

Towards circular water: Upscaling advanced wastewater treatment by ozonation for pharmaceutical control

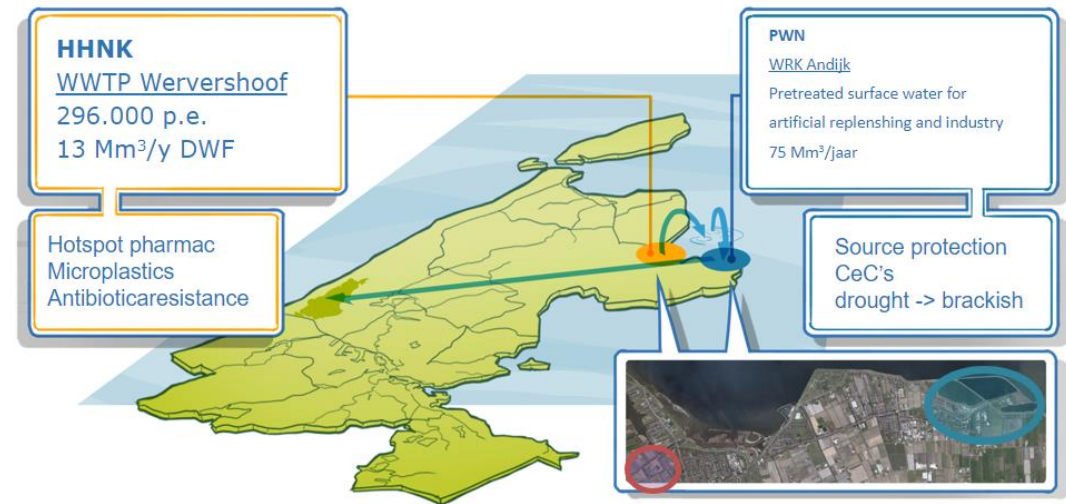
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Research partners

- HHNK, Water Authority North Holland
- PWN, Water Supply Company North Holland
- PWN Technologies, R&D Drinking Water Technology

Stakeholders interests research

- HHNK: Quality improvement
- PWN: Source protection
- HHNK & PWN: Wastewater reuse



Technical requirements

- 70% OMP degradation over the entire treatment process
- Bromate formation must be manageable

Research objectives

- Comparing two ozone injection systems to make better informed design decisions for the full-scale plant at WWTP Wervershoof
- Better understanding of ozonation and hands-on experience

Comparing ozone injection systems

Roturi®

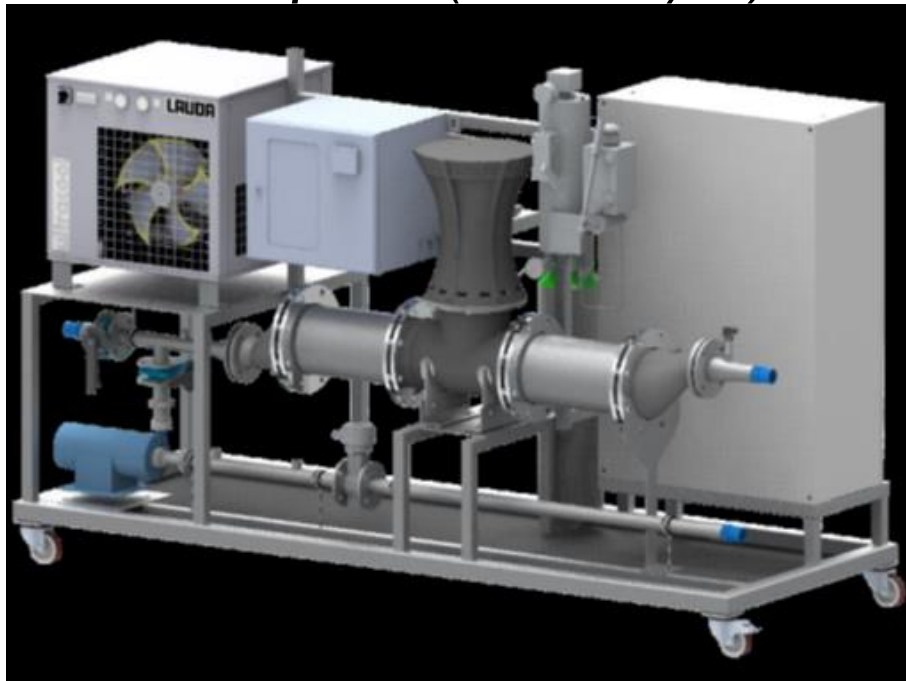
- Inline injection
- Rotating venturi
- No full-scale experience on WWTP effluent

Bubble Column

- Conventional system
- Proven technology for WWTP effluent (Germany, Switzerland)

Experimental setup

Roturi® pilot (10 m³/h)

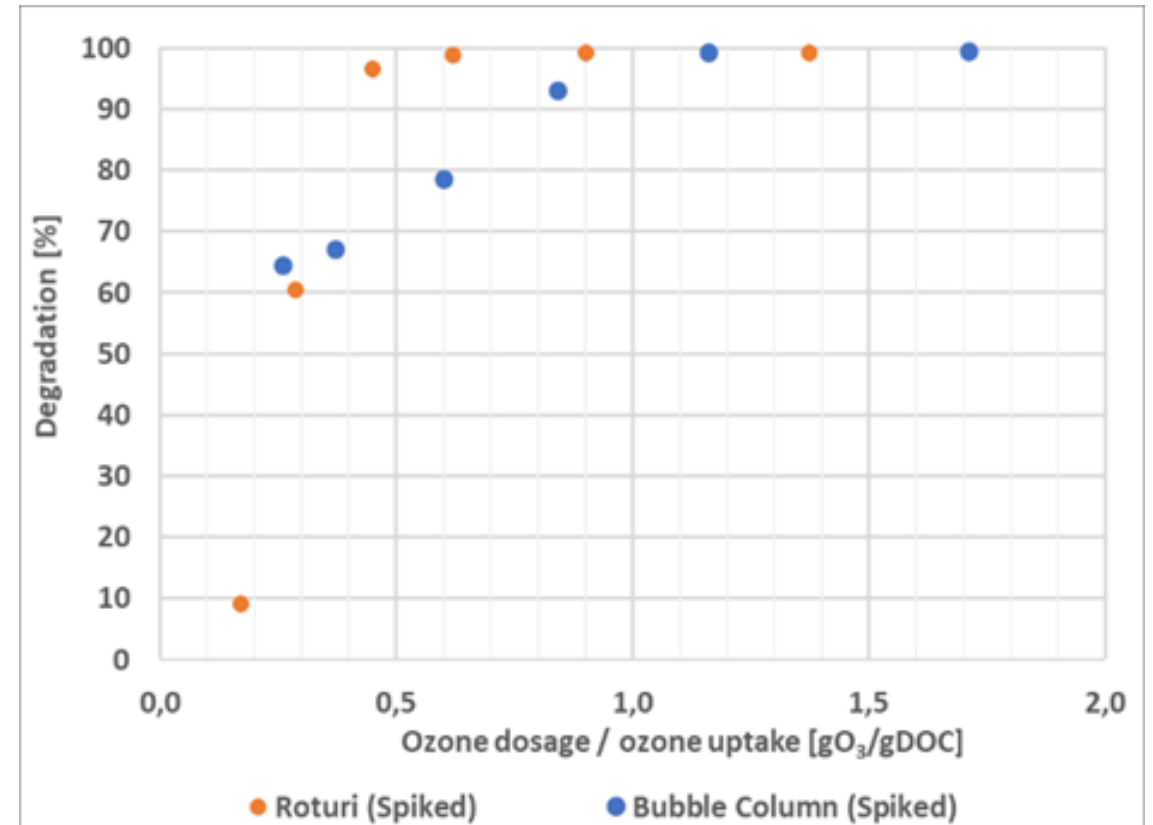


Bubble Column bench scale (6 L)



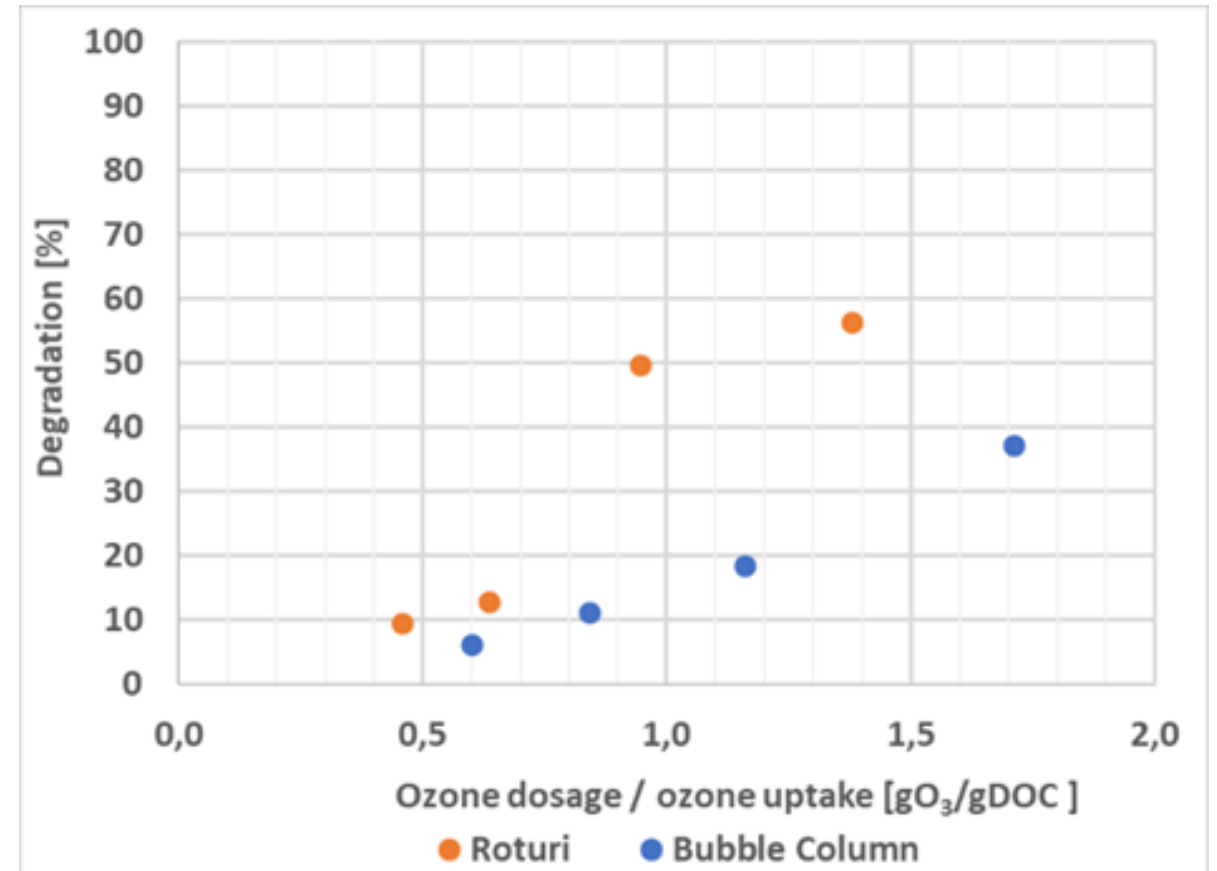
Roturi vs Bubble Column (Spiked)

- 11 Target pharmaceuticals
- Detection limit
- Spiked matrix (x100)



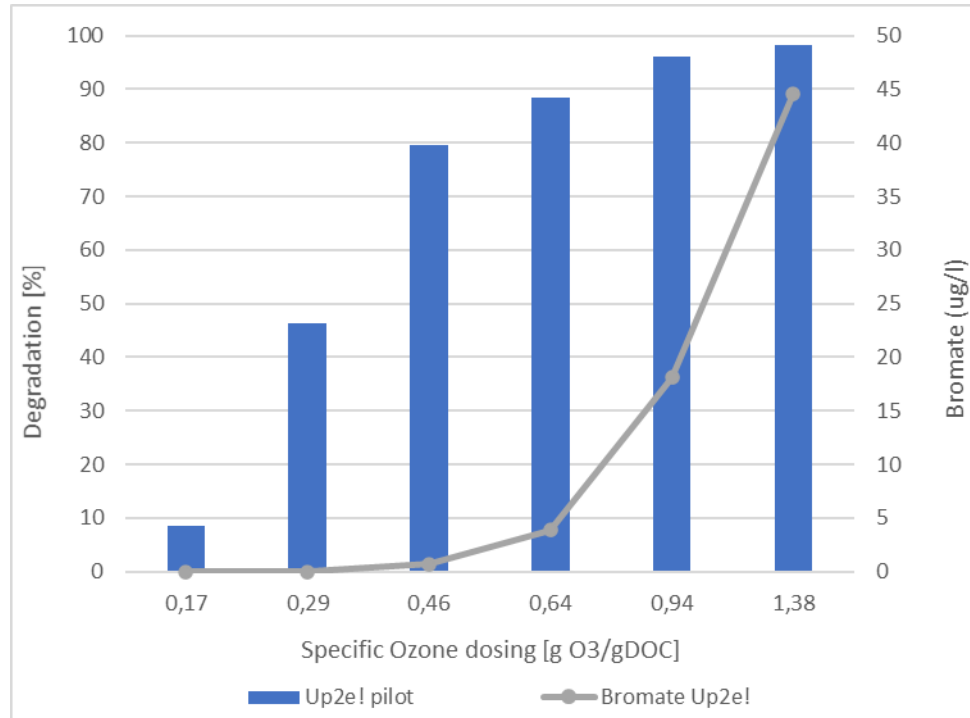
Roturi vs Bubble Column (Metformine)

- Low reaction rate constant for ozone (K_{O_3})
- Requires higher ozone dosage



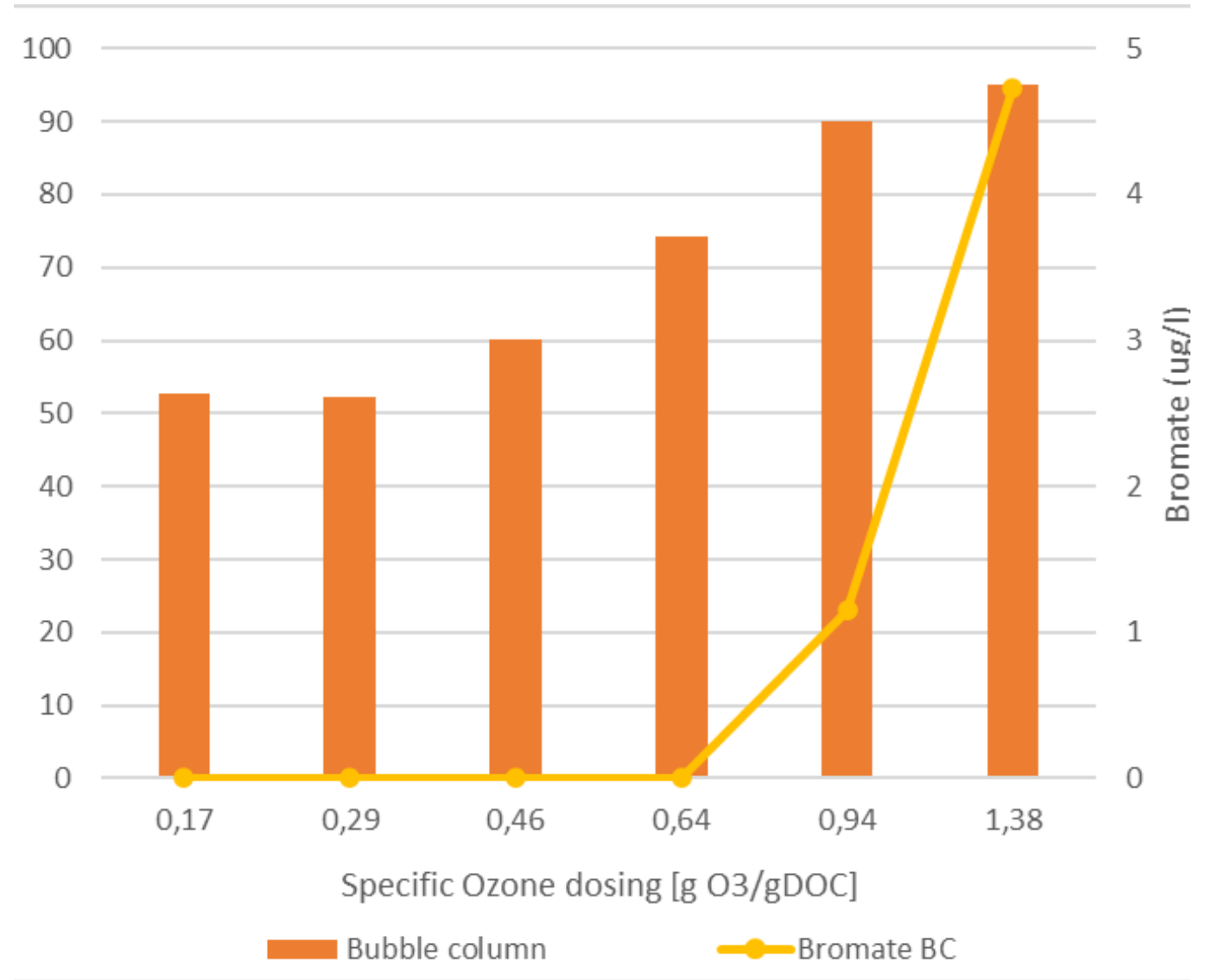
Bromate formation: Roturi

- High bromate formation



Bromate formation: bubble column

- Relatively low bromate formation



Conclusions

- The Roturi can degrade more OMP with a lower specific ozone dose than the bubble column
- The Roturi forms bromate faster at a higher specific ozone dose

WWTP Wervershoof

Load: 296000 p.e.

Q24: 50000 m³/d

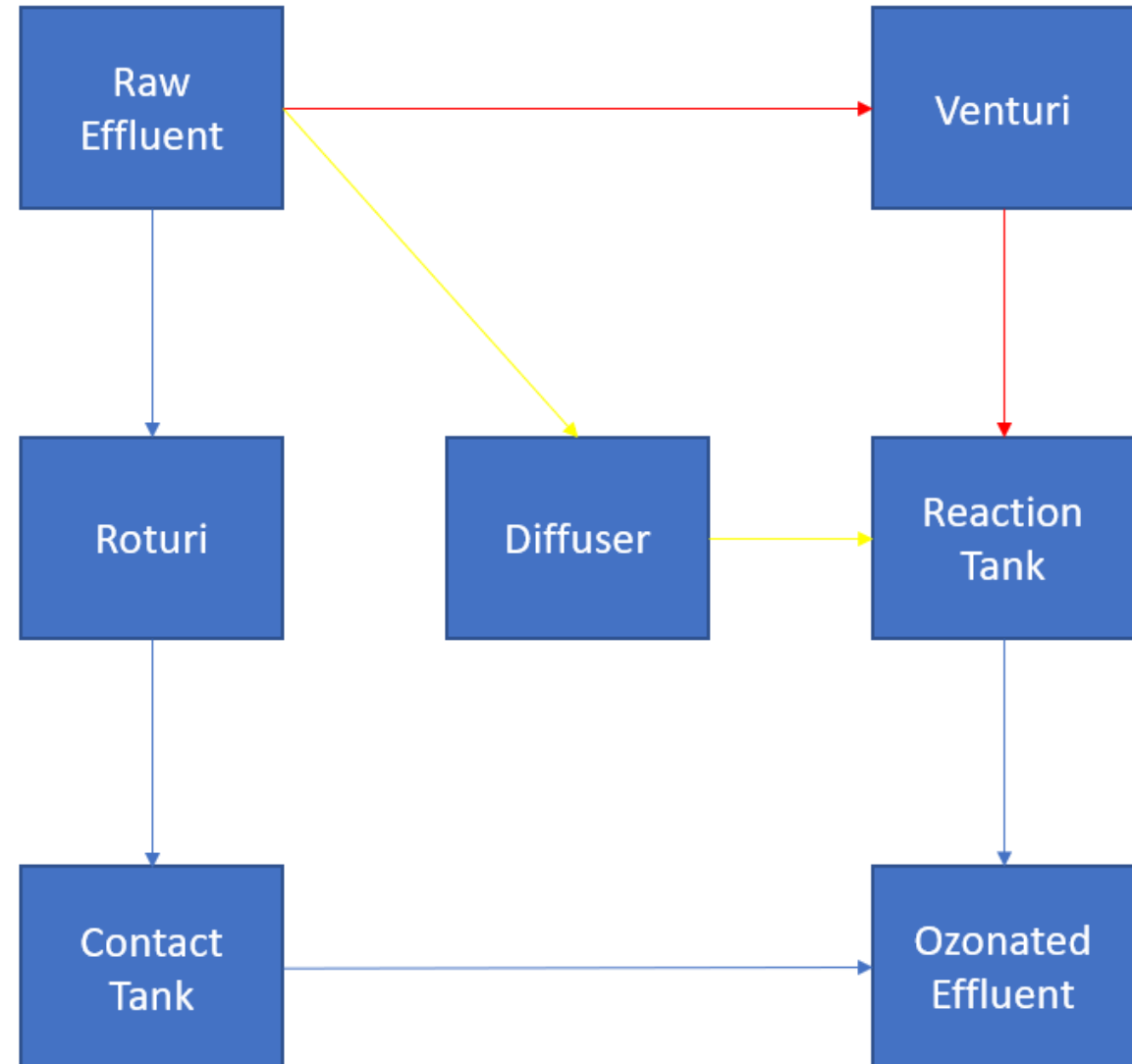
RWF: 7800 m³/h

DWF: 3000 m³/h



Design of the full-scale ozonation plant WWTP Wervershoof

- 3 different ozone injection systems
- 700 m³/h (1/4 of DWF)
- Modular design
- Expansion possible



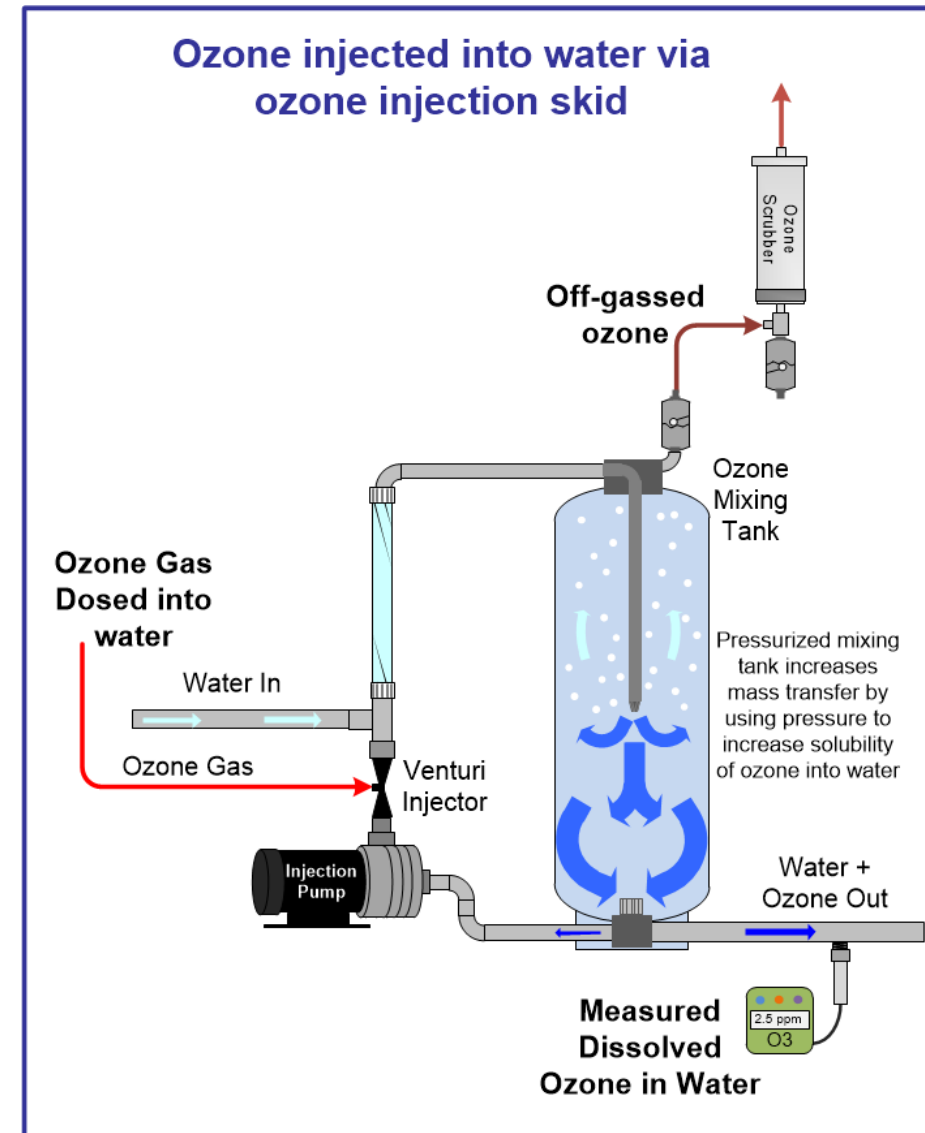
Roturi

- Inline injection
- Two Roturis
- Compact
- Contact tank



Venturi injection

- Conventional



<https://www.oxidationtech.com/ozone/solubility/venturi-injector-vs-bubble-diffusers.html>

Diffusers

- Conventional
- Reaction tank



Scaling up!

- Digital Twin for advanced process control
- Poster presentation at YWP
- Q3 - 2022

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