NC STATE UNIVERSITY

Department of Chemical & Biomolecular Engineering

Optimizing Spray Dryer Operations: Enhancing Efficiency and Sustainability for Reduced Carbon Footprint

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Project Goals

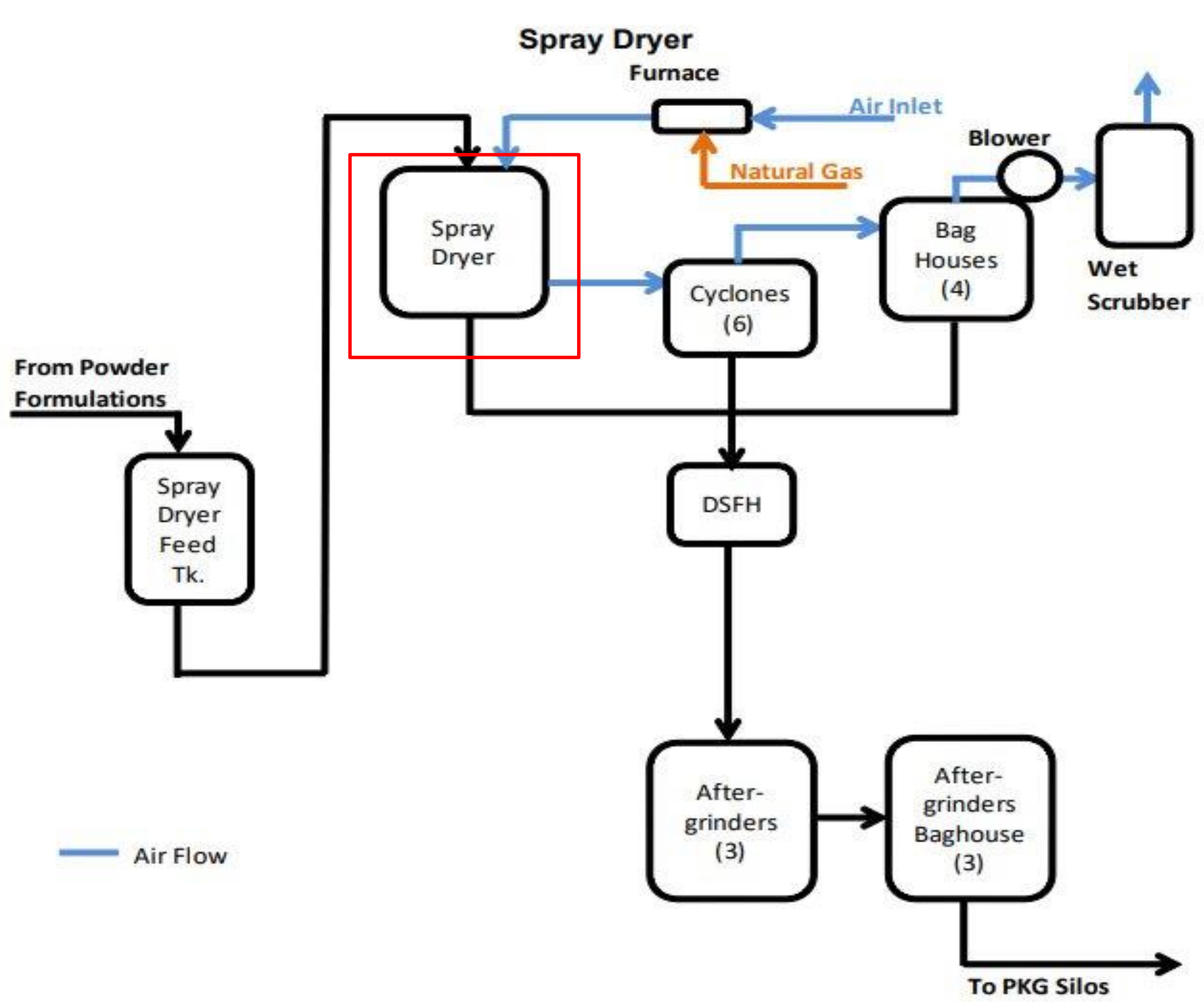
- Identifying **decarbonization** opportunities through the evaluation of **green energy sources**
- Evaluation of **efficiency opportunities** to reduce the carbon generation per pound of product applicable to the existing technology

Background

- **38%** Scope 1 & 2 emissions reduction by 2030
- **Good Growth Plan**
  - Strive for carbon-neutral agriculture
  - Invest **$2B** in sustainable agriculture breakthroughs **by 2025** and deliver two sustainable technology breakthroughs each year

Current Process

- Spray dryer is located in **St. Gabriel, LA**
  - Product: powdered **Atrazine**
  - Spray dryer operation: **~8K MT CO_2/annual footprint**
- Currently operates by **burning natural gas** a fuel source



Biofuels

- **Current:** Combusted Natural Gas
- **Alternatives:**
  - Biomass-stock (Butanol)
  - Fuel-stock (Methanol)

methanex the power of agility

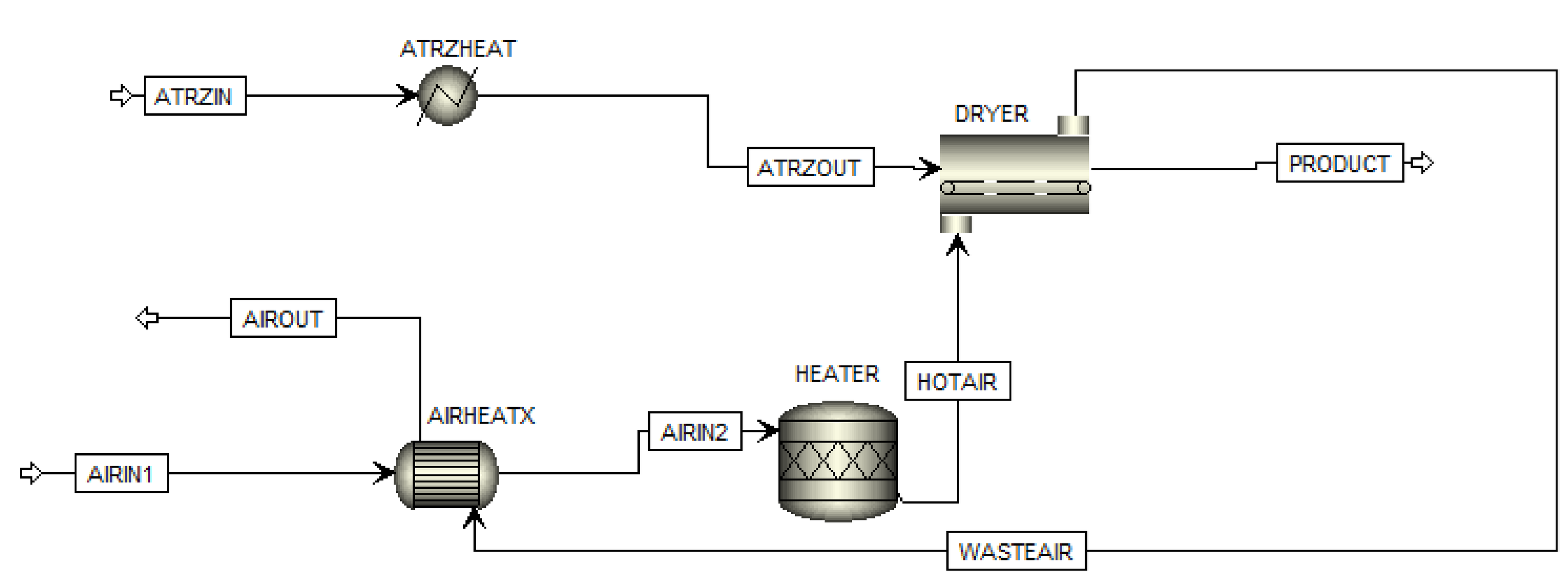
Criteria	Importance (Weight)	Natural Gas (Current)	Biobutanol	Biomethanol
Ease of Implementation	1	0	-1	1
Resource Availability	3	0	1	2
Safety Rating	5	0	-2	-1
Emissions Reduction	5	0	1	2
Energy Density	5	0	3	-1
Initial Cost	2	0	-1	-1
Operation Cost ($/MMBTU)	4	0	-2	0
Implementation Time	3	0	-2	-1
	Totals:	0	-1	3

- **Economic Analysis**
  - Current Price: $4.00 /MMBTU
  - Methanex Pricing: $1.83 /gal → $28-32 /MMBTU

Need 73 mil BTU/hr: 8,809 MT CO_2 per year

Process Improvement

- **ASPEN** was used to model the addition of heat exchangers to the spray drying system



- Types of **preheaters** evaluated:
  - Electric heater using renewable energy
  - Air-to-air heat exchanger using excess heat

Ambient Air Conditions	Natural Gas Required (cuft/min) No HeatXer	Only Atrazine preheater	Atrazine and Air preheaters	Efficiency gain from Atrazine preheater	Efficiency gain from both preheaters
5C, 20%	580	535	485	7.76%	16.38%
10C, 30%	570	525	480	7.89%	15.79%
20C, 50%	558	511	470	8.42%	15.77%
30C, 80%	558	502	467	10.04%	16.31%
35C, 100%	565	502	470	11.15%	16.81%

Criteria	Importance Weighting	Current (LNG)	Preheat Atrazine Before Spray Dryer	Preheat Air Before Fired Heater
Initial Cost	2	0	-1	-3
Operating Cost ($/mt)	4	0	1	1
Time to Implement	3	0	-1	-2
Emissions Reduction	5	0	1	1
Ease of Implementing	1	0	-1	-1
Safety	3	0	-0.5	-0.5
	Totals:	0	1.5	-5.5

- **Sizing:**
  - Atrazine Preheater: Modeled as double pipe carbon steel heat exchanger with an area of 105 sq ft
  - Air Preheaters: Series of 25 plate heat exchangers with an area of 3,000 sq ft each

Equipment	Cost of equipment and installation	MMBTU of CO2 reduced annually	Annual operational cost reduction	Years to pay off
Atrazine Preheater	$ 16,700.00	27979	$ 111,914.49	0.1492
Air-Air Preheaters	$ 14,200,000.00	50165	$ 200,659.19	70.7668

Conclusion

- **Biofuels:** 8,809 > 8,000 MT CO_2/year at cost increase of $24-28/MMBTU
  - Only feasible if combined with process changes (improve efficiency)
- **Atrazine preheater:** Annual savings of $112,000 with an equipment cost of $16,700
  - Recommended solution to implement into process
- **Air preheater:** Annual savings of $88,000 with an equipment cost of $14,200,000
  - Only viable if cost of fuel increases significantly

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