Study of the settleability of grit particles

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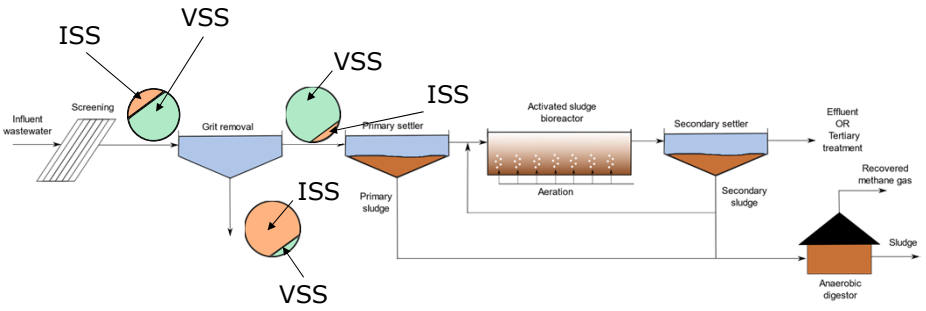
Water Resource Recovery Facility (WRRF)

• Grit Removal System (GRS)



But, what is grit?

• No existing standard definition of grit

• General definition used:

*« Grit is traditionally defined as **inorganic particles** larger than 0.21 mm (65 mesh) and with a specific gravity greater than 2.65. » (U.S. EPA, 2004)*

Grit removal

- Settling process
- **Grit particles settling velocity** estimated through Stokes' Law considering spherical sand particle characteristics within the laminar flow range:

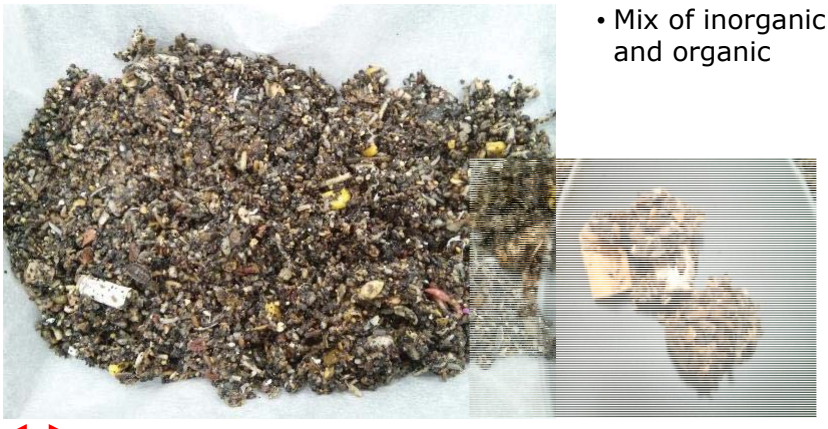
$$v_s = \frac{g \times (\rho_p - \rho_w) \times d_p^2}{18 \times \mu}$$

ρ_p = 2.65 d_p = 212 µm

By definition: for a d_p = 212 µm → $v_s = 143\ m/h$

But, what is grit?

- Normal grit appearance



- Mix of inorganic and organic

1 cm

But, what is grit?

• What can influence the settleability of the grit particles?

Clean sand

Grit

Adapted from Wilson et al. (2007)

Finally, grit is…

• Water Environment Federation's Grit Task Force in "Guidelines for Grit Sampling and Characterization" (WEF, 2016) recommends that :

« The definition of grit for the purpose of sampling be the ***settling velocity*** *of the grit particle as it exists in the raw wastewater of the appropriate size that is intended to be removed by the system being sampled.»*

Problem statement

- There is no standard procedure to characterize grit
- Grit characterization is complex because:
  - Wide variety of grit characterization methods
    - e.g. dry sieving and wet sieving
  - Wide variety of parameters to be studied to characterize grit
    - e.g. particle size, settling velocity and density
  - Difficulties with sampling
    - Representative sample

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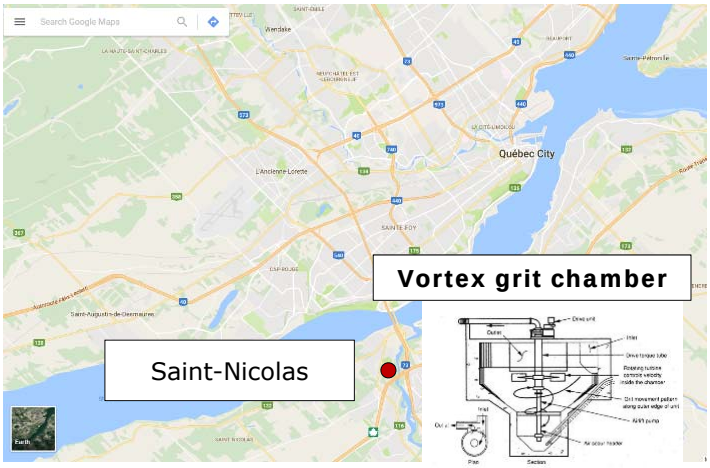
Objective

- Evaluate the performance of different settling velocity characterization methods in use today to characterize wastewater particles
  - ViCAs (French acronym of Wastewater Settling Velocity)
  - Elutriation

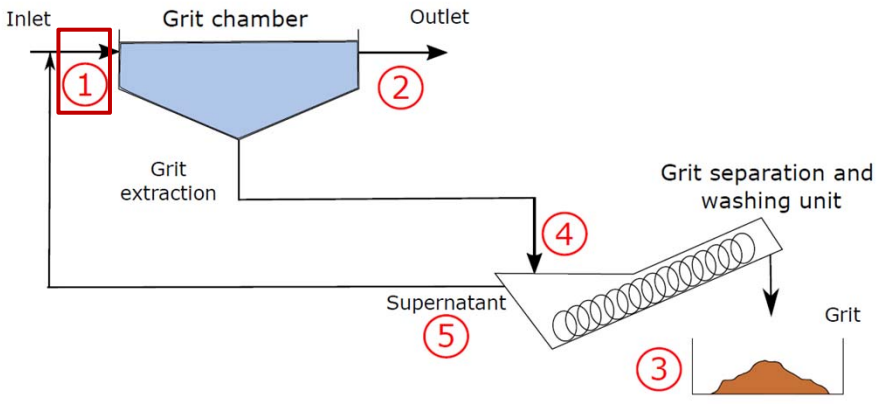
Case study

- St-Nicolas WRRF



Sampling point

- Sampling point

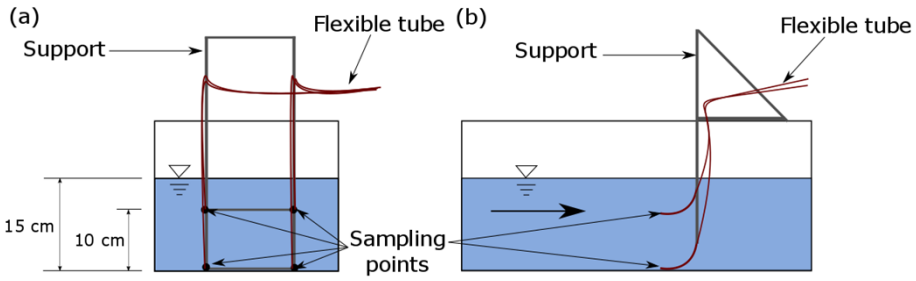


Sampling equipment

• Multipoint sampler developed by Veolia

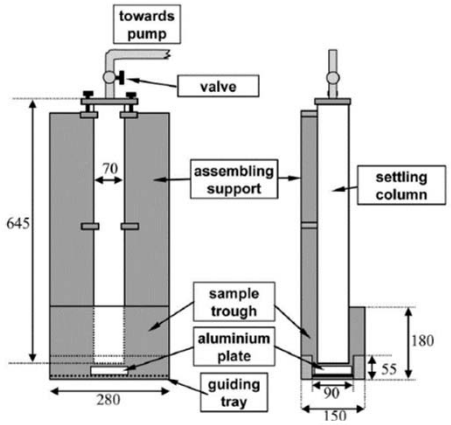
Sampling equipment

• Multipoint sampler developed by Veolia



Characterization methods

• ViCAs (French acronym of Wastewater Settling Velocity)



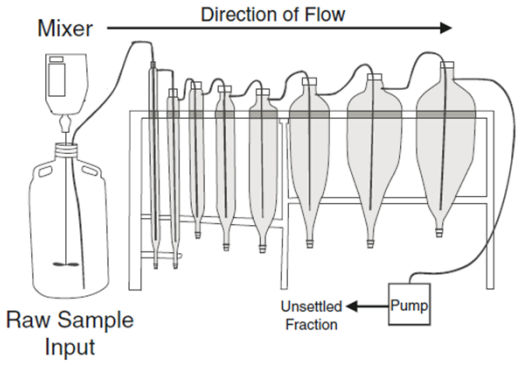
Chebbo and Gromaire (2009)

Measurement of TSS collected in cups at predefined time steps during batch settling

Application:
- Stormwater
- Sewage
- WWTP

Characterization methods

• Elutriation



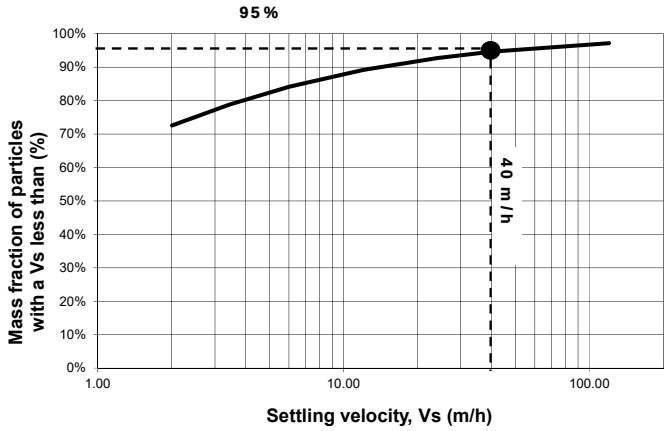
Krishnappan et al. (2012)

Measurement of TSS separated in different columns under flowing water conditions

Application:
- Stormwater
- Sewage

Characterization methods

• PSVD curves



Characterization method requirements

• Criteria to select a characterization method

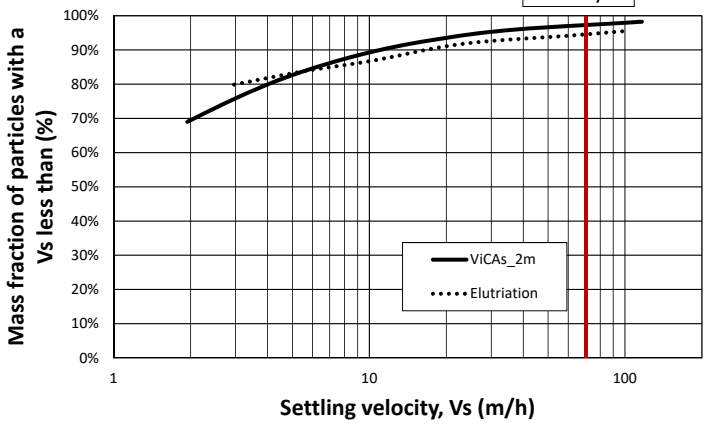
	Characterization method
Be safe	?
Be repeatable	?
Be representative of reality	?
Require small sample quantity	?
Allow storage of sample before analysis	?

Results

• PSVD results

Metcalf and Eddy (2014)

70 m/h



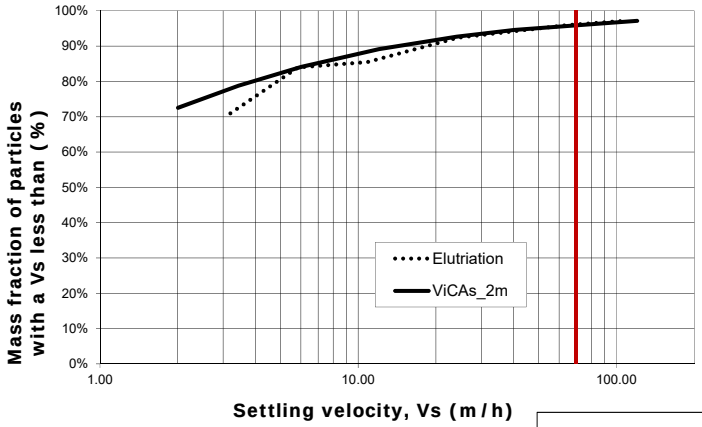
TSS = 60 mg/L

Results

• PSVD results

Metcalf and Eddy (2014)

70 m/h



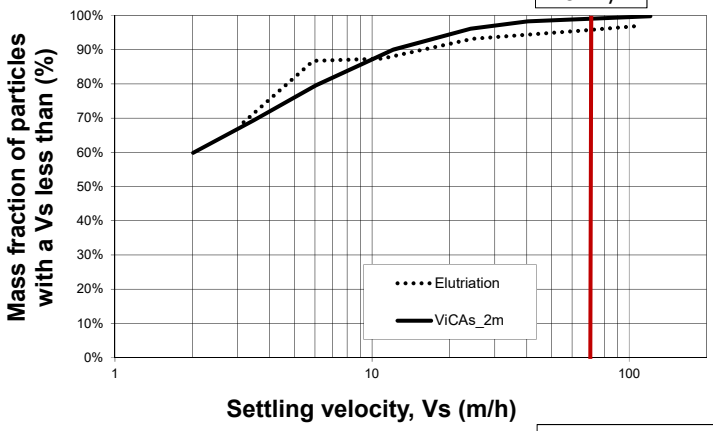
TSS = 250 mg/L

Results

• PSVD results

Metcalf and Eddy (2014)

70 m/h



TSS = 310 mg/L

Discussion

• Particle settling velocity distribution (PSVD) methods

	2m-ViCAs	Elutriation
Be safe	✗	✗
Be repeatable	✓	✓
Be representative of reality	✓	✓
Require small sample quantity	✓	✗
Allow storage of sample before analysis	✗	✗

Conclusions

- The existing PSVD methods have to be adapted for fast settling particles
- 2m-ViCAs columns and elutriation test allow to study the same PSVD
  - Further studies should be done to determine which is better
- The study of the PSVD is preferred to characterize grit particles
  - Allowing a better estimation of the grit chamber performance

Thank you for your attention!

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