Enhancing sustainability of surface water filter beds through acoustic monitoring

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1. Introduction & Aims

- **Urban surface water pollution is an ever increasing problem;** especially with rising population with a predisposition to live in highly impermeable urban areas and more intense rainfall due to climate change.
- **Hyrdo International's Up-Flo® Filter is an effective method to treat this at stormwater sewer outlets;** removing grit, hydrocarbons and suspended solids.
- **However maintaining the porous filter media so performance is effective remains an issue;** with difficulties in knowing when to replace the media leading to performance decline and unnecessary maintenance costs.
- **Acoustic waves can provide detail about the porous media;** factors such as permeability and porosity affecting the waves.
- **Understanding this detail will allow for a sensor system to be developed that can effectively monitor the porous filter media;** with acoustics providing low cost and power requirements.

2. Experiments

- Filler media, grade B Silica Sand, was studied using an acoustic experiment where the acoustic signal in water, fully saturated filter media and various clogged media samples could be studied.
- Detailed measurements of the media(s) were made; hydraulic permeability, particle size, concentration .
- Studying acoustic speed and amplitude of the wave in various media and sediment concentrations allows for relationships about the media's condition to be determined.

Fig 1: *Acoustic transducers in deaired water*

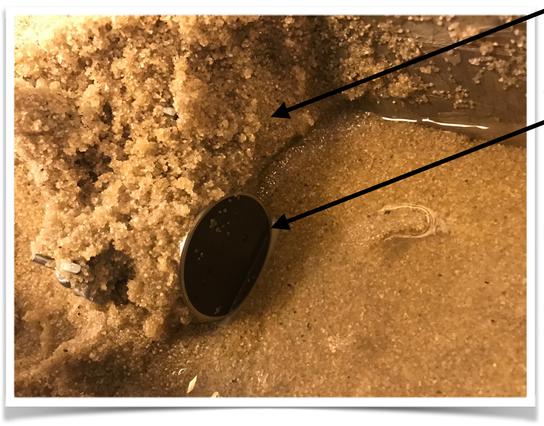

Fig 2: *Acoustic transducers in partially covered in media*

3. Results

3a. Wave speed

- Acoustic wave speed allows for information about the media to be obtained.
- Acoustic wave speed increases as sediment fills pores in the filter media.
- There is an even greater increase in wave speed when in the presence of media rather than water.

Wave speed against frequency in various media

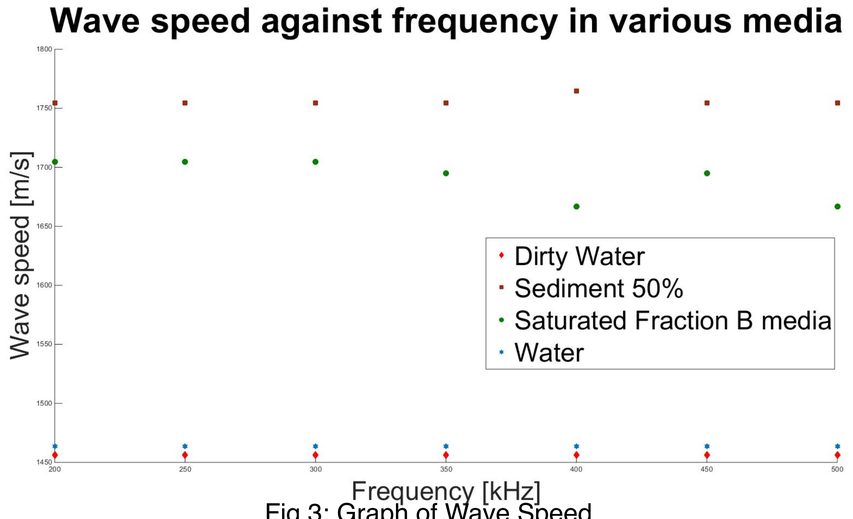

Fig 3: Graph of Wave Speed

3b. Amplitude

- Amplitude provides key information about the state of the media, as the media absorbs and reflects the wave energy.
- The wave speed becomes significantly faster in media and the amplitude becomes significantly reduced.
- Amplitude is also related to the frequency of the wave.
- In filter media higher frequencies become more attenuated.

FFT of 500kHz pulse at 120mm in various media

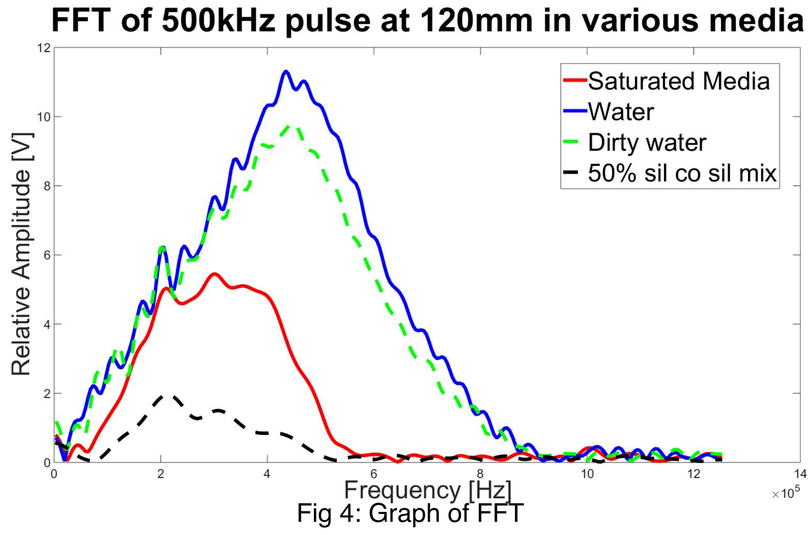

Fig 4: Graph of FFT

4. Conclusion

- Detecting an increase in the wave speed and acoustic attenuation the sensor system allows measurement of the percentage of pores filled with silt and the permeability.
- Factors that affect the acoustic wave are the temperature, water salinity and air bubbles.

5. Further Work

- Studying the effect of distance on the acoustic wave between the sender and receiver.
- Determine the effect of various saturation levels on the acoustic signal.
- Controlled sedimentation tests with known levels of pore filled.
- Full scale rig tests of the Up-Flo® filter to determine filtration efficacy at removing known sediments.
- Conductance work to determine information about the media and the conditions of the filter.
- Prototype sensor development and testing.

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