Ventilation in Sewers Quantified from Measurements of CO_2

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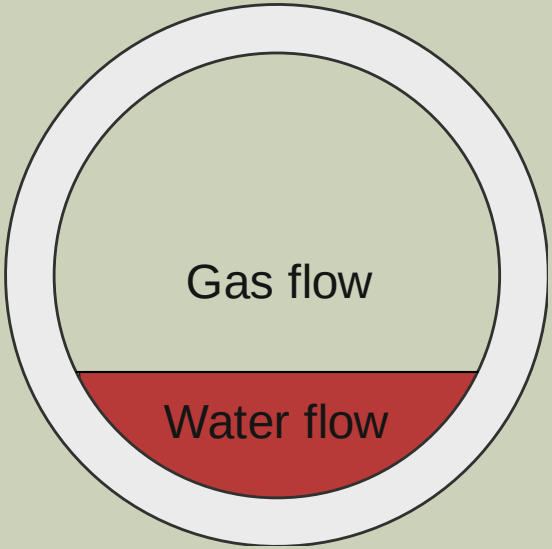
WHAT IS A SEWER?

- Conveyer of water
- Conveyer of gas
- Biological and chemical reactor



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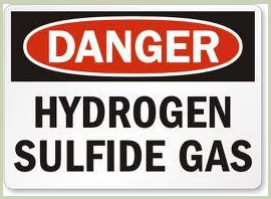
WHY STUDY VENTILATION?

- Odor problems
- As long as the smelly sewer gas stays in the sewer – why care?

- Asset corrosion
- Corrosive hydrogen sulfide attacks concrete and metals

- Safety issues
- Hydrogen sulfide is highly toxic



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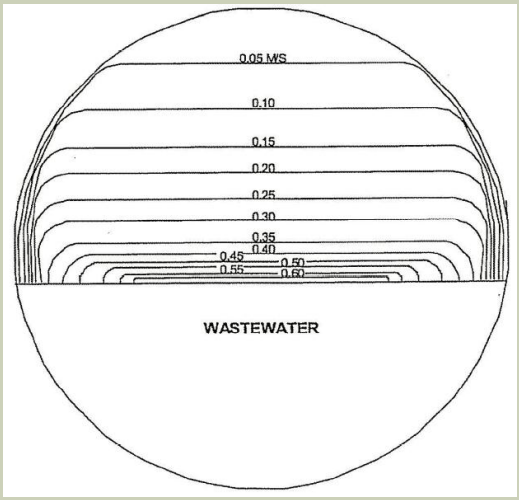
WHAT DO WE KNOW ABOUT SEWER VENTILATION?

- Sewer gas is transported by means of:
- Drag effects
- Wind at surface
- Barometric pressure gradients
- Temperature gradients
- Changes in water level – pumps starting and stopping



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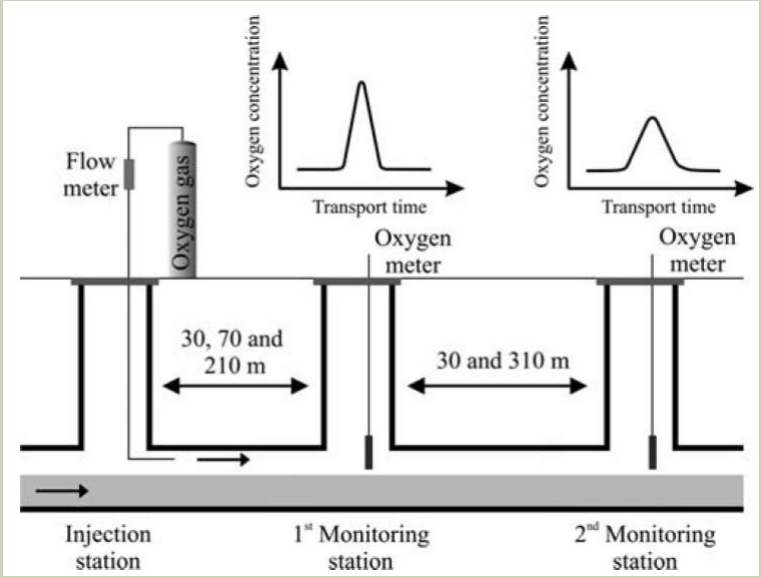
HOW IS VENTILATION MEASURED?

- Measuring methods typically used:
  - Anemometers
  - Tracer gas experiments
  - Pressure transducers
  - Physical models

- Ventilation is a dynamic phenomenon changing in time and space

- Tracer measurements and velocities are labour intensive and do seldom give us the full dynamics of the process



Madsen H I, Hvitved-Jacobsen T, Vollertsen J (2006).
Gas Phase Transport in Gravity Sewers – A methodology for determination of horizontal gas transport and ventilation.
Water Environment Research, 78(11), 2203-2209

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OBJECTIVES

- We test if CO_2 can be used as a naturally occuring tracer – overcomming those issues

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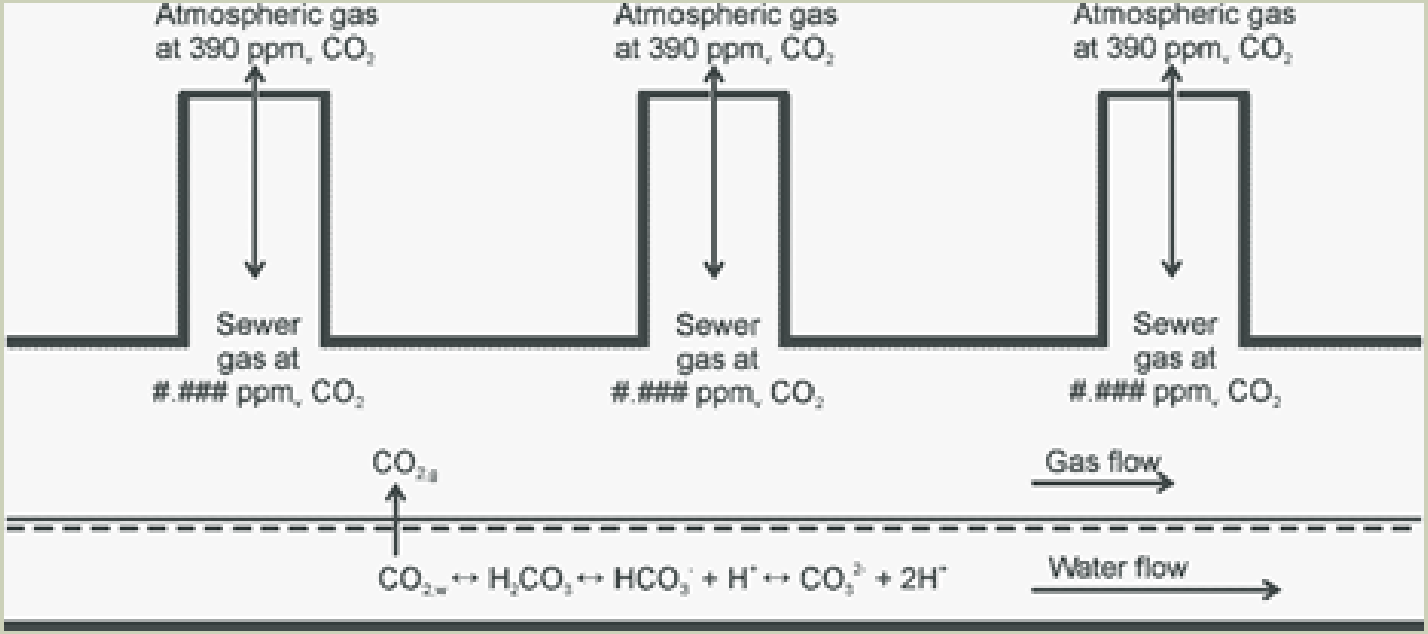
CONCEPTUAL IDEA



- High CO2 concentrations in water
  - Caused by biodegradation and potable water CO2 contents
  - Easily measurable
- Low CO2 concentrations in atmosphere
  - Constant

- CO2 is released at a known rate from water to gas
  - Release rates depend on hydraulic conditions in the pipe

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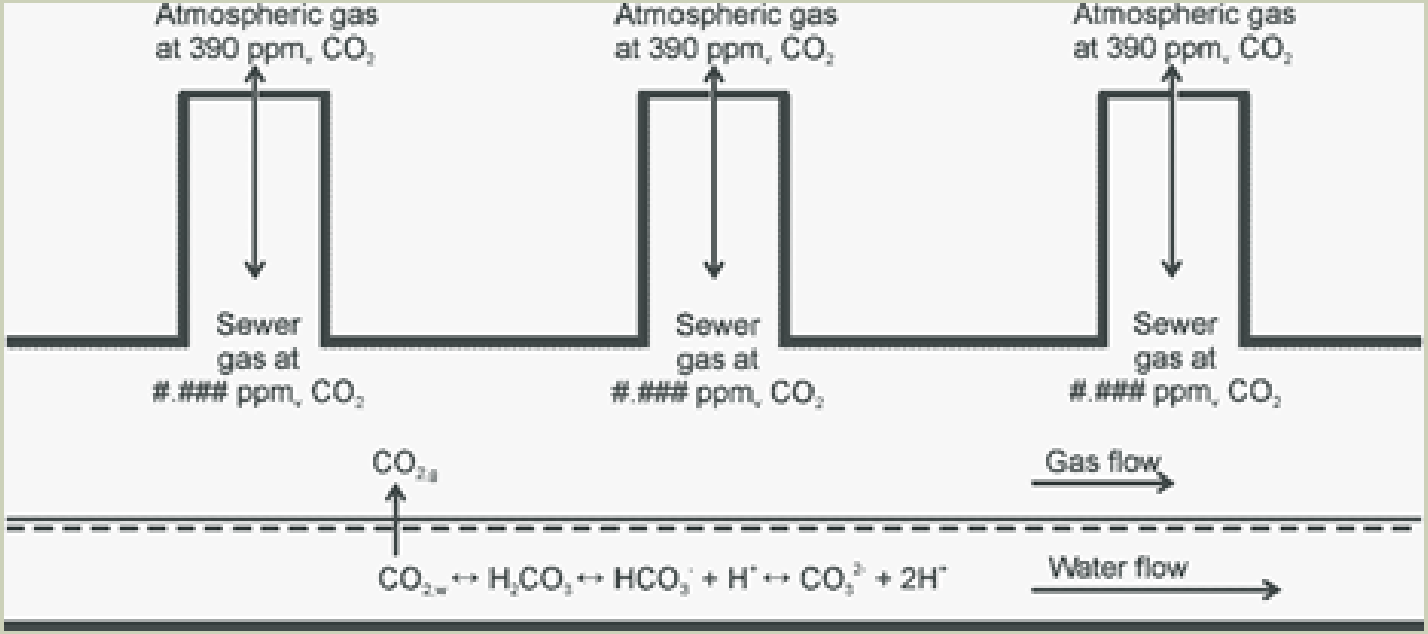
CONCEPTUAL IDEA



- In a completely closed system the partial pressure of CO2 is the same in the water as in the gas
- In a completely ventilated system, the partial pressure of CO2 in the sewer gas is the same as in the atmosphere

- In a partly open system, the CO2 concentration in the gas tells us how fast the sewer gas is ventilated out

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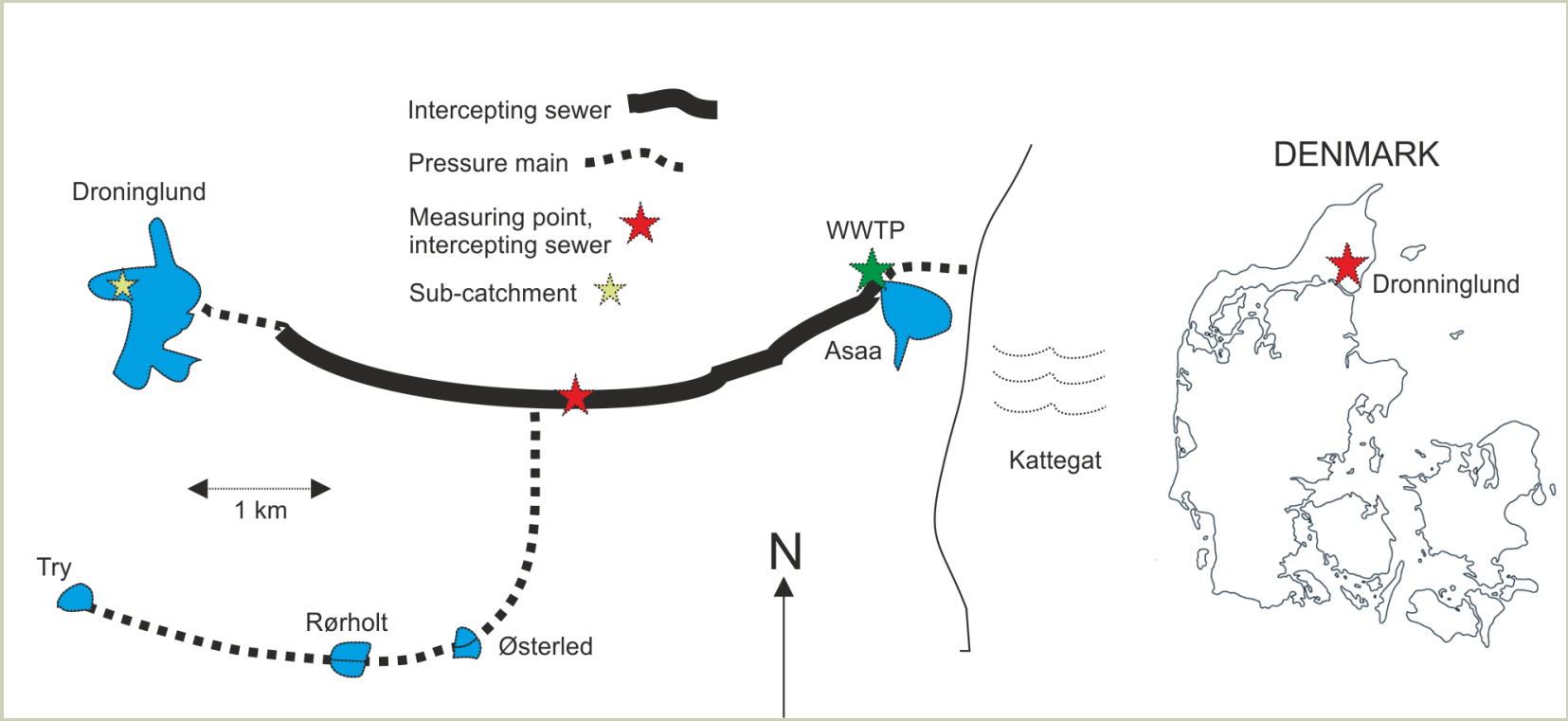
PROJECT SITE

- We have tested this at an intercepting sewer in Denmark



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MEASUREMENT CAMPAIGN

- Installation of equipment in the sewer

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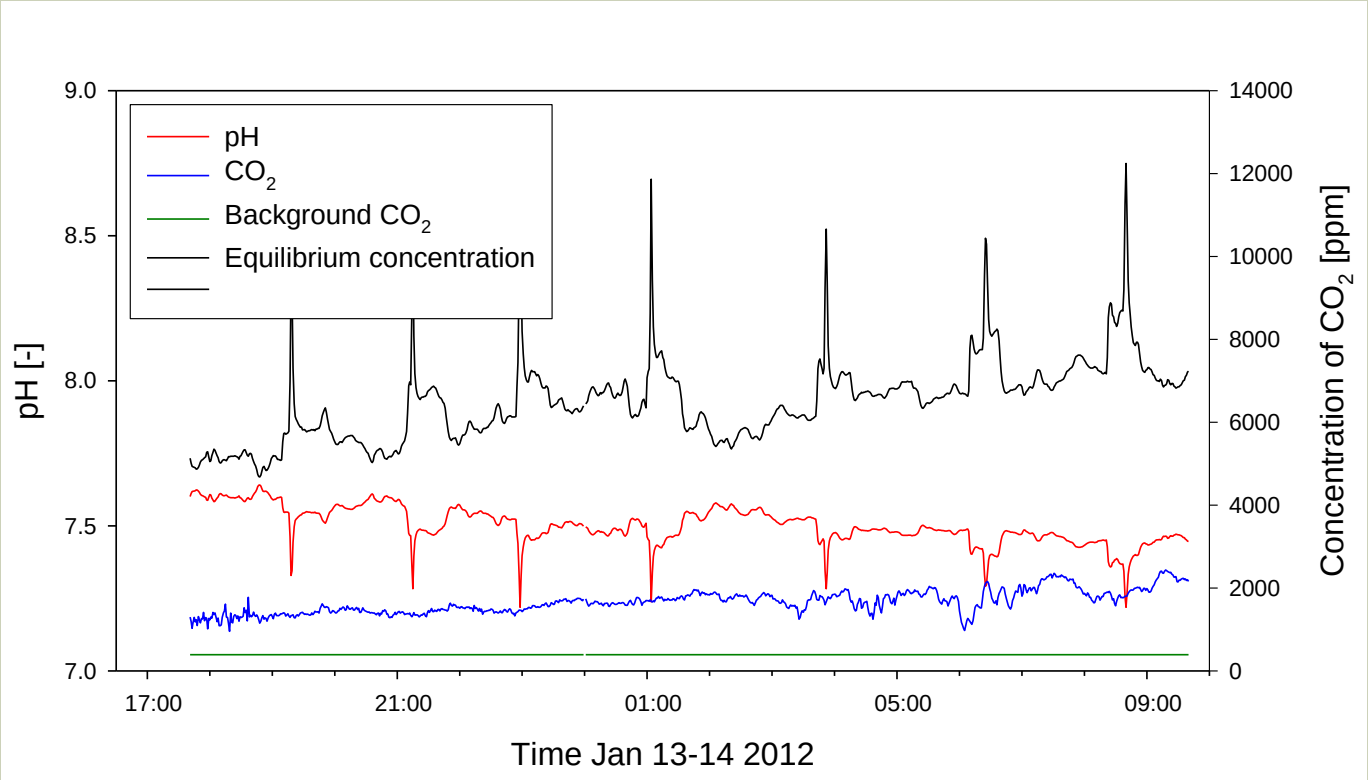
RESULTS

- Data from January 2012



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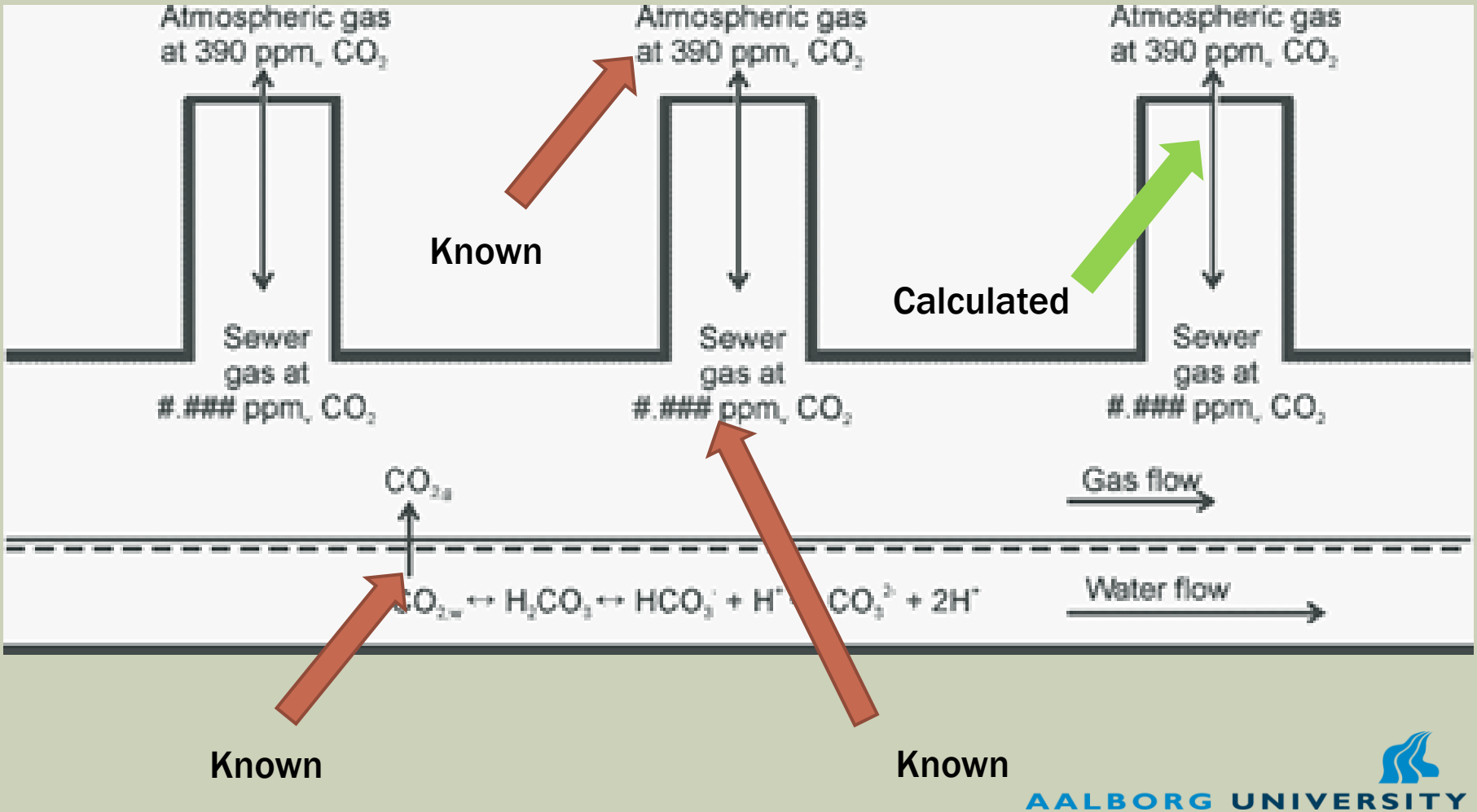
CONCEPTUAL IDEA



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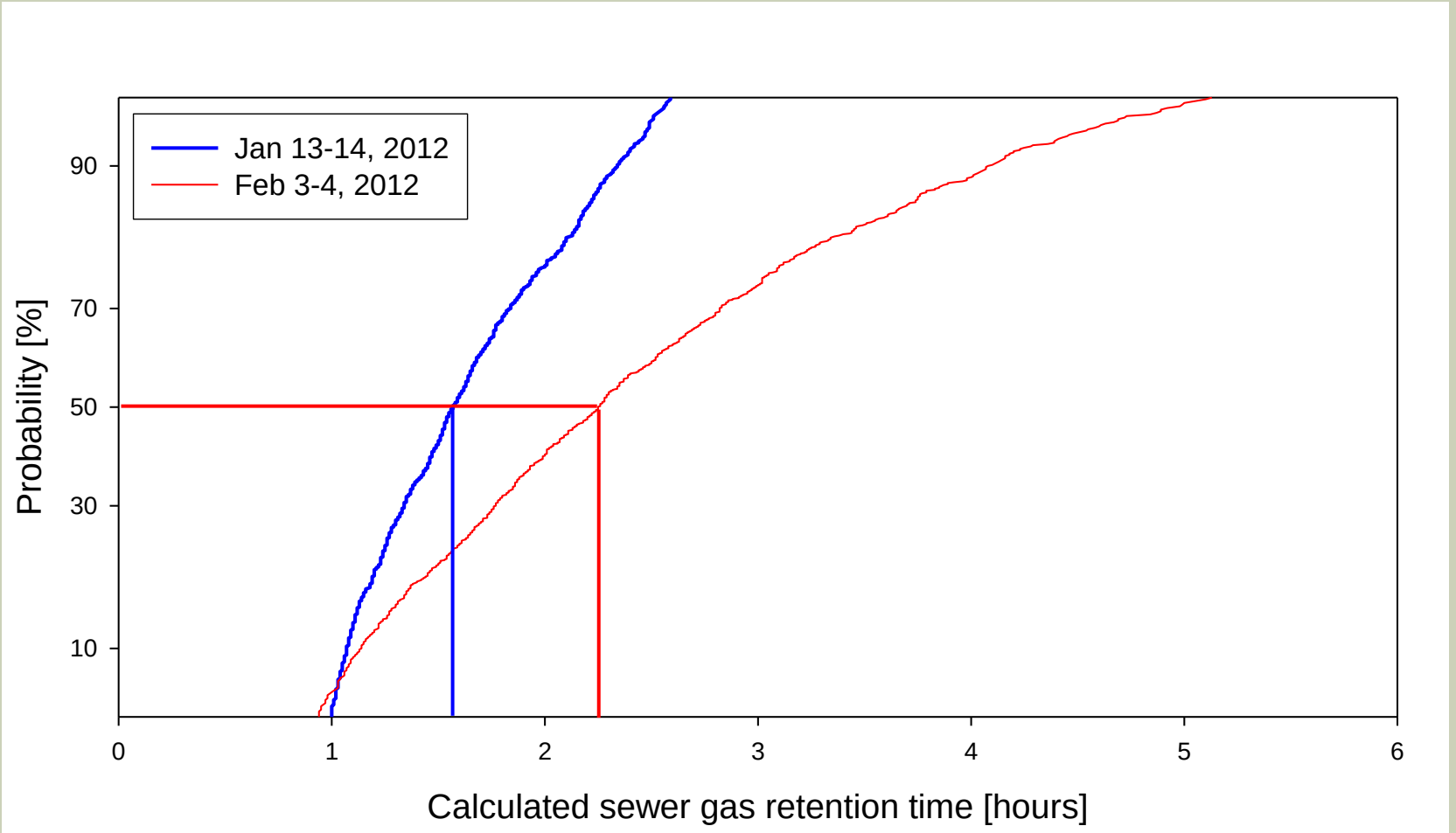
WHAT WILL THE RETENTION TIME BE?



LIMITATIONS OF THE METHOD

- To release CO_2 from the water to the air, pH must be below ~8
- A sufficient amount of alkalinity must be present in the wastewater

CONCLUSIONS

- A new approach to the sewer air ventilation has been suggested
- In this case study sewer-air retention times around 1.5-2.5 hours were found
- The method should be addaptable to other systems as long as the pH is not too high and when a certain amount of alkalinity is present

Questions?