Solar Thermal Energy for Biodiesel Process Heating

Donny Cagle

Wind Energy Program Coordinator

Clarendon College

Clarendon, Texas

ASES 2010

Problem

To offset the use of electricity associated with the process heating requirements of biodiesel.

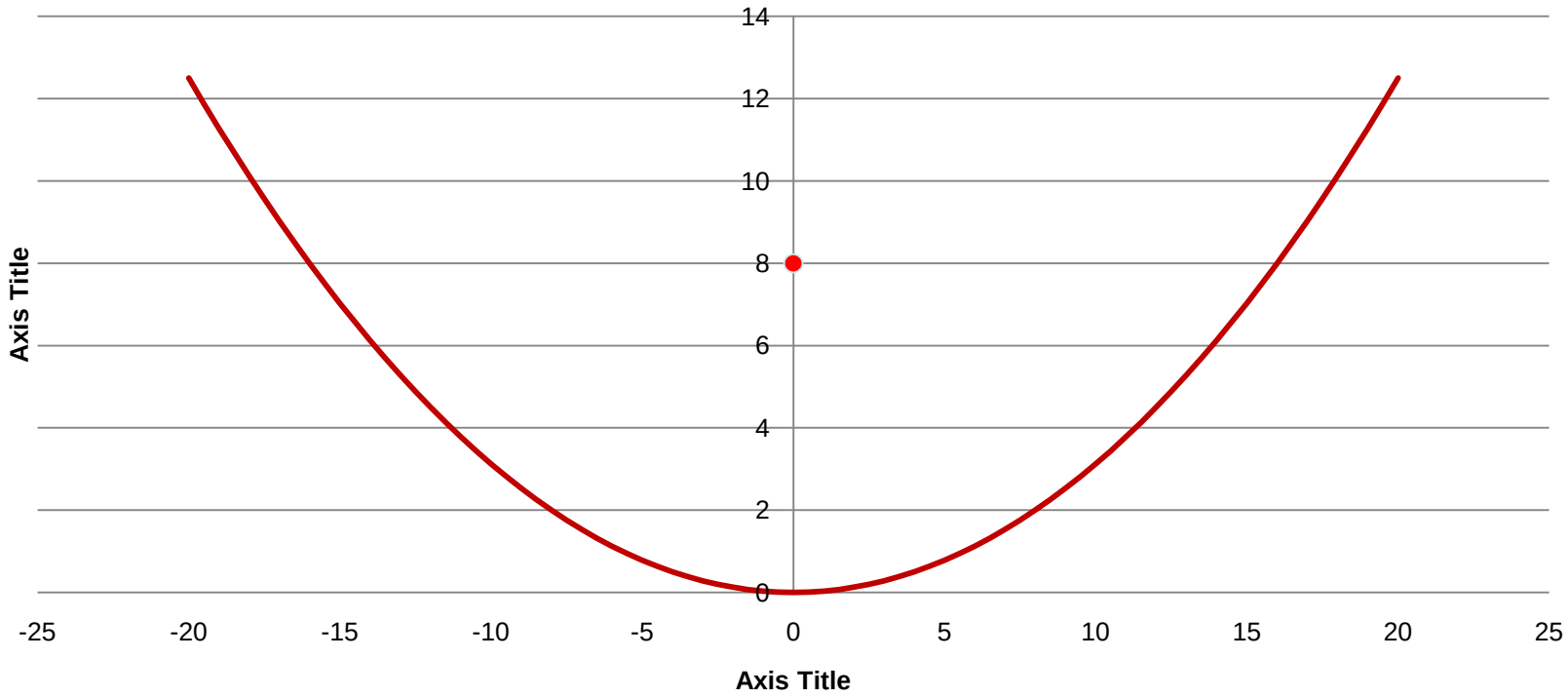
Experimental Design

- Measure performance using electrical resistive heat as primary energy source for heating waste vegetable oil (WVO) and biodiesel
- Substitute solar collector as the primary energy source for heating WVO and biodiesel
- Collect energy and temperature data for comparison

Parabola

Arc length = 48.8 in
P = 8 in

Y = x^2/4P



Parabolic Trough Dimensions

Mirror Length: 2.14 m

Mirror Width: 1.02 m

Area of Incidence: 2.18 m^2

Parabolic Trough

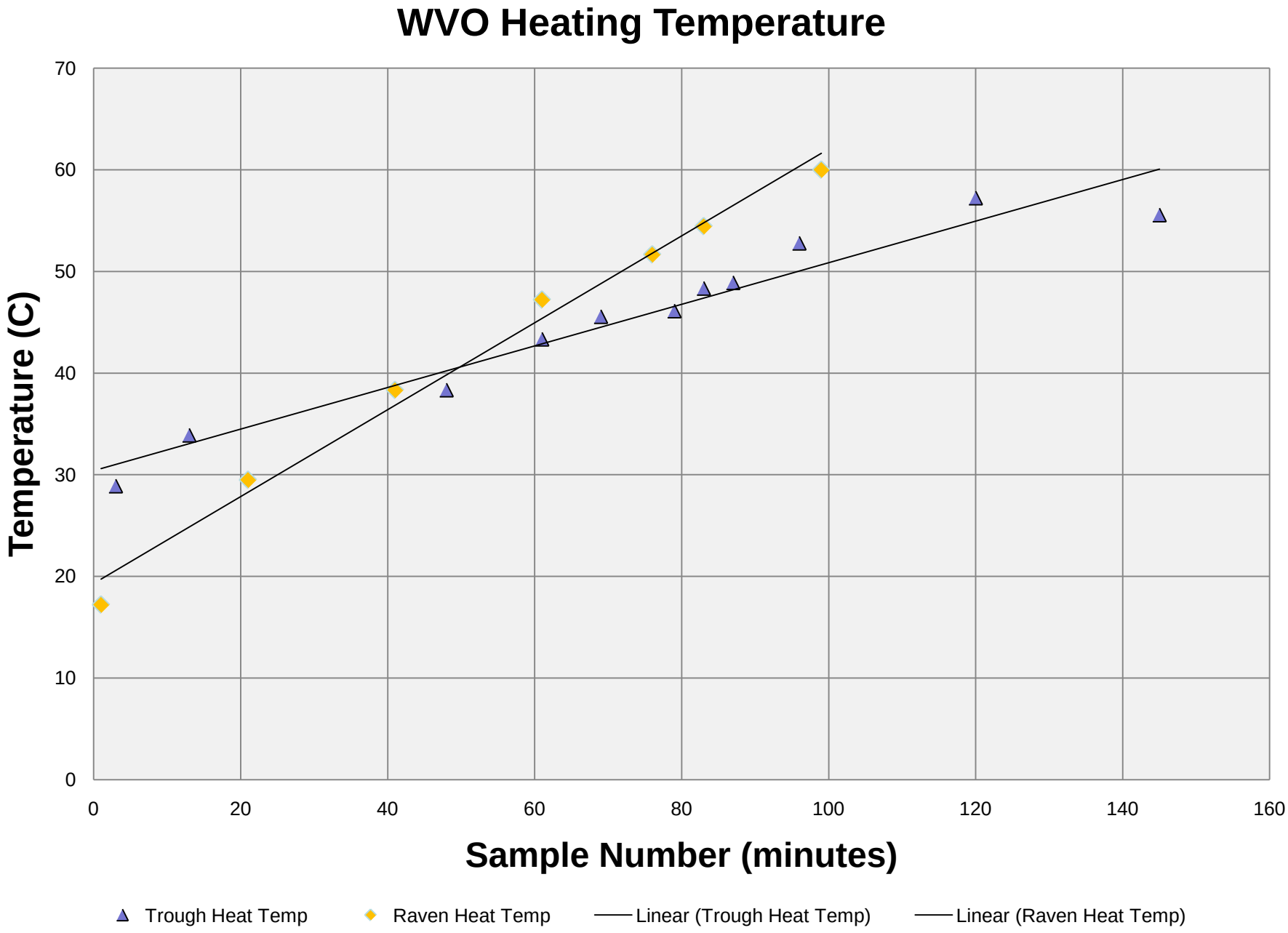
Formica Backing

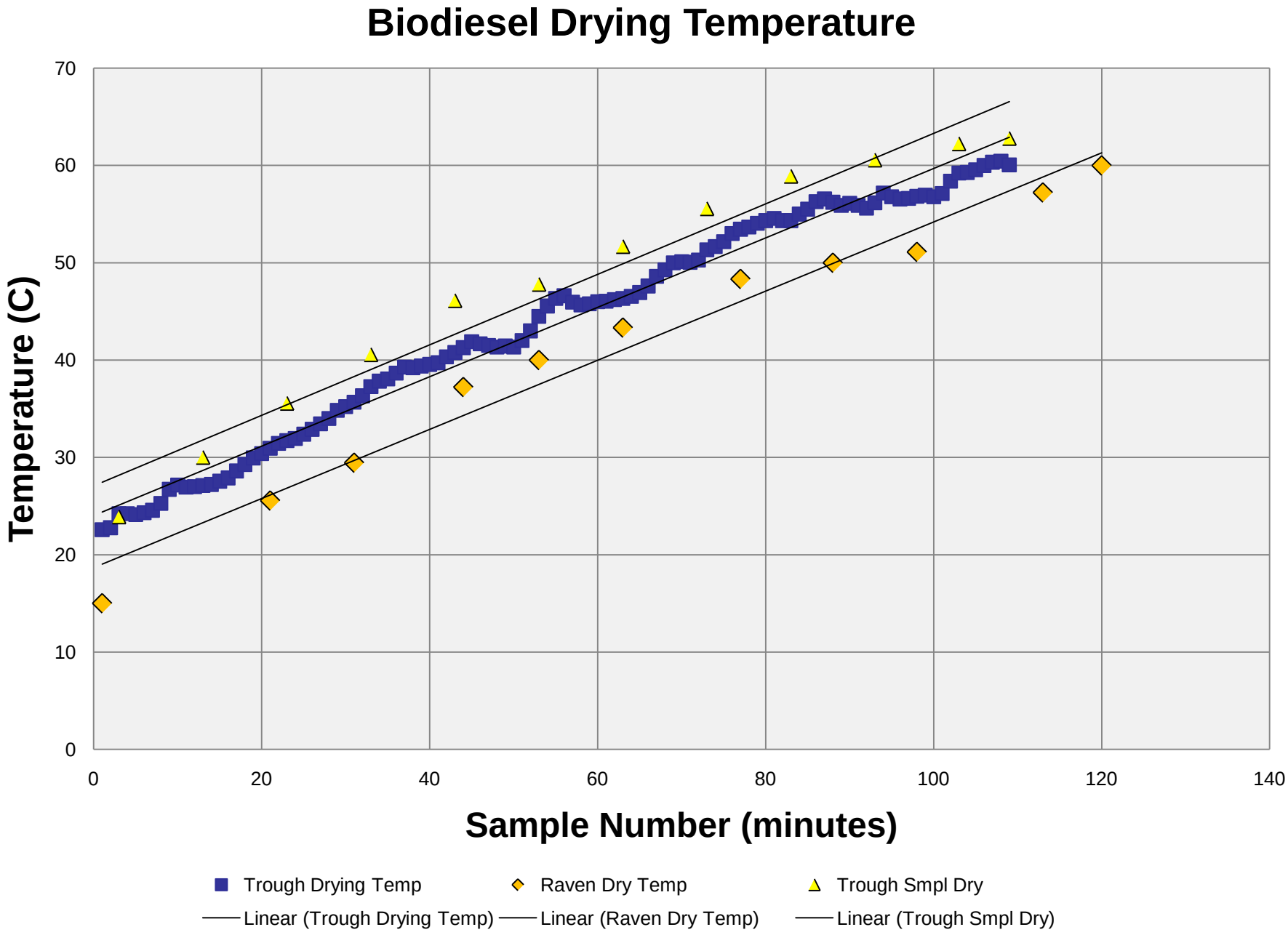
Carnival Mirror

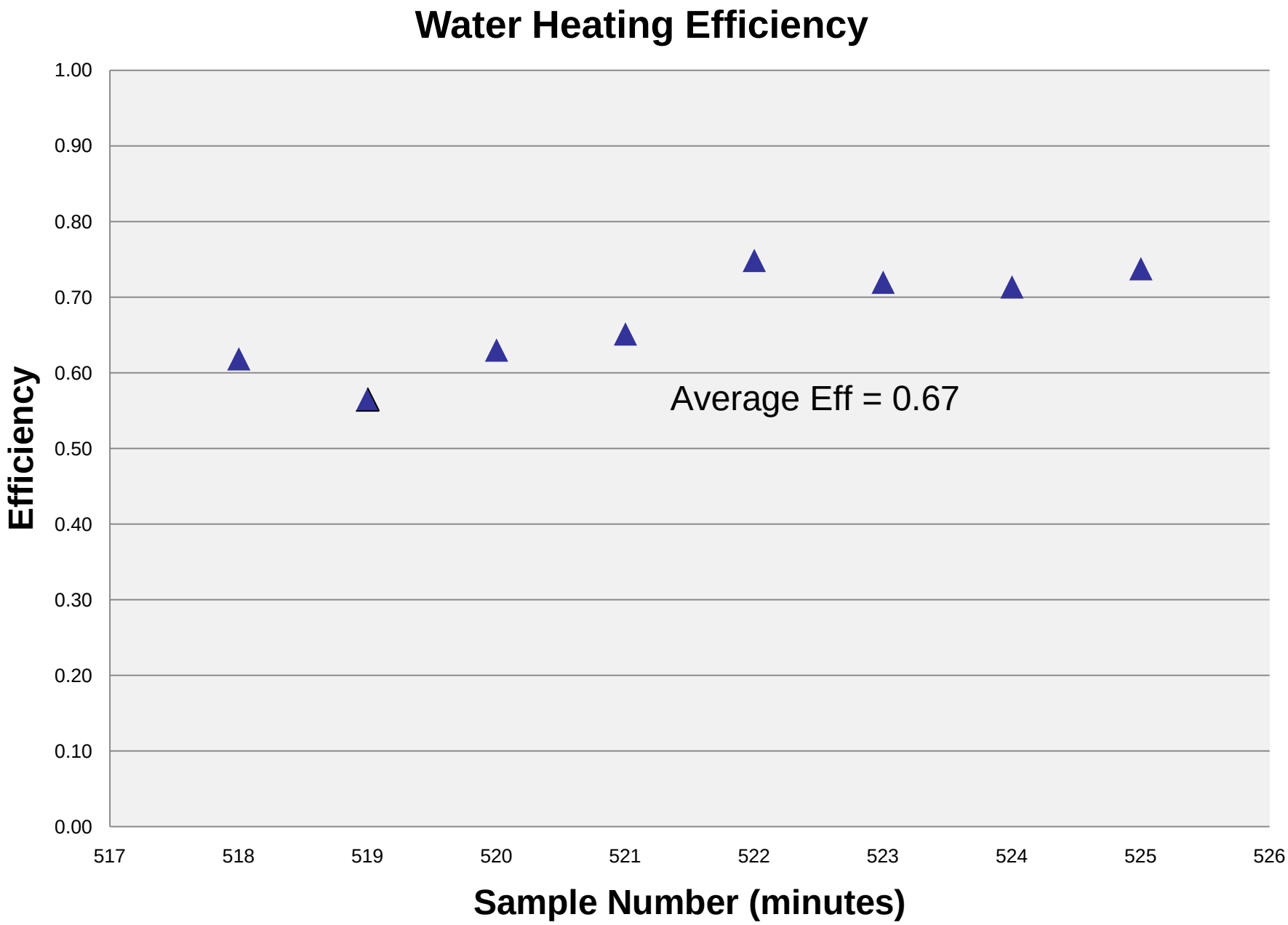
Biodiesel Batch Processor

Trough and Processor in Series

Trough in Series


WVO Heating Temperature
Temperature (C)
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
160
Sample Number (minutes)
Trough Heat Temp
Raven Heat Temp
Linear (Trough Heat Temp)
Linear (Raven Heat Temp)


Biodiesel Drying Temperature
Temperature (C)
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Sample Number (minutes)
Trough Drying Temp
Raven Dry Temp
Trough Smpl Dry
Linear (Trough Drying Temp)
Linear (Raven Dry Temp)
Linear (Trough Smpl Dry)


Water Heating Efficiency
Efficiency
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Average Eff = 0.67
517
518
519
520
521
522
523
524
525
526
Sample Number (minutes)

Conclusion

- The parabolic trough converted enough energy to heat waste vegetable oil for a 24 gallon biodiesel process.
- Measured performance data indicated an average trough efficiency of 67%. This means that with a tracking system and a peak solar irradiance of 1000 watts per square meter, a 2.18 m^2 trough would have a power rating of ~1.46 kW.

Conclusions

- Given the lower operating temperature used for this study in the range of 54-60 ◦ C (130 -140 ◦ F), concentrated solar power could be a feasible addition to other production processes as well.

- Further investigation should be conducted with regards to:
  - Specific Heat
  - DNI

Thanks You!!!