PREMIER
TECH

Comparison of long term performance of two disinfection approaches

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The material being presented represent the speaker's own opinions and do NOT reflect the opinions of NOWRA.

INTRODUCTION

In 2007:

NOWRA 1st International Conference – Baltimore, MD

« Sustainable,
low maintenance disinfection
for onsite systems »

by Roger Lacasse

INTRODUCTION

Presentation of a low maintenance-passive biological disinfection approach (Fdi) specifically developed by Premier Tech for onsite wastewater applications in response to maintenance challenges of more generally used disinfection systems.

CONTEXT

- Chlorination and UV light - the most common methods used for wastewater disinfection.
- Very well-adapted for municipal applications.
- O&M requirements may be a challenge to assure sustainable performance for onsite applications

CONTEXT

Chlorination:

- Environmental risks related to toxicity for aquatic life and trihalomethane (THM) compounds formation by reacting with organic matter present in treated effluent (U.S. EPA, 1999).
- To be efficient chlorine must be added on a regular basis which is often deficient because few regulations include mandatory maintenance requirements.

CONTEXT

UV light:

- Less environmental risks because no chemical reaction with organic matter.
- Reliability of UV disinfection is subjected to transmissivity of UV light in the wastewater to be treated which is influenced by many factors acting in different ways.

FACTORS INFLUENCING UV LIGHT TRANSMISSIVITY

- TSS concentration in effluent (masking UV rays for bacteria inactivation, NSFC, 1998).
- Iron and manganese in concentration > 0.3 and 0.05 mg/L absorb UV light.
- Calcium (hardness) in combination with iron promote quartz tube fouling (Sehnaoui, 2001).
- Humic and fulvic acids (color) absorb UV light
  - Dose vs acceptance level

QUARTZ TUBE FOULING:

Quartz tube fouling is also increased by many other factors specific to onsite conditions (not existing in municipal WWTP):

- Potable water mainly coming from individual well with water quality varying from site to site (groundwater in rocky formation has variable concentrations in calcium, iron and manganese). For municipal water treatment plant these parameters are frequently at lower level.

QUARTZ TUBE FOULING:

Cont'd …

- Flow interruption (vacation, week-end, etc.) increases wastewater temperature in UV unit promoting carbonates precipitation on quartz tube (Whitby, 2002).
- Water softener backwash in septic systems has a major impact on quartz tube fouling.

CONTEXT

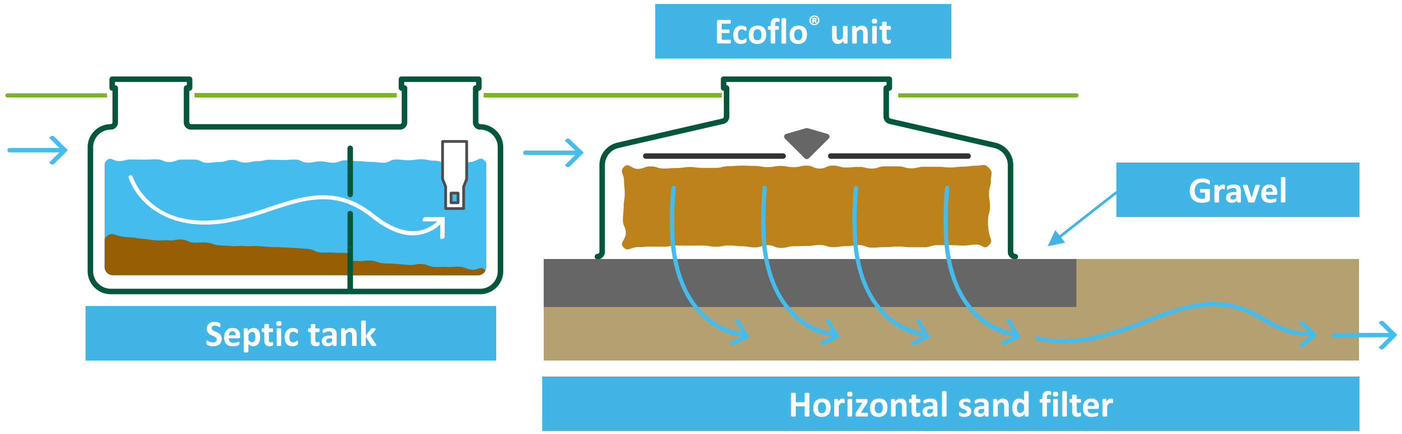
UV light:

- All of the previous factors influencing UV disinfection performance and time required for quartz tube fouling are dependant on :
  - quality of drinking water used at each site.
  - family habits.
  - performance of wastewater treatment system used in front of the UV unit.
- It is site specific!
- Design and maintenance of UV light product should be adapted to these conditions to minimize their impact on performance

PASSIVE BIOLOGICAL DISINFECTION

In view of these challenges, a need remains for low maintenance disinfection systems suitable for individual applications

Approach based on horizontal filter bed preceeded by an advanced treatment system



Inlet zone composed of 8'' of gravel on 12'' of sand fed vertically and maintained well-drained.

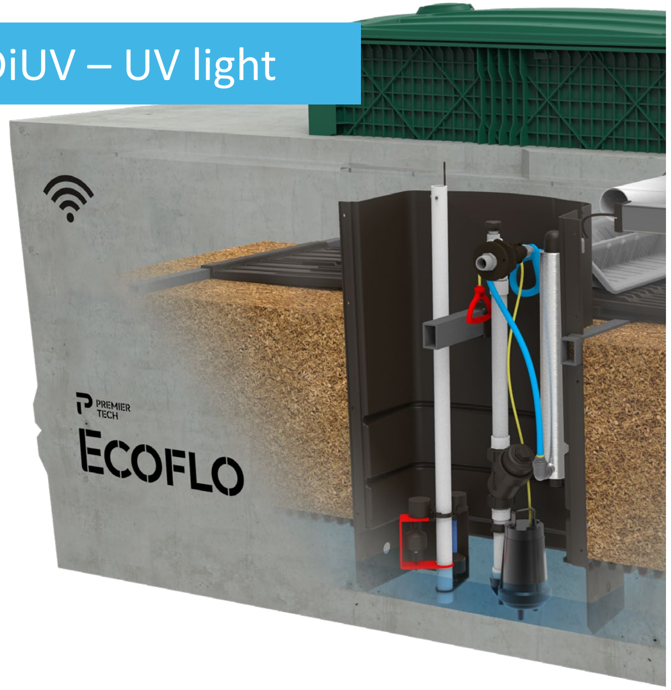
12'' layer of sand (length of 21 ft and slope of 4 to 5 %).

Width of HSF is function of design flow and linear loading rate.

COMPARISON TWO CERTIFIED DISINFECTION APPROACHES - COMMERCIALIZED BY PTWE

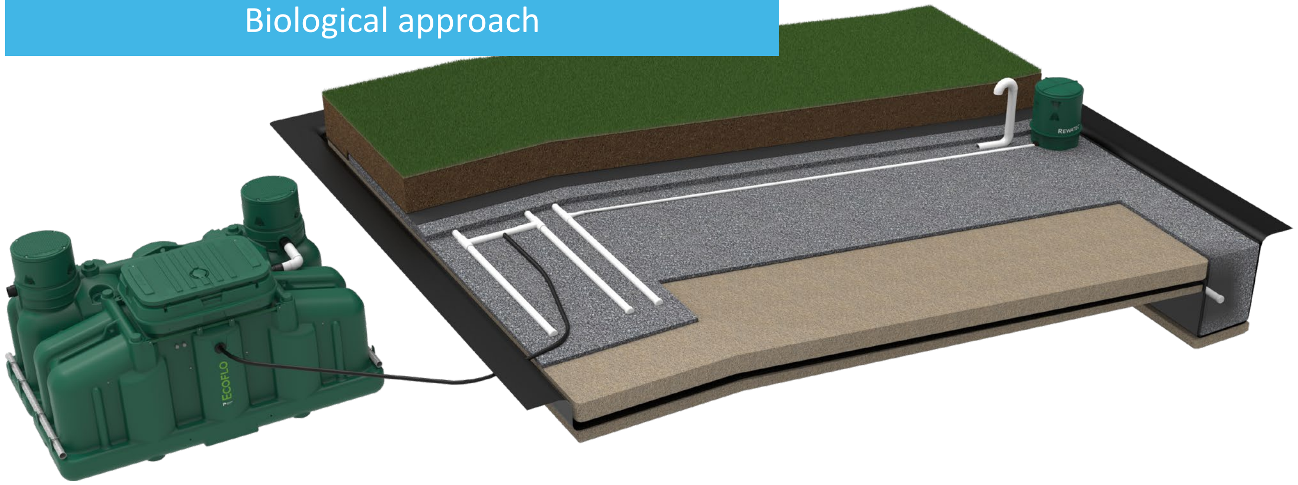
Based on NQ 3680-910 and CAN/BNQ 3680-600 testing protocol and third party field audit since 15 years

DiUV – UV light



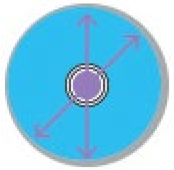
2006

Fdi – Lateral sand filter
Biological approach



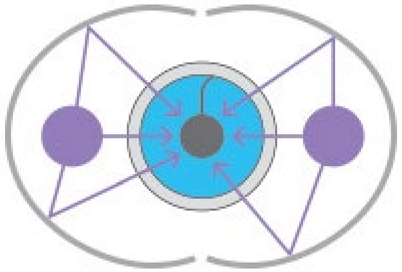
2009

DiUV BY PTWE



CLASSIC UV DISINFECTION

INTEGRATED OR SEPARATE TANK



SELF-CLEANING UV DISINFECTION

SEPARATE TANK ONLY

RECAP OF CERTIFICATION REQUIREMENTS

	Duration	Flow Regimen*	Stress Tests
BNQ NQ 3680-910	52 weeks	• 35% morning • 25% noon • 40% evening	• Laundry day: 3 days of laundry over 5 days. • Parents at work: 40% of Q in the morning and 60% in the evening. • Power/equipment failure: 48-hour stoppage. • Vacation: No water supply for 8 consecutive days.
CAN/BNQ 3680-600		1st 26 weeks sequence: • 35% morning • 25% noon • 40% evening 2nd 26 weeks sequence: • 40% morning • 60% evening	

*: *Distributed over a 3h-period each.*

RECAP OF CERTIFICATION REQUIREMENTS

<table>
<tr><th></th><th>Sampling Frequency</th><th>Sampling During Stress Tests</th></tr>
<tr><td>BNQ NQ 3680-910</td><td rowspan="2">5 days/week</td><td>All stress tests: Sampling only the 1st day of stress test sequence and 24h after full completion of the stress test sequence for 6 consecutive days.
Power/equipment failure: 48h after completion of the stress test sequence for 5 consecutive days.</td></tr>
<tr><td>CAN/BNQ 3680-600</td><td>All stress tests: <u>sampling during stress tests</u> for 5 consecutive days.

Except for Power/equipment failure: 24h after completion of the stress test for 5 consecutive days.</td></tr>
</table>

RECAP OF CERTIFICATION REQUIREMENTS

<table>
<tr><th></th><th>Temperature</th><th>Field Performance Audit</th></tr>
<tr><td>BNQ NQ 3680-910</td><td>• Tested in cold climate only
• Influent controlled at 64°F (18°C) or colder</td><td rowspan="2">10% of installs
min. 5 & max. 10 annually

Passing criteria:
80% compliance of sites audited</td></tr>
<tr><td>CAN/BNQ 3680-600</td><td>• Tested in cold climate only
• Influent controlled at 52°F (11°C ±1) or colder</td></tr>
</table>

RECAP OF CERTIFICATION REQUIREMENTS

	Classification
BNQ NQ 3680-910	Class V: • 15 mg/L $CBOD_5$ • 15 mg/L TSS • 200 CFU/100 mL*
CAN/BNQ 3680-600	Class BIV-DII: • 10 mg/L $CBOD_5$ • 10 mg/L TSS • 200 CFU/100 mL*

** For UV ligth disinfection 20 CFU/100 mL to account for photoreactivation as required by Quebec regulation.*

STATISTICAL COMPARATIVE ANALYSIS

INRAE – Agriculture and Environment National Research Institute (France)

Number of data available Effluent	FDi (certification 2009)			DiUV (certification 2006)		
	TSS	BOD_5	FC	TSS	BOD_5	FC
BNQ Certification	120	120	357	119	119	355
BNQ Field Audit	72	72	72	58	58	58

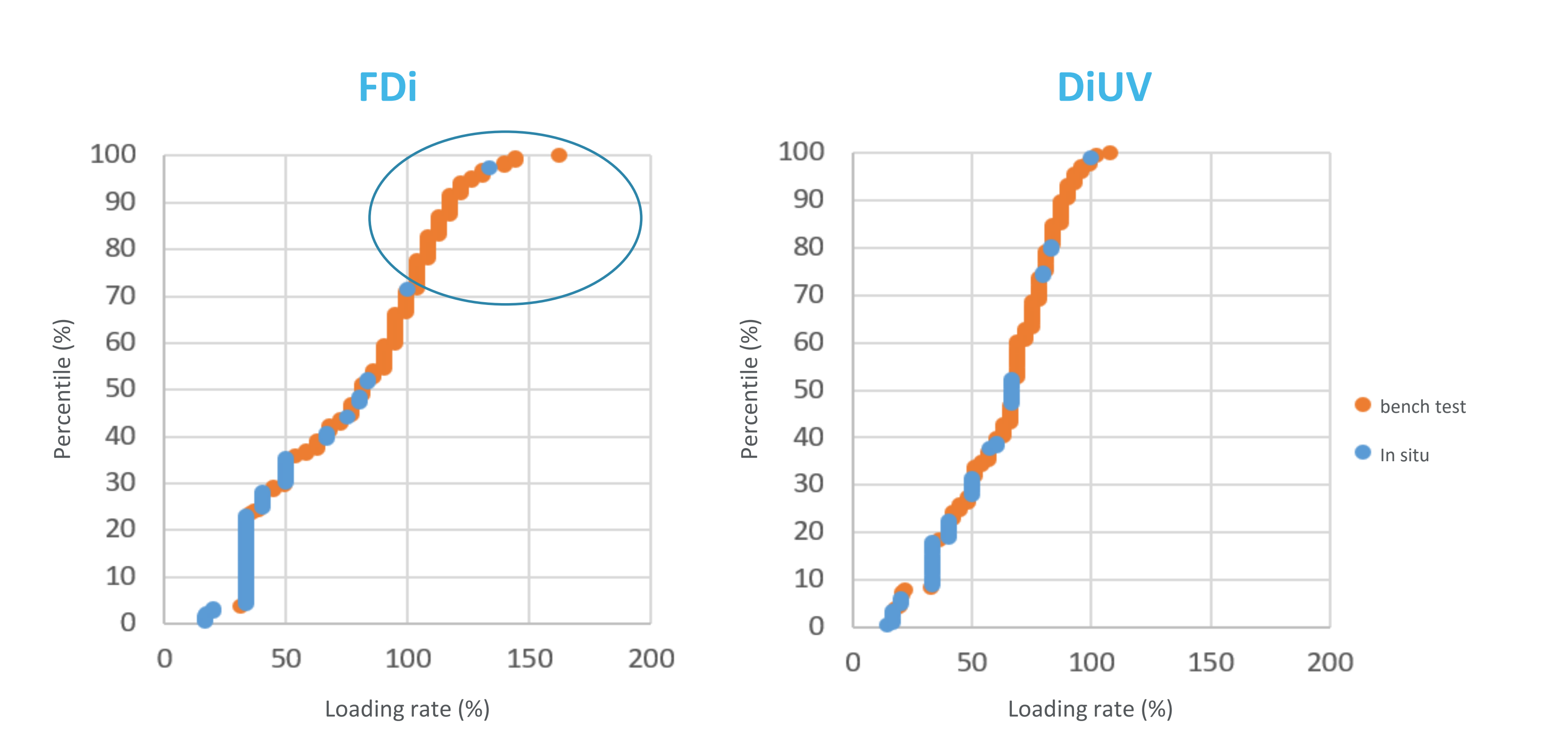
STATISTICAL METHODOLOGY

Generalized ln-linear tool:

- Used to analyze the effect of several explanatory variables on a dependent variable
- Dependant variable: treatment efficiency
- Focus on disinfection
- Explanatory variables:
  - Type of disinfection systems – DiUV vs FDi
  - Source – bench test vs in-situ results
  - Loads applied (hydraulic and organic)
  - Age of the installation

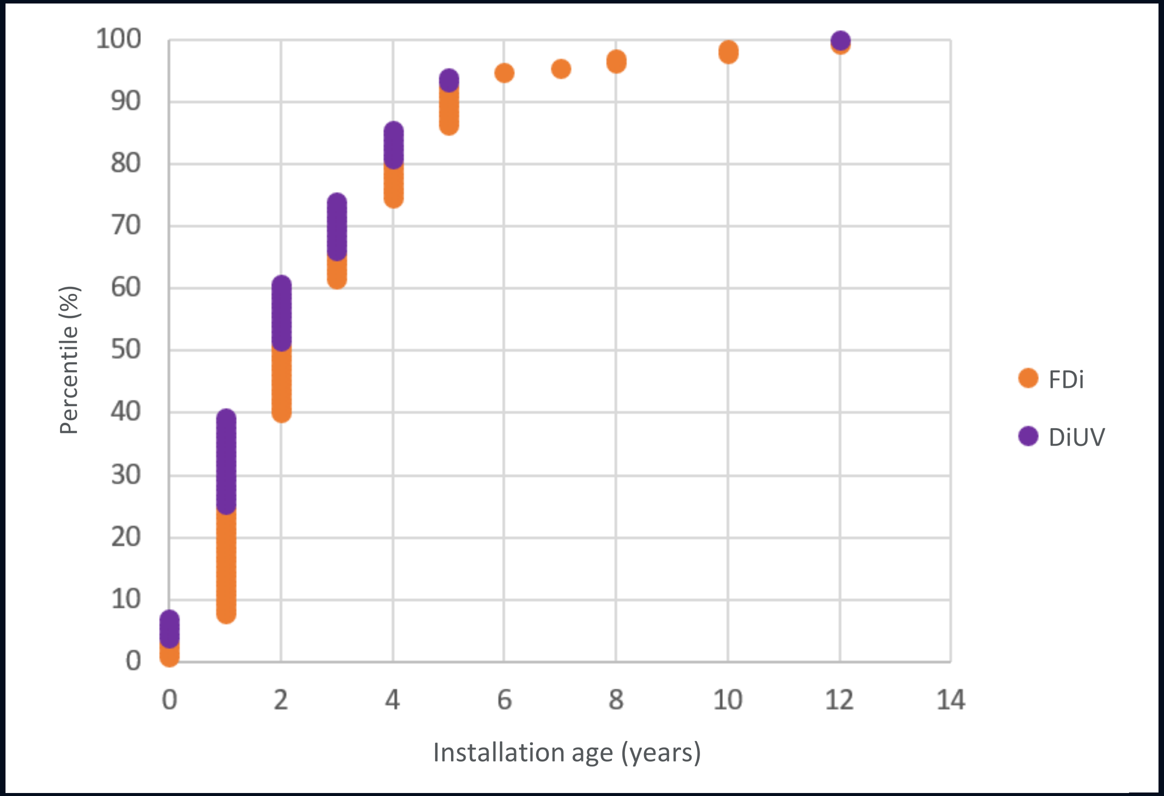
EXPLANATORY VARIABLES | ORGANIC LOADING

FDi organic loading > 100% for 30% of bench test data



EXPLANATORY VARIABLES | SYSTEM AGING

60% of audited in-situ installations are 2 years old and less



UV lamp are replaced annually

QUANTIFICATION LIMITS

- 2 mg/L TSS
- 5 mg/L BOD_5
- 10 CFU/100 mL

DATA DISTRIBUTION | BENCH TEST VS QUANTIFICATION LIMITS

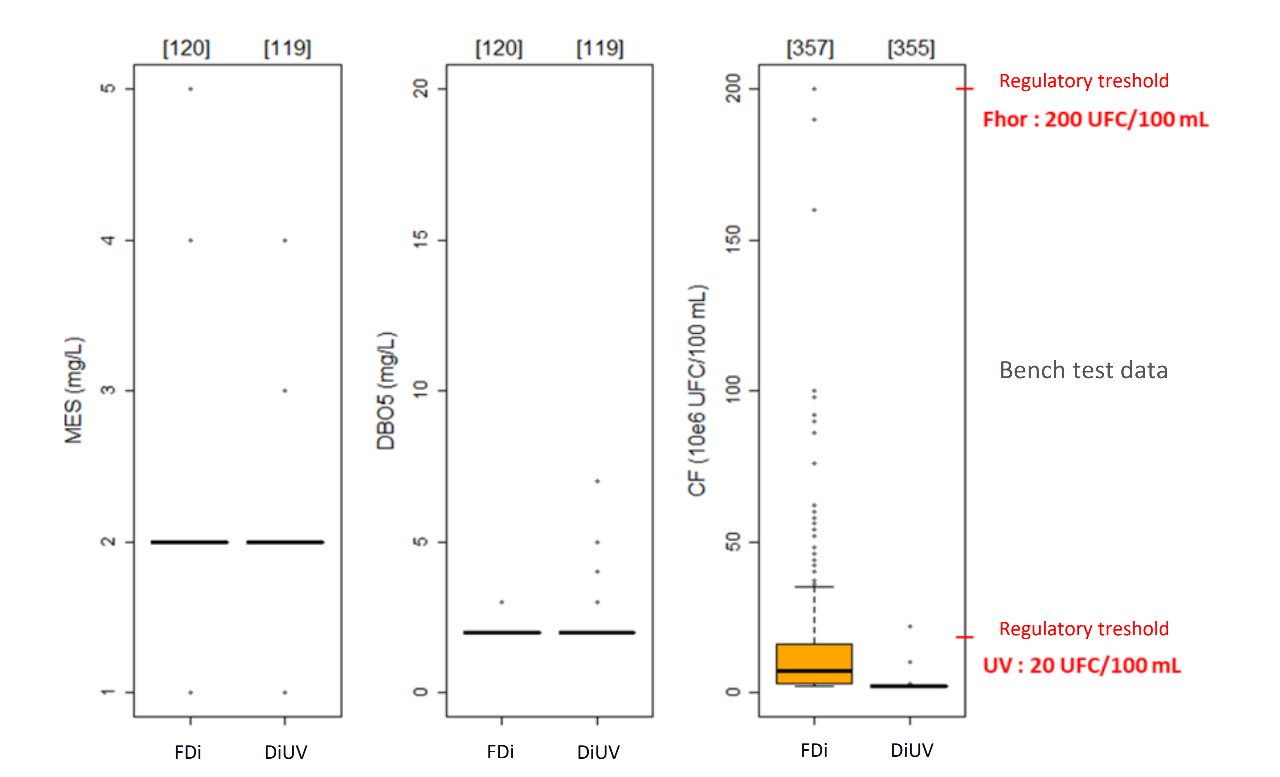
- TSS and BOD_5 almost all < quantification limits
- Significant difference between FDi and DiUV

  Median:

  FDi = 4.41 CFU/100 mL

  DiUV = 0.04 CFU/100 mL

  Log 2 difference for fecal coliforms



DATA DISTRIBUTION | IN-SITU TEST VS QUANTIFICATION LIMITS

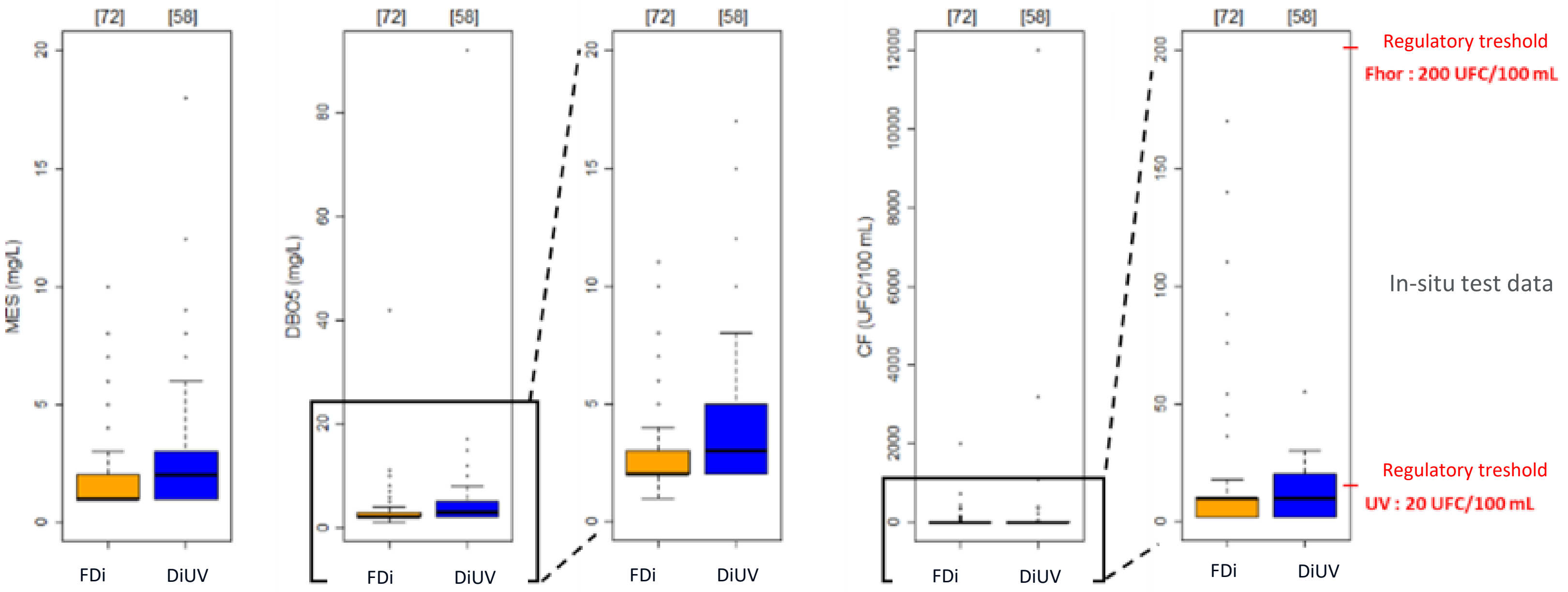
- TSS and BOD_5 < variability for FDi (Biofiltration)
- Significant difference between FDi and DiUV

80th percentile:

FDi = 20 CFU/100 mL

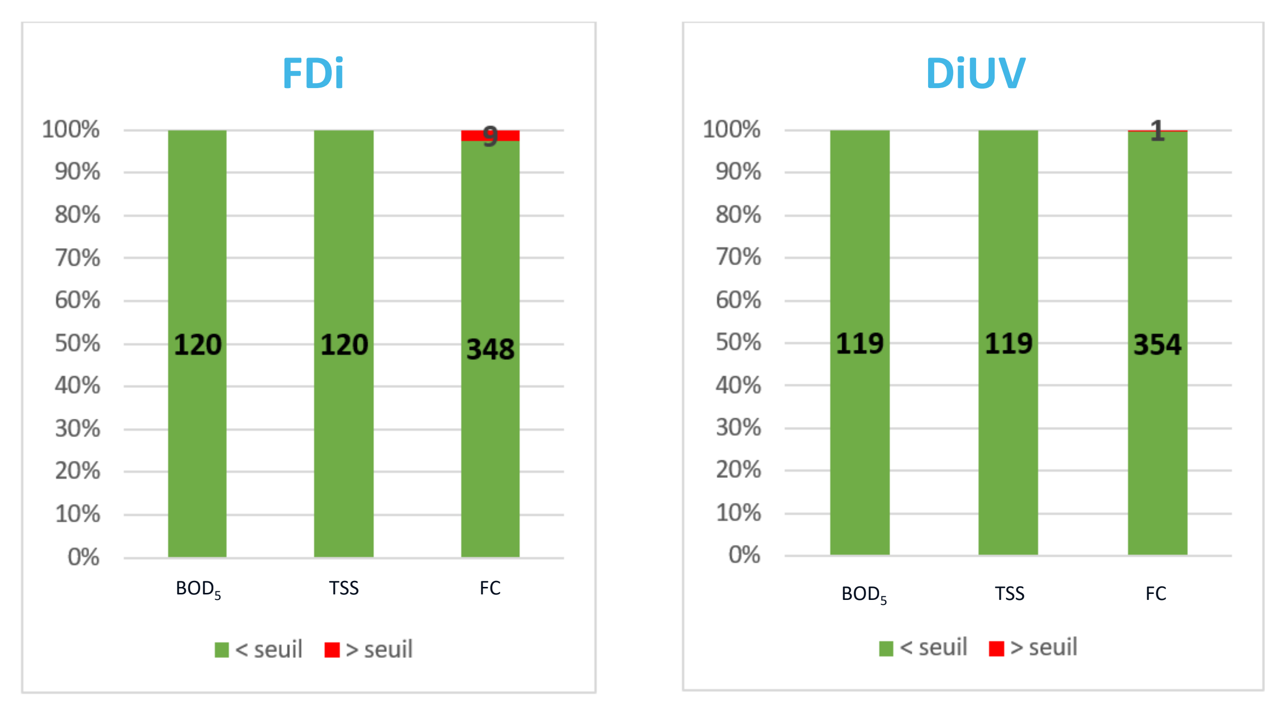
DiUV = 18 CFU/100 mL

DiUV more variable



CERTIFICATION DATA | BENCH TEST (BNQ)

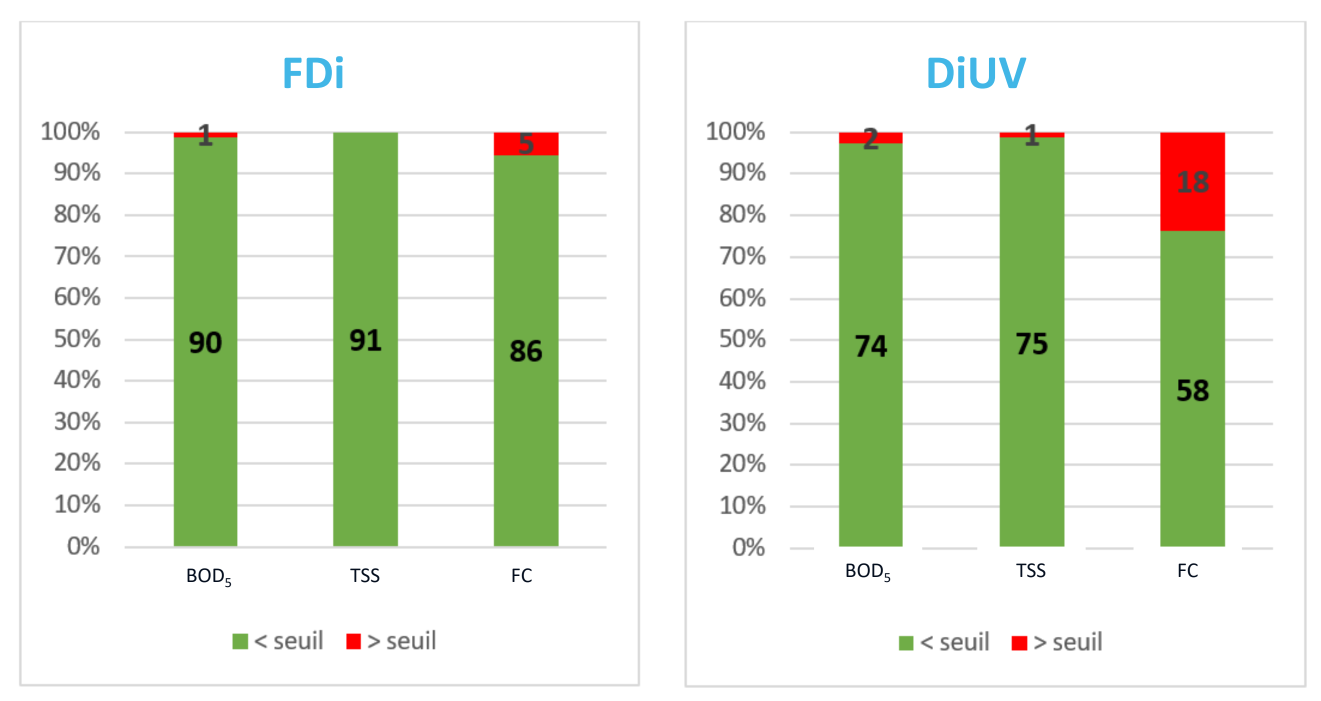
- DiUV more stable than the FDi
- Regulatory thresholds:
  - DiUV 99,7% compliance (20 UFC/100 mL)*
  - FDi 97% compliance (200 UFC/100mL)



*Ref: Photoreactivation - Demers 2004, MELCC 2005

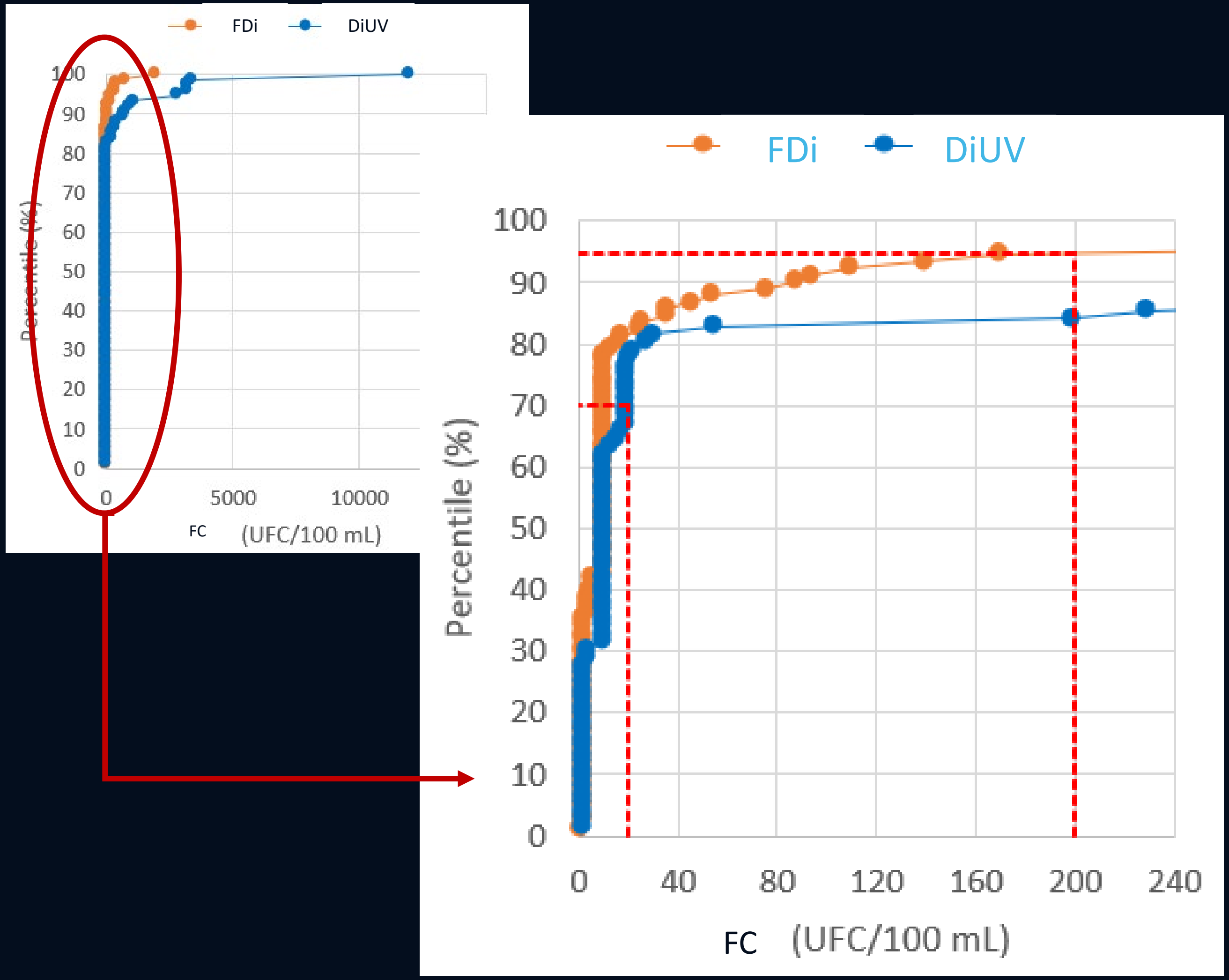
FIELD AUDIT | IN-SITU

- FDi better performance and more stable than UV units*
- Regulatory thresholds:
  - FDi 94% compliance (86/91)
  - DiUV 76% compliance (58/76)



* Noted that more than 50% of units evaluated in in situ conditions were "self-cleaning" UV units and all systems were maintained at least once a year

FIELD AUDIT | IN-SITU



- Percentile- regulatory thresholds:
  - FDi : 94.6%
  - DiUV : 70%

    70% - photoreactivation

    85% - w/o photoreactivation

Conclusions:

UV vs biological disinfection

These results demonstrate the limit of platform tests for disinfection technology as UV light:

- Testing platforms are using municipal wastewater where concentrations
  in calcium, iron and manganese are at low level compared to characteristics
  of groundwater mainly used for single dwelling installation.
- No reject of softener backwash as observed for onsite system.
- Few period of time at zero flow promoting carbonates precipitations on quartz tube.

Conclusions:

UV vs biological disinfection

- Based on the previous, few fouling of quartz tube is observed on platform and no maintenance is required to maintain good conditions for UV efficiency (UV light transmission)
- In real conditions, compliance to regulatory threshold could be reach (without photoreactivation consideration) if intensive maintenance is provided (more than 50% of tested units were "self-cleaning" devices and all systems were maintained at least once a year)
- FDi – No significant performance difference between bench test and field testing
- FDi – robustness of the passive approach

Thank you!

Questions?

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