Fermentation driven tools to lessen its environmental impact during production

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Lallemand Biofuels & Distilled Spirits

Valerie Preston

Technical Sales Manager

Distilling, USA

Our team supports you with:

Dedicated support

- Fermentation
- Troubleshooting
- Research & development
- Sensory evaluation

Education

Alcohol School
Craft Distilling Seminar

Products

- Yeast
- Nutrients
- Enzymes
- Bacteria

Unrivaled partnerships

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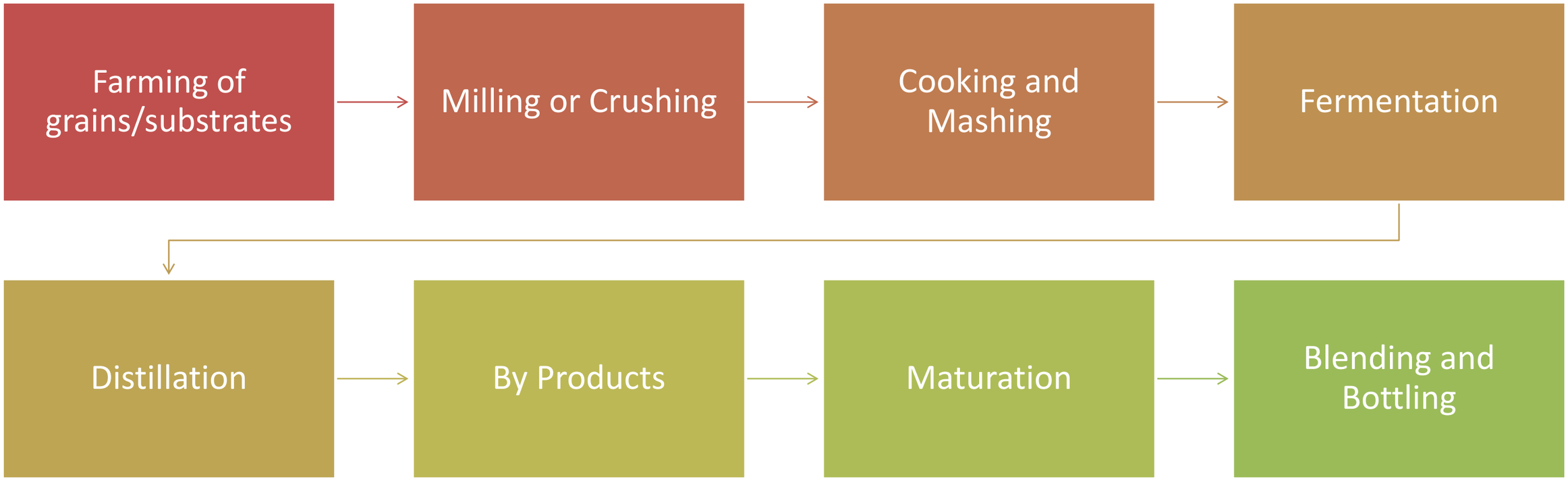
More distilleries are looking to become sustainable to become more environmentally friendly, more appealing to consumers, and implement cost savings!

Where Can Sustainable Practices be Applied in a Distillery?



What Are Typical Distillery Inputs?

Substrates – grains, molasses

Fermentation Ingredients – Yeast, nutrients

Water – cooking, heating, cooling

Steam – heating, cooling, cooking

Energy – pumps, agitators

Push For Sustainable Farming

How does this affect distillers?

What can distillers do to assist in this effort?

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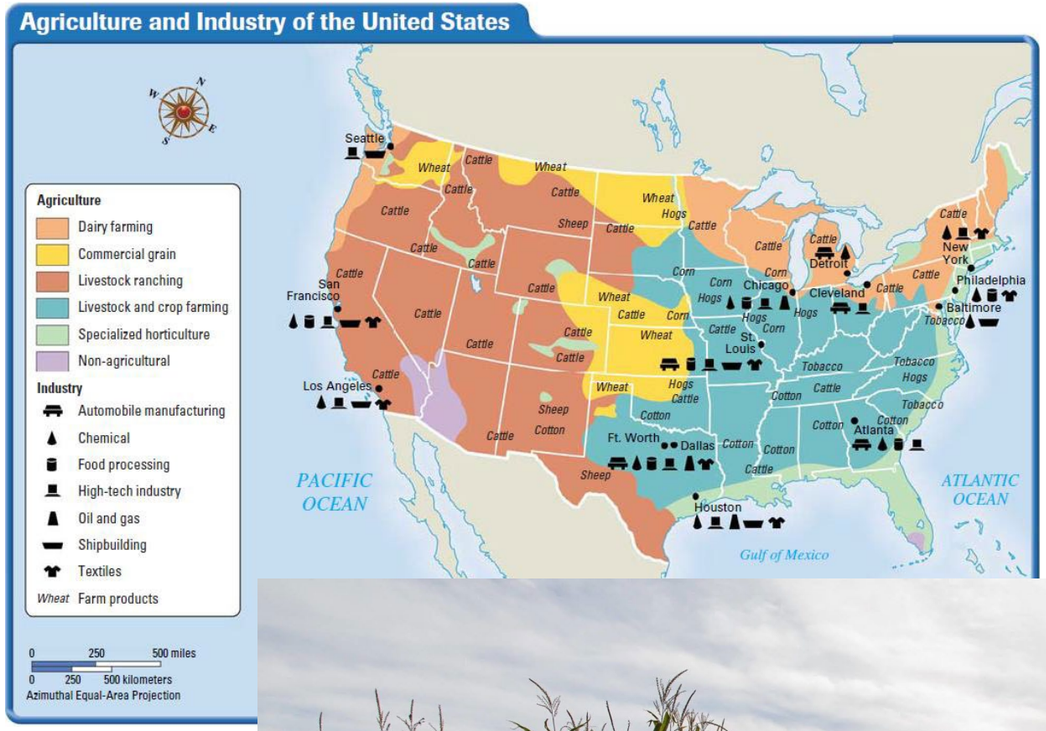
Grains – Life Cycle Analysis

- **Fertilize the soil -** products from anaerobic digestors
- **Planting -** contract local farmers for desired grains
- **Irrigation** – crop selection for less water demand
- **Harvest** – Grain selection for best yield
- **Transport** – Ideal to source as local as possible
- **Storage and Grinding** - renewable fuel sources available?
- **Fermentation Substrate -** option to use commercial enzymes in place of malted barley.
- **Spent Grains** - feed or variety of co products.



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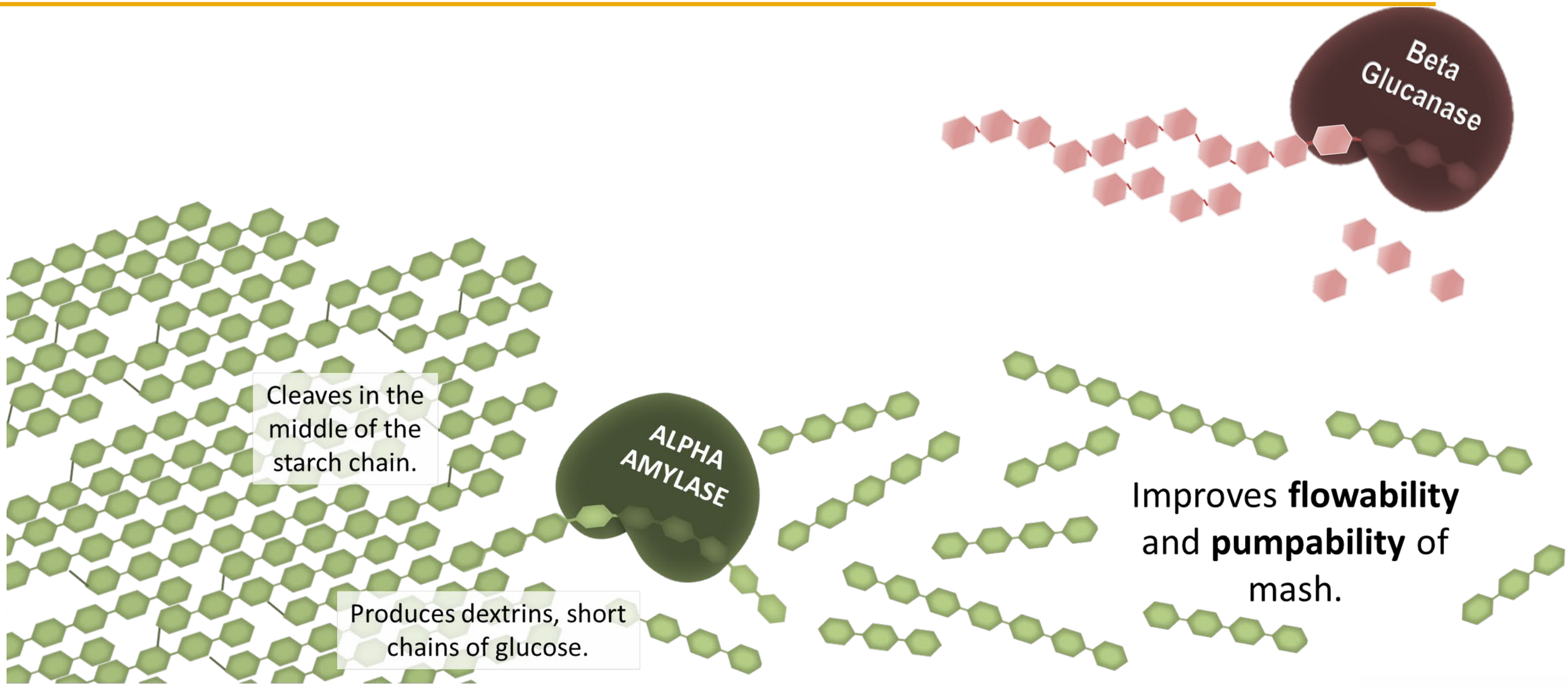
Yeast

Enzymes

Nutrients

Enzymes Effect Viscosity



Viscosity Effects Heat Transfer

Heat Transfer is very efficient here

Heat Transfer very poor, comparatively

Case Study – Optimized Cook - Bourbon

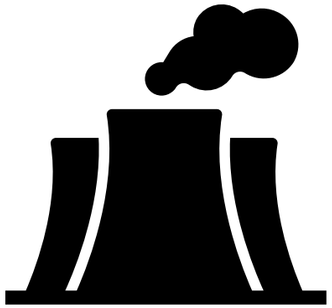
ANONYMOUS DISTILLERY

What We Did…

- Replace existing enzyme protocol and products
- Full Protocol Optimization – Hitting perfect temps and time, in right order…

What We Saw…

- Reduction of enzyme dose by factor of 6 (***0.6L****/Ton grain to* ***0.1L****/Ton grain*)
- Reduction of heating time by 1hrs **(15%)**
- Reduction of cooling time by 2+hrs **(~25%)**
- Reduction in amount of dough balling



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High Gravity Fermentations

- More ethanol produced
- Increased distillation efficiency
- Saves Water by up to 40%!
- Allows greater yield per fermenter

- Be aware of high osmotic pressure

Typical vs. VHG Inputs and Impacts

Typical Gravity

For every Liter of Pure Alcohol…

- 7lbs grain
- 8grams yeast
- 4grams nutrient
- 0.3 hrs FTE labor
- 0.06 days time/overhead
- 4,300 BTU’s
- 3.5gal ferm water

Very High Gravity

For every Liter of Pure Alcohol…

- **7lbs grain**
- 10 grams yeast
- 6 grams nutrient
- **0.175 hrs FTE labor**
- **0.03 days time/overhead**
- **2,500 BTU’s**
- **2 gal ferm water**

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Rum Production at the Distillery

Optimizing Fermentation for Highest Ethanol Yield Using Lallemand Biofuels & Distilled Spirits Guideline

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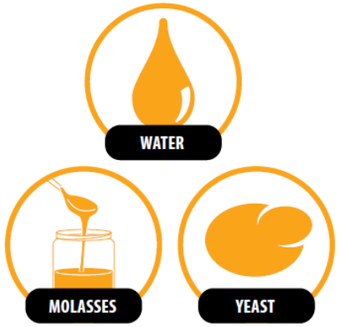
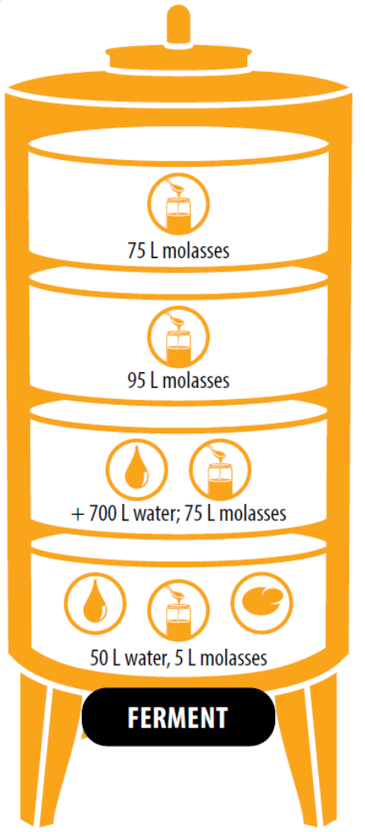
Fermentation (Fed Batch): For 1000 L, Fermentation time: 28-36 hours, Temperature: 32° - 34° C (89.6° - 93.2° F)

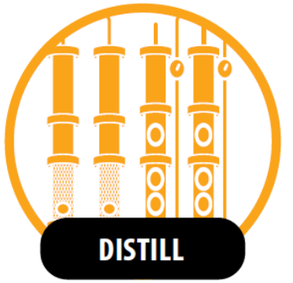
Step 2
Add rest of the water to your fermenter + 30% of molasses

Step 3
After 10 hours, add 40% of molasses

Step 4
After 10 hours, add last 30% molasses.







Distillation:

Step 5
Ethanol: 94.9% min

Propagation:

Step 1

- Add water 5% of ferm volume and molasses to reach 6-8 Brix
- DistilaMax® HT 1g/litre (per final volume)
- DAP : 0.5 – 0.7g/litre
- DistilaVite® GN : 0.3 – 0.5g/ litre
- Temperature: 32°- 34° C (89.6° - 93.2° F)
- Propagate for 6-8 hours

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lallemandcraftdistilling.com

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Yeast

Choose a yeast that optimizes your process

Effectively convert substrate into ethanol, don’t waste it!

Ideal strains can save water, time, and energy.

Yield & Residual Sugars

	Proof Gallons/ Bushel	Absolute Gallons/ Bushel	Liters Absolute EtOH/ Metric Ton	EtOH(g)/ Grain(g)	Residual Sugar %	Residual Sugar (lbs) in a 10,000 gallon fermentor assuming 26 BG beer
Maximum Theoretical Yield	6.11	3.06	455.1	0.3592	0.0%	0 lbs
Fuel Ethanol Industry Benchmark Yield	6.00	3.00	446.9	0.3527	1.3%	96 lbs
Distilled Spirits Industry Benchmark @93% Yield Efficiency	5.68	2.84	423.2	0.3341	4.9%	372 lbs
Primary Conversion/Fermentation Only	4.80	2.40	357.5	0.2822	15.1%	1,140 lbs
Distilled Spirits Industry Basement Yield Performance	4.20	2.10	312.8	0.2469	22.0%	1,662 lbs

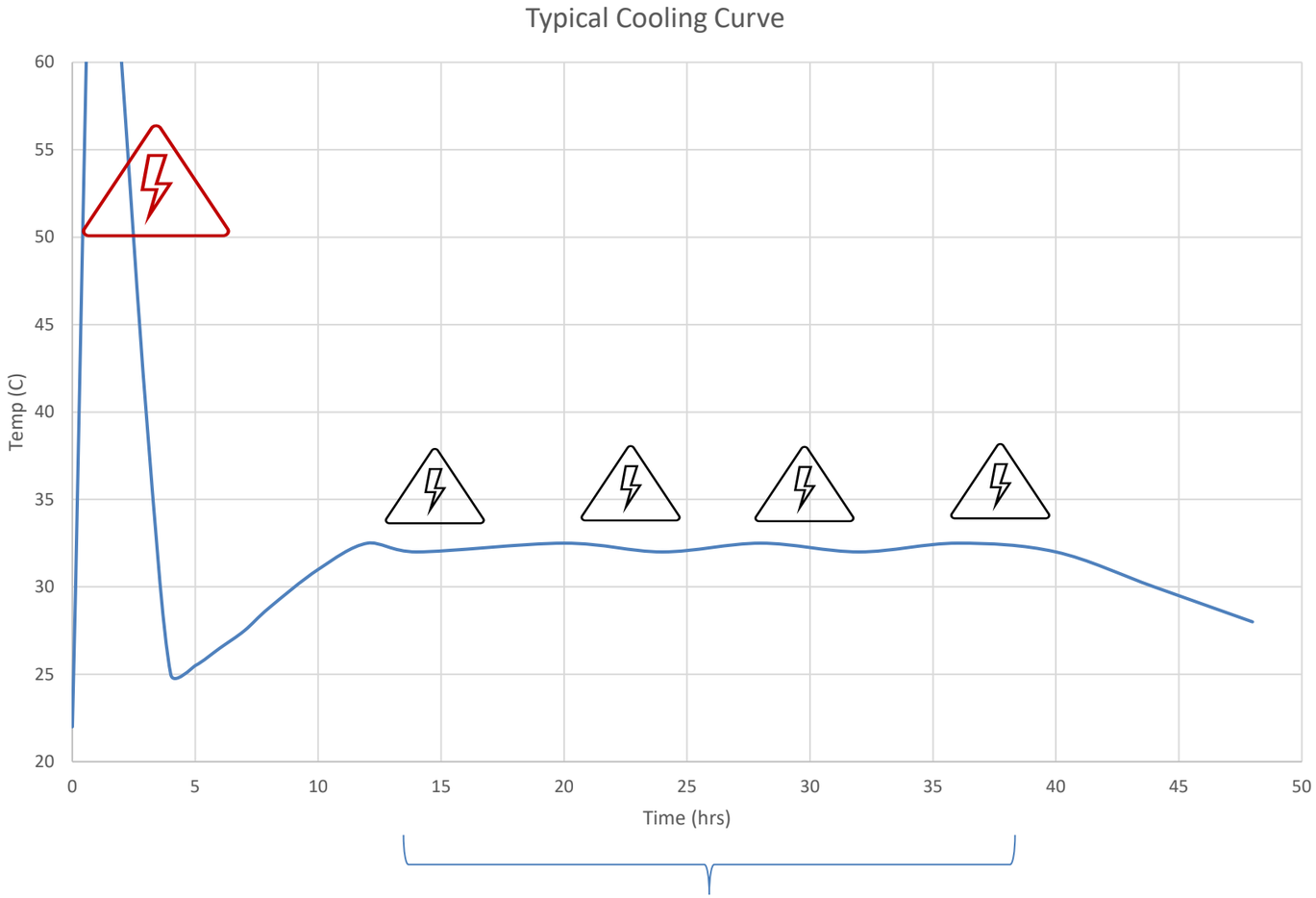
Assumptions:

Corn: 74% starch
14% Moisture

Residual sugars subjected to the heat of distillation are often the single largest source of spirit defects and inconsistency!

Thermotolerance and Its Effect on Distillery Sustainability

As mash approaches the temp of our cooling water, it gets harder to cool…

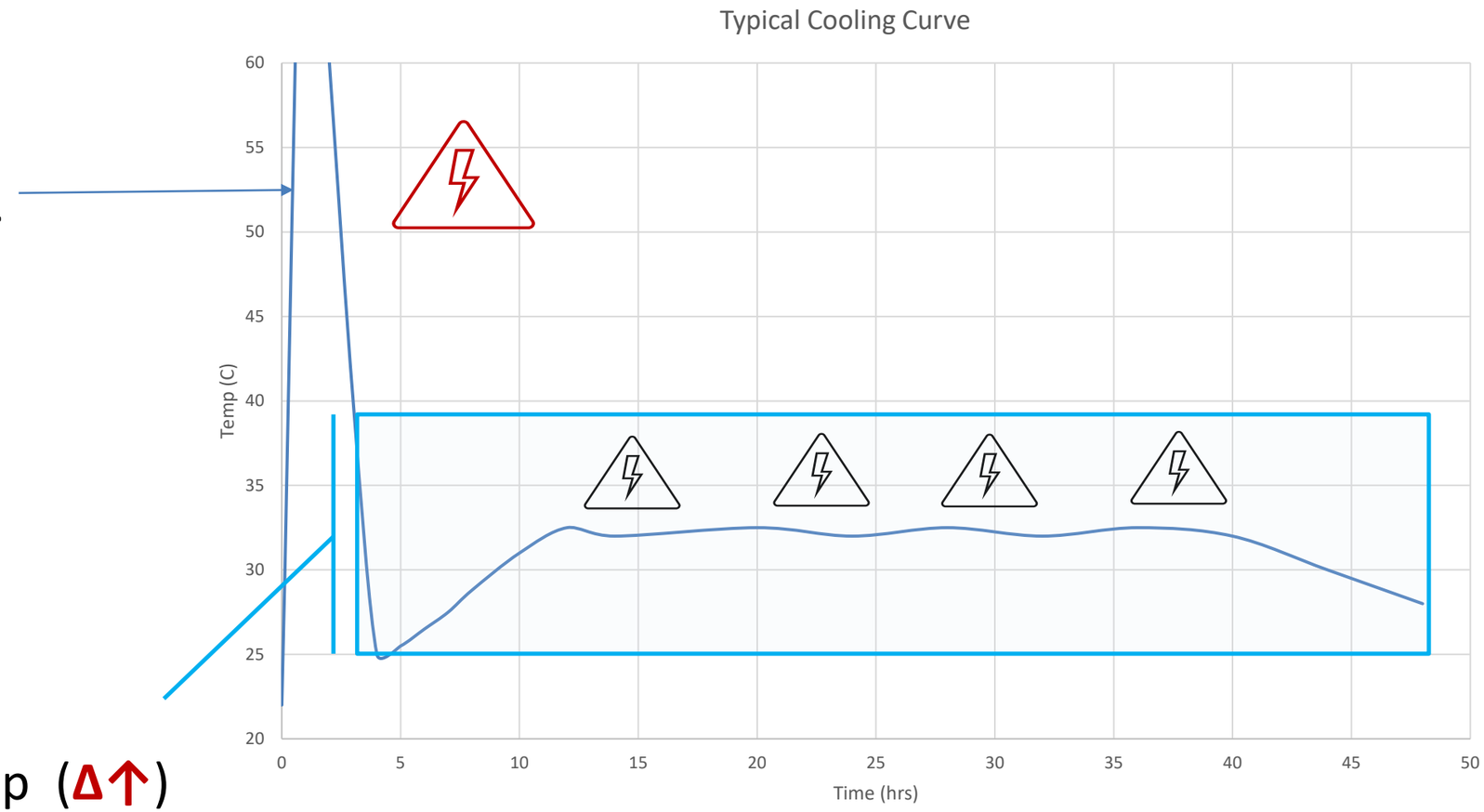


This takes quite a bit of Energy, or Water to cool

Thermotolerance and Its Effect on Distillery Sustainability

Heat Transfer is very efficient here

less water needed for heat removal (per unit heat remove)



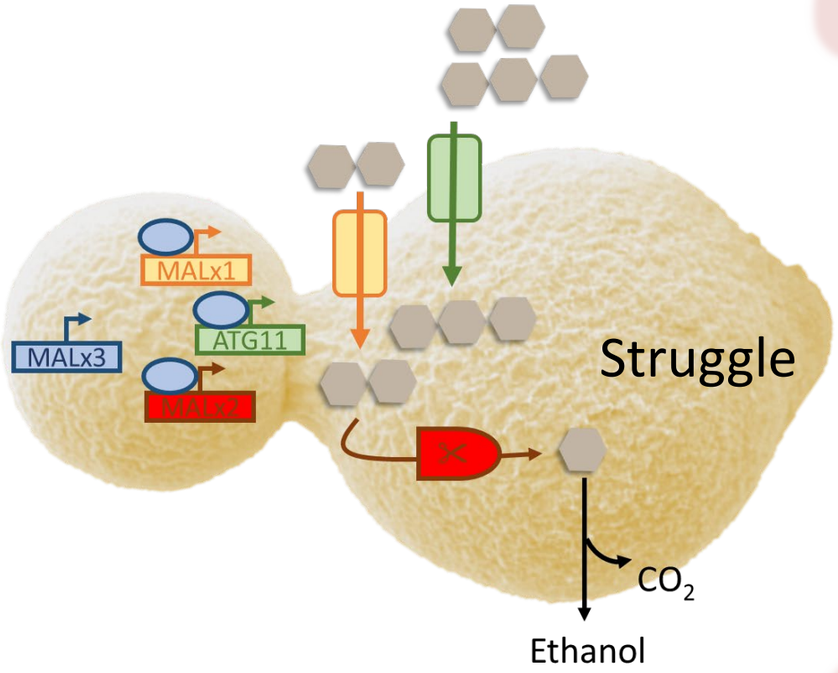
Heat Transfer <u>much</u> less efficient…

- Decrease coolant temp (Δ↑)
- Increase Coolant Volume (more water usage)

Thermotolerance and Its Effect on Distillery Sustainability

Problem is… Biology!!!

- Generally, Yeast prefer <34C
  - Enzyme/Protein Tolerances
  - Metabolic Shifts
  - Stress Responses



Off-Flavors

Low Yields

Slow Fermentations

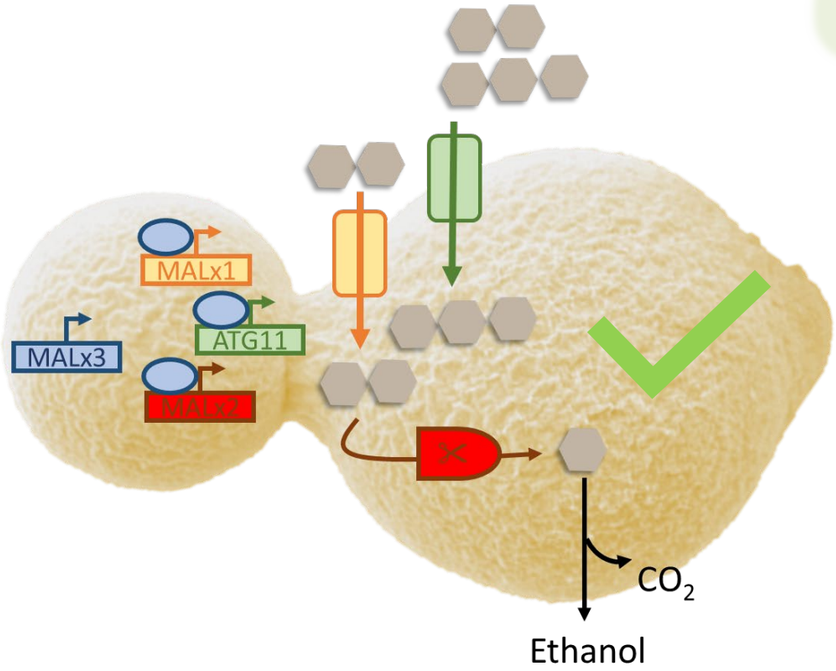
Stalled Fermentations

Bacterial Contamination

Thermotolerance and Its Effect on Distillery Sustainability

SOLUTION is… Biology!!!

- SOME Yeast handle <37C
  - New/Unique Enzymes/Proteins
  - Different Metabolisms
  - Shifted Stress Tolerances
  - Membrane Composition



Good Flavors

High Yields

Fast Fermentations

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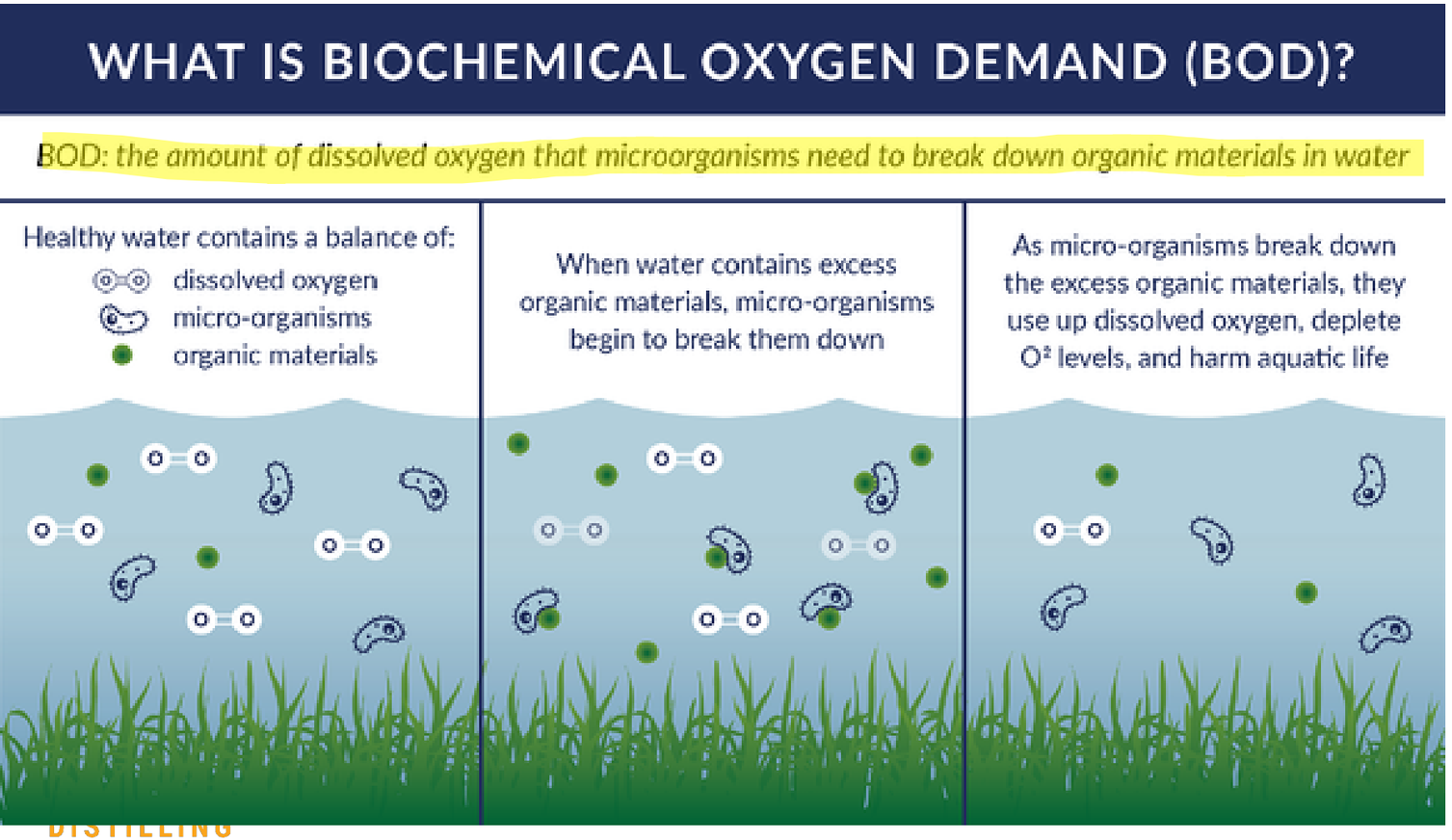
By Products Handling

- Whole Stillage – easiest way to rid of by products
- Separation – value added products
- Anaerobic digestors – creates co product and renewable fuel
- Creative outlets – perceived well by the public

By product handling

Biological Oxygen Demand (BOD)

BOD Level in mg/liter	Water Quality
1 - 2	**Very Good:** There will not be much organic matter present in the water supply.
3 - 5	**Fair:** Moderately Clean
6 - 9	**Poor:** Somewhat Polluted - Usually indicates that organic matter present and microorganisms are decomposing that waste.
100 or more	**Very Poor:** Very Polluted - Contains organic matter.



By ensuring distillers are achieving conversion efficiency and ideal sugar utilization, the energy and resources spent on water treatment can be greatly reduced.

Trials with Lallemand enzymes and protocols and shown a 40-50% reduction in BOD/COD of waste water.

Review

- Easily applicable sustainability efforts
- Enzyme affects on mash transfer
- High Gravity Fermentation
- Temperature Control via Yeast Selection
- Yield Optimization
- Tools in your toolbox!

Thank You for Your Participation…

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