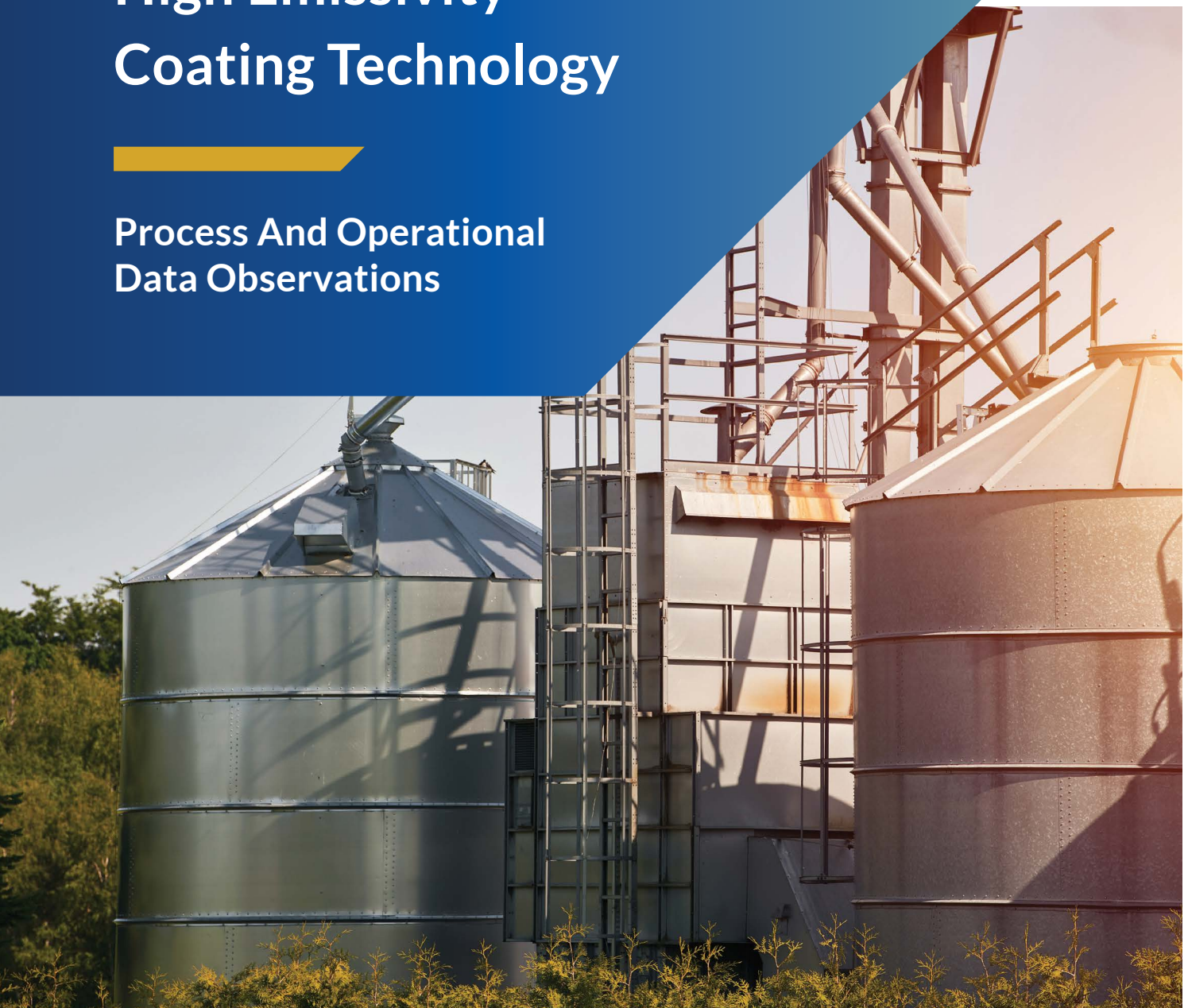




Application Of Emissshield High Emissivity Coating Technology

Process And Operational
Data Observations



Project Overview

Guardian Energy Lima (GEL), owns and operates an ethanol production facility in Lima, Ohio. GEL contracted Chase Nedrow Industries to install Emisshield High Emissivity Coating Technology on thermal process equipment operated at the facility.

Technology Summary

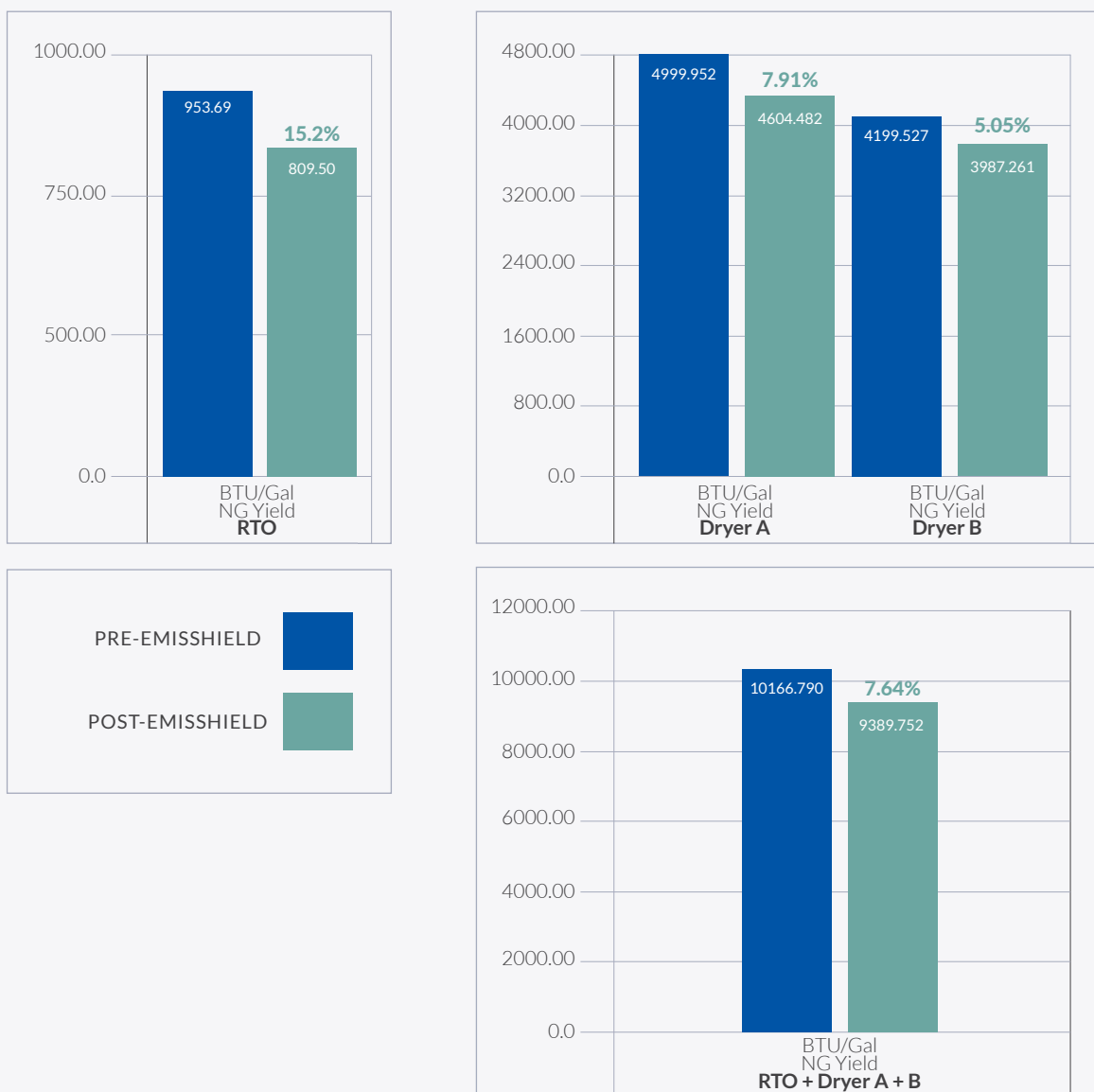
Emisshield® is a NASA licensed, high emissivity coating technology that has demonstrated the ability to increase heat transfer and improved energy usage, while increasing production in nearly all heat driven industrial applications. Emisshield® Systems are ceramic nanoparticle materials with high emissivity and heat re-radiation capabilities extending over a wide temperature range of up to 3100°F. Emissivity is the ability of a surface to emit heat as radiation, or thermal energy. Emisshield® increases the emissivity of a surface, which allows for the absorption and re-radiation of energy more efficiently, reducing the amount of energy that penetrates the substrate, keeping the shell cooler and the Unit running at maximum efficiency. Emisshield® can be applied to thermal oxidizers (TOs), regenerative thermal oxidizers (RTOs), boilers, and dryers.

Emisshield Hect Application

GEL contracted with Chase Nedrow Industries to install Emisshield HECT in two natural gas fired dryers, and one natural gas fired RTO. Over the course of November 17-18, 2022, Emisshield HECT was applied to the RTO burner cone, ceramic fiber modules on the side walls and ceiling, and door. Emisshield HECT was also applied to each of the dryers' burner tiles, combustion chamber, including the upper and lower transition, and to the hot face of the dryer doors.

Emisshield Hect Application

Upon startup post-coating GEL operators noticed significant process improvements. Facility personnel believe that due to the application of Emisshield HECT, GEL was able to improve operational productivity. Operational data was analyzed for a comprehensive period of operation pre-Emisshield HECT application occurring from February 25, 2022, through November 11, 2022. This data was compared against operational data obtained post-Emisshield HECT application occurring from November 27, 2022, through January 12, 2023. Postapplication data occurring beyond January 13 was not included within this analysis, as cellulase was introduced into the fermentation process. Data from November through January more accurately demonstrates the direct impact of Emisshield HECT.



Data tables detailing the production and operational observations are attached. The following operational and process improvements were observed:

- The natural gas combustion rate (measured in MMBtu/hr) decreased in all coated units. Overall natural gas combustion of all units combined (RTO, Dryer A, and Dryer B) decreased 0.33% post-Emisshield application (with observed higher DDGS throughput rates), when compared to pre-Emisshield operation.
- Natural gas yield (measured in Btu/gal) has improved, meaning less natural gas is being combusted to produce one gallon of ethanol. Overall, the natural gas yield decreased 7.64% post-Emisshield application, when compared to pre-Emisshield operation.

- Other operational improvements allowed for an increase in ethanol production which can be further capitalized with the improved capacity gained in the dryers recognized with the application of Emisshield HECT. GEL observed an increase in approximately 45 tons per day of DDGS, when compared to pre-Emisshield operation.
- Post-Emisshield testing conducted on March 1, 2023, preliminary (pending OEPA approval) shows Volatile Organic Compound (VOC) destruction efficiency increased to 97.88%. This is compared to engineering testing conducted on November 8, 2022, pre-Emisshield application, using the same EPA approved methodologies, which demonstrated a VOC destruction efficiency of 95.45%
- Temperature improvements were observed in all equipment. Dryer A and B inlet temperatures decreased post-Emisshield application, and RTO outlet temperature decreased. RTO combustion chamber temperature increased with the use of less natural gas combustion, which could be a contributor to the increase in destruction efficiency. Furthermore, pre- and post-thermographic inspection data of the RTO indicates lower shell temperature after Emisshield HECT application.



Conclusion



Preliminary process data observed post installation of Emisshield HECT shows favorable operational benefits. Energy efficiency improvements and ethanol production gains are evident in data presented post coating. Benefits will vary based on the thermal processes coated.

Data Tables

	RTO		Dryer A	Dryer B
	RTO TEMP °F	RTO OUT TEMP °F	Dryer A Inlet Temp °F	Dryer B Inlet Temp °F
Pre-Emisshield	1629.74	374.32	993.39	889.23
Post-Emisshield	1637.85	372.41	900.55	870.57
% Reduction		0.51%	9.35%	2.10%

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	RTO		Dryer A	
	NG Consumption MMBtu/day	NG Yield Btu/Gal	NG Consumption MMBTU/day	NG Yield BTU/gal
Pre-Emisshield	198.06	953.69	1059.484	4999.952
Post-Emisshield	184.25	809.50	1049.472	4604.482
% Reduction	6.97%	 15.12%	0.94%	 7.91%

	Dryer B		RTO + Dryer A + B	
	NG Consumption MMBtu/day	NG Yield Btu/Gal	NG Consumption MMBTU/day	NG Yield BTU/gal
Pre-Emisshield	890.415	4199.527	2147.96	10166.790
Post-Emisshield	907.043	3987.261	2140.77	9389.752
% Reduction	-1.87%	 5.05%	0.33%	 7.64%