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Brewery Wastewater: Solutions for the Problem



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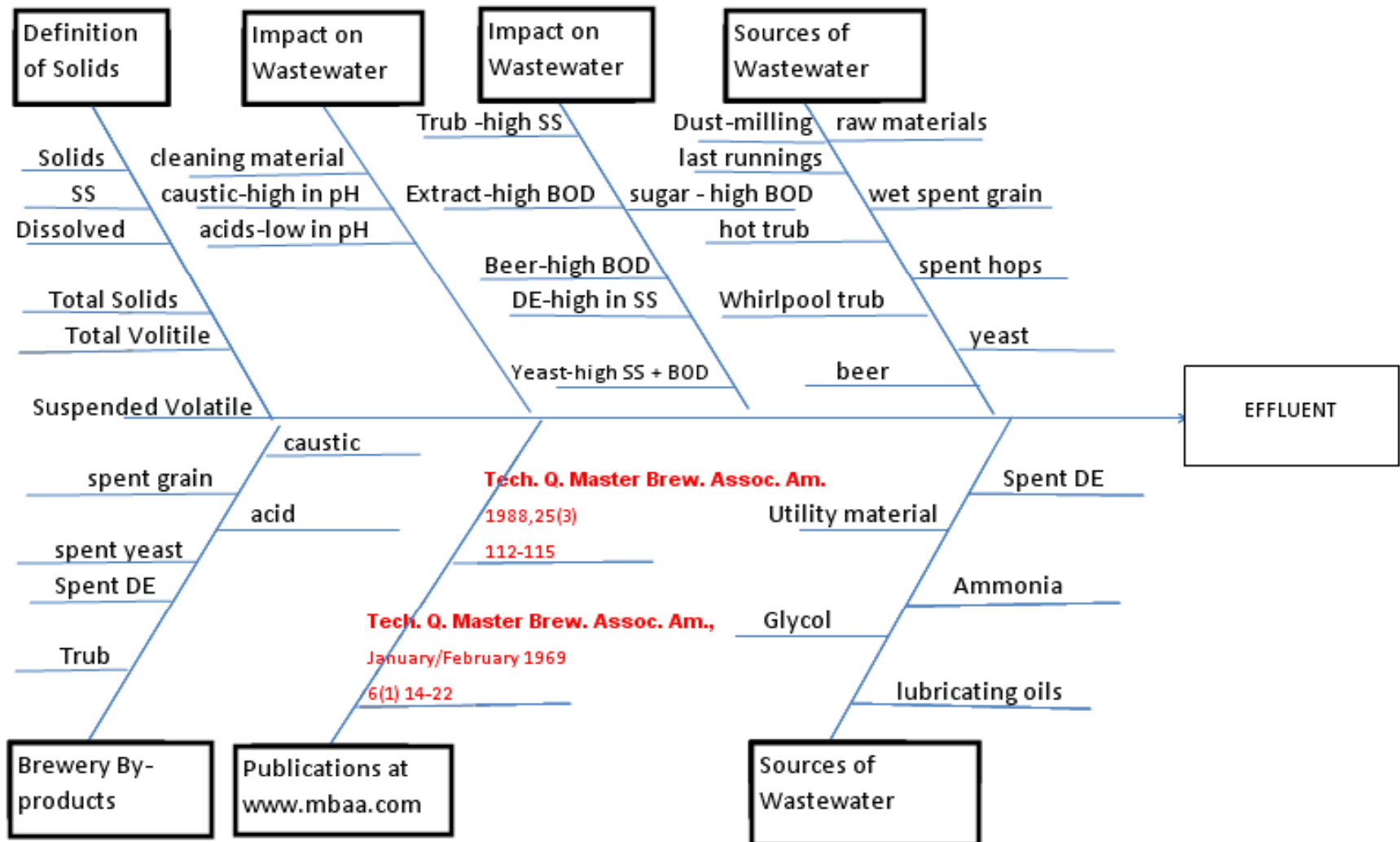


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What We Will Discuss:

- Biochemical Oxygen Demand (BOD): Where does it come from?
 - *High and low numbers and the effect on the environment*
- Definition of SOLIDS,
- Sources of brewery waste,
- Impact of brewery waste,
- Brewery by-products
- Solutions.







Biochemical Oxygen Demand: Where does it come from?

Biochemical Oxygen Demand (BOD) is the amount of oxygen required for complete (aerobic) biological decomposition of organic material. The standard laboratory method (BOD₅) tests the amount of dissolved oxygen consumed in a closed aqueous system over a five-day period.

Beer, Wort	~ 80,000 mg O ₂ /Liter
Last running's (lautering)	~ 10,000 mg O ₂ /Liter
Brewery Wastewater	~ 1,000 – 2,000 mg O ₂ /Liter
Household Wastewater	~ 300 mg O ₂ /Liter
Cleaned Wastewater	~ 25 mg O ₂ /Liter

The table above shows how much Oxygen is utilized in the “BIOCHEMICAL OXIDATION” calculated in mg of oxygen per liter. The high BOD is a result of organic substances.





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Definition of SOLIDS

Solids can be classified into five different types:

1. Suspended Solids (SS)
2. Suspended Volatile Solids (SVS)
3. Dissolved Solids (TDS)
4. Total Solids (TS)
5. Total Volatile Solids (TVS)





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1. Suspended Solids (SS):

- ✓ Solids that are non-filterable with glass fiber filters, equivalent and not volatilized at 103° C.
- ✓ Very small particles remaining dispersed in a liquid due to turbulent mixing that can create turbid or cloudy conditions.
- ✓ Measured in milligrams per liter (mg/L).

2. Suspended Volatile Solids (SVS):

- ✓ Portion of suspended solids that are volatilized at 550°C.





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3. Total Dissolved Solids (TDS):

- ✓ Solids that are in solution and therefore non-filterable.

4. Total Solids (TS):

- ✓ Solids present whether suspended or dissolved.

5. Total Volatile Solids (TVS):

- ✓ Portion of total solids that are volatilized at 550° C.





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Sources of Brewery Waste:

- Milling: Dust
- Mash tun: Wet spent grain; last runnings
- Wort kettle: Hot trub; spent hops
- Whirlpool: Trub; spent hops
- Fermentation: Yeast, beer
- Beer Storage: Yeast, beer
- Filtration: Spent DE, beer
- Packaging & Utility Material: Ammonia, Glycol, lubricating oils, etc.





Sources of Effluent Loads

<u>Source</u>	<u>Operation</u>	<u>Characteristics</u>
Mash Tun	Rinsing	Cellulose, sugars, amino acids, 3,000 ppm B.O.D
Lauter Tun	Rinsing	Cellulose, sugars, spent grain, can be high in S.S. (3,000 ppm), B.O.D ~ 10,000 ppm
Spent Grain	Last runnings and washing	Cellulose, nitrogenous material, very high in S.S. (30,000 ppm), up to 100,000 ppm B.O.D
Boil Kettle	Dewatering	Sugars, nitrogenous residue, B.O.D ~ 2,000 ppm
Whirlpool	Rinsing spent hops and hot trub Trub discharge and rinsing	Proteins, sludge and wort, High in S.S (35,000 ppm), B.O.D ~ 85,000 ppm
Fermenters	Rinsing	Yeast, ~ 6,000 ppm S.S. ,up to 100,000ppm B.O.D
Storage Tanks	Rinsing	Beer, Yeast, Protein, HIGH S.S (4,000 ppm) ~ 80,000 ppm B.O.D





Sources of Effluent Loads

<u>Source</u>	<u>Operation</u>	<u>Characteristics</u>
Filtration	Cleaning, start up; end of filtration; leaks during filtration.	EXCESSIVE SS (up to 60,000 ppm), beer, yeast, proteins, up to 125,000 ppm BOD.
Beer Spills	Waste, flushing, etc.	1,000 ppm BOD
Bottle Washer	Discharges from bottle washer operation.	High pH; high SS and BOD; especially through load of paper pulp.
Keg Washer	Discharge from keg during kegging operation.	Low on SS ~ 400 ppm Higher at BOD
Miscellaneous	Discharged cleaning and Sanitation materials; floor washing; flushing water, boiler blow-down, etc.	Relatively low on SS and BOD, but problem here is due pH and chemicals discharged into sewer.





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Impact of Brewery Waste

- ✓ Beer, extract and sugars have no SS, but they have dissolved solids.
- ✓ Depends on aging time and filtration conditions. The wastewater BOD can be high if pumping and filtration create a lot of yeast cells in the filter bed (DE and Yeast).

Spent Grain	High in SS
Trub	High in SS
Extract	High in BOD
Sugars	High in BOD
Beer	High in BOD
DE	High in SS; NO BOD
Yeast	High SS, High in BOD





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Impact of Brewery Waste

- ✓ Brewery Cleaning Agents: If brewery cleaning agents, such as acids or caustics, are released into a wastewater treatment plant, drastic pH fluctuations within the effluent will result.
- ✓ pH fluctuation can cause operational problems.

Solution:

Higher buffer capacity (Hydraulic Retention Time, or HRT) of the wastewater from wastewater treatment in order to avoid high pH fluctuations.





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Brewery By-Products:

- ✓ Spent Grain
- ✓ Spent Yeast
- ✓ Trub
- ✓ Spent DE
- ✓ Caustic Solutions
- ✓ Heavy Metal





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Solutions

Possible technologies for TSS (total suspended solids) removal from wastewater:

- ✓ Sedimentation
- ✓ Screening
- ✓ DAF unit

=> **Anaerobic technology** to remove soluble chemical oxygen demand (SCOD).





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Solutions

General Benefits of the Anaerobic Technology:

- ✓ Proven technology for efficient biological BOD/COD degradation with small footprint requirements (75-90% BOD removal efficiency).
- ✓ Transforming organic load in the waste water into biogas for producing Green Energy.





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Solutions

General Benefits of Anaerobic Technology:

- ✓ Enables optimized application of the energy consuming aerobic technology for degradation of remaining BOD/COD load only.
- ✓ Minimizes the amount of biosludge for disposal from the aerobic stage.





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Thank you for your attention!

