Warsaw University of Technology
Faculty of Environmental Engineering

Dissolved Ozone Flotation as a innovative and prospect method for treatment of micropollutants and wastewater treatment costs reduction

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12th WWW YES, Arcueil, France, 21 - 25 May 2012

AGENDA

• Dissolved Air Flotation (DAF) vs. Dissolved Ozone Flotation (DOF)

• Possible enhancements in water/wastewater tratment by DOF

• Aims of the project

• Materials and Methods

• Results

• Merits and demerits of DOF

• Research plan

• Conclusions

Dissolved Air Flotation - theory

• separation of liquid and particles

• fat, oils, suspended solids, coloids (after agglomeration) removal

• mining industry, water and wastewtaer treatment

• conventional flotation – bubbles ~ 100-300μm
micro- and nanoflotation ~ 5-20μm

• pre-treatment of industrial wastewaters (dairy, fruit& vegetable, paper etc.), separation of excess activated sludge and effluent

• coagulation and flocculation needed before separation

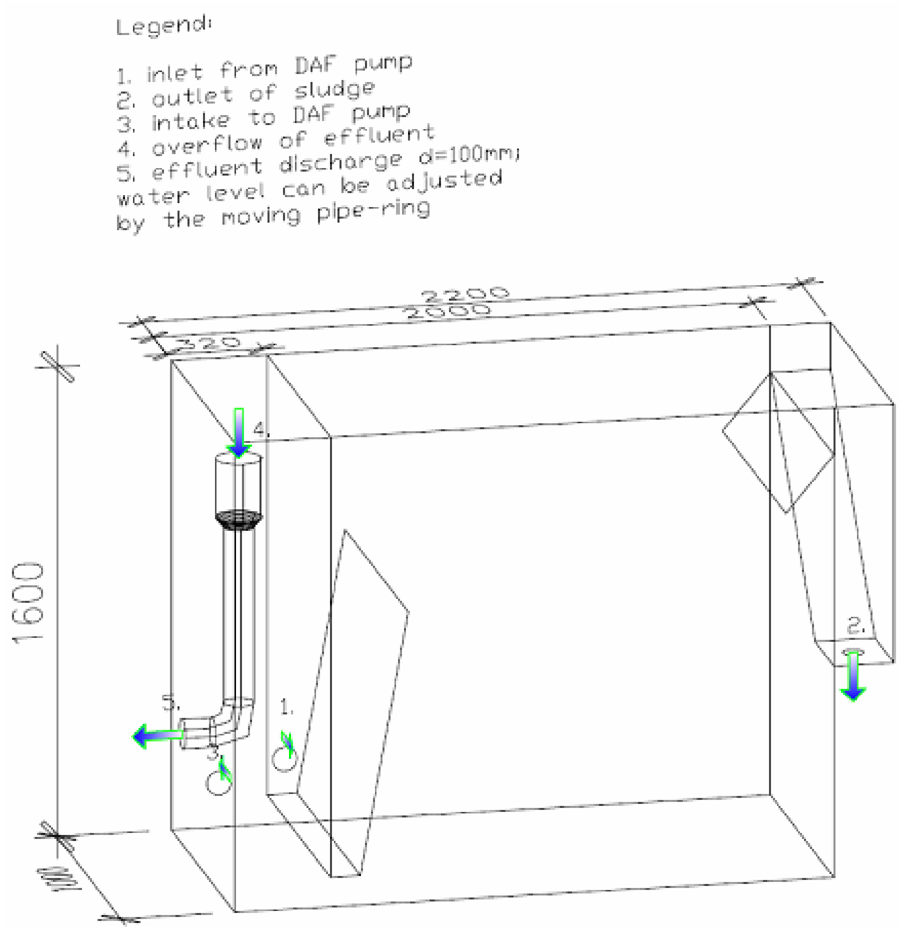
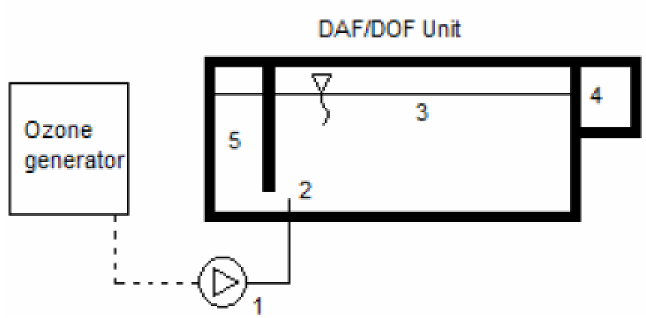


Figure 1. Scheme of DAF unit

Dissolved Air Flotation vs. Dissolved Ozone Flotation theory

Feature	DAF	DOF
feeding gas	oxygen, air	ozone
oxidizing ability	+ (only oxygenation)	+++++
TSS reduction	+++++	++++
COD reduction BOD reduction	++ ++	++++ ++++
▪ biodegrability of effluent compare to influent	the same	Improved/higher
coagulants and flocculants dosing	needed	small amounts or not needed
external equipment	not needed	ozone generator

Figure 2. DAF/DOF testing unit



Possible enhancements in water/wastewater tratment by DOF

• removal of micropollutants, odour removal

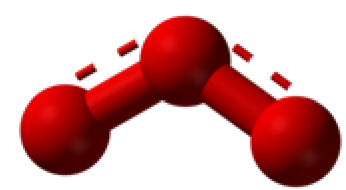
• increase of pollutants biodegradability in wastewater

• reduction of wastewater treatment costs by reducing the footprint of biological treatment step

• reduction in chemicals (coagulants and flocculants) dosing

• the algae removal from water to prepare it to potable water conditions / algae harvesting for further usage (biofuel, pharmaceuticals, animal’s food etc.)

• reduction of the excess sludge generation – DOF for final separation



Aims of the project

• to examine the effectiveness of a combination of two processes: micro- and nanoflotation with ozonation

• to examine technical and operational factors affecting the process (bubbles size, pH conditions, coagulant and flocculant addition)

• to examine treatment efficiency of the DOF process compare to DAF process in case of treatment fracturing fluids, industrial wastewater and water containing algae

• to choose trace micro-pollutant (i.e. biocide in used fracturing fluid) and check its removal efficiency by DOF with comparison with DAF method

• to examine the potential reduction of operating costs and treatment efficiency

• to research the influence of ozone on potential increase of wastewater biodegradability

Materials and Methods

• laboratory flotation unit/ pilot testing
(ozone generator 10g/h, DAF –Nikuni pump, flotation unit V=150L)

• physiochemical and technical parameters influence

- pH, temperature
- bubbles size (ozone mass transfer)
- ozone dosage, oxidation rate vs. economy,
- process kinetics

• chemical analysis

- COD, BOD, TOC, TSS removal
- biodegrability and toxicity

• chromatography: GC or HPLC for detailed analysis of chemical compounds transformation

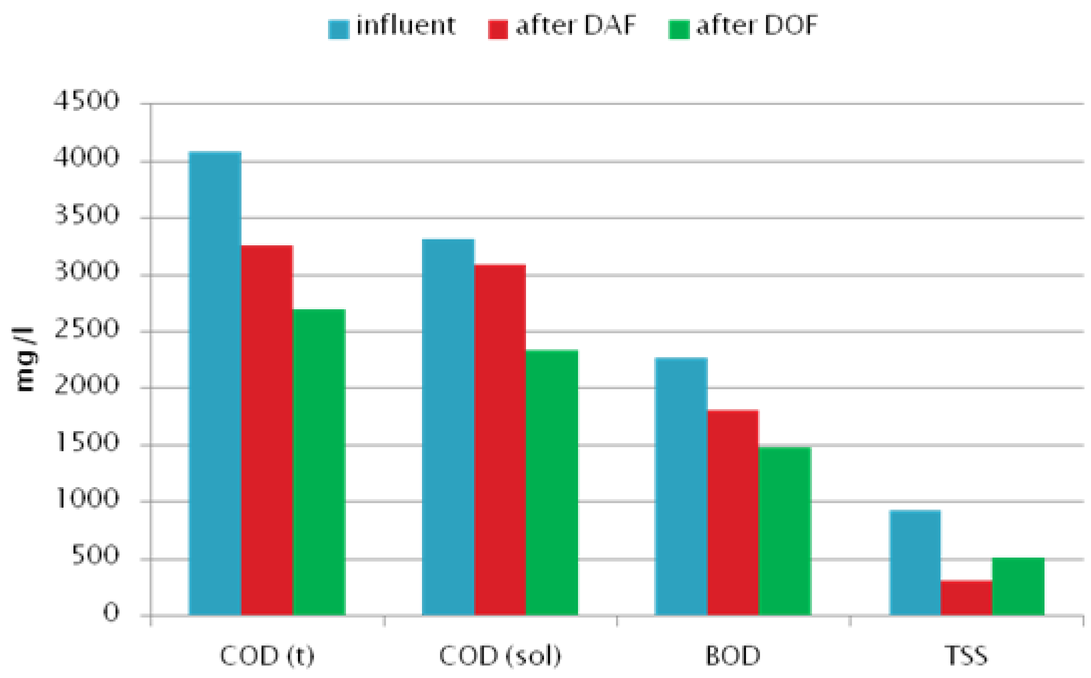
Results

- apple processing plant, Q=1 400m^3/d
- at the moment: sieve – DAF – biological treatment (activated sludge)
- DAF: iron(III) sulfate and anionic polymer (optifloc)

Following reductions:

- COD: 20.1 % DAF – 33.8% DOF
- BOD: 20.3% DAF – 34.8% DOF
- TSS: 66.6% DAF – 45.2% DOF

- oxidation yield: 0,07gO_3 / 1gBOD
  23mgO_3 /dm^3



Results

Parameter	Unit	After DAF	After DOF	% reduction for DOF compared to DAF
Reactor size	m^3	3 807	3 587	5.8
Oxygen demand	kgO_2/h	105.2	129.0	18.5
Air demand	Nm^3/h	3 150	3 870	18.6
Energy demand for aeration (air blower motor power)	kWh	110	130	15.4
Excess sludge production	kg/d	1 816	1 648	9.3

• ATV method for dimensionig of biological treatment step

• biological reactor: high: 6.0m; process temperature 15°C

• total savings: 32 000 €/ year (lower energy consumption, iron (III) sulfate dosing, lower sludge production

Merits and demerits of DOF

1) Merits:

- more efficient water/ wastewater treatment

- reduction of biological treatment step, reduction of excess sludge production

- elimination of micropollutants

- synergy of mechanical treatment and ozonation in one unit

- possible cost reduction (coagulants, smaller biological plants)

2) Demerits

- control of excessive ozone – ozone sensors

- materials needed to construct resistant unit

- price of ozone generators

Research plan

• design and construction of laboratory flotation testing unit

• research on defining process parameters

• research on the wastewater from selected industries and fracturing fluids

• research on water containing algae

• elaboration of the results and publication in journals

• further questions and possible research aspects

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Conclusions

Results

• DOF more effective for COD and BOD removal than DAF

• TSS removal higher for DAF – polymer adjustment needed

• prospect pre-treatment method

Further research

• more harmful wastewater i.e. fracturing fluids, cosmetics wastewater

Further laboratory test would be focused on checking process efficiency in case of removal selected micropollutants i.e. biocide, wastewater toxicity.

• kinetics, pollutants transformation, factors affecting the process, process parameters

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