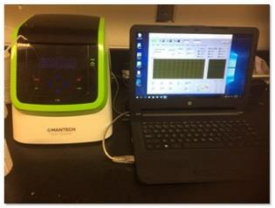

Development and Application of Oxygen Demand Testing using Industrial Effluent

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ABSTRACT

The purpose of this study is to develop capacity and protocols for oxygen demand testing that can be used for instruction and research within the BioScience Technology program.

For application purposes we chose the PeCOD® system that offers a unique nanotechnology-based approach to COD analysis.

BACKGROUND

The Canadian Water Quality Guidelines[1] have certain parameters for the quality of water.

- Dissolved Oxygen (DO) is the most fundamental parameter of water, essential to the metabolism of all aquatic aerobes
- DO content in water is a balance between input of oxygen and consumptive metabolism of these organisms
- Human factors influence this consumptive demand with organic waste and effluent as significant contributors
- Depletion of DO due to this consumption is an indicator of wastewater treatment requirements as lack of oxygen rather than an excess causes adverse effects in freshwater systems
- Chemical Oxygen Demand (COD) is a general indicator of water quality by measuring the amount of organics in water
- Biological Oxygen Demand (BOD) is a measure of the portion of total carbon oxidized (consumed) by aerobic microorganisms

There are different methods to determine oxygen demand

- COD is a measure of the amount of oxygen required to chemically oxidize reduced minerals and organic matter of a sample
- BOD is a standard microbial incubation procedure to measure the oxygen required to oxidize organic material and certain inorganics
- In Saskatchewan, a wastewater secondary treatment process must produce effluent with no more than 30 mg/L of BOD5[2]

Different methods available for testing include:

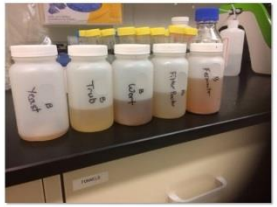
- Standard Method BOD (BOD5 – 5 day test) a century old method
- Envolure Enverdi BOD test kit (48 hr) determines BOD of samples directly based on tracking a fluorescent redox indicator to measure consumptive demand in a 96-well plate format
- Standard Method COD (2 hours) a 60 year old test that requires dichromate, mercury and acid chemicals
- Mantech PeCOD (15 minutes)
- The PeCOD[3] instrument is a water quality monitoring system that is easily operated and does not require additional methods
- Works by photocatalytic oxidation and UV-illuminated TiO2
- A strong correlation between PeCOD COD and BOD is possible
- PeCOD can essentially monitor in 'real-time', which is beneficial for in stream testing at industry locations

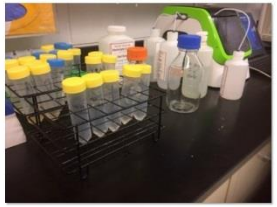
OBJECTIVES

- Determine method to use for oxygen demand testing
- Develop methods and protocols for oxygen demand testing
- Utilize the PeCOD method as it is safe, green and fast
- Use PeCOD to add a resource and skill set within the BioScience program
- Apply PeCOD to various brewery effluents for COD analysis with future goal of organics monitoring and reduction
- Apply practices to breweries that produce a significant amount of wastewater very high in organics and are subject to municipal surcharges (300 mg/L is a common discharge limit for industrial wastewater)

EXPERIMENT

- Received online training on the PeCOD instrument and protocol
- Calibrated instrument with standards for optimal results
- Obtained brewery samples for preparation and testing
- Optimized process for samples, lab and equipment
- Determined the COD in different stages of brewery waste
- Compared values with known standards and QC checks
- Determined if different preparations of effluent give equivalent results (all samples were filtered to remove solids and particulates, producing distinct sample effluent fractions)
- For brewery samples a PeCOD COD multiplier of 0.55 has been demonstrated to give a BOD reading comparable to BOD5[4]





- Materials and PeCOD instrumentation for sample analysis

RESULTS – CHEMICAL OXYGEN DEMAND (mg/L)

Sample	Wort	Fermenter	Yeast	Trub	Filter Powder
Dilution / Replicate	1/50	1/50	1/50	1/50	1/10
1	3298.36	3222.25	4388.94	2371.51	2062.61
2	3372.04	3227.45	4362.27	2407.41	2118.62
3	3301.04	3059.35	4385.47	2361.07	1968.97
4	3278.57	3039.52	4410.10	2413.68	2117.05
Average	**3312.50**	**3137.14**	**4386.69**	**2388.42**	**2066.81**
Actual COD (mg/L)	**165625**	**156857**	**219334**	**119421**	**20668**
Estimated BOD[4] (mg/L)	**91093**	**86271**	**120633**	**65681**	**11367**

- The data shows that the yeast effluent sample has the highest average COD and corresponding BOD estimate
- The Fermenter and Wort effluent samples have similar COD reading and the Trub effluent has a lower COD
- The Filter Powder effluent sample has the lowest COD (only a 1/10 dilution required to analyze)
- The results of the experiment show differences within the various brewery waste samples that can be accurately replicated

CONCLUSIONS

- Experiment objectives achieved, further research into COD and BOD in the future including sample correlation to actual BOD
- PeCOD is an acceptable and rapid method for testing COD in water and waste samples
- BOD can be determined from the PeCOD data with a multiplier
- The PeCOD instrument is a potential resource for teaching and research purposes within the BioScience Technology program.
- There is opportunity to apply this technology for measurement of effluent/wastewater using COD and BOD in the wider community

REFERENCES

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