



**22nd Distillers Grains Symposium**  
Des Moines, Iowa - May 16 & 17, 2018

***The D3MAX Process and the Path to Large  
Scale Cellulosic Ethanol Production***

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SOURCE: BBI International

April 24, 2018

## Ace Ethanol to Install D3MAX Technology at its Stanley, Wisconsin Facility

Adoption of both D3MAX and Whitefox Technologies will result in making Stanley ethanol plant one of the most efficient ethanol facilities in the world.

**Stanley, Wisconsin** – (April 24, 2018) – **D3MAX, LLC** and **Ace Ethanol, LLC** announced today that Ace Ethanol will be the first plant to integrate the patented D3MAX technology with its existing corn dry mill. Ace Ethanol has received approval from its directors and members to proceed with the design and construction of the corn kernel fiber-to-ethanol plant. "The team at D3MAX is extremely excited to hear the news that the Ace board and members approved moving forward with the project," says, Mark Yancey, technology officer at D3MAX. The integrated facility will also employ membrane-based ethanol recovery technology supplied by Whitefox Technologies, resulting in significant energy savings for the integrated facility. Ace has selected Fagen Inc. to build the new plant. Construction is scheduled to begin this summer, pending final negotiations and signing of the contract with Fagen.

Last year Ace Ethanol and D3MAX conducted extensive pilot testing of the D3MAX technology. "The D3MAX process was able to exceed our performance goals," says Neal Kemmet, president and general manager at Ace Ethanol, LLC and Fox River Valley Ethanol, LLC. "Based upon the pilot testing, D3MAX demonstrated the ability to substantially improve our companies' financial performance by converting corn kernel fiber to cellulosic ethanol. We are excited to have selected the companies who we believe are the best and construction contractors to build the D3MAX plant, and the yeast and enzyme suppliers who give us the best opportunity to boost our bottom-line."

Based on the results of pilot testing, Ace and D3MAX selected DSM to supply enzymes for the D3MAX process, and Lallemand Distilled Spirits has been selected to supply the yeast. The existing Ace plant and the new D3MAX process will be fully integrated to achieve maximum energy efficiency and ethanol yield. Selection of the companies who will work together to build the first D3MAX plant is another major milestone for D3MAX on its path to commercialization. "We have assembled the best team with the best technology to build the first commercial-scale D3MAX plant," says Yancey. "We are employing a fully integrated design at the Ace plant which will make it one of the most energy efficient ethanol plants in the US with the highest ethanol yield per bushel. The combined facility will be as energy efficient as the current Ace ethanol plant. We are excited to make this announcement and begin the construction of what we believe will be the new benchmark for the industry. Yancey, the D3MAX process is the only corn kernel fiber-to-ethanol process that will not require an independent engineer to certify the ethanol production every 500,000 gallons of cellulosic ethanol produced. With the D3MAX process, cellulosic ethanol can be measured directly avoiding the cost of re-certification required by EPA for in-situ corn kernel fiber processes and processes that convert starch or sugar with the cellulosic sugars. Currently, all other corn kernel fiber technologies require costly re-certification every 500,000 gallons.

To learn more about D3MAX visit: [www.D3MAXLLC.com](http://www.D3MAXLLC.com).

To learn more about Ace Ethanol visit: [www.aceethanol.com](http://www.aceethanol.com).

# Introduction to D3MAX

- BBI began developing cellulosic ethanol technology in 2007 resulting in a patent in 2012 for “the conversion of fermentation residuals to ethanol” using a dilute acid, enzymatic hydrolysis, and fermentation process
- In 2014 BBI signed a license agreement with WB Services to commercialize the technology; WB Services went out of business in 2015
- 2015: BBI created D3MAX, LLC and later completed an equity raise to develop the BBI technology
- 2016: D3MAX and AdvanceBio designed and built the D3MAX pilot plant
- 2017: D3MAX signed an agreement with Ace Ethanol to test the pilot at their 50 mgy corn dry mill in Stanley, WI; pilot testing was successfully completed by the end of 2017
- April 2018: Ace and D3MAX announce the first commercial scale D3MAX plant to be installed at Ace Ethanol
- D3MAX is owned by its investors and founders; the company is managed by a board of managers which includes Joe and Tom Bryan, Mark Yancey and a private investor
- Our business model is to license D3MAX technology to dry mill ethanol plants in the US and other countries



# Ace - D3MAX Project Team

- Ace Ethanol – owner/operator of the first D3MAX plant
- D3MAX – corn fiber-to-ethanol technology provider
- Fagen Inc – EPC contractor
- AdvanceBio – process design (process model, MEB, PFDs, P&IDs)
- Fluid Quip Process Technologies – process equipment specs
- DSM – hemicellulase and cellulase enzyme supplier
- Lallemand Biofuels & Distilled Spirits – yeast supplier
- Whitefox Technologies – membrane ethanol recovery technology

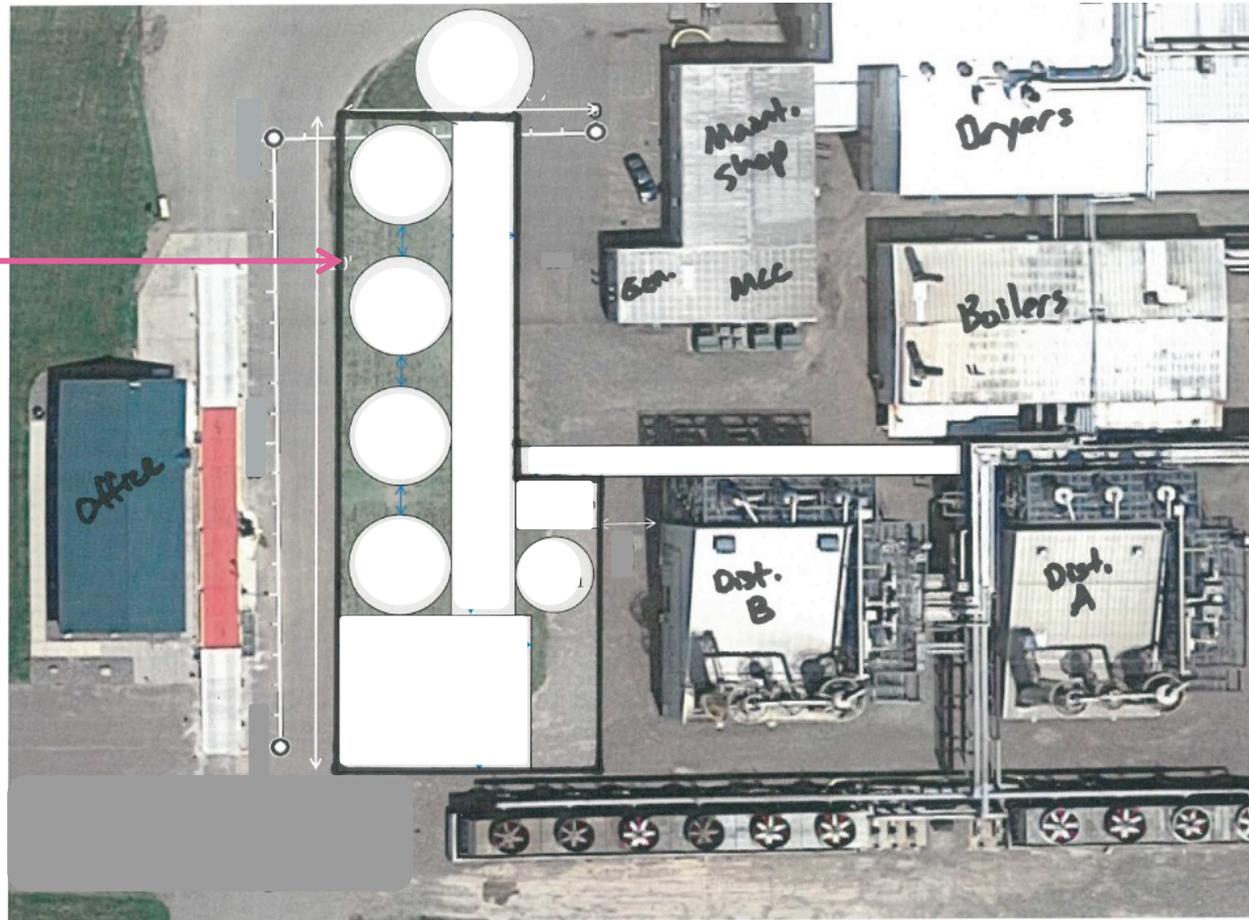
# Ace Ethanol – Stanley, WI



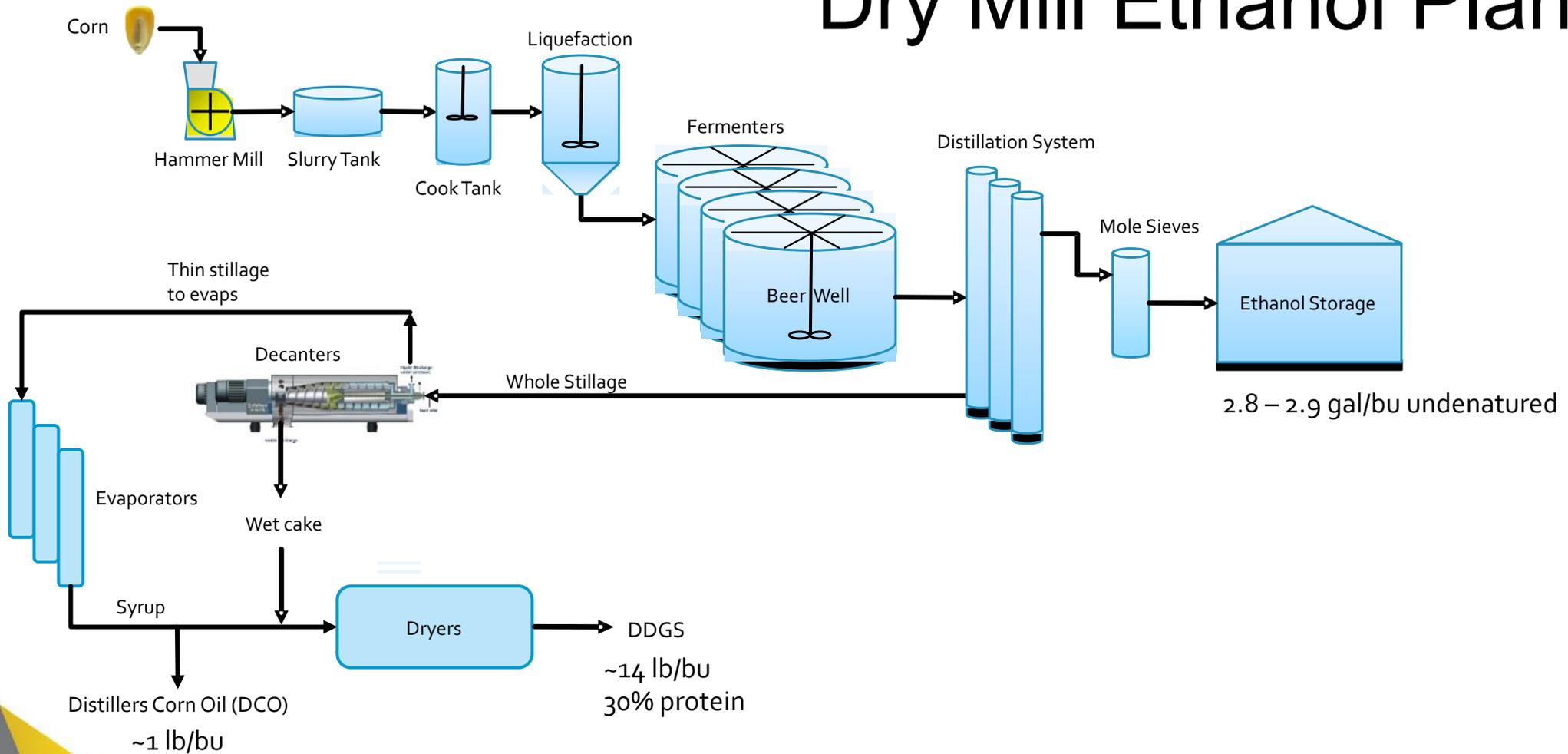
D3MAX  
Project Site

# Ace Ethanol - D3MAX Plant Layout

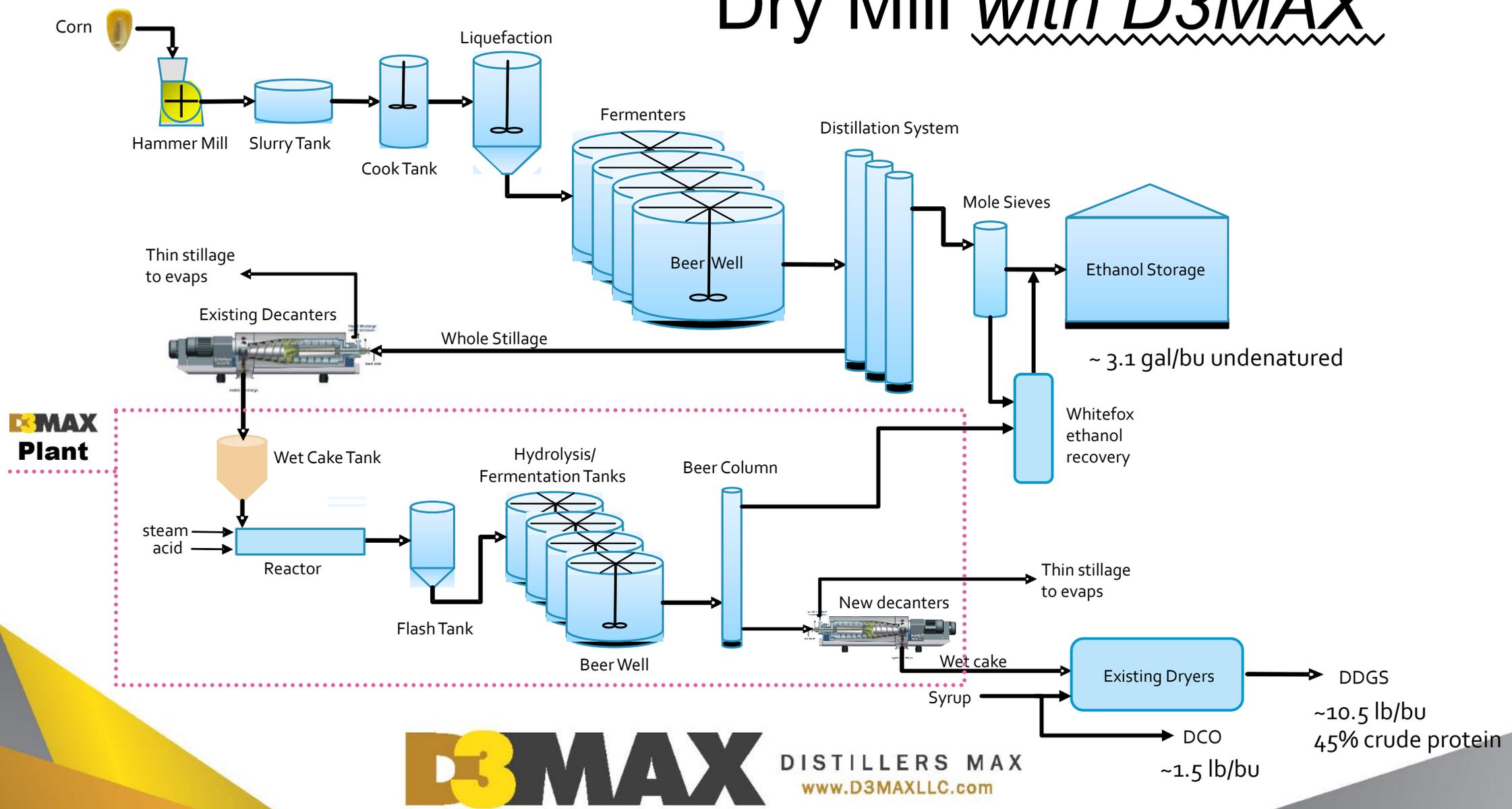
D3MAX  
Project



# Dry Mill Ethanol Plant



# Dry Mill *with D3MAX*



# D3MAX Advantage

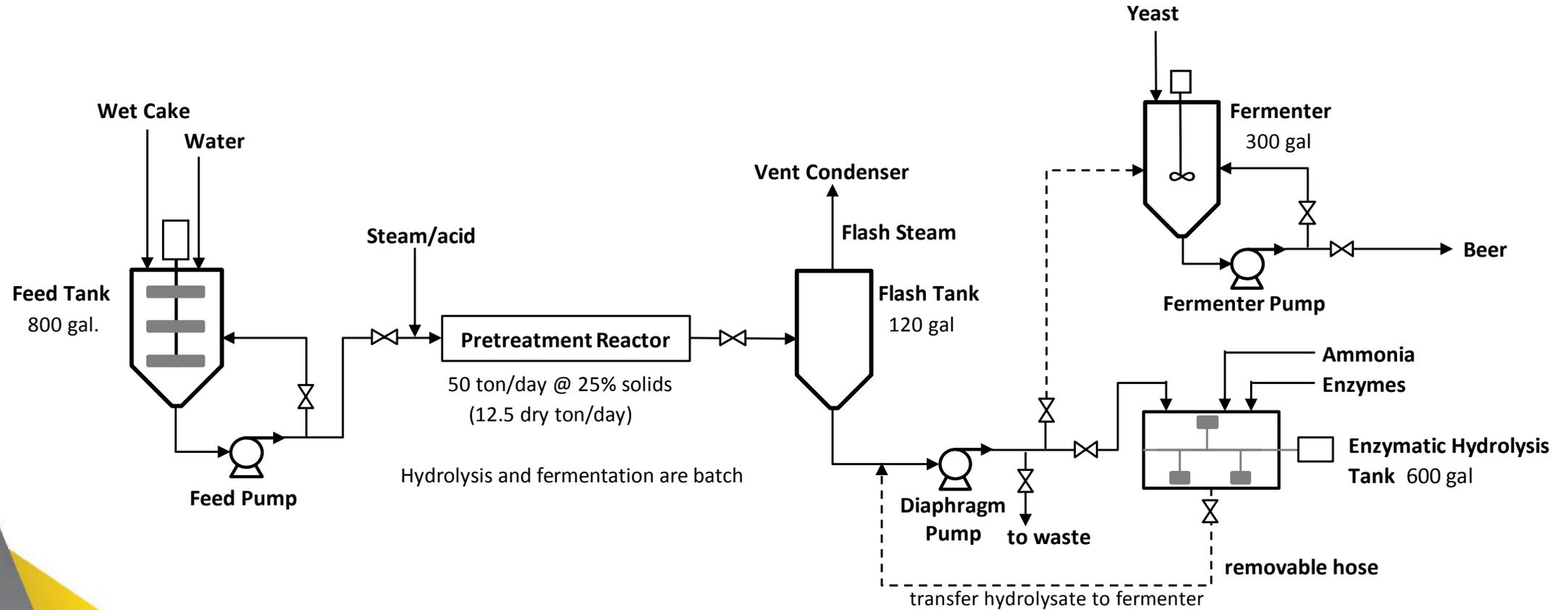
- D3MAX provides a fully integrated solution for the conversion of corn fiber to ethanol resulting in the highest ethanol yield and energy efficiency in the industry
- Yield ~3.1 gal/bu UD; 7-8% increase from current ethanol production
- No increase in energy use when integrated with the Whitefox system
- DDGS protein ~45% crude protein (as is); DDGS volume reduced ~25%
- Distillers Corn Oil recovery increased ~1/2 lb/bu
- \$20 million capex for D3MAX at 50 mgy plant; \$35 million for 100 mgy plant –
  - Additional plant upgrades may be required to support the project (e.g. Whitefox)
- Grind can be increased 20% or more (will likely increase capex)
- No EPA recertification of cellulosic ethanol production every 500,000 gallons



# Summary of D3MAX Pilot Testing

- Pilot testing successfully demonstrated the D3MAX process and allowed Ace and D3MAX to select the best enzymes and yeast while providing critical data for the design of the commercial-scale process at Ace
- From March '17 to the end of October '17, Ace and D3MAX conducted over 150 pretreatment tests and 45 enzymatic hydrolysis and fermentation tests
- The pilot testing demonstrated that the D3MAX process can pretreat wet cake at very low temperatures and low acid concentrations with high yields of soluble and monomeric sugars
- Pilot fermentation tests demonstrated the capability of the Lallemand yeast to convert the C5 and C6 sugars to ethanol in an acceptable fermentation time
- Wet distillers grains from the pilot process were produced so that drying tests could be conducted, and feed analyses performed; the feed analyses indicate high protein and excellent feed properties in the resulting co-product

# D3MAX Pilot Plant Flow Diagram



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# D3MAX Pilot System



# Flash Tank, Fermenter and Feed Tank



# Enzymatic Hydrolysis Tank



# Feeding Wet Cake to the Feed Tank

(video)



# Pretreated Wet Cake



# Pretreated Wet Cake

(video)



# Pretreated Wet Cake in Horizontal Mixer

(video)



# Pretreated Wet Cake after Enzymatic Hydrolysis

(video)



# D3MAX DDGS Production

**DDGS - current Ace production vs. D3MAX (50 mgj plant)**

<u>DDGS Production</u>	<u>Current</u>	<u>With D3MAX</u>
Ton/day	333	253
Ton/year	118,220	89,720
Lb/bu	13.6	10.3
Moisture	11.5%	11.5%
Crude protein (as is)	30%	45%

# D3MAX Hi Protein DDGS

*This is a preliminary analysis subject to change upon further testing*

Typical Analysis

Analysis	As Received	On Dry Matter	Units
Dry matter Content	89.5	----	%(m/m)
Moisture Content	10.5	----	%(m/m)
Crude Fiber	1.07	1.2	%(m/m)
Crude ash content	6.820	7.62	%(m/m)
NDF	4.8	----	%
Crude Fat	1.43	1.60	%(m/m)
Crude Protein	45.56	50.90	%(m/m)
ADF	11.86	13.25	%(m/m)
Total Digestible nutrients	74.7	83.46	%(m/m)
Protein Solubility	----	47.79	%
Starch Content	2.296	2.565	g/100g

RUP and Undigested Crude Protein Analysis

Analysis	%
Total Feed CP % DM	56.05
Estimated RUP %CP	47.89
Undigested CP %CP	20.76

Estimated percent CP by compartment	%
Rumen	52.11
Intestine	27.13
Total	79.24

❖ Animal feeding trials will be conducted this summer with poultry, swine and dairy cows

# D3MAX Hi Protein DDGS

*This is a preliminary analysis subject to change upon further testing*

Amino Acid Profile

Analysis	Result	Units
Alanine	2.91	%
Arginine	1.48	%
Aspartic Acid	2.3	%
Cystine	1.41	%
Glutamic Acid	5.87	%
Glycine	1.53	%
Histidine	.95	%
Isoleucine	1.29	%
Leucine	4.42	%
Lysine	.91	%
Methionine	.79	%
Phenylalanine	1.67	%
Proline	3.07	%
Serine	1.81	%
Threonine	2.04	%
Tryptophan	.21	%
Tyrosine	1.46	%
Valine	2.10	%

Minerals

Analysis	Result	Units
Calcium	.03	%(m/m)
Copper	7.2	PPM
Iron	196.21	PPM
Potassium	1.67	%(m/m)
Magnesium	.50	%(m/m)
Manganese	24.62	PPM
Sodium	.03	%(m/m)
Phosphorous	1.26	%(m/m)
Sulfur	1.55	%(m/m)
Zinc	79.73	PPM



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# Corn Fiber: the Path to 1.5 BGY Cellulosic Ethanol

- Using corn fiber takes advantage of the existing ethanol plant's infrastructure, staff, management and financial strength (significantly reduces capex)
- Ethanol plants can use Balance Sheet Financing (avoids significant project delays due to Project Financing and loan guarantees)
- As a cellulosic ethanol feedstock, corn fiber is unique:
  - Low lignin – lignin binds enzymes – less enzyme required with corn fiber
  - DDGS has a high value compared to a lignin coproduct obtained with other feedstocks
  - Corn fiber in wet cake has been “pre-pretreated” by the ethanol plant – reduces pretreatment severity which lowers capex and opex
  - No wastewater treatment required, no lignin boiler or lignin processing required
  - No harvesting, transportation, or storage required; corn fiber is available year-round

# D3MAX Financial Projections

Dry Mill Plant Capacity and Optional Grind Increase →	50 mgy Plant No Grind Increase	50 mgy Plant 15% Grind Increase <sup>1</sup>	100 mgy Plant No Grind Increase	100 mgy Plant 15% Grind Increase <sup>1</sup>
Cellulosic Ethanol (7% increase) (D gal/yr)	3,500,000	4,000,000	7,000,000	8,000,000
EBITDA (year 2 – cellulosic gallons only)	\$11,248,262	\$13,042,244	\$23,054,293	\$26,647,586
Internal Rate of Return (on 40% equity)	81%	93%	99%	112%
IRR with D3 RINs zeroed out	24%	28%	31%	36%
EPC Capital Cost	\$20,000,000	\$21,100,000	\$34,900,000	\$36,700,000
EPC Capital Cost/Gal	\$5.73	\$1.81	\$5.00	\$1.57
Equity Payback (40% equity), years	1.1	<1.0	<1.0	<1.0
Debt Service Coverage Ratio, year 2	3.96	4.40	4.66	5.16
Net Earnings for all gallons, year 2	\$0.17	\$0.18	\$0.18	\$0.19
Net Earnings per bushel, year 2	\$0.53	\$0.55	\$0.56	\$0.58

Note 1: 15% grind increase results in 24% increase in overall ethanol production

# Wrap Up - Benefits of D3MAX

- Ethanol yield 3.1 gal/bu undenatured (UD)
- Corn Oil +0.5 lb/bu
- DDGS Protein 30% → 45% (wet basis)
- No Increase in overall energy use with the integrated D3MAX solution
- DDGS Volume Reduced 25% - Increase Grind 20% or more
- Maximize D3 RINs
- Increase Net Income 17-19¢/gal for all gallons produced
- Improve energy efficiency and lower CI score
- Very high return on investment

# 34<sup>th</sup> International Fuel Ethanol Workshop

CenturyLink Center, Omaha, Nebraska

June 11-13, 2018

<http://www.fuelethanolworkshop.com>

## D3MAX Presentations:

Tuesday June 12, 3:30 to 5:00 – *Increase Your Grind and Produce Cellulosic Ethanol from Corn Kernel Fiber with D3MAX*

Wednesday June 13, 10 am – *Invitation only presentation for ethanol producers by D3MAX and Ace Ethanol*





Maximize profits

Maximize D3 RINs

Maximize corn grind

Maximize ethanol yield

Maximize corn oil recovery

Maximize corn fiber to ethanol

Maximize overall energy efficiency

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