

Developing Phosphorus fractionation methodology in wastewater

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The issue with phosphorus

Despite significant investments into phosphorus removal treatment, wastewater treatment discharges contribute to elevated phosphorus levels in freshwater, leading to eutrophication and damaging environmental health.

To reach environmental health targets tighter restrictions are being imposed on wastewater discharges, with consents as low as 0.1 mg/l. This is extremely challenging, requiring removal of recalcitrant phosphorus fractions. Removing these fractions requires an increase in understanding how phosphorus fractions other than SRP respond to treatment and how fraction changes across a treatment train.

A consistent, scientific and thorough fractionation methodology is required to enable the data gathering and analysis required to develop this understanding.

Aims of the new methodology

- Provide improved resolution between different phosphorus species
- Provide for differentiation between traditionally defined “particulate” matter, smaller colloidal particles and dissolved species
- Avoid a reliance on complex or expensive techniques allowing utilization on-site throughout the sector

Fraction key

f(0.025) – Fraction following passage through a 0.025 µm filter. Such fractions measure only phosphorus in free solution or associated with ultra fine particulates (particle diameter <0.025 µm)

f(0.45) – Fraction following passage through a 0.45 µm filter. These fractions measure phosphorus in free solution or associated with particulates with a diameter below 0.45 µm. These fractions have historically been referred to as “dissolved”
U – fractions that have not been filtered.

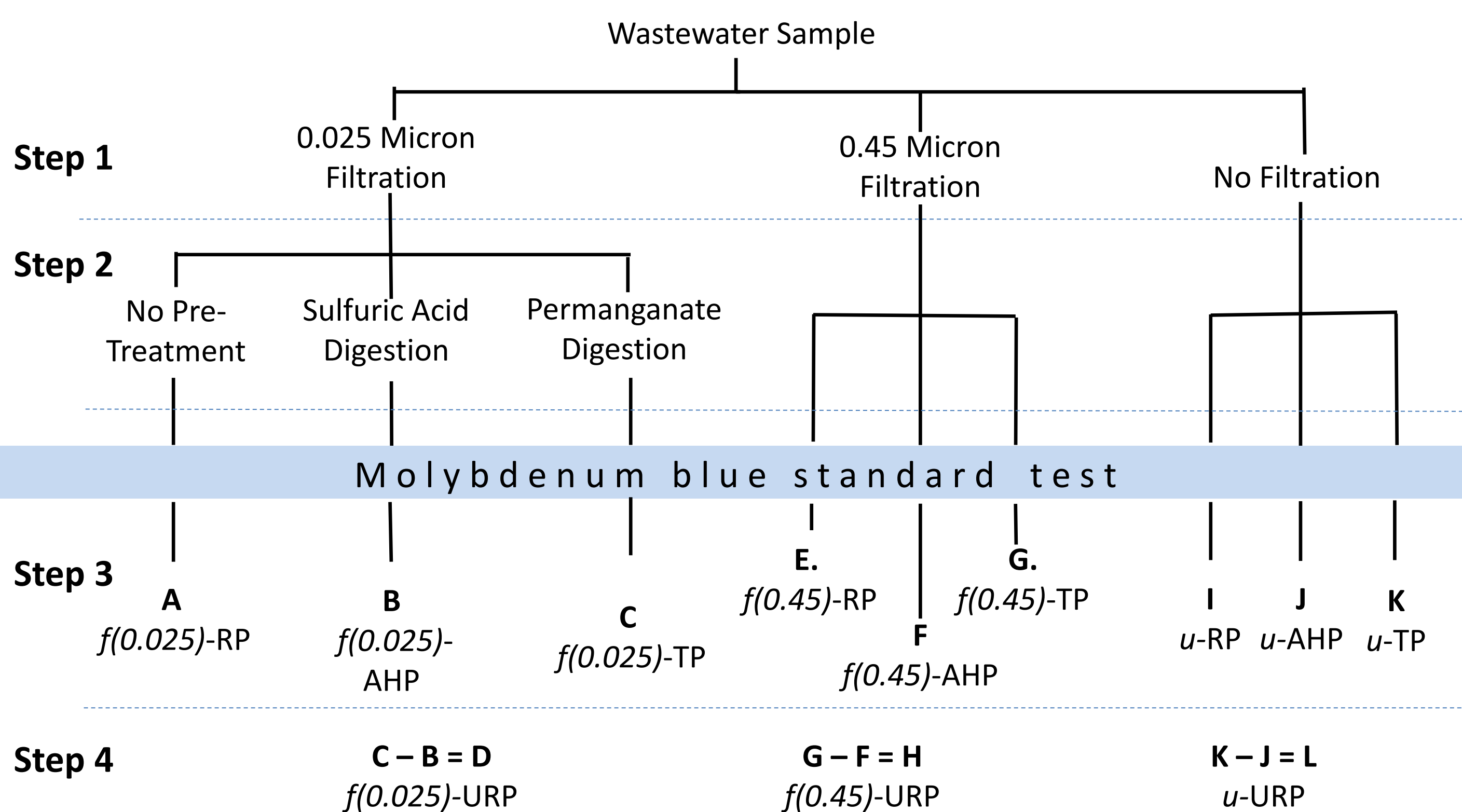
RP – (Molybdate) Reactive Phosphorus. Such fractions measure phosphorus species that forms blue complexes with molybdate ions without requiring pre-digestion.

AHP – Acid Hydrolysable Phosphorus. Fractions that form molybdenum blue complexes following digestion with sulfuric acid.

URP – (Molybdenum) Unreactive Phosphorus. Measurement of phosphorus species that only form molybdenum blue complexes following persulfate digestion. Historically (and incorrectly) this fraction has been referred to as “organic”

TP – Total Phosphorus. Measurement of phosphorus that forms molybdenum blue complexes following persulfate digestion. It is assumed that all phosphorus species following persulfate digestion will form molybdenum blue complexes.

Schematic of phosphorus fractionation method



Step 1 – Filtration

The sample is passed through a filter (or no filter). This allows for differentiation between phosphorus associated with different sized particles and those in solution

Step 2 – Pre-digestion

An oxidising agent (or none) is added to the sample. This allows for differentiation between different chemical species of phosphorus.

Step 3 – Cell test

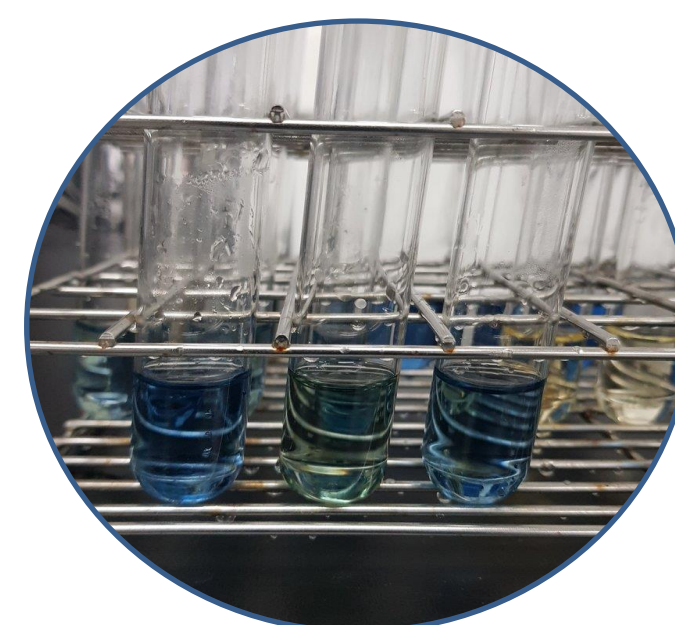
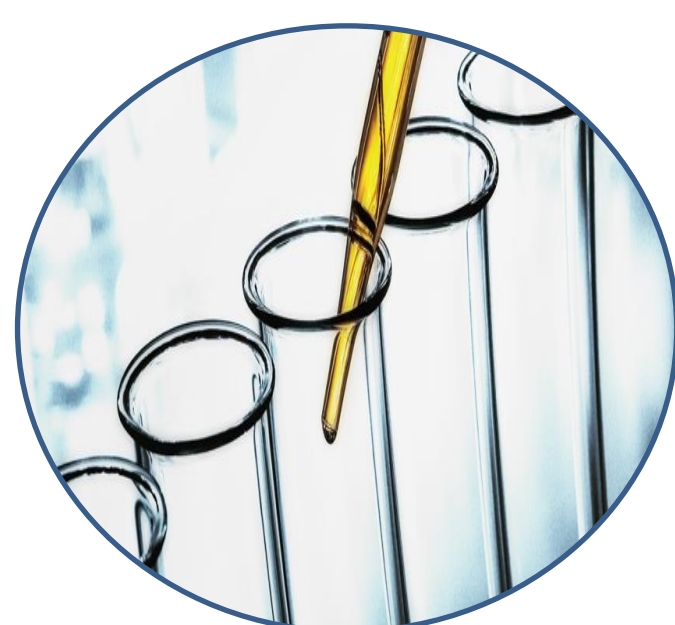
The sample is added to a commercially available molybdenum blue cell test, and analysed via photospectrometry. This quantifies phosphorus in the measured fraction

Step 4 – Calculations

Fractions such as particulate or unreactive phosphorus can be calculated from other measured fractions.

Moving forward

One of the biggest hurdles to improving phosphorus removal processes in wastewater is the lack of accessible data regarding non-SRP or TP fractions in wastewater, and how fractionation changes across processes. It is my hope that this methodology can be implemented by multiple utilities, and the data shared with utilities and academia, allowing analysis and development of our understanding of how non-SRP fractions interact with phosphorus removal processes. This will then allow the optimization of P removal through cost efficient, resilient processes.



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