PYROLYSIS OF HAZELNUT SHELLS

TEAM 2.1

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OBJECTIVES

- Analyze the economic feasibility of turning hazelnut shells into biochar

- Design a time effective pyrolysis unit

- Ensure a maximum 2 season payback period (8 month seasons)

BACKGROUND

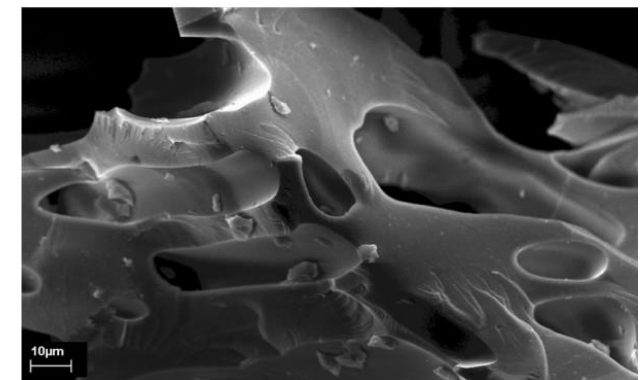
https://www.istockphoto.com/photos/hazelnut-shell

- 65,000 tons of hazelnuts grown and processed every year in Oregon
  - ~28,500 tons of shells
- Shell uses
  - Slug barrier
  - Water retention
- **Biochar soil additives**
  - Created via pyrolysis
  - Increase water retention
  - Overall increase in available nutrient elements (Na, K, Ca, Mg, ...)


https://www.chardirect.com/

Pua, Fei Ling, et. al. www.researchgate.net

DESIGN & SIZING

Through convective heat flow, achieve optimal conversion temperature

Main Considerations
- Spherical particle assumption using typical packing correlations
- Ensure low oxygen environment
- Sizing for completion within the given time frame (8 months)

- Current design allows for 20-minute batch times with 10 minutes active gas flow for ensuring homogeneity of reaction
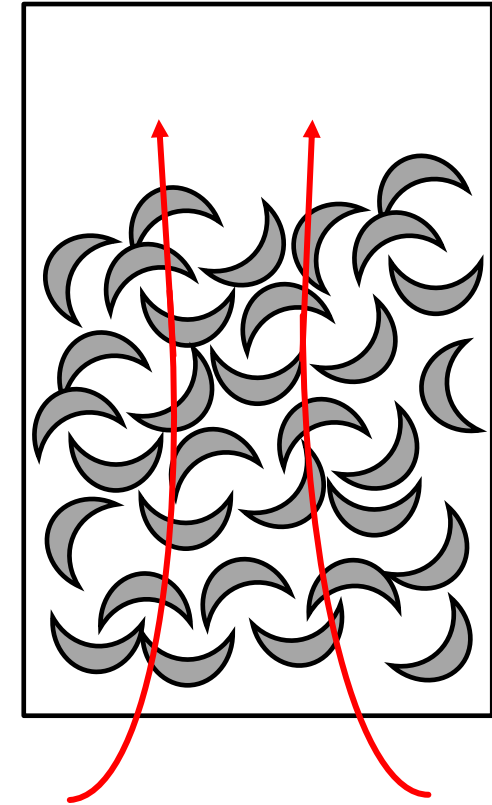
Combusted hot gas

Gnielinski(1978) correlation

OVERALL PROCESS DESIGN
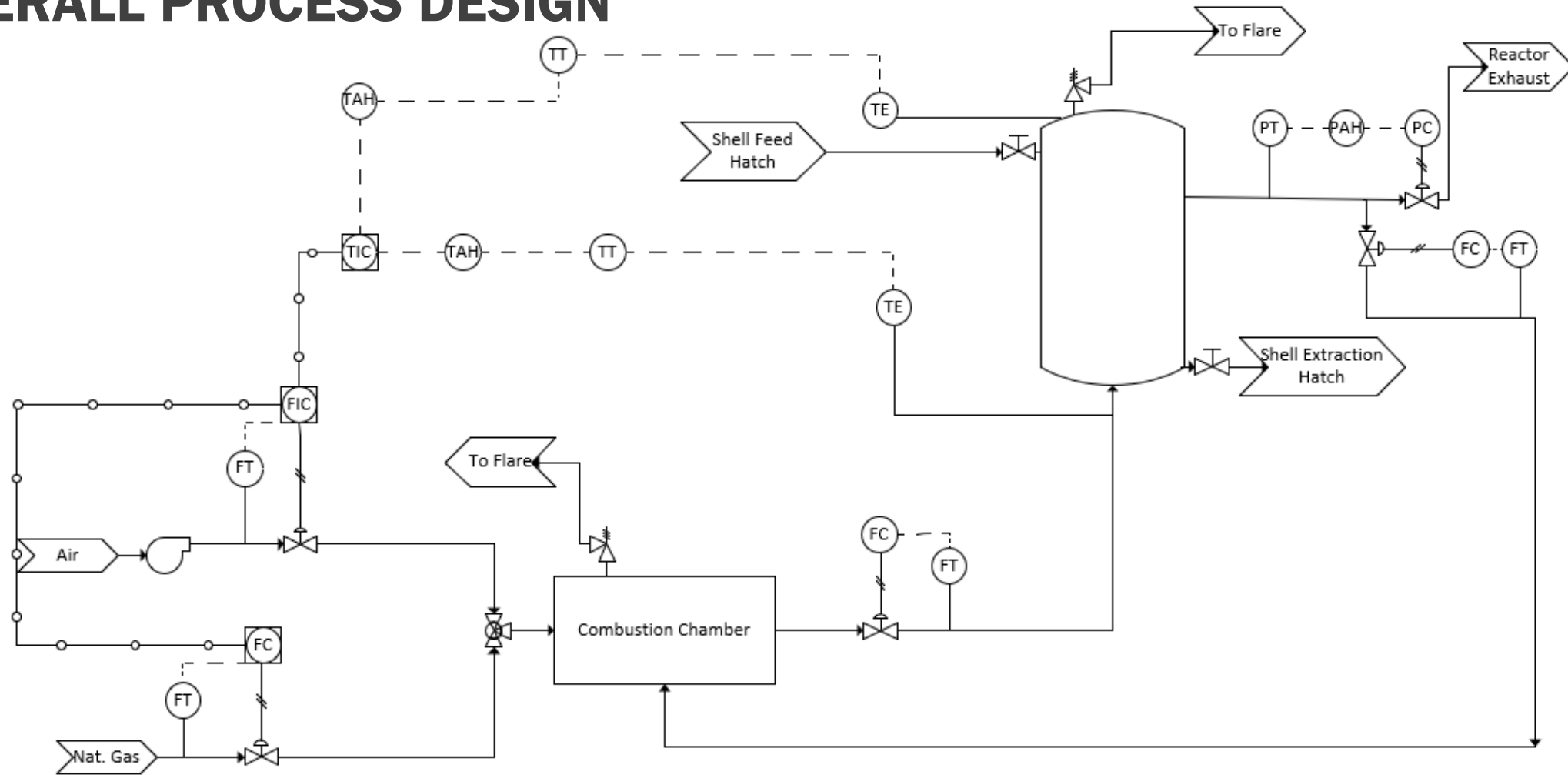
MARKET

- Current price of bulk biochar is $2100-$2800 per US ton
    - Predicted to dip as current prices make it exclusive to high end markets
    - Current bulk shell sale price is about $7.5 per US ton

- Assumed a 7.6% tax rate and 12% interest rate

- Pay back period of 1 season with an end return of 800% after 7 seasons

TECHNICAL DATA

Pyrolysis Data

- Optimal conversion temperature - 500K

- Gas flow rate - 0.25 m/s

- Gas convection - 45 W/m²K (Gnielinski correlation)

- Required conversion for one shell - 20 seconds

Tank sizing

- Length - 2.55 m

- Diameter - 2.55 m

- Volume - 13 m³

- Insulation thickness - 10 cm

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