Water-free Protein Enhancement of Dry Distillers Grains with Solubles (DDGS)

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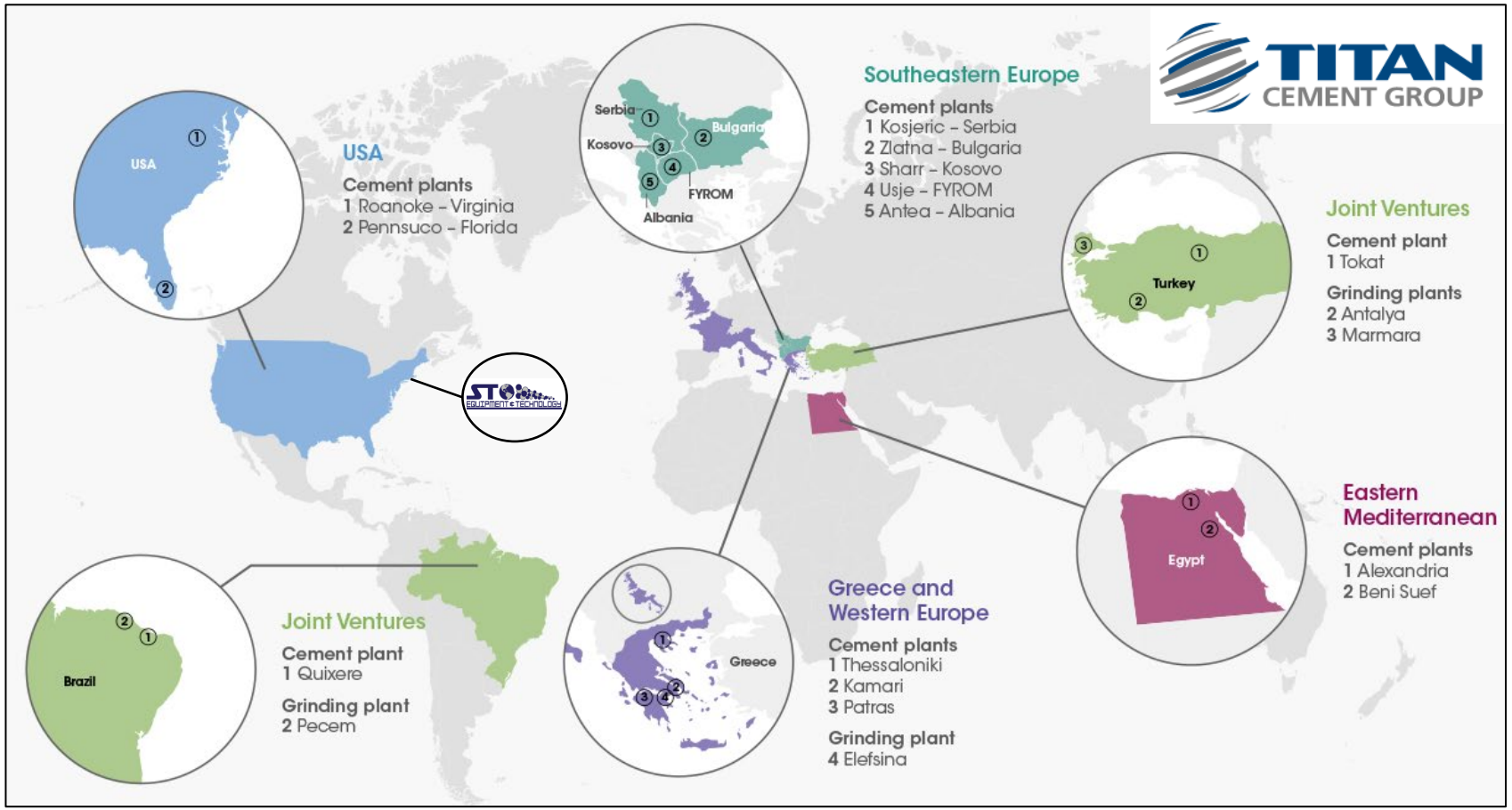
Who is ST Equipment & Technology?



Titan Cement Group

- *A vertically-integrated, multiregional building materials company*
- *EUR €1.6B of revenue (2020)*
- *5,400 Global Employees*

Core Business:

- *Concrete, Cement, Block, Aggregates and Fly Ash*

ST Equipment & Technology (STET)

- STET is wholly owned by Titan Cement Group
- Headquartered in Boston, MA, USA
- The leader in electrostatic separators for fine powders
- Product line covers Food, Feed and Minerals

STET Separator

- Entirely Dry Process: No Water or Chemicals
- High Rate, Continuous Electrostatic Separator
- Single-Step Process
- High Feed Rate: 15 – 20 tons / hour for DDGS
- Low Energy Consumption: 2-4 kWh / ton
- Designed for Processing Combustible Dusts
- Fully Commercialized – 25 Years of Operation

Proven Processing Technology

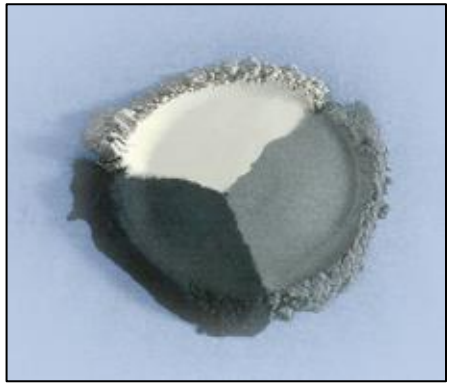
- ***STET Separators***

Location	Units	Starting
United States	13 Units	(1995)
United Kingdom	4 Units	(2002)
Canada	2 Unit	(2005)
Europe	3 Units	(2011)
South Korea	2 Units	(2014)
India	1 Unit	(2015)
Japan	1 Unit	(2018)
Philippines	1 Unit	(2019)

- **STET Separators: 27 Units**
- **1995 – First Commercial Operation**
- **20+ Million Tons Processed**





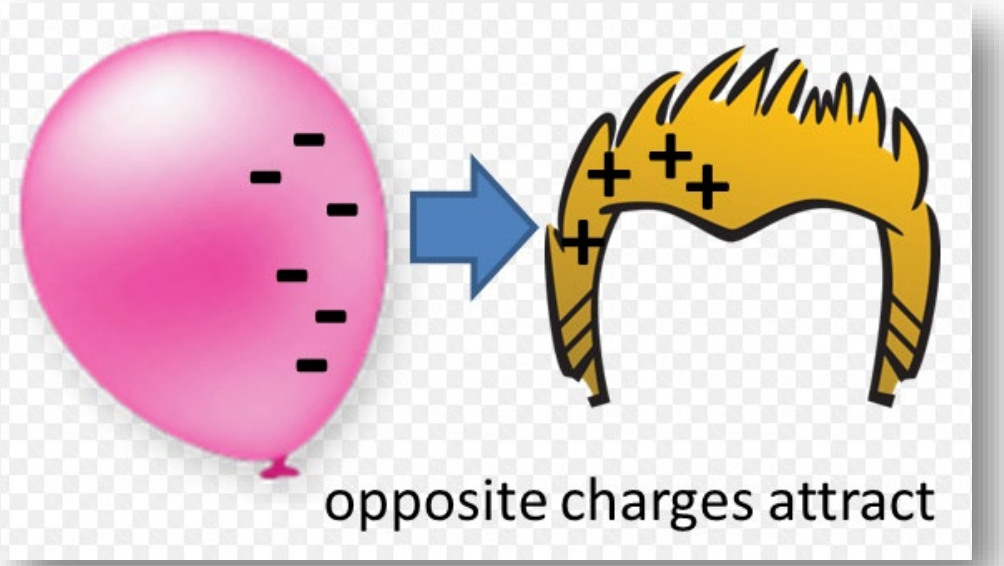
- Experience in Wide Variety of Fine Powders:
  - Food & Feed
  - Minerals
  - Fly Ash
- Commercially Proven
- Operating Since 1995

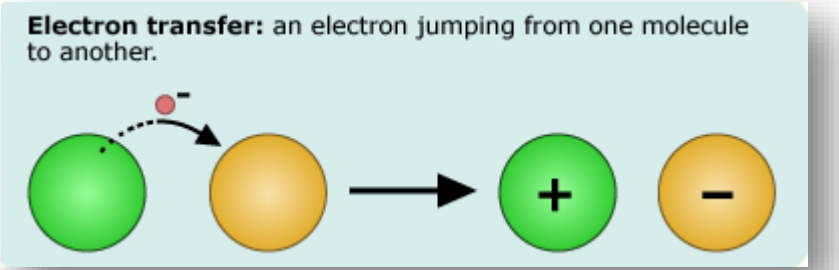
Description of STET Process

F42 - Fly Ash Separator, South Korea

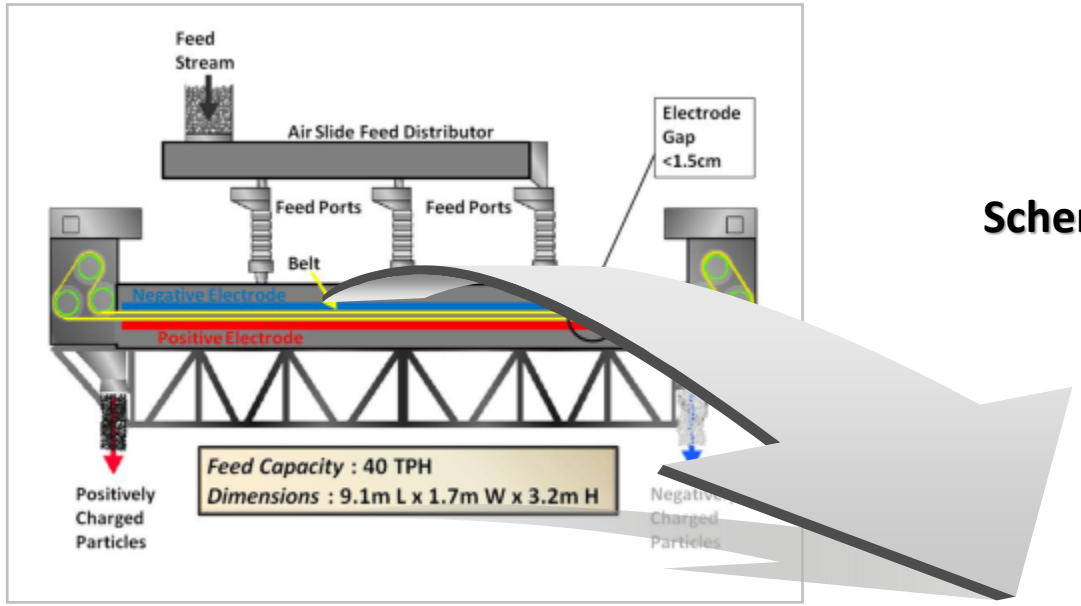
Electrostatic Separation (ESS)

- Electrostatic Phenomena Observed Since Ancient Times.
  - Documented as Early as 600 BC
  - Amber charged with Animal Fur would Attract Small, Light Objects
- Today Electrostatics Used in Minerals Processing and Recycling.

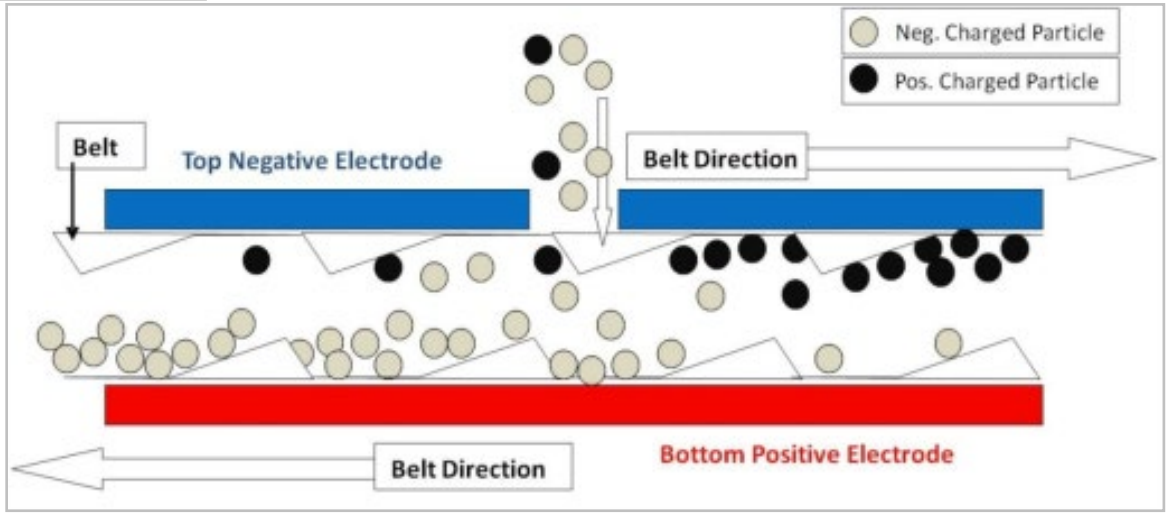




Schematic of the Separator

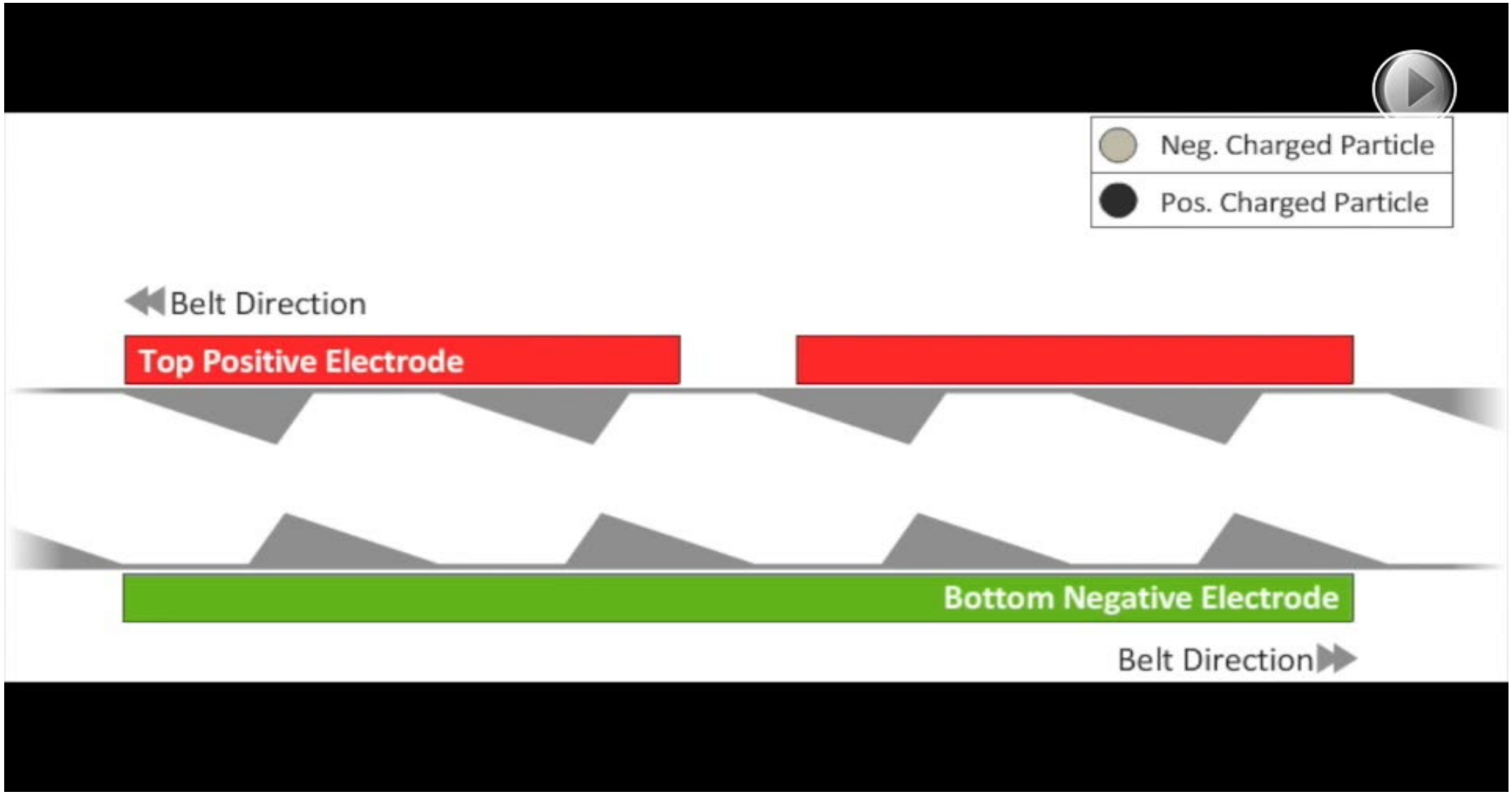


Schematic of the Separator and Electrode Gap



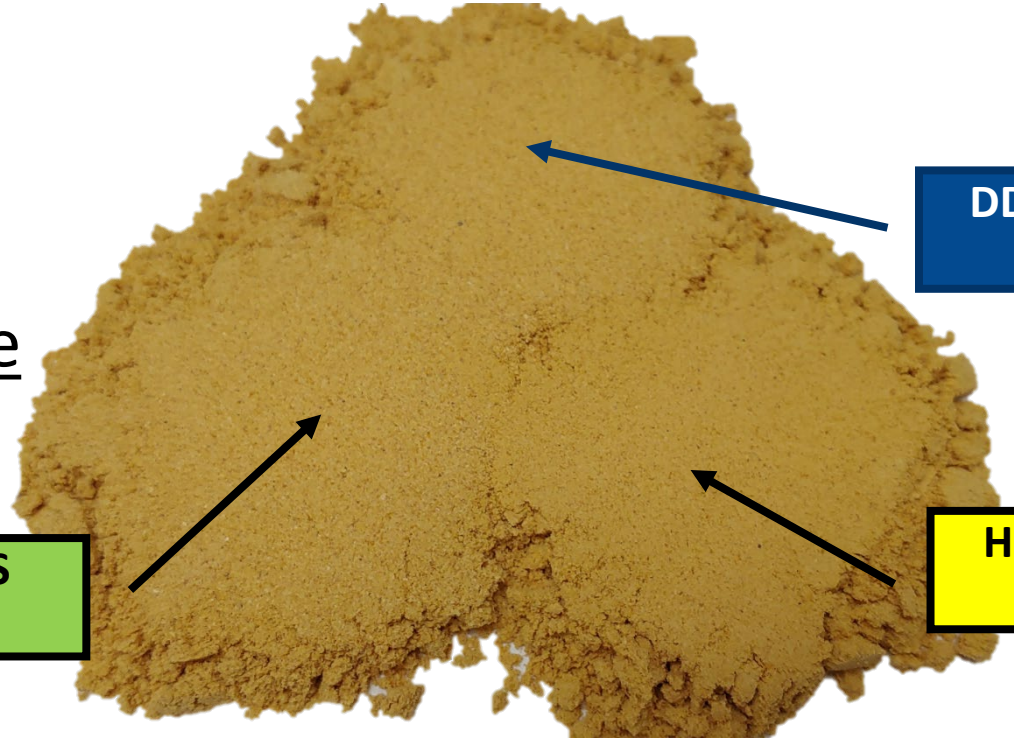
- **Small gap and vigorous agitation**
- **High electric field strength with moderate applied voltage (typ. 8-20 kV)**
- **High efficiency multi-stage separation through charging/recharging & internal recycle**

Belt Animation

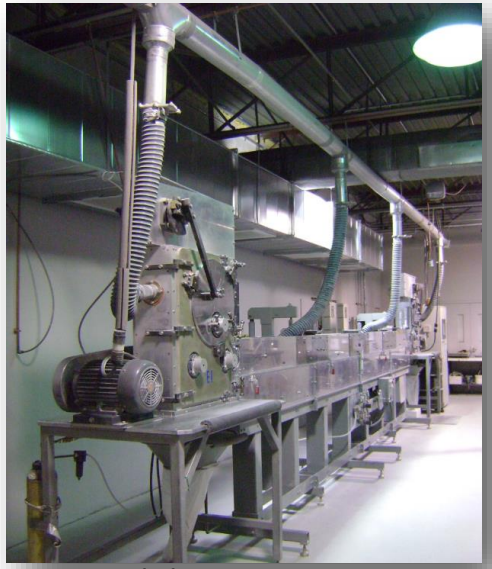


Separation of DDGS – Pilot Scale

- Sample of DDGS Milled and Tested with STET Separator at Pilot Scale
- Result: +15% Absolute Increase in Protein for DDGS



Pilot Scale Separator

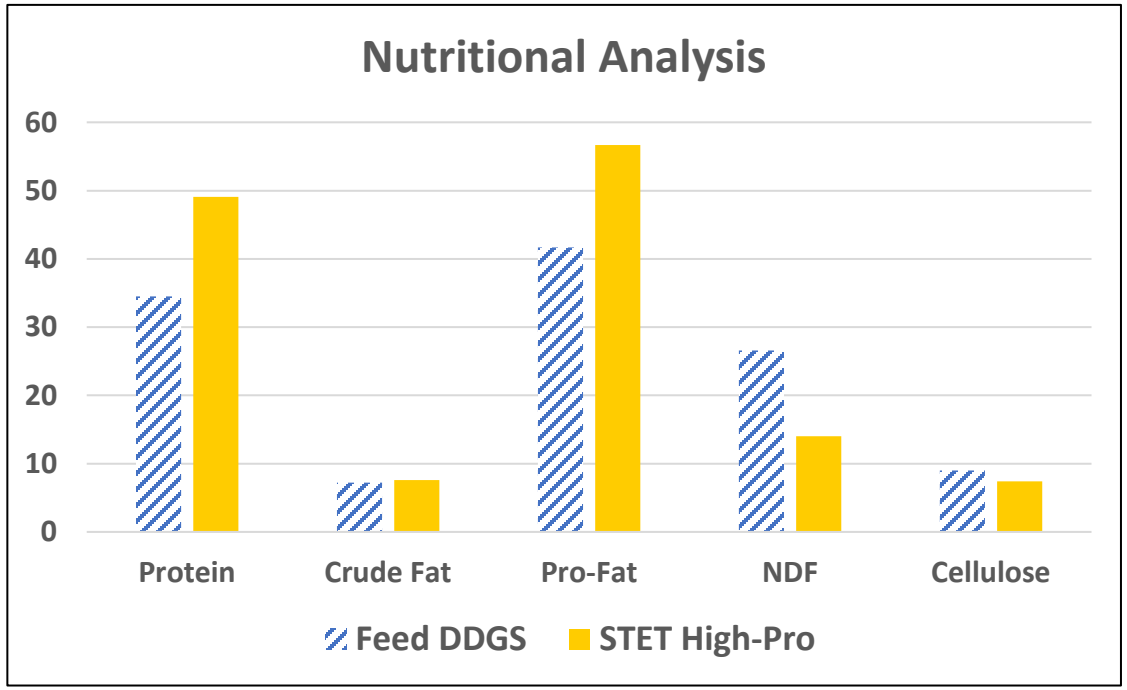


	Protein (DB)	Crude Fat (DB)	Pro-Fat (DB)	Crude Fiber (DB)	NDF (DB)
Standard DDGS	34.5%	7.2%	41.7%	6.9%	26.6%
STET High Pro DDGS	**49.1% (+14.6)**	**7.6%**	**56.7% (+15)**	3.8% (-3.1)	14.0% (-12.6)

DDGS - Nutritional Analysis

STET DDGS Nutritional Analysis													
	Moisture	Protein	Ash	Crude fat	Crude fiber	ADF	NDF	Lignin	Cellulose	Ca	P	Na	S
DDGS	4.4	34.5	6.6	7.2	6.9	11.3	26.6	2.3	9.0	0.022	1.1	0.2	0.8
High-Pro	4.4	49.1	8.8	7.6	3.8	11.0	14.0	3.6	7.4	0.024	1.1	0.1	1.0
Low-Pro	4.4	26.7	5.5	7.1	9.0	11.8	34.8	1.6	10.3	0.022	1.0	0.2	0.7

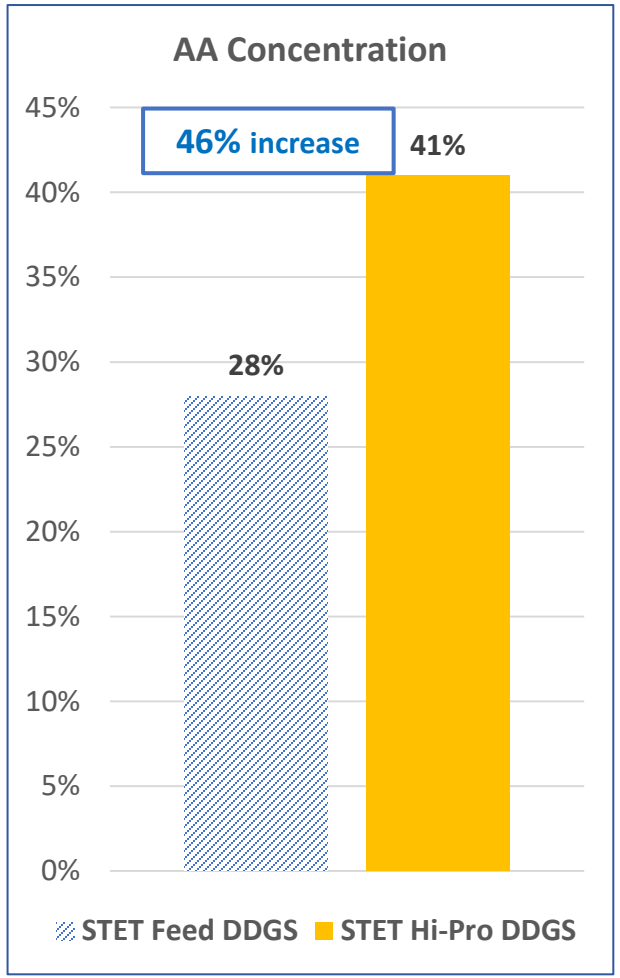
All values shown in % DB

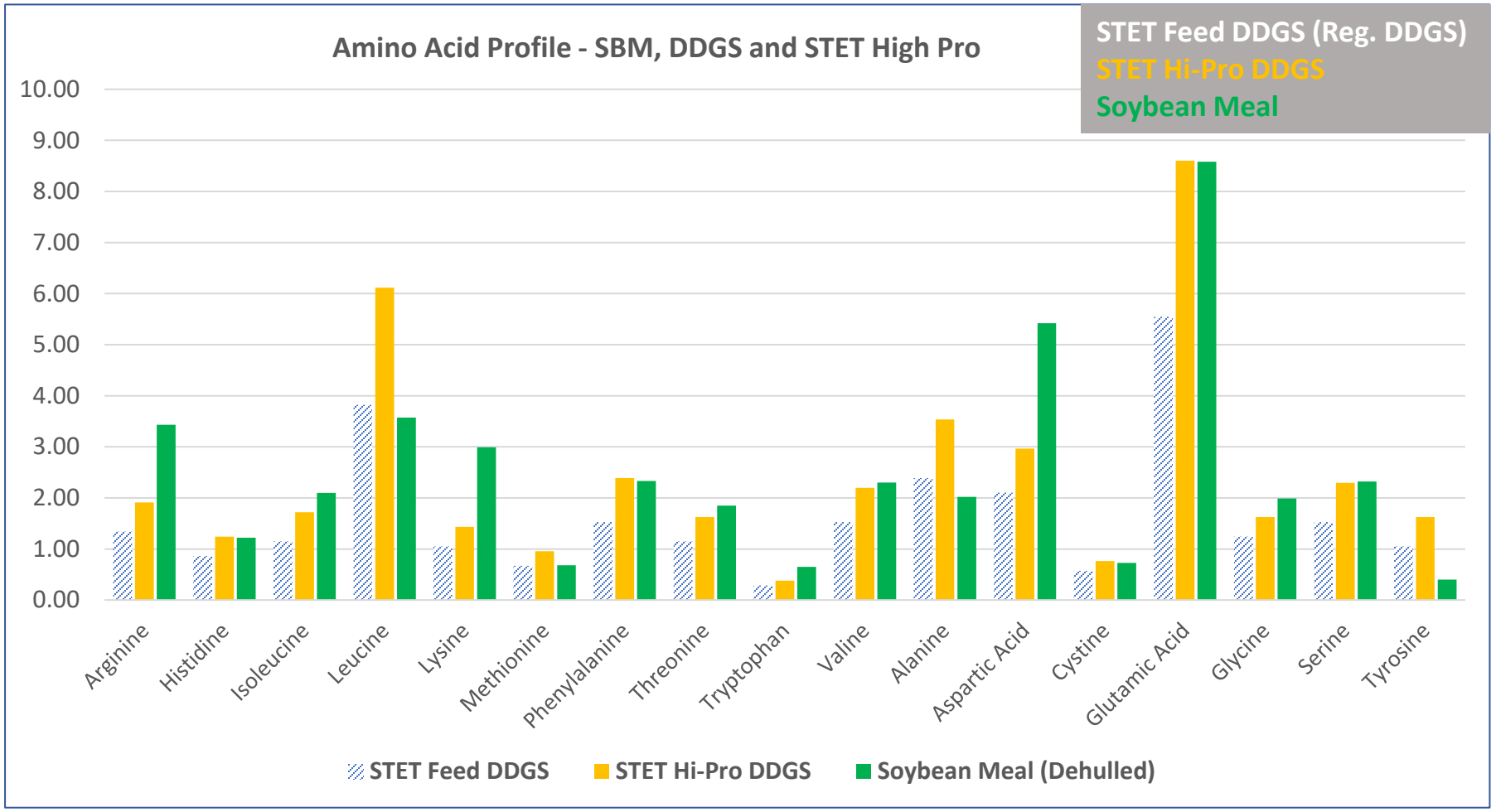


STET High-Pro DDGS:

- +48% Protein
- 57% Pro-Fat
- 47% Reduction in NDF
- 45% Reduction in Crude Fiber

DDGS - Amino Acid Profile





- **Amino Acids Concentrate with Increasing Protein levels of DDGS**
- **Reduction in Crude Fiber, NDF and Cellulose**

AA Digestibility and Energy

Amino Acid	AA	AA Content (As-Is)	AA Digestibility (%)	Digestible AA Content (As-Is)
Arginine	ARG	1.91	88.4%	1.69
Histidine	HIS	1.19	83.2%	0.99
Isoleucine	ILE	1.86	86.8%	1.61
Leucine	LEU	5.97	94.0%	5.61
Lysine	LYS	1.28	60.1%	0.77
Methionine	MET	0.89	86.4%	0.77
Phenylalanine	PHE	2.67	90.6%	2.42
Threonine	THR	1.66	84.1%	1.40
Tryptophan	TRP	0.31	93.7%	0.29
Valine	VAL	2.27	89.7%	2.04
Alanine	ALA	3.33	88.7%	2.95
Aspartic Acid	ASP	2.83	69.9%	1.98
Cystine	CYS	0.89	85.0%	0.76
Glutamic Acid	GLU	7.41	90.3%	6.69
Serine	SER	2.05	87.3%	1.79
Tyrosine	TYR	1.96	91.5%	1.79
Proline	PRO	3.86	92.7%	3.58
Total:		**42.3**	**87.7%**	**37.1**

STET High-Pro		
Dry Matter	%	92.5
TME_n (Poultry)	kcal/kg DM	4,605

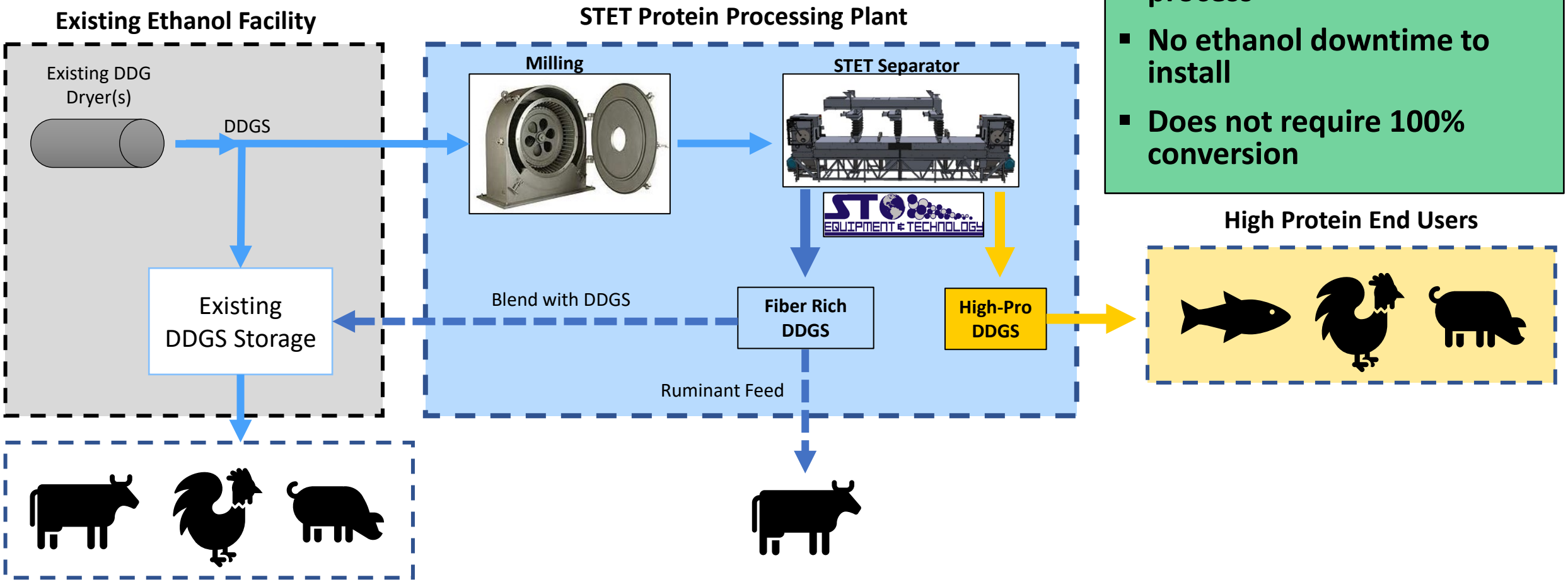
STET High-Pro DDGS:

- 30% Increase in TME_n (poultry) over standard DDGS
- 87.7% AA Digestibility

No Modification to Ethanol Process

"Bolt-On" Addition to Ethanol Facility

No Modification to Ethanol Process

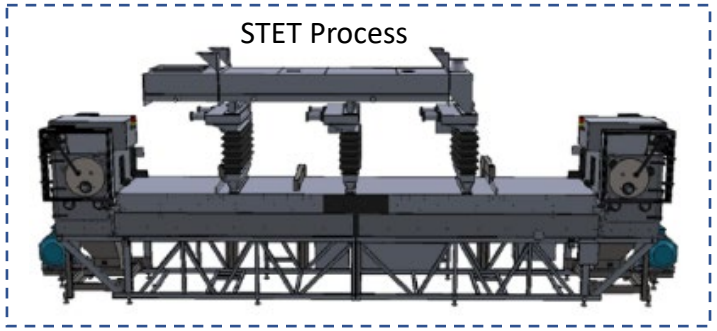


Benefits:

- **Independent of ethanol process**
- **No ethanol downtime to install**
- **Does not require 100% conversion**

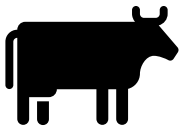
STET Process Yield

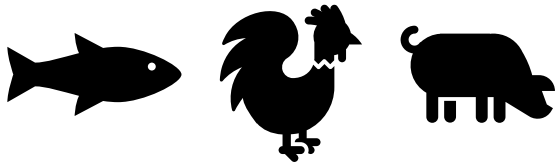
1 Ton DDGS



Fiber Rich DDGS

Protein Rich DDGS





0.65 - 0.8 Ton
High-Fiber

0.2 - 0.35 Ton
High-Pro
(3.1 - 5.4 lb / Bushel)

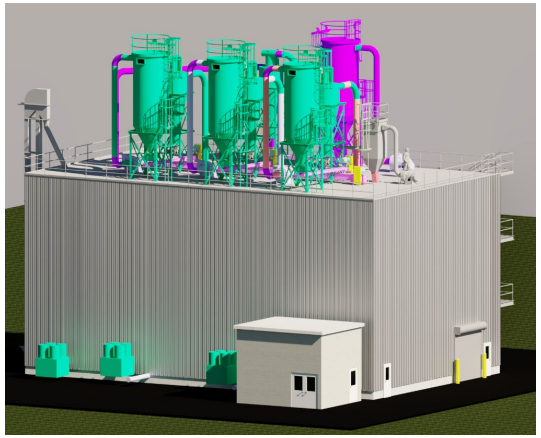
- Adjustable Yield and Protein Content of High Protein DDGS.

STET Protein Processing Facility

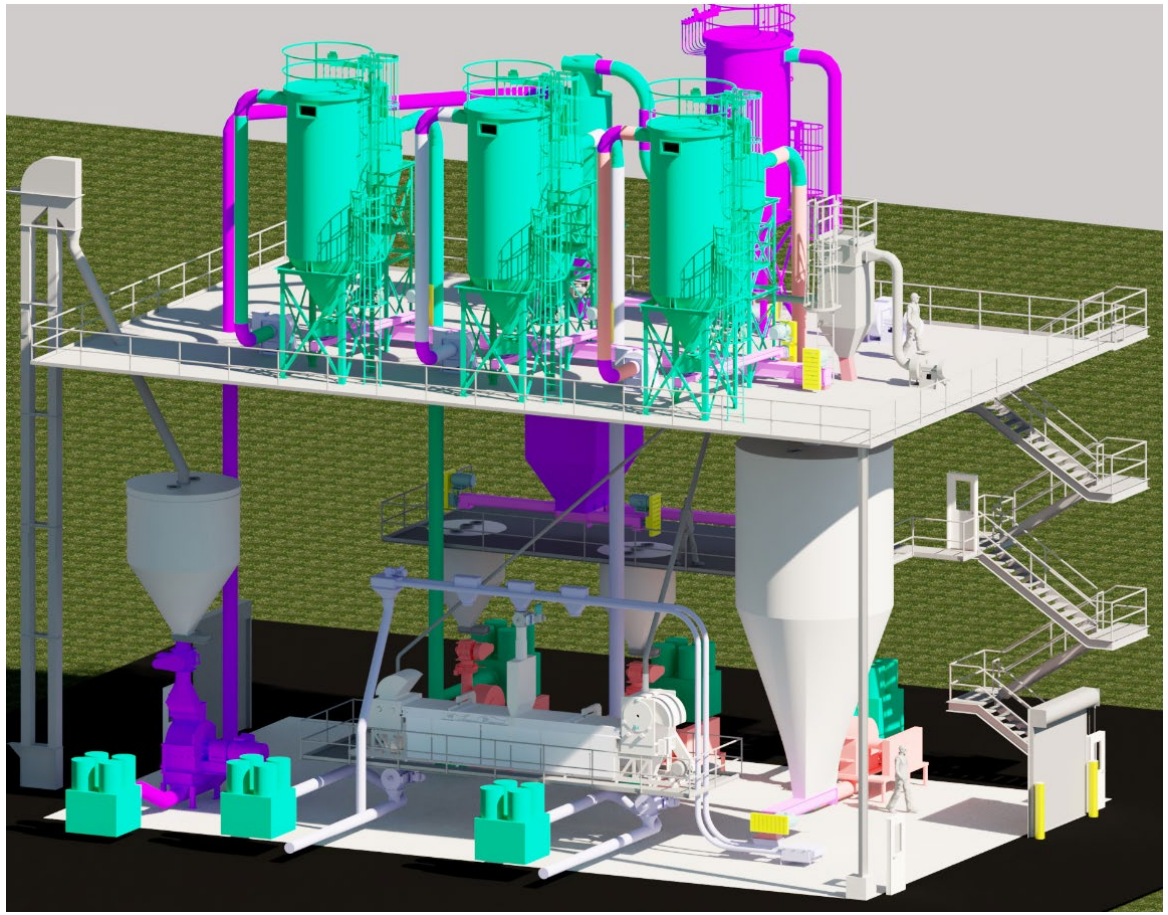
WL Port-Land Systems (WLPLS)

- 45 years of Feed Industry Experience
- Designed & Built 27 new feed mills
- 70+ Feed Mill Renovations

WLPLS and **STET** can offer turnkey processing facility.



STET Protein Processing Plant:



Benefits to Ethanol Plants

Benefits to Ethanol Producers:

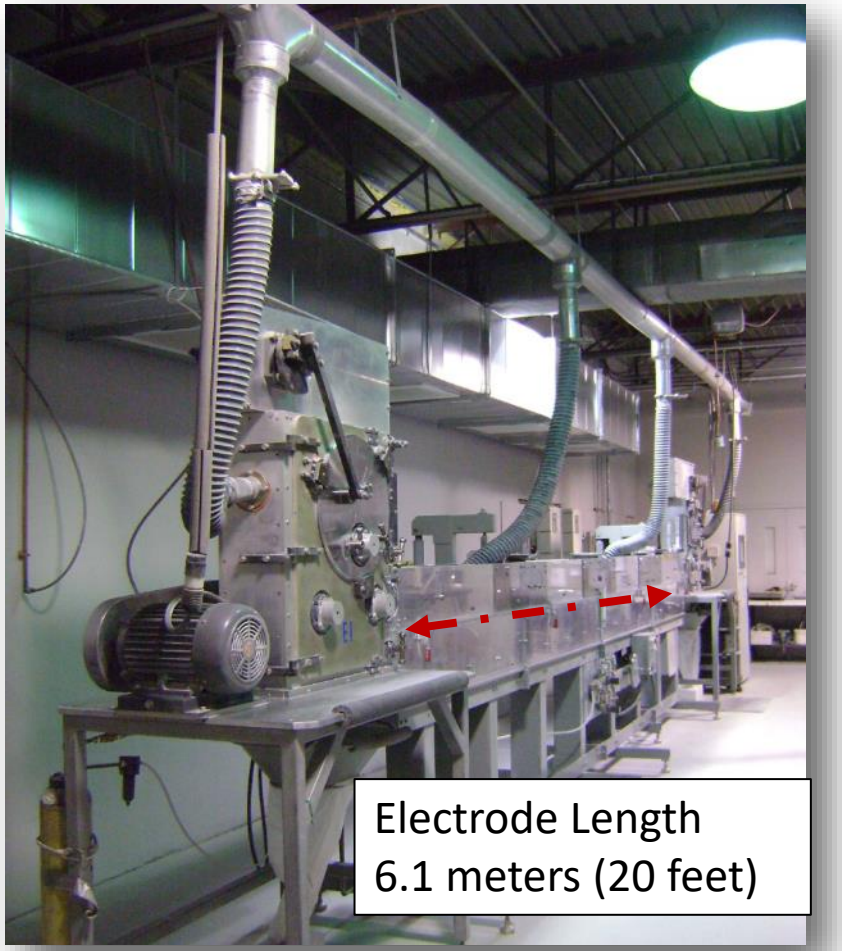
- ✓ Improve margins → increase revenue of Co-Products
- ✓ Requires no modification to ethanol process.
- ✓ No ethanol production downtime required.
- ✓ Completely independent of ethanol process. Can operate when ethanol system is down.
- ✓ Allows for phased installation – does not require processing of entire plant DDGS.
- ✓ Generate and sell branded products – not commodities.

Process Testing Capability

STET Technical Center – Needham MA USA

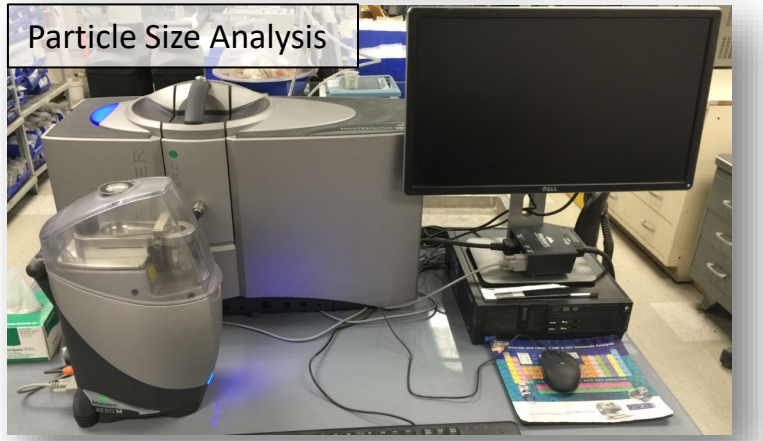
Bench-Scale Separator

Pilot-Scale Separator

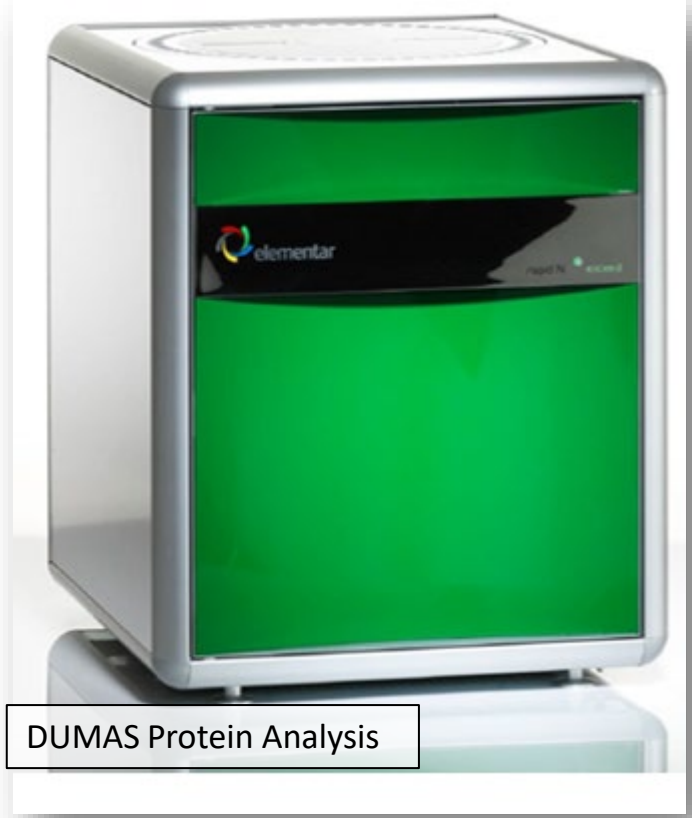


Testing & Analysis

Milling Equipment

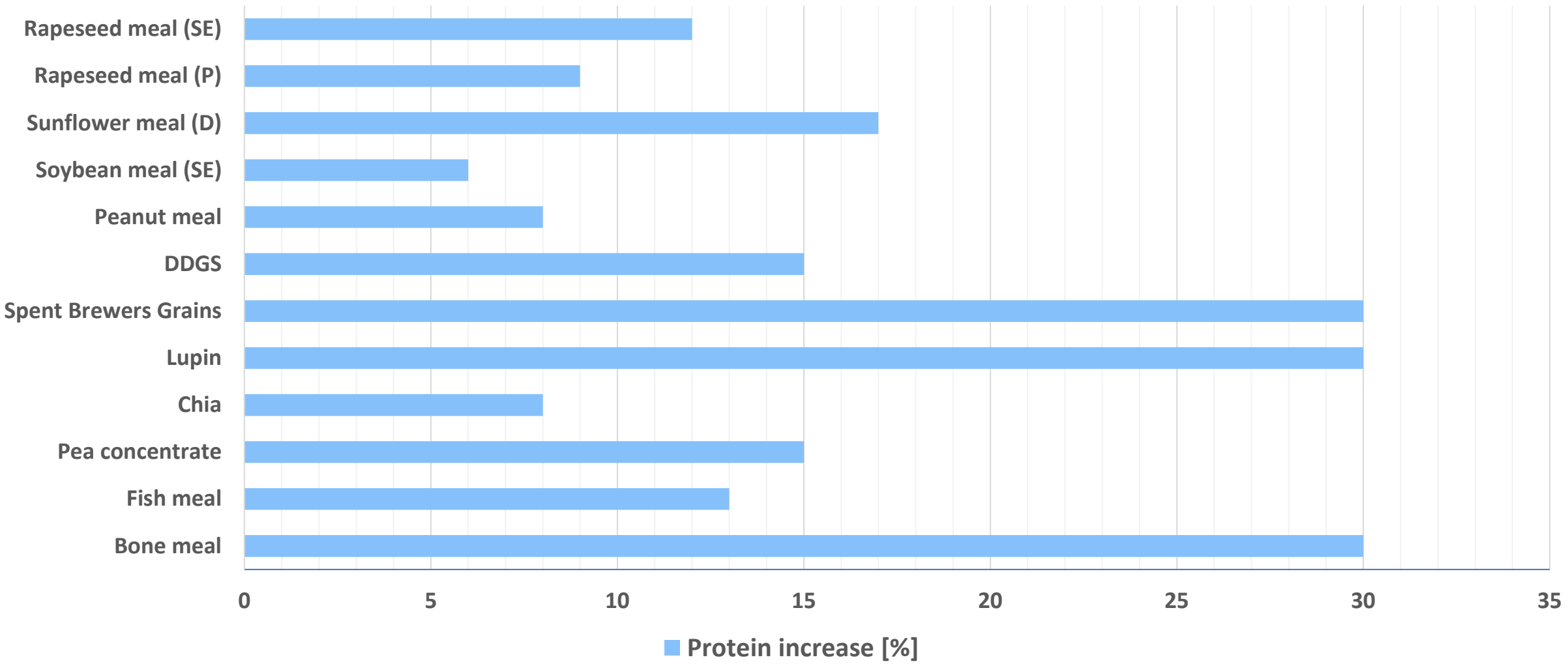


Particle Size Analysis



DUMAS Protein Analysis

Other Applications Tested



Summary & Conclusions

- STET is new to ethanol industry and offers entirely different route to generating **high-protein DDGS**.
- STET process generates DDGS with **+48% protein** and **57% pro-fat** content.
- STET is **completely independent** of the ethanol process.
- STET process is **fully commercialized** in other industries. STET separators have been operating for **25 years** in fly ash recycling.
- STET is seeking ethanol industry partners to continue development.

Thank You!

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