Simple Method for Monitoring Organic Matter Composition in Manitoba Surface Waters

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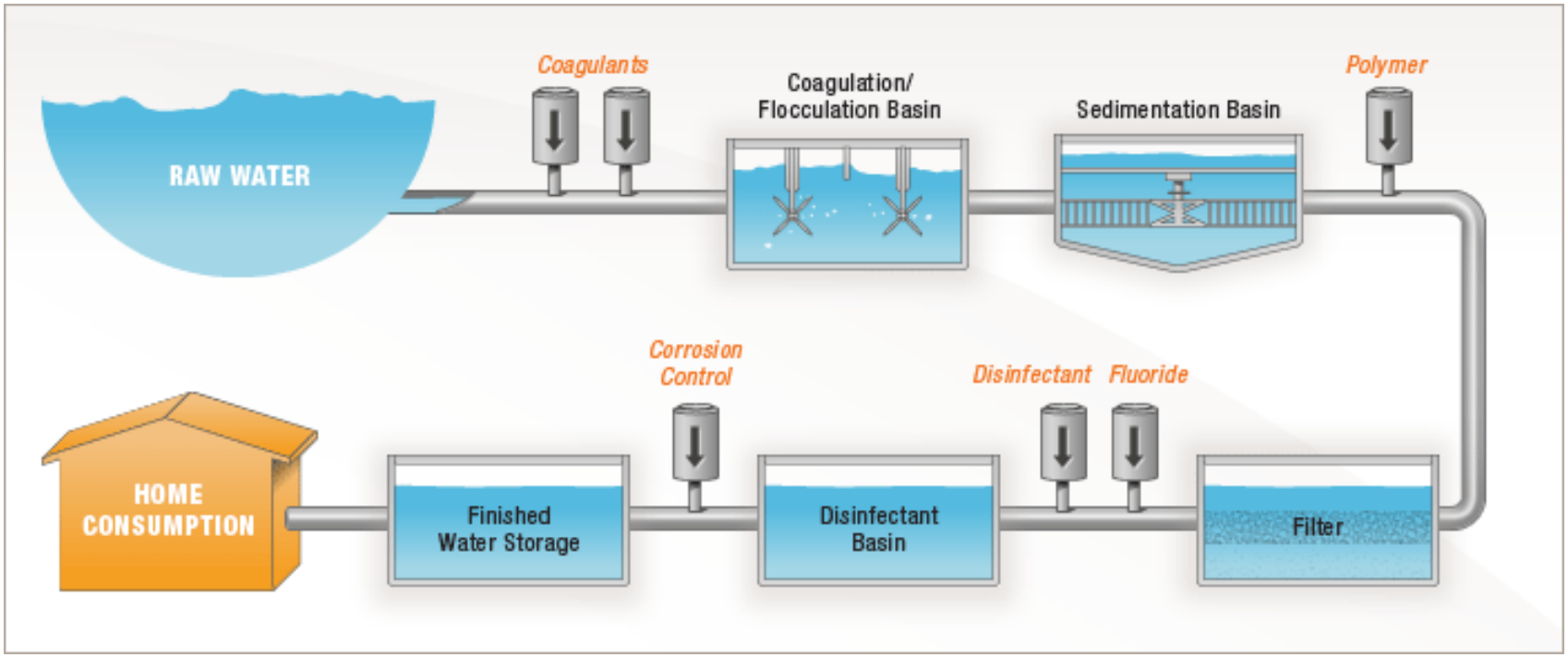
Water Treatment Process

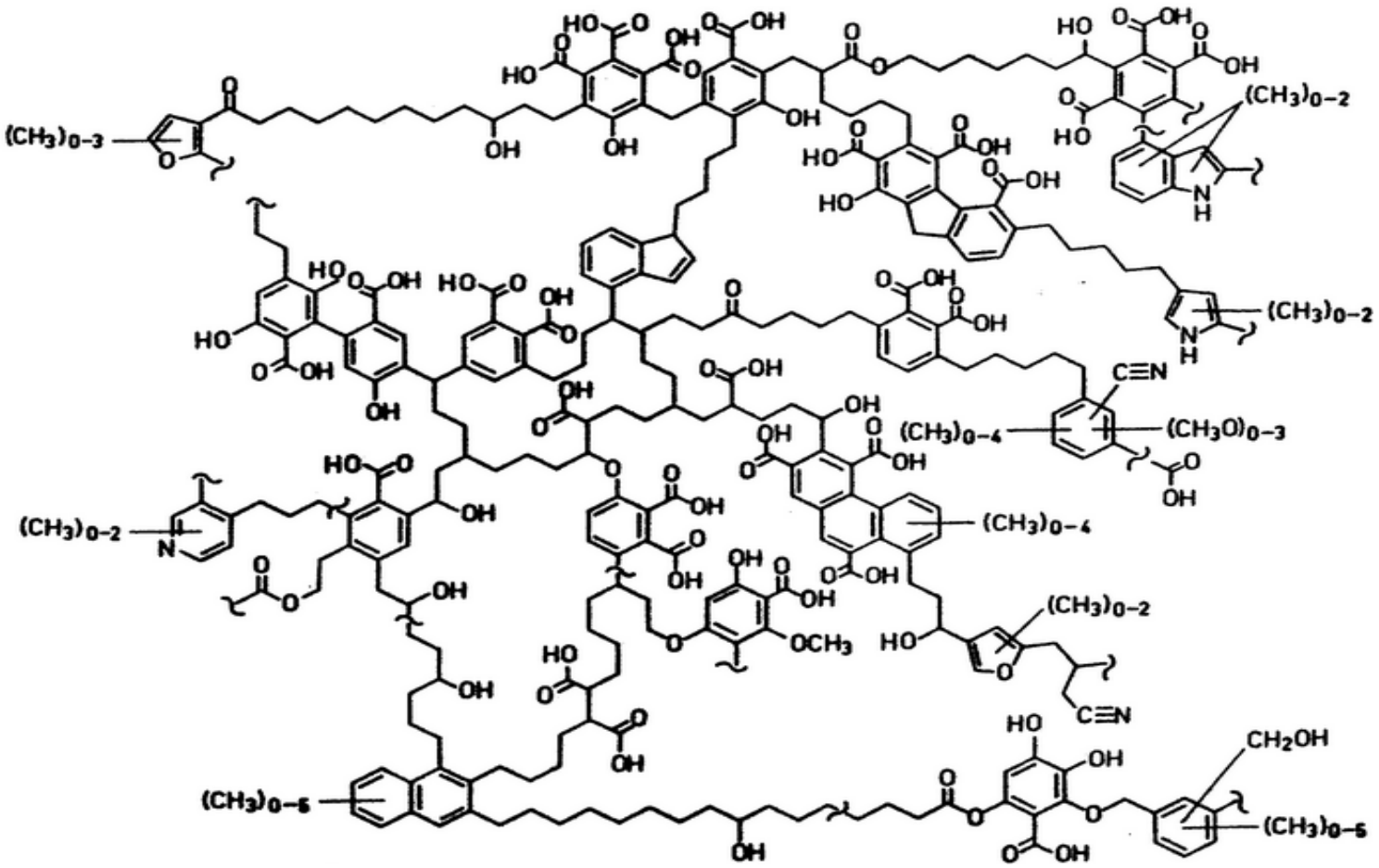
- Potable (drinking) is treated to remove turbidity, hardness, and natural organic matter (NOM) from raw waters
- Treated using chemical coagulation and filtration
- Water is disinfected using chlorine before distribution



Natural Organic Matter (NOM)

- Complex mixture of organic compounds consisting of aromatic, aliphatic, and phenolic structures
- Composition subject local environmental influences
  - Unique to location
- Contains numerous fractions
  - Fractions have different properties
    - Acidic or basic
    - Hydrophobic or hydrophilic
    - Molecular weight
  - Fraction containing humic matter highly reactive

Natural Organic Matter



Proposed humic molecule

Natural Organic Matter

Problems in drinking water

- Not a direct health concern
- Causes poor taste, odour and color
- Impacts treatment operations
  - Increased chemical costs
  - Clog filters or membranes
- Aid in transportation of pollutants or metals
- React with chlorine during the disinfection process
  - Forms disinfection byproducts i.e.) Trihalomethanes

Trihalomethanes

- Most common group of disinfection byproducts
  - Chloroform
  - Bromoform
  - Bromodichloromethane
  - Dibromochloromethane
- Form from a reaction with NOM and disinfectant
  - Humic fraction most reactive
- Group 2B or 3 carcinogens
- Manitoba regulation <100 ppb
- 50-70% Manitoba systems do not meet regulations

Hypothesis

Understanding the composition of NOM in surface waters can help identify the potential to form THMs

Monitoring changes in NOM composition can indicate seasonal changes that could increase THMs in finished water

Understanding the removal of humic fraction during treatment can identify problematic processes that need optimization to control THM formation

Problem

- WTPs never measure NOM composition
  - Currently accepted method – XAD Method
    - Long sample preparation and experimental run times
      - ~ 10-12 days per sample
  - Not applicable for monitoring in a water treatment plant
- Most surface waters high in NOM
- Only 3 systems in Manitoba have been characterized
  - Assiniboine River
  - Red River
  - Lake Winnipegosis

Problem

Lake Winnipegosis

Humic Fraction : 54-58% Winter (November 2012)
42-67% Spring (March 2013)

Objective

Phase 1 (Completed)

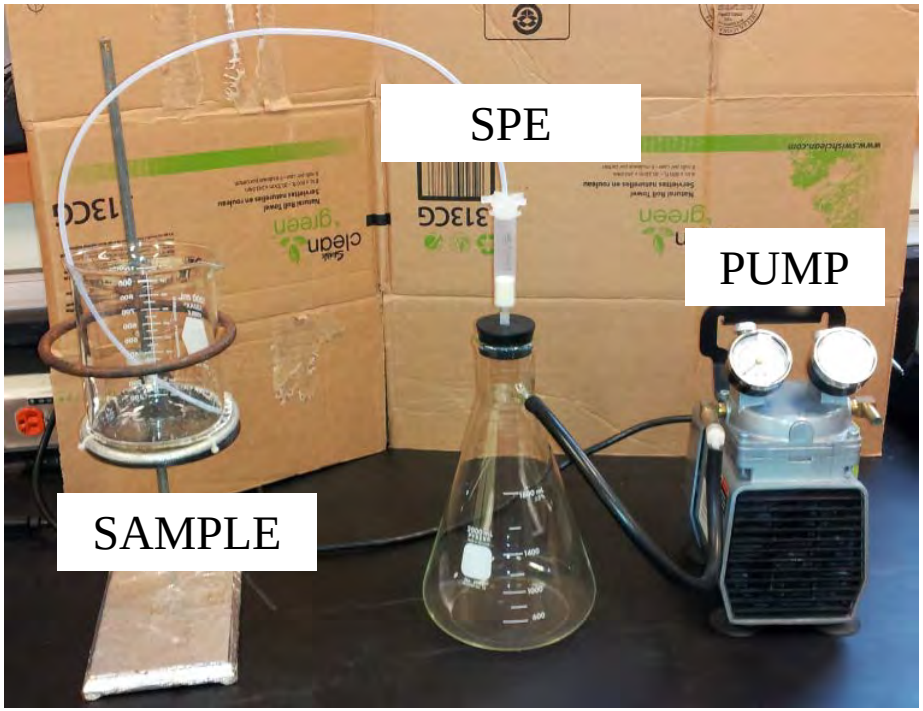
- Develop a new fractionation method that can isolate and quantify humic fraction in natural waters under the same operational conditions as the accepted XAD method

Phase 2 (Underway)

- Investigate applicability in water treatment plant
  - Monitor NOM composition of water source
  - Evaluation of water treatment processes
- Investigate new method as a simple monitoring method for water treatment plant operators

Phase 1-Experimental Method

- Developed a novel Solid Phase Extraction (SPE) method
  - Significantly shorter to measure humic fraction
    - ~ 2 hours



Phase 2- Current Research

- Measure NOM composition of surface waters in different regions in Manitoba
  - Canadian Prairies
    - Lake Winnipegosis (Manitoba Interlake)
  - Canadian Shield
    - East side of Lake Winnipeg
- Most systems use surface waters
- Most systems struggle to meet THM regulations

Conclusions

- Understanding the NOM composition of water source can indicate the potential for the formation of THMs
- SPE simple and applicable for monitoring in water treatment plant
  - Measure composition of water source
  - Measuring the removal of NOM fractions by water treatment plant
  - Can indicate water treatment processes which need optimization to remove THM precursors