Evaluation of a flue-cured tobacco bulk barn exhaust air heat recovery system

Justin Macialek and Grant Ellington
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Bio&Ag ENGINEERING

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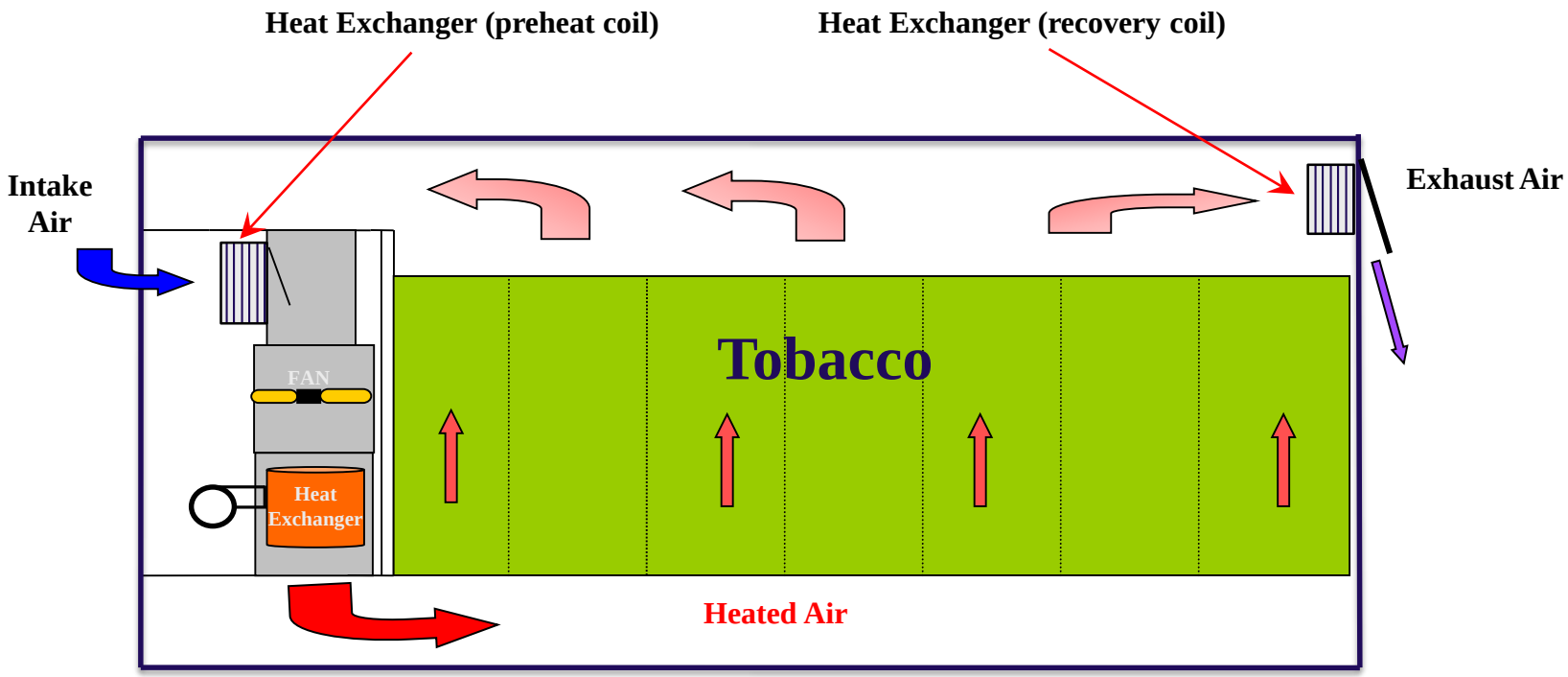
Background

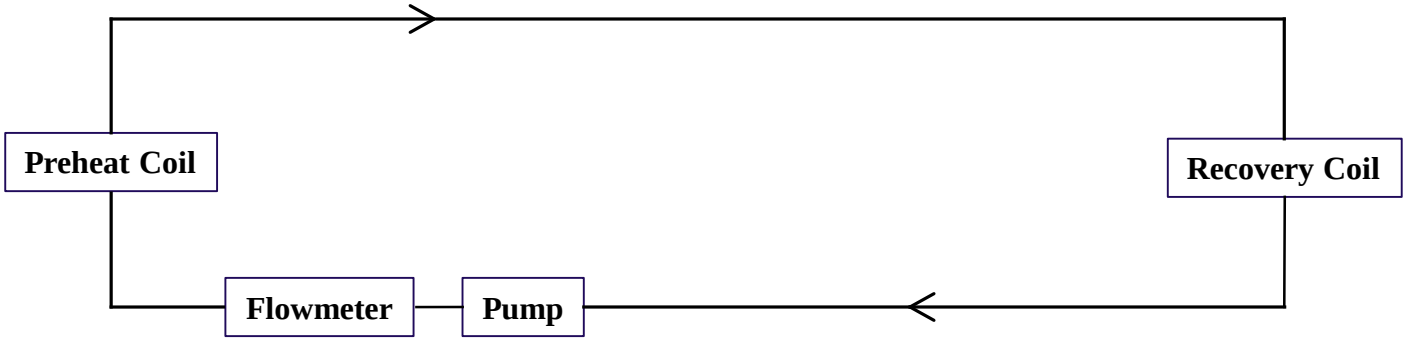
- Energy usage remains a significant input cost
- Substantial price fluctuations of conventional fuels in recent years and continued uncertainty of future prices
- Energy efficiency and energy conservation is the best source of new energy
- Research continues to explore energy efficiency improvements and evaluation of new or existing technologies to reduce energy usage
- Exhaust air heat recovery systems have been utilized on commercial applications for many years to reduce energy costs
- Significant amounts of energy can be recovered from a tobacco barn exhaust air stream
- Concept was utilized with tobacco curing in the 1980s
  - *6 to12% fuel savings*

Background – continued

- Work was initiated in 2014 on an existing DeCloet barn
  - *two identical barns used for comparison*
- Air to water system was used to minimize any structural changes to existing barns
- Commercially available components used and can be installed on any new or existing make barn
- Two on-farm locations utilized – 2015
  - *Total energy footprint (LP gas and kWh usage)*
  - *Coil parameters for water and air stream, inlet and exit temperatures monitored*
  - *Green and cured leaf weights*
  - *Cure duration*
  - *Cured leaf quality*

Heat Recovery System Schematic

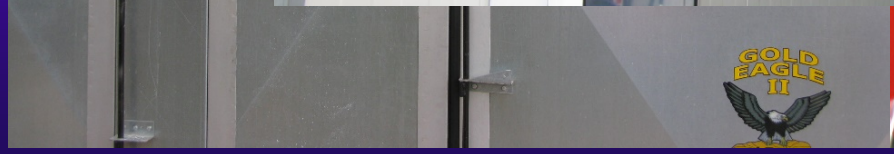




Exhaust Air Heat Recovery System

Exhaust Vent
Heat Exchanger
(recovery coil)

Intake Vent
Heat Exchanger
(preheat coil)



Components

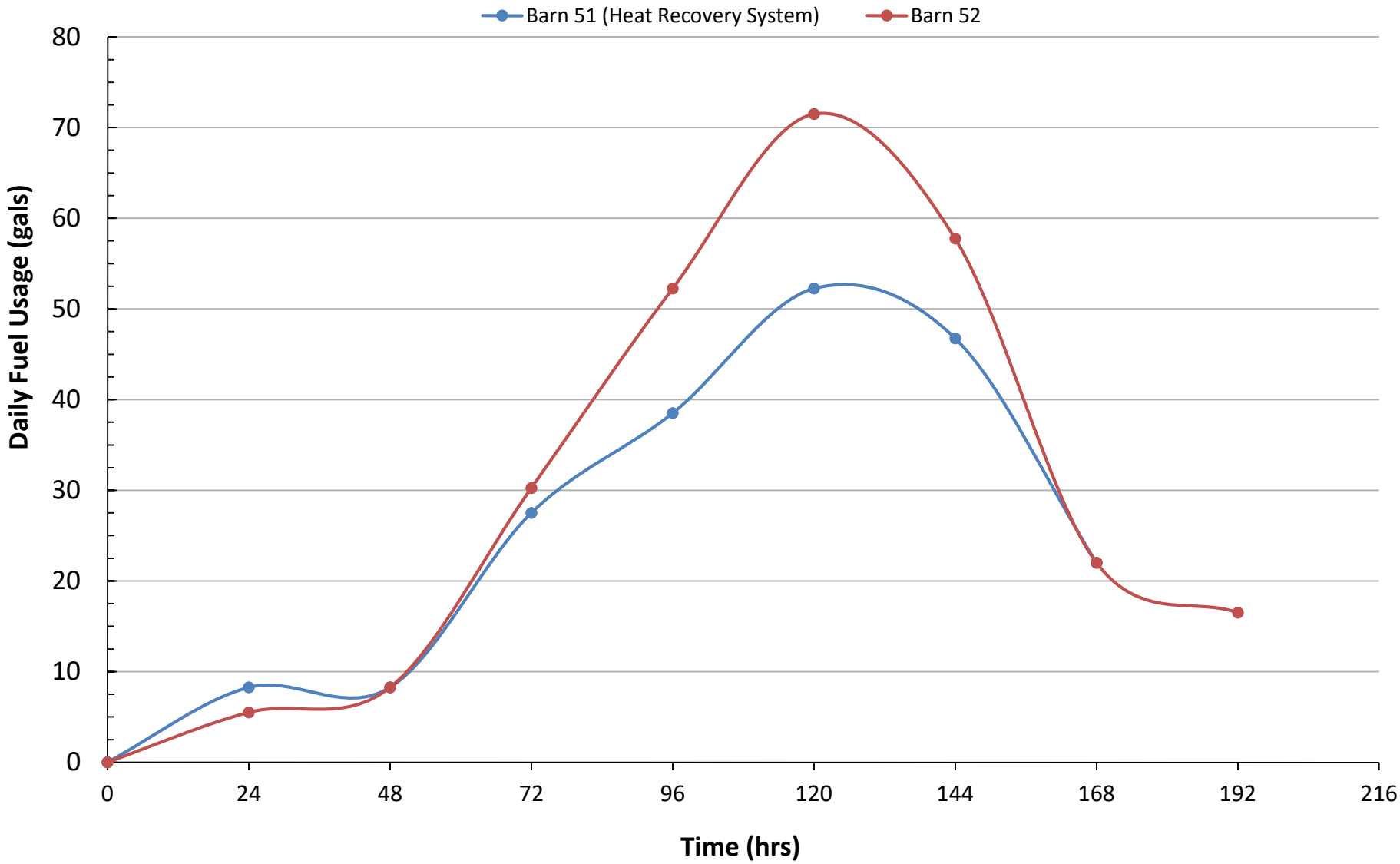
- Piping
  - 2014- 1 inch Pex
    - 13/16 inch i.d.
  - 2015- 1 inch Pex -Al – Pex
    - 1 inch i.d.
- 190 hrs average cure duration
  - 1/20 hp (113W); 21.5 kWh
  - 1/25 hp (91 W); 17 kWh
- Flow rate:
  - 10 gpm 2014
  - 6 gpm 2015

Air Flow Rate

	Leaf Drying Intake Air Flow Rate (cfm)
Barn 52, DeCloet	3,027
Barn 51, DeCloet, 14 fins per inch	1,401
Barn 29, DeCloet, 10 fins per inch	2,016
Barn 35, Long, 14 fins per inch	2,508

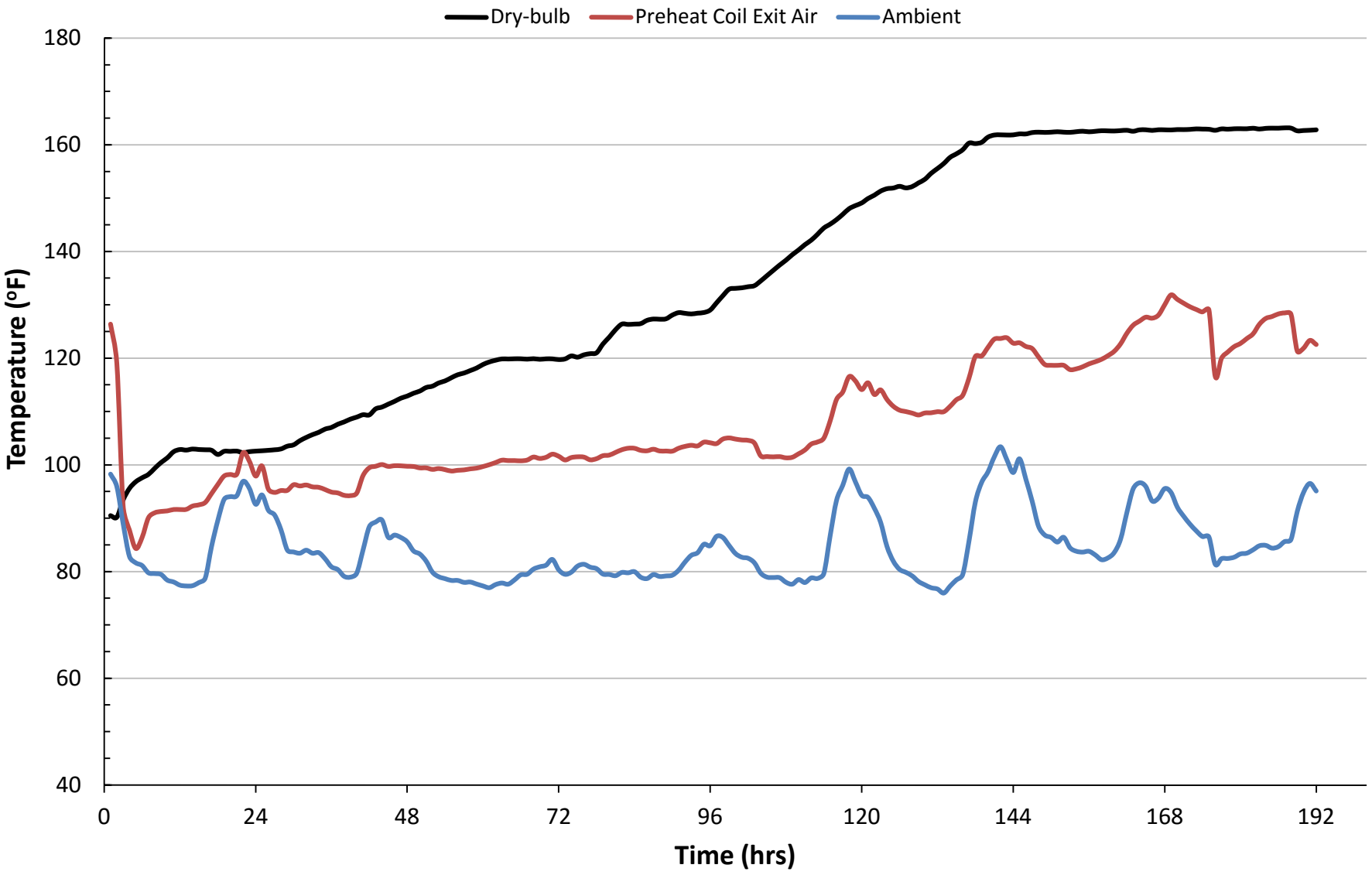
Cure 7 Daily Fuel Usage Comparison

(60 gallon difference)



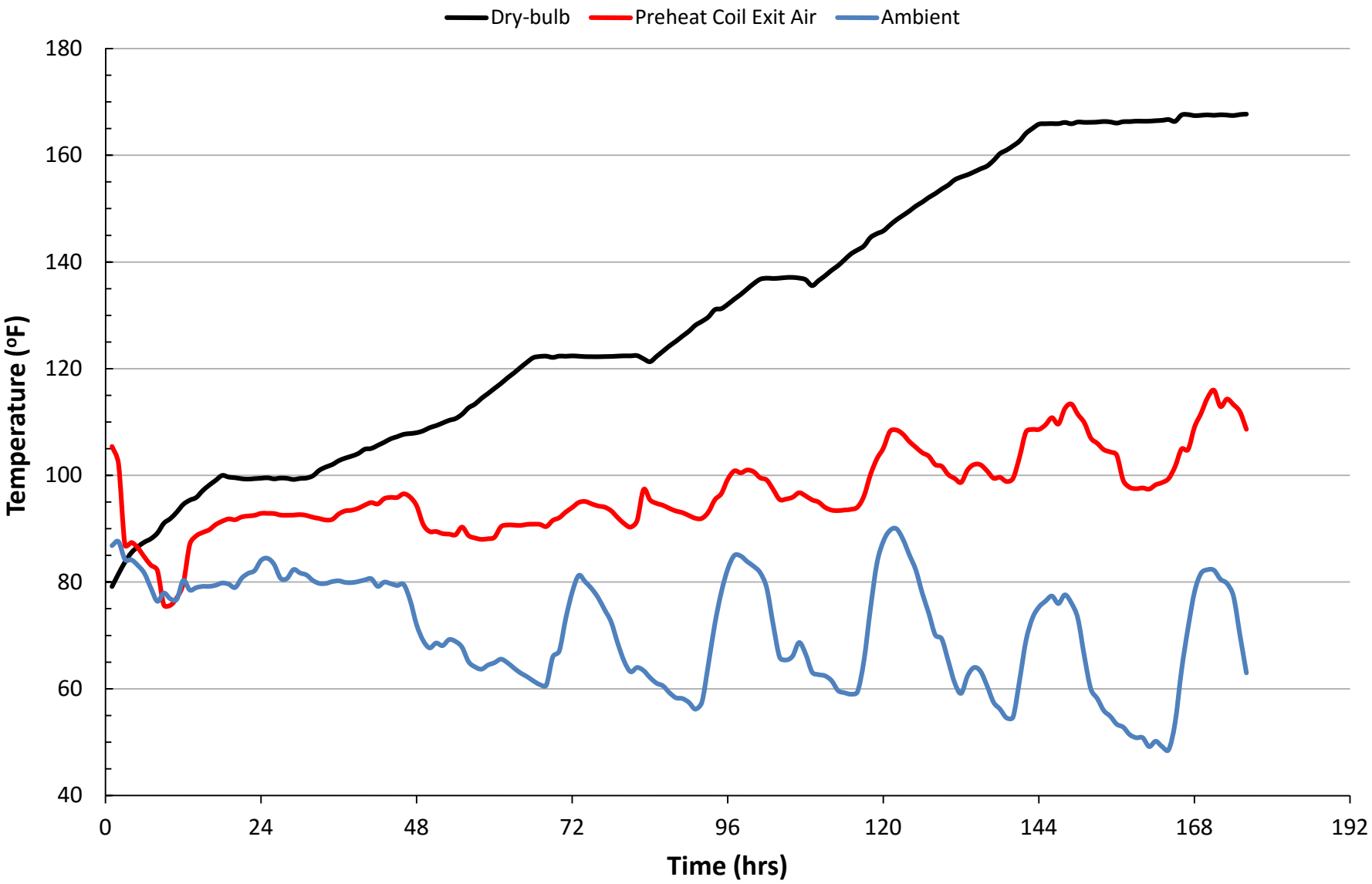
Preheat Coil Inlet and Exit Air Temperature Profiles

(Cure 6, 2014)



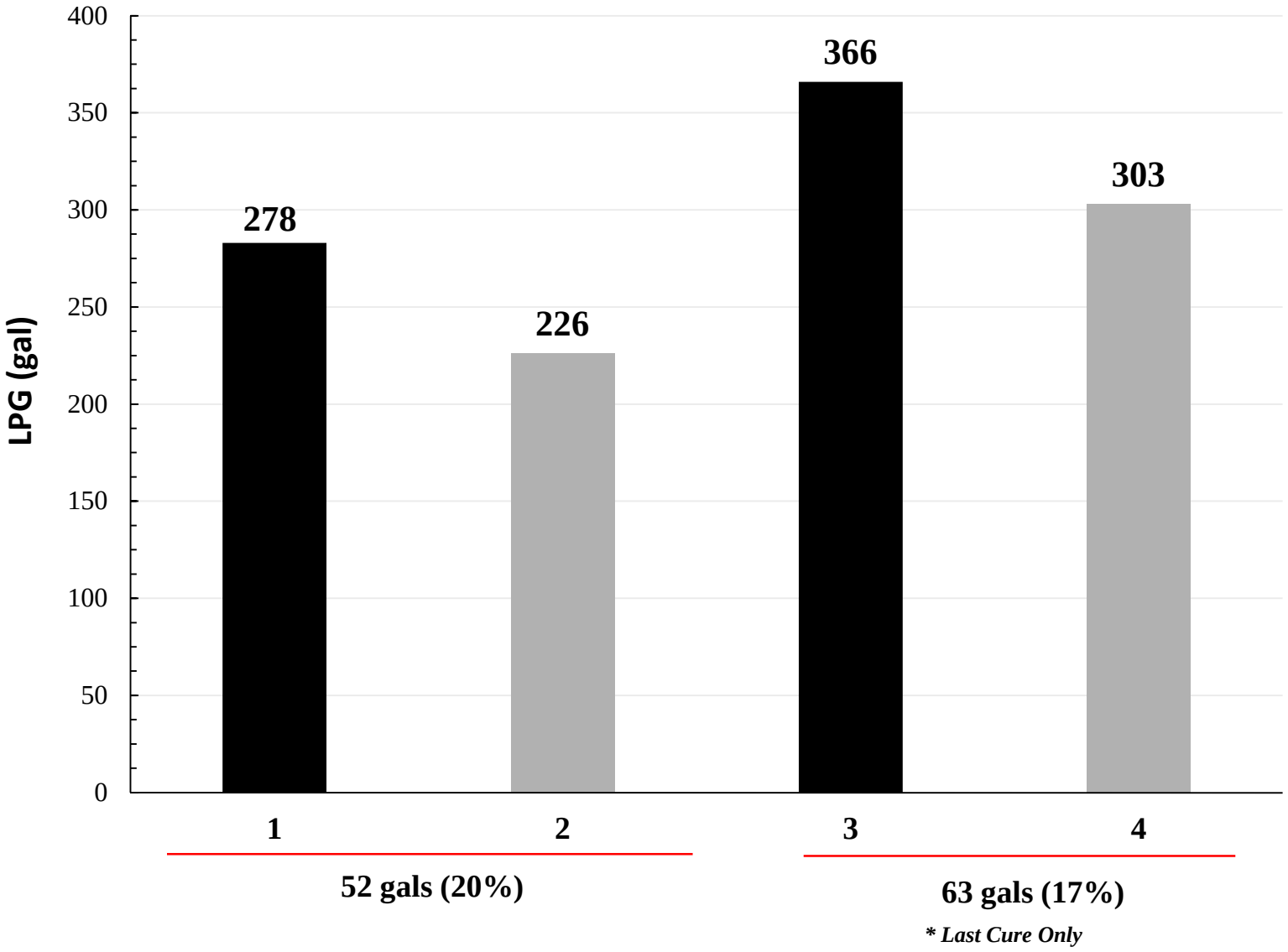
Preheat Coil Inlet and Exit Air Temperature Profiles

(Cure 10, 2014)



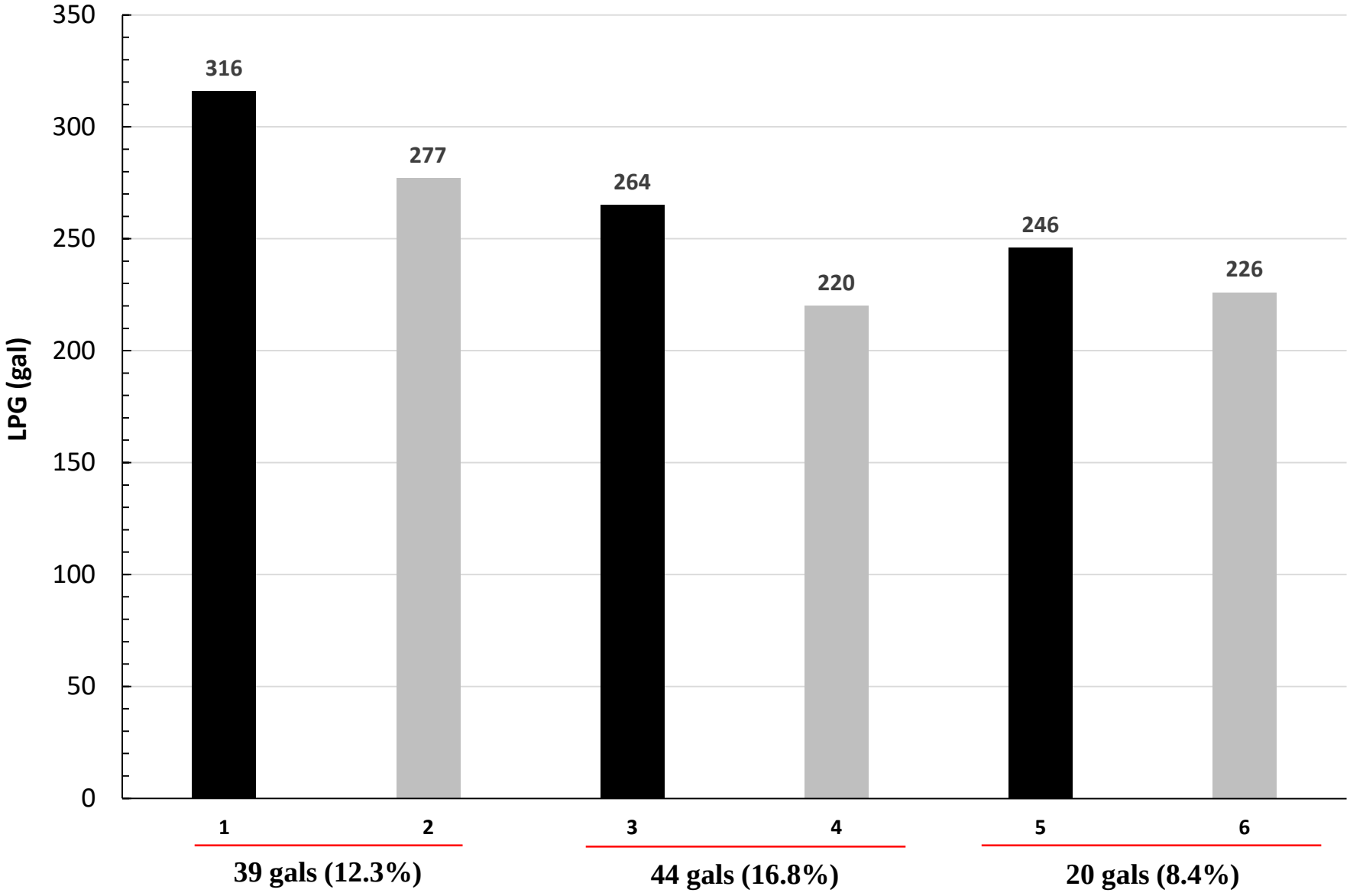
Exhaust Air Heat Recovery System Average Fuel Savings – 2014

Johnston County Location (*DeCloet* Barns – 10 Cures; *Long* Barns – 1 Cure)



Exhaust Air Heat Recovery System Average Fuel Savings – 2015

(*DeCloet* – 6 Cures; *Long* – 4 Cures; *New DeCloet* – 3 Cures)



System Component Cost

Item	Cost
Preheat coil	$432
Recovery coil	$638
Pump (1/20 hp)	$82
1 inch Pex-Al-Pex (80ft)	$92
Shipping and fees	$99
Filter	$43
Expansion Tank	$30
Pressure gage	$10
Fittings	$90
Air scoop	$18
Air vent	$8
Shut off valves	$38
Mounting Hardware	$30
Total	**$1,609**

Heat Recovery System Summary

- Fuel savings averaged over the 2015 season for both barn makes at the Johnston location was approximately 15% (40 gal) per cure
  - *savings varied 30 to 58 gallons per cure*
  - *typical heat recovered from exhaust air varied 10,000 to 38,000 Btu/hr per cure*
- Minimal management
- Curing time was not extended
- Cured leaf was darker in the *DeCloet* barn with system
- System cost is approximately $1800 installed
- Simple payback at 15% fuel savings is approximately 5 to 6 years
  - *2015 prices, 8 cures per season*
- Plan to continue work in 2016
  - *add more barns with tube-axial fan configuration*
  - *optimize system parameters (flowrate, coil design)*
  - *evaluate maintenance requirements and equipment longevity*

Acknowledgements

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Questions?