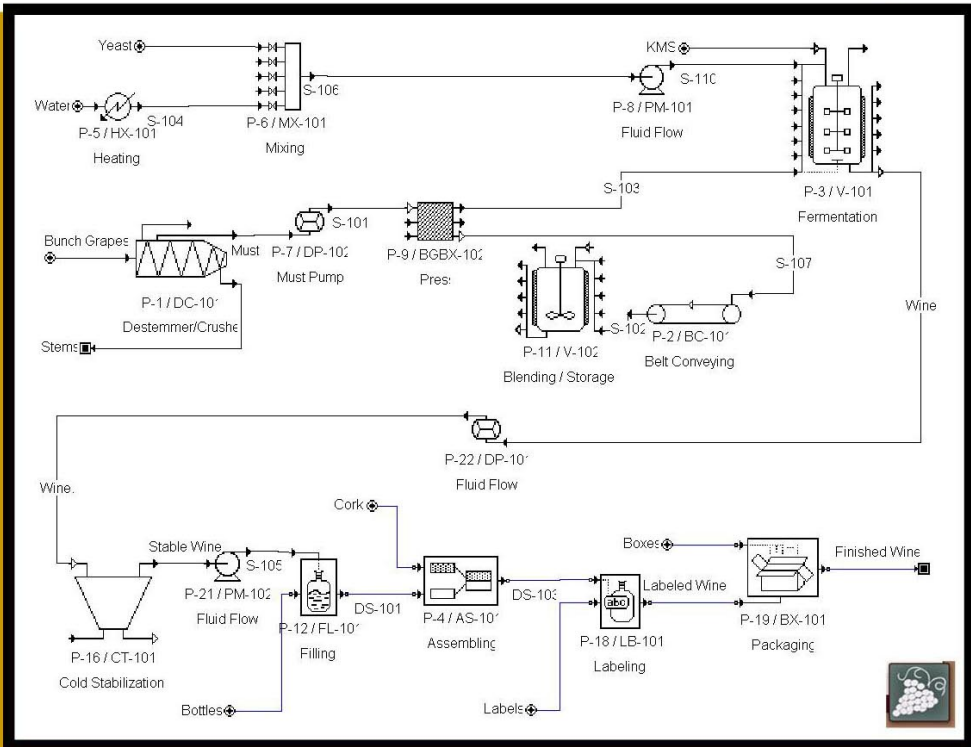
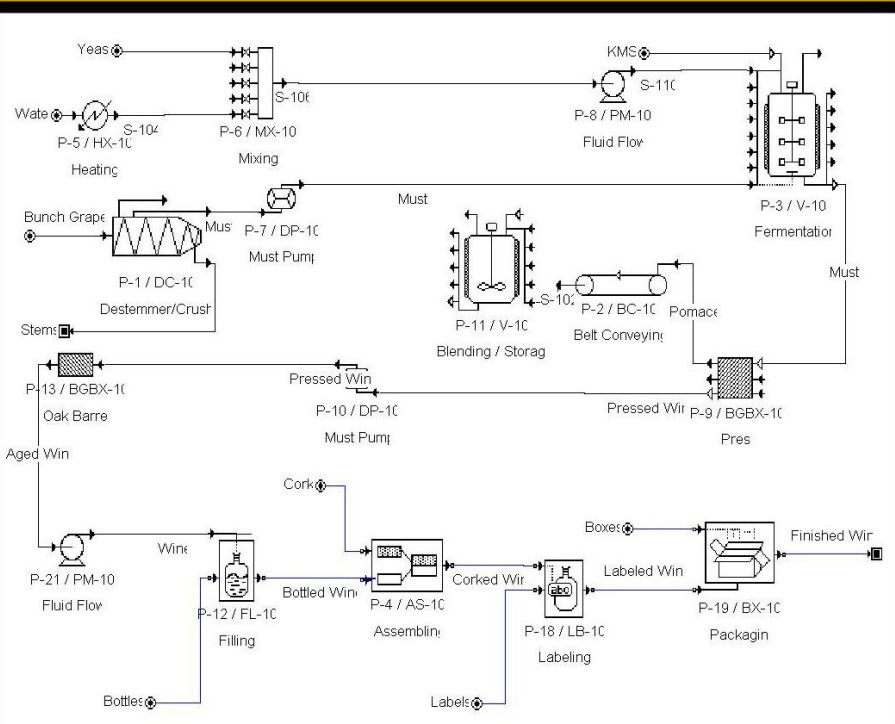
Crush Time - 7 days (16hr/day)

Inoculum Preparation

Saccharomyces cerevisiae yeast
1 g yeast/gallon juice
Mix yeast with 10 mL water/g
Hold at 100-102°F for 20 min

Fermentation Time - 14 days

Oak Barrel Aging - 1 year



White Wine Process Information

Grapes - Chardonel, Pinot Gris

Capacity - 12,500 gallon/year

Crush Time - Same as red

Inoculum Preparation - Same as red

Fermentation Time - 30 days

Aging - No aging required

Cold Stabilization - 28°F





Destemmer Crusher from Quality Wine and Ale Supply



Grapes in Crusher Rollers*



Membrane Press*

Equipment Costs	Price per Unit	Capacity	Quantity	Total Cost
Agitator	\$ 18,300.00	7.35 kW	1	\$ 18,300.00
Jacketed Stainless Steel Tanks				
5000 gal	\$ 44,900.00	5,000 gal/batch	9	\$ 404,100.00
1000 gal	\$ 18,000.00	1,000 gal/batch	14	\$ 252,000.00
500 gal	\$ 12,100.00	500 gal/batch	10	\$ 121,000.00
55 gal	\$ 3,400.00	55 gal/batch	18	\$ 61,200.00
Motorized Crusher-Destemmer Press	\$ 1,199.00	1361 kg/hr	1	\$ 1,199.00
Press	\$ 10,000.00	12,000 kg/press	1	\$ 10,000.00
Propylene Glycol Refrigeration System	\$ 55,000.00	45 ton glycol	1	\$ 55,000.00
Labelers	\$ 1,000.00	600 bottles/hr	1	\$ 1,000.00
Must Pump	\$ 5,600.00	2280 L/hr	4	\$ 22,400.00
Heat Exchanger (Tank Heater)	\$ 6,500.00	3.25 sq. meter	1	\$ 6,500.00
Filter	\$108,900.00	12 sq. meter	1	\$ 108,900.00
Filter Pads	\$ 21.80	---	2	\$ 43.60
Semi-industrial Pump	\$ 8,000.00	45.72 m head, 0.05 m pipe discharge	2	\$ 16,000.00
Fillers	\$ 1,450.00	600 bottles/hr	1	\$ 1,450.00
Semi-automatic Corker	\$ 3,000.00	600 bottles/hr	1	\$ 3,000.00
French Oak Barrels	\$ 1,000.00	50 gal/batch	150	\$ 150,000.00
Water Distiller	\$ 6,800.00	8 L/hr	1	\$ 6,800.00
Conveyor Belt	\$ 18,000.00	1 m x 8 m	1	\$ 18,000.00
Cold Stabilization Cooling Tower	\$ 72,900.00	1.05x10 ⁷ kJ/hr	1	\$ 72,900.00
Miscellaneous (\$/gal produced)	\$ 0.28	---	14000	\$ 3,920.00
Materials Handling	\$ 25,500.00	1 Forklift and 1 Truck	1	\$ 25,500.00
Lab Equipment	\$ 760.62	Various lab supplies	1	\$ 760.62
Total Equipment Expense				\$1,359,973.22

Direct Costs	Percent of Equipment Cost	Total Cost
Installation	40.00%	\$ 543,989.29
Instrumentation and Controls	25.00%	\$ 339,993.31
Piping	31.00%	\$ 421,591.70
Electrical System	20.00%	\$ 271,994.64
New Building	47.00%	\$ 639,187.41
Grounds and Landscaping	15.00%	\$ 203,995.98
Service Facilities	55.00%	\$ 747,985.27
Land	Calculated	\$ 135,000.00
Total Direct Costs		\$4,663,710.82
Indirect Costs	Percent of Equipment Cost	Total Cost
Equipment	---	\$ 1,359,973.22
Engineering and Supervision	30.00%	\$ 407,991.97
Construction and Expenses	35.00%	\$ 475,990.63
Legal Expenses	4.00%	\$ 54,398.93
Contractor's Fee	20.00%	\$ 271,994.64
Contingency	40.00%	\$ 543,989.29
Total Indirect Cost	75.00%	\$ 1,754,365.45
Working Capitol		\$ 1,019,979.92
Fixed Capitol Investment		\$ 6,418,076.28
Total Capital Investment		\$7,438,056.19

Material Costs	Amount	Price	Quantity/Year	Total
Red Grapes	1 ton	\$ 500.00	90	\$ 45,000.00
White Grapes	1 ton	\$ 500.00	90	\$ 45,000.00
Distilled Water	1 gal	\$ 0.0029	2285243	\$ 6,660.20
Yeast (5 g for 5 Gal)	5 g	\$ 1.05	42241	\$ 8,870.69
Malolactic Culture (1 g for 6 gal)	1 g	\$ 14.95	750	\$ 11,212.50
Potassium Metabisulfite	1 lb.	\$ 4.25	17.1	\$ 72.68
Total Raw Materials				\$116,816.06
Bottles (750 ml - 0.198 gal)	12/ case	\$ 13.95	10101	\$140,908.95
Labels	30/ pack	\$ 4.50	40404	\$ 18,181.80
Boxes	12/ box	\$ 4.50	10101	\$ 45,454.50
Corks	100/ pack	\$ 19.85	1212	\$ 24,060.58
Total Packaging Materials				\$228,605.83



Stainless Steel Jacketed Fermentation Tanks*



Pad Filter*

Full Time Labor (i = 1.5%)	1988 Salary	2007 Salary
Winemaker	\$ 30,000	\$ 39,808.52
Assistant Winemaker	\$ 20,000	\$ 26,539.01
General Manager/Sales	\$ 50,000	\$ 66,347.54
Clerical	\$ 18,000	\$ 23,885.11
Part Time Labor	Hourly Rate	Hours/Year
Crush and Press Operations	\$ 7.25	70
Total Labor Cost		\$157,087.69

Manufacturing Costs	Method	100% Capacity
Direct production costs		
Raw Materials costs	Mass Balance	\$ 116,816.06
Packaging Material costs	Mass Balance	\$ 228,605.83
Total Labor	Heuristic	\$ 157,087.69
Utilities	10% of Total Product Cost	\$ 157,664.44
Maintenance and repairs	2% of Fixed Capitol Investment	\$ 123,212.53
Operating supplies	1% of Fixed Capitol Investment	\$ 61,606.27
Laboratory charges	20% of Operating Labor	\$ 31,417.54
Patents and royalties	1% of Total Product Cost	\$ 15,766.44
Fixed Charges		
Depreciation	12 Year, Straight Line	\$ 109,697.77
Local taxes	1% of Fixed Capitol Investment	\$ 61,606.27
Insurance	0.4% of Fixed Capitol Investment	\$ 24,642.51
Rent	8% of Land and Buildings	\$ 55,814.22
Plant overhead costs	50% of Total Labor and Maintenance	\$ 140,150.11
General Expenses		
Administrative costs	20% of Total Labor and Maintenance	\$ 56,060.04
Distribution and marketing costs	10% of Total Product Cost	\$ 157,664.44
Research and Development costs	5% of Total Product Cost	\$ 78,832.22
Total Product Cost		\$ 1,576,644.38



Racked Oak Barrels*

Cost per Bottle	\$ 6.57
Selling Price per Bottle	\$ 11.36
Gross Profit per Year	\$ 2,725,712.51
Net Profit per Year	\$ 1,115,708.43
Return on Investment (ROI)	15%



Bottle Sparging and Filling*

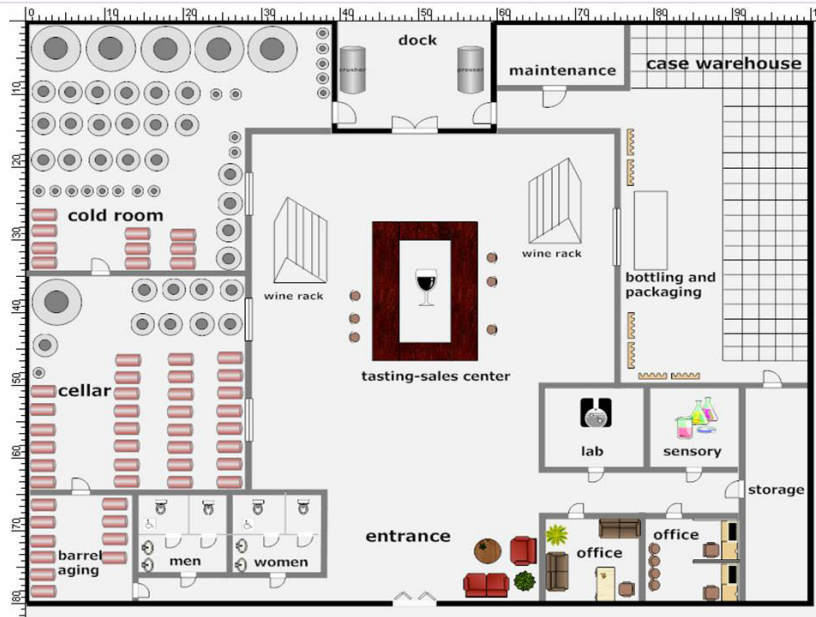




Proposed Winery Location in Southern Indiana*

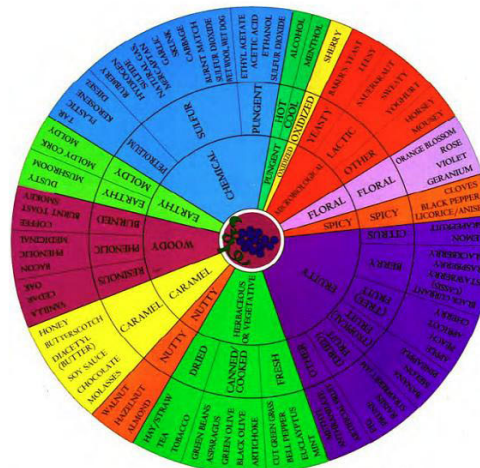
Winery Location

- Close to proposed future site of Interstate 69 through Southern Indiana
- Few wineries in the area
- Land cost near Washington, IN is approximately \$3,000/acre
- With future plans to include a vineyard, the acreage required to produce the amount of grapes to run at maximum capacity of 180 tons of grapes per year with grape yield at 6.75 tons/acre including the building, landscaping, and room to expand 50% is 45 acres at a cost of \$135,000
- Cost to run a vineyard is approximately \$7,000/year plus the cost of land



Proposed Winery Floor Plan

Unit Operation	Critical Control Points
Vineyard Sampling	QC: Grape ripeness according to sugar content HACCP: Microbial presence on grapes - wash and process as quickly as possible
Crush/Press	QC: Rot culling, temperature control HACCP: Foreign material
Must	QC: Brix, pH, fermentable nitrogen, temperature, oxygen, enzymes
Fermentation	QC: Brix, pH, titratable acidity, sensory, temperature, yeast (strain, inoculum volume, % viable, purity) HACCP: SO ₂ Addition, final % alcohol
Press	QC: Sensory, tannin content, color
Malolactic Fermentation	QC: Bacteria strain, inoculum volume, purity)
Clarification	QC: Sensory, oxygen content, protein stability, bitartrate stability
Barrel Aging	QC: Sensory, oxygen (regulated by refilling headspace), MLF status, SO ₂
Bottling	QC: Sensory, fill level, oxygen, material stability HACCP: Microbe content in bottle - clean with water, KMS, and sparge with SO ₂ or N ₂
Bottle Aging	QC: Sensory, storage temperature, temperature fluctuations, optimum release date, minimum exposure to UV light



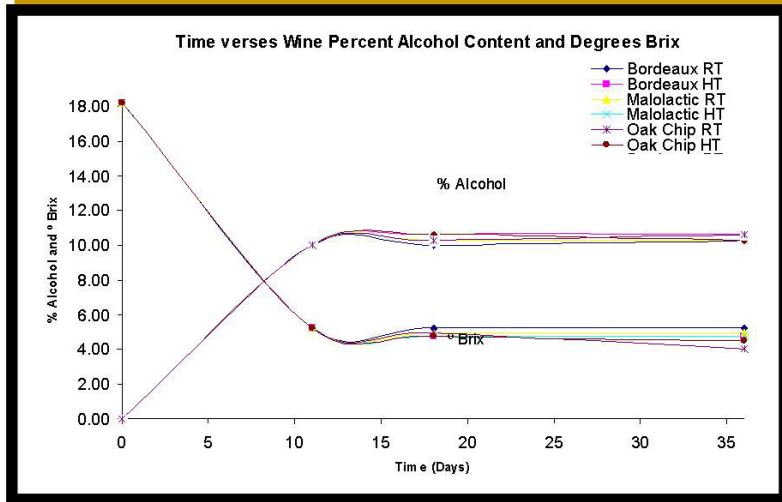
Sensory Properties Wine Descriptor Wheel*

Typical Red Bordeaux Wine Descriptors (Butzke and Haehl, 2006)

Winemaking experimental parameters and design of experiments		
Variable	Low Level (-)	High Level (+)
Temperature	21°C	35°C
Oak Chip Addition	0 g/L	7.5 g/L
Malolactic Bacteria Addition (<i>Oenococcus oeni</i>)	0 g/L	6.5 g/L



Experimental Fermentation Vessels and Corked Wine Bottles



Aesthetic Vineyard Landscape

Future Work

1. Patent Disclosure
2. Control Systems for major unit operations (PID)
3. Byproduct recovery (grape seeds, skins, stems)
4. Vineyard addition
5. Experiment with different grape varieties, yeast strains, oak varieties and forms, and temperatures.

Acknowledgements

Dr. M. R. Okos, Dr. C. E. Butzke, Jill Blume, Ellie Butz, and Floyd Alsmann

