FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

An Integrated Process Review of Chemical Oxygen Demand (COD) Sources from Thermally Treated biomass Pellets and their Release into Runoff

Quantifying the issue and outlining pathways to minimize the cost of treatment

April 2026

Principal Author: Laurenz Schmidt

FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

Table of Content

Contents

FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

List of Tables, Figures, and Equations

Glossary

BOD	Biochemical Oxygen Demand	mg/L
CAPEX	Capital Expenditures	
CENER	National Renewable Energy Center of Spain	
Cl^-	Chlorine Ion	
CO	Carbon monoxide	
CO2	Carbon dioxide	
CO_3^{--}	Carbonate Ion	
COD	Chemical Oxygen Demand	mg/L
d.b.	dry base (for moisture calculation)	
DOC	Dissolved Organic Carbon	
ECN	Energy Research Center of the Netherlands	
EFB	Empty Fruit Bunches from palm oil production	
EPA300	EPA method for chromatographic measurements of anions and cations in water	
ET_0	Actual Evapotranspiration (Penman-Monteith)	

FAO	Food and Agriculture Organization with water standards)
FIFO	First IN- First OUT
FOG	Fats, Oils, Greases
GAC	Granulated Activated Carbon
Hach 8000	Dichromate-based spectrophotometric COD determination
HCO_3^-	Bicarbonate Ion
HMF	Hydroxymethylfurfural
HW	Hot water treated biomass fibers, then pelletized (typ. 210°C)
IEA	International Energy Agency
LIFO	Last IN - First OUT
MBBR	Moving Bed Bio Reactor
OH^-	Hydroxyl Radical
OPEX	Operations Expenses
Ozone:AOP	Ozone: Advanced Oxidation Processes (H_2O_2, UV)
PET	Potential Evapotranspiration(Thornthwaite)
pH	Measurement of acidity and alkalinity
PSA	Pressure Swing Absorption (oxygen generation)
SBR	Sequencing Bio Reactor
SE Pellets	Pellets made from Steam-exploded biomass fibers
SECTOR Deliverable 6.7	EU-funded Report on Production of Solid Sustainable Energy Carriers
SEW	SE pellets from biomass that was washed after SE
$SUVA_{254}$	Specific UV Absorption at 254 nm wavelength = UV_{A254}/DOC
TAP	White pellets that were torrefied after pellet formation
TBP	Pellets made from torrefied biomass fibers
TOC	Total Organic Carbon
TSS	Total Suspended Solids
UmU	University of Umeå
UVA_{254}	UV Absorption at 254 nm wavelength
VOC	Volatile Organic Compounds

FutureMetrics™ LLC
8 Airport Road
Bethel, ME 04217, USA

1 Introduction

Over the past several years, the issue of COD in runoff from open-air storage piles of so-called "black" pellets has gained increasing importance and scrutiny. The matter is of great importance in areas with high sensitivity to water pollution and the well-being of marine life. The early developers of torrefaction and steam treatment technologies initially treated the problem as a lower-tier issue.

All of them have realized that it is a first-order problem that needs to be addressed if a coal substitute in the form of black pellets is to achieve a higher adoption rate.

FutureMetrics conducted a study and offers our findings in a high-level engineering report structure for a COD-targeted pellet runoff assessment that regulators, engineers, and project developers can use. It reflects the reality that different black pellet technologies produce different COD signatures, and that meteorology, storage design, and treatment strategy determine the economics of the final solution.

The structure follows a logic chain used in environmental engineering studies:

Pellet type → COD generation → site conditions → runoff formation → treatment options → techno-economic optimization.

FutureMetrics observed that the issue of COD in runoff from black pellet piles remains insufficiently addressed. Specifically, variations among pellet types and factors such as weather conditions, water penetration into the pile, the chemistry of COD-causing substances, pile management, treatment options, and fuel type selection warrant a comprehensive review, as many variables interact.

This report discusses these variables and aims to assist decision-makers in the pellet manufacturing industry to determine the feasibility of a project, narrow the choices, and to design targeted tests tailored to their specific situation. The results of these tests enable cost-optimized decisions about fuel selection, pile management, and runoff treatment to support full compliance with local regulations. The combination of these activities leads to a substantial derisking of the budget and schedule for any planned project.

The report is, in many ways, the first of its kind in terms of practical application to the emerging black pellet sector.

This report does not provide a "silver bullet" to solve all COD issues uniformly but informs the reader what to look for and how to consider the variables in their decision process.

We show experimentally verified data from various fuel types and suppliers and illustrate how to approach the selection of the appropriate treatment process.

The information provided is a generic guideline, not a specific set of instructions for solving a specific project's challenges. Each project's fuel mix, fuel yard design, local precipitation and temperature parameters, generation profiles, and other critical variables will contribute to the determination of the best and most cost-effective solution for meeting regulatory requirements.

1.1 New Research and Analysis

- Assessment of COD generation from different pellet types
- Key findings on COD release behavior
- Summary of recommended management and treatment strategy
- Estimated cost range for the suitable solution(s)

1.2 Output

- COD release ranges (mg/L, kg/t of pellets, and kg/month for given pellet piles)
- COD sensitivity to pellet mix in the pile
- Required treatment capacity
- Recommended treatment pathway