Biological degradation of spent de-icing fluids in a municipal wastewater treatment plant – experiences and challenges

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Introduction

Deicing chemicals necessary to ensure safety.

Runoff causes major local pollution problems.

At the Oslo Airport (OSL):

- > Monopropylene glycol (MPG) is used for aircraft deicing and anti-icing.
- > Formiate is used for runway, taxi strip and gate area deicing.
- > Goal is to collect and recycle/reuse/treat as much spent deicing fluid as possible.

Deicing platforms

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Collection of spent airport deicing fluid (DF)

Fraction (A): ~10-12 % MPG
Feasible for recycling.

Fraction (B): ≤ 2 % MPG (34000 mg/L COD)
Majority used as external C-source for denitrification at nearby municipal WWTP.

Fraction (C): Dilute mixture of MPG and formiate runoff.

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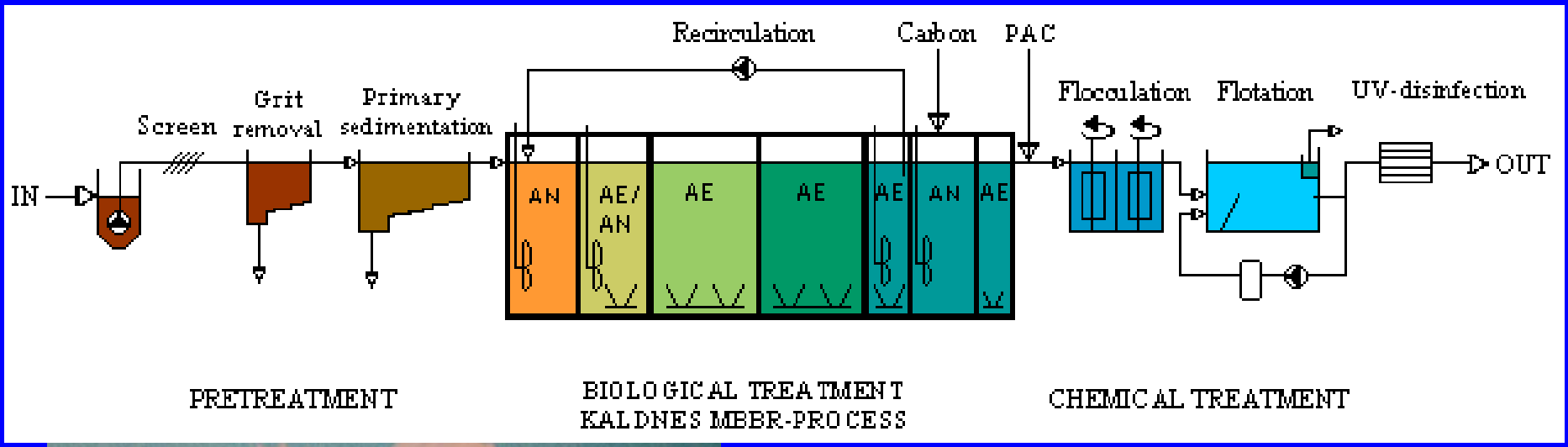
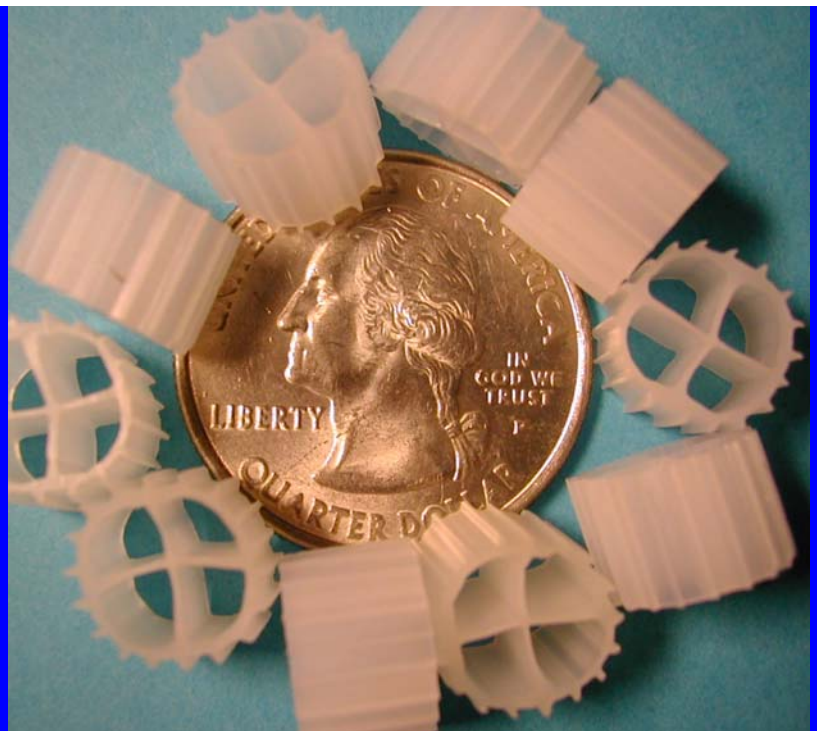
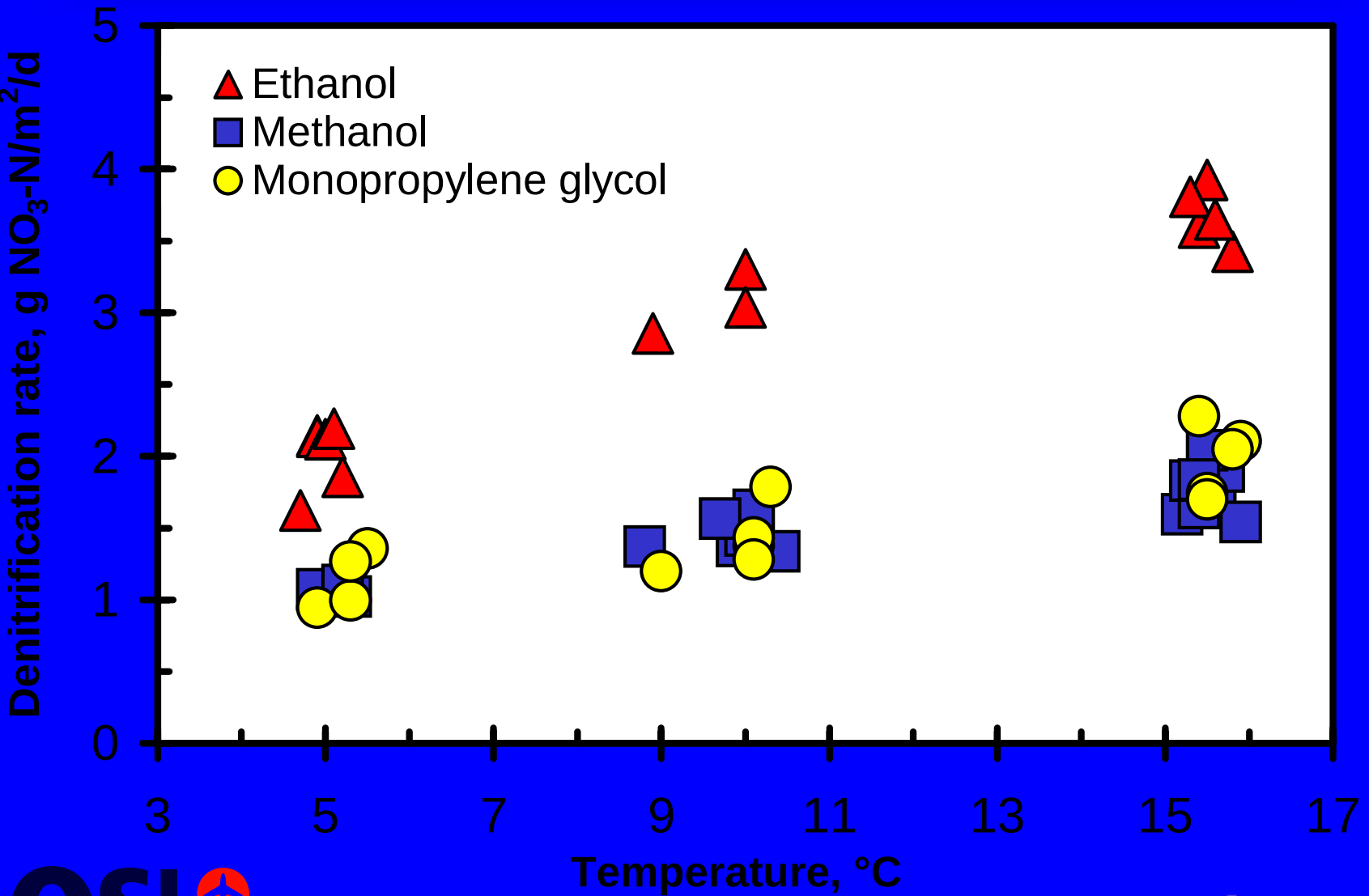
Existing municipal WWTP





DN rates for alternative carbon sources



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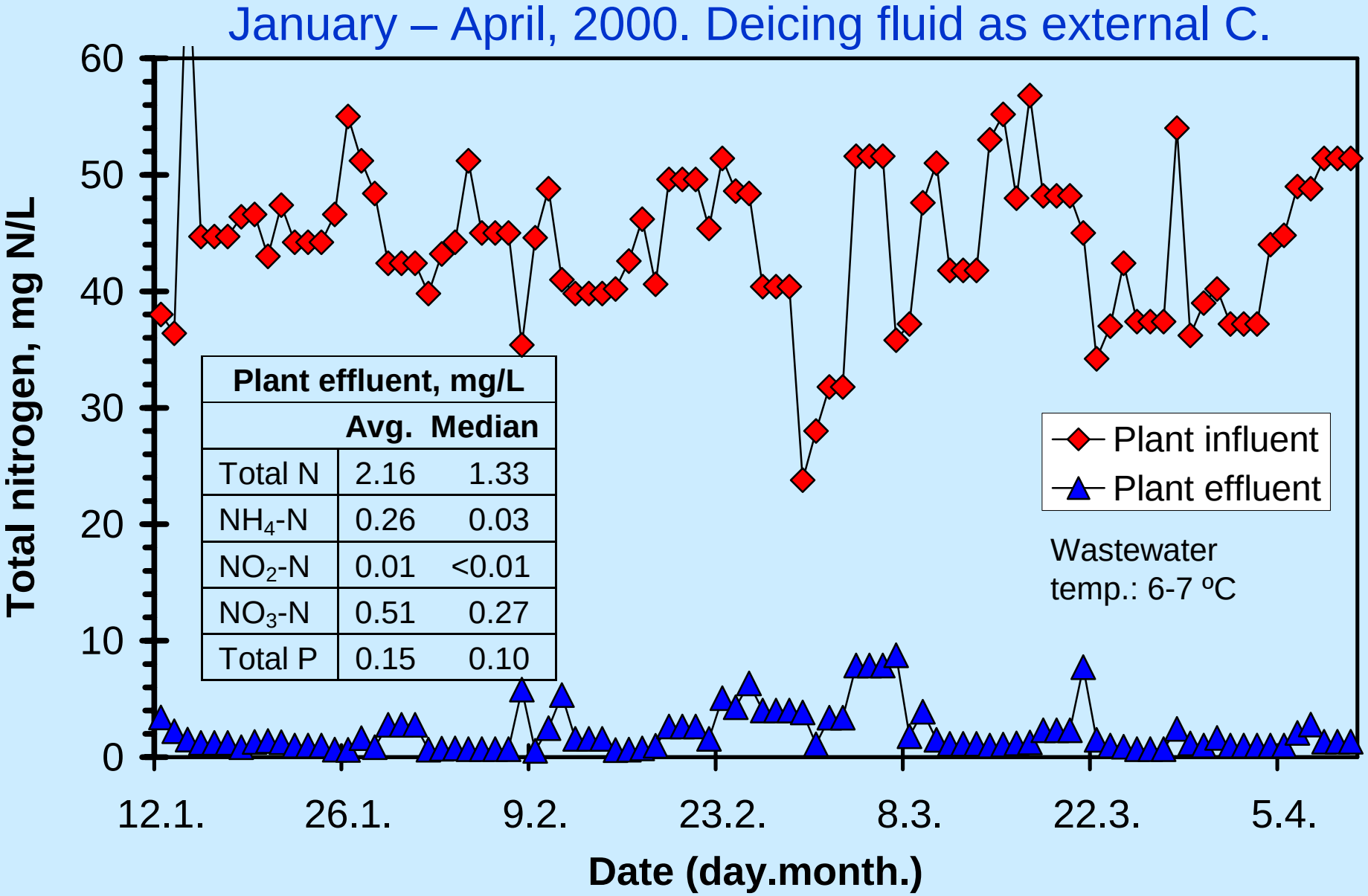
Gardermoen WWTP – 1st guarantee testing



Plant effluent, mg/L		
	Avg.	Median
Total N	2.16	1.33
NH_4-N	0.26	0.03
NO_2-N	0.01	<0.01
NO_3-N	0.51	0.27
Total P	0.15	0.10

Additives studied:

- Fatty alcohol ethoxylate
- Benzotriazole
- Sodium petroleum sulphonate

Application of results:

The results were initially used to limit the discharge of spent de-icing fluid to ensure that the discharges did not cause environmental harm.

OSL then initiated the supplier to use more environmentally sound additives in de-icing fluids delievered to Norwegian airports.

Alternative concepts for treatment of dilute DF runoff

(I) New pre-treatment plant fully integrated with municipal WWTP. Municipality builds and operates.

(II) OSL builds and operates new pre-treatment plant. Pre-treated WW and dewatered sludge to municipal WWTP.

(III) OSL builds and operates new plant for complete treatment. Dewatered sludge to municipal WWTP.

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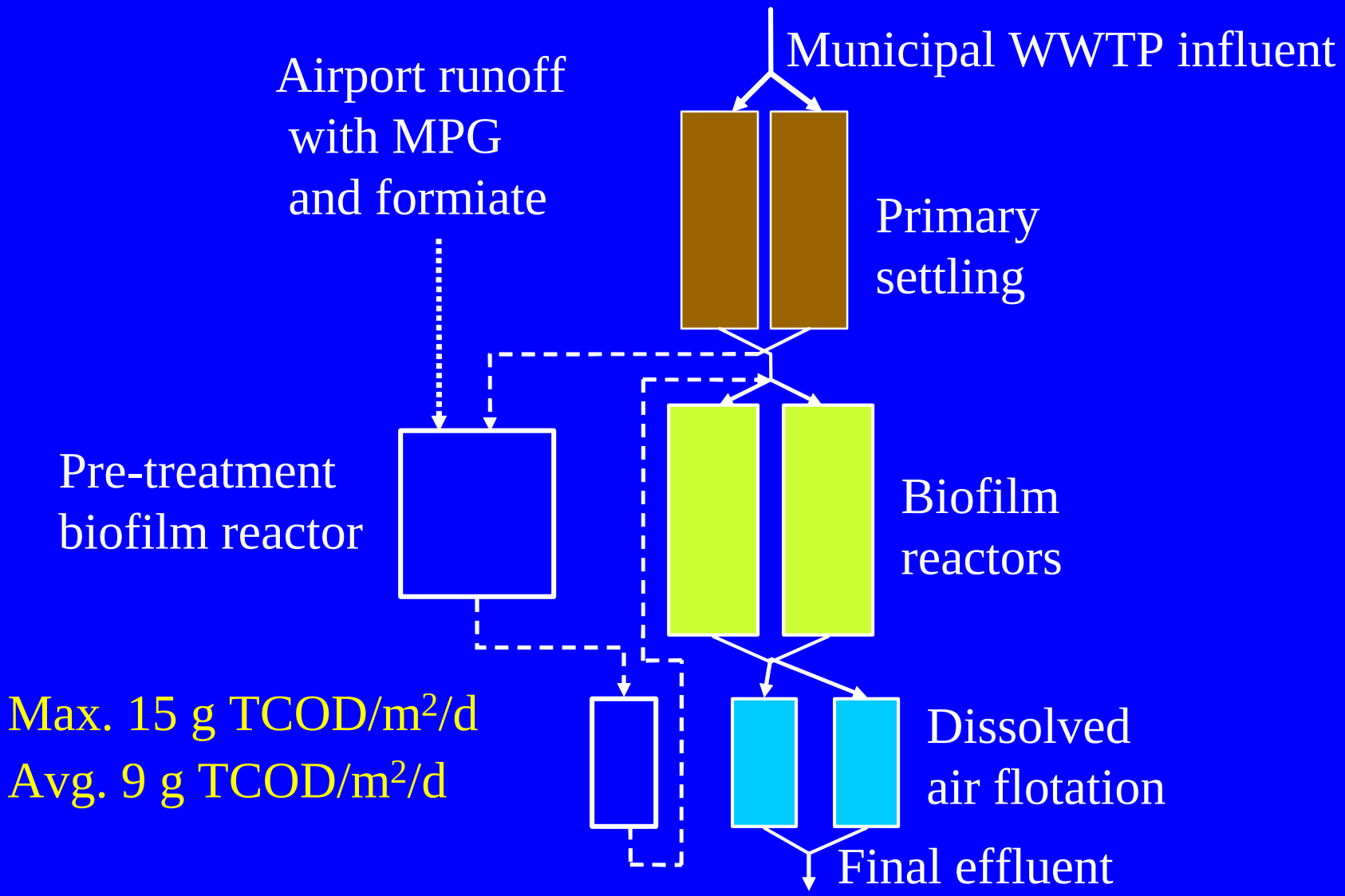
Alternative (I): Pre-treatment for DF runoff integrated with municipal WWTP

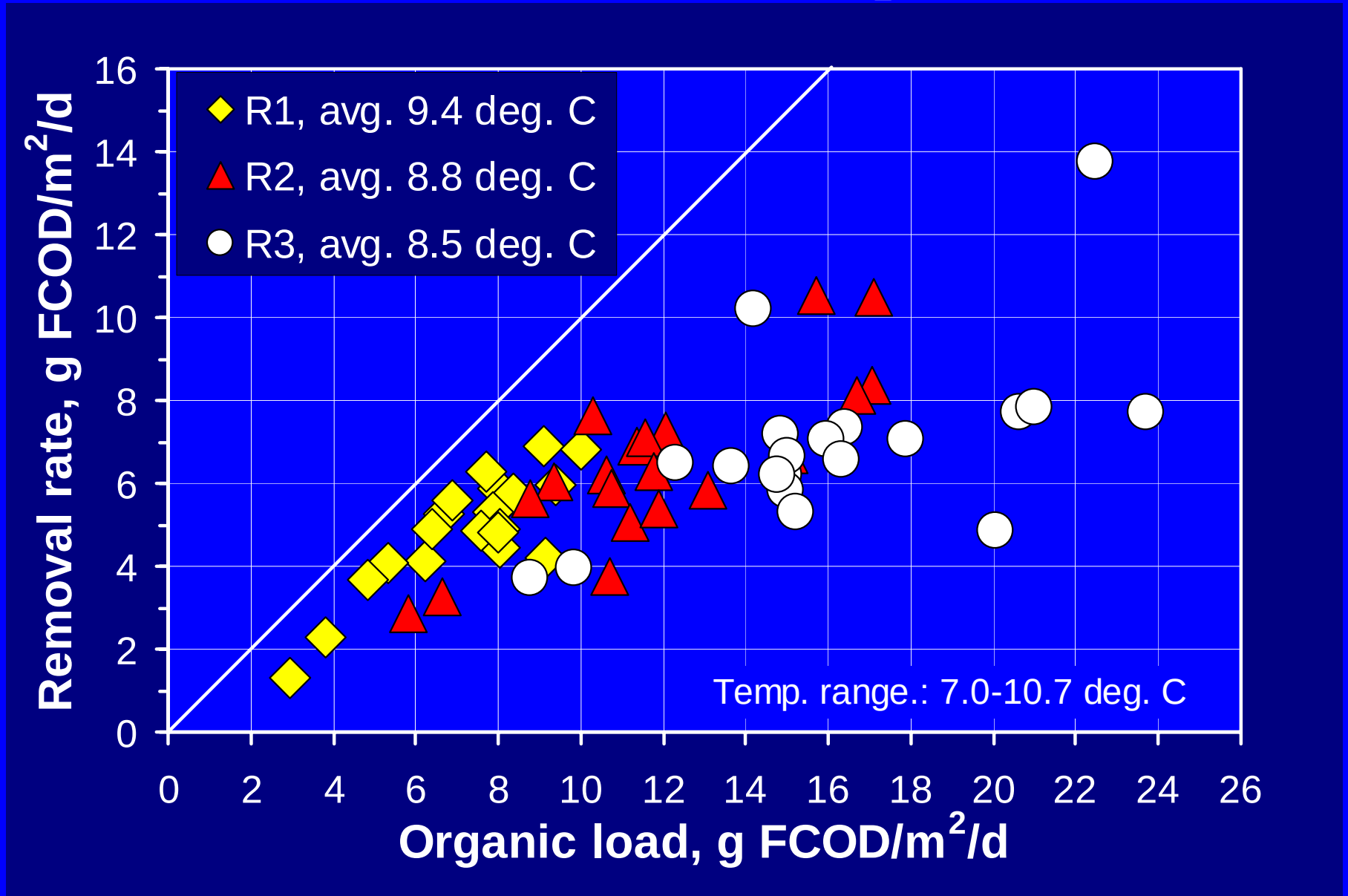


OSL decided to run pilot and lab-scale tests to verify design

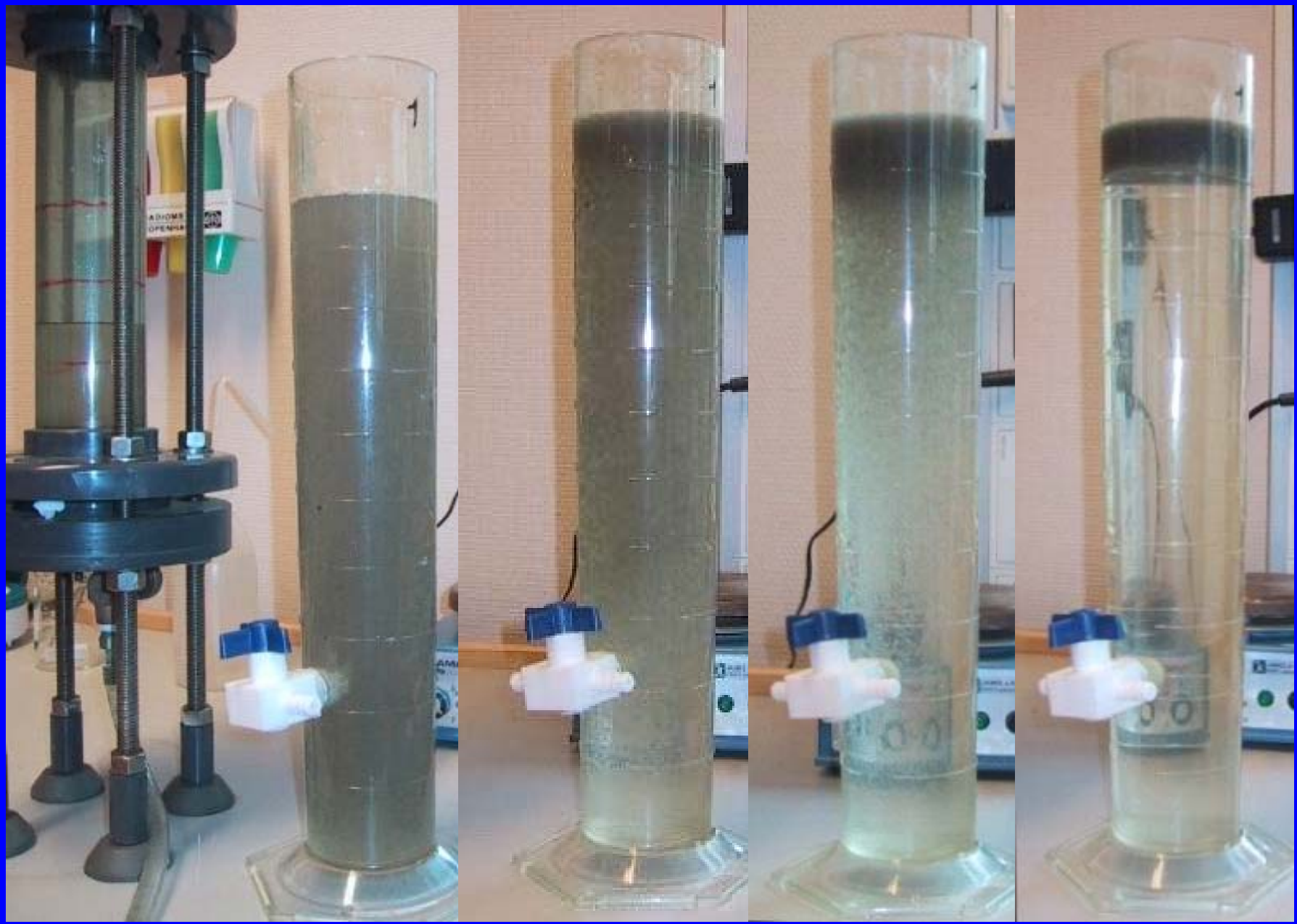
- Moving bed biofilm reactors (MBBRs) with Kaldnes type K1 biofilm carriers:
  - > Large Pilot-Plant
  - > Small Pilot-Plant
  - > Lab-Scale Reactors
- DAF separation of biofilm solids (Jar-test apparatus and small, batch-operated DAF)

Results from biological treatment

Lab-scale MBBRs in test period one



DAF separation of biofilm solids



CONCLUSIONS – DF pre-treatment

Tests confirmed validity of original design values used for pre-treatment of DF runoff from the Oslo Airport.

At temperatures of 8-9 °C and organic loads up to 23 g TCOD/m^2/d in the biofilm reactors, subsequent coagulation with 280 to 340 mL PAX-21/m^3 wastewater, followed by DAF separation, produced a pre-treated effluent suitable for discharge to the biological stage at the municipal WWTP.

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CONCLUSIONS – DF pre-treatment

Treatment at very low temperature (3.5 °C) resulted in higher than desired effluent concentrations. Thus, cold DF runoff should be mixed with as much of the warmer, primary treated wastewater as possible.

Full-scale pre-treatment plant completed in 2004, and has performed very well. Average effluent concentration of only 111 mg COD/l after pre-treatment.

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