Micro Malt House Process & Design

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Background
- Practice that dates back to ancient times
- Process remains same
- Current market is dominated by macro-malters
  - 20 companies own 70% of Market
  - Macro-malters hold a majority of patents
- Equipment oriented
- Macro-malters generally have similar equipment
- Malt is a by-product of the brewing process
- Malt can be made from other materials such as:
  - Sorghum, millet, corn, wheat, and rice
  - Comes in varieties of 2 row and 6 row

Objectives
- Create a process to produce high quality malt
  - Process remains same
  - Fit the project to the local market
  - Increase demand for local products and environmental sustainability
  - Increase demand for craft brews
  - Increase reinvestment into local community
  - Decreasing CO2 emission & pollution
  - Requires growth of craft brewing by ~18% per annum
  - Requires local material sourcing
- A locally processed malt product can fill two market niches by:
  - Providing a useful information to Mr. Jim Mosely to create full scale operation
  - Performing scale-up to meet malt demand for 1% of Indiana Malt Market (110,000 lbs. per year)
  - Performing experiments to identify key variables in production to obtain a consistent and saleable product
  - Providing local product for brewers and consumers
  - Providing infrastructure to connect local farmers and brewers in a sustainable economic relationship

Method
- Steep: Performed 3 immersion cycles of 8/4 hours submerged and couching respectively.
  - Steeping temperature and germination time had the most significant effect on the final sugar content.
  - Steeping temperature and germination time had less effect than trial number.
- Germination: Sprayed with water and mixed every 4 hours to stimulate release of sugars.
  - Measured sugar content in Brix over 30 minutes.
- Kiln: A fluidized bed dryer was used to decrease MC to 4% with 40 or 60" C, 1.5 m/s air.
- Hulls of seeds milled and submerged in 65° C water to mimic benefits.
- Cleaning: Cleaning agents: Lack recyclability, more costly than water
- Optimization
- Decreasing CO2 emission & pollution
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Results
- Steeping temperature and germination time had the most significant effect on the final sugar content.
- Steeping temperature and germination time had less effect than trial number.
- Problems:
  - Several trials experienced contamination from the lack of an HTST cleaning cycle
  - Actual germination times deviated from the planned schedule
  - Rootlet to seed length exceeded desired ratio

Analysis
- Raw material cost:
  - $0.065 per lb. feed barley
  - $0.095 per lb. malt barley
- Break even price: $0.20 per lb.
- Price for ROI of 20%: $0.83 per lb.
- Scaling up to 5x production yield ROI of 29%

Economic Analysis
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Equipment Energy Use
- Equipment
  - Energy Use per Year (kWh)
  - Humidifier: 1,645
  - Condenser and Heat Exchanger: 440
  - Kiln: 470
  - Blowers: 205
  - Decanter: 220
  - Pumps: 460
- Total: 2,760

Scheduling
- 1 day Steeping
- 4 day germination
- 6.26 days per batch
- 67.4 batches per year
- 52 available weeks per year
- Water recycled from Clean and Steeping decreases waste. Water is also recovered from wet barley as the kiln dries them.

Design Alternatives
- Clean:
  - Steam: High cost to purchase, storing tank would be more expensive due to pressure requirements, heating requirements offset by pumping requirements to maintain pressure.
  - Cleaning agents: Lack recyclability, more costly than water
- Germination:
  - Floor germination: Difficult to maintain moisture content and environmental control
  - Kiln: Floor kiln: Increase difficulty in recapturing water
- Kip: Single vessel: Increase in equipment cost for a unified design, careful scheduling can mimic benefits
- Tank Design:
  - Single tank for cleaning and holding water: Increase in heating and cooling costs

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