Mass Transfer in Wastewater Chlorine Contact Channels

By

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Objectives

- Investigate chlorine loss in three open chlorine contact channels
  - Wind direction/speed across channels
  - Possibilities to conservation of chlorine

Google's Satellite Imagery

Open Channels' Schematic

90 million gallons/day

Methods

- Assumptions:
  - Well mixed, same concentration on any plane perpendicular to flow direction
  - Wind velocity and direction are constant
  - Channels are straight (curvature negligible)

Methods con't

- Theory:
  - Reynolds Number

$$\mathrm{Re} = \frac{\rho v L_c}{\mu}$$

    - Determination laminar or turbulent flow

  - Sherwood Number (Barry's Equation)

$$\frac{\bar{k}L}{D} = 0.0365(\mathrm{Re})^{\frac{4}{5}}(Sc)^{\frac{1}{2}}$$

    - Determination of the average mass transfer coefficient, k

Methods con’t

- Fuller-Schettler-Giddings

$$D = \frac{.001T^{1.75}M_{AB}^{1/2}}{P[(\sum v)_A^{1/3} + (\Sigma v)_B^{1/3}]^2}$$

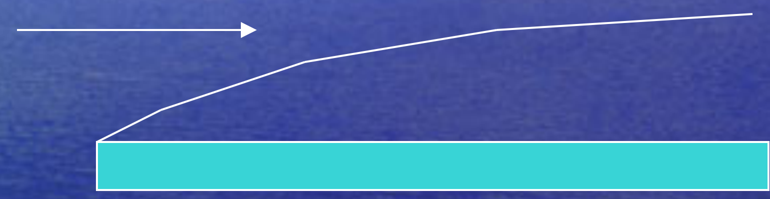
  - Determination of chlorine’s diffusivity

- Mass flux

$$E = \bar{k}MW\int_0^L C(x)dx$$

Boundary Layer Theory

Perpendicular wind
Thin boundary



Parallel wind
Thick boundary

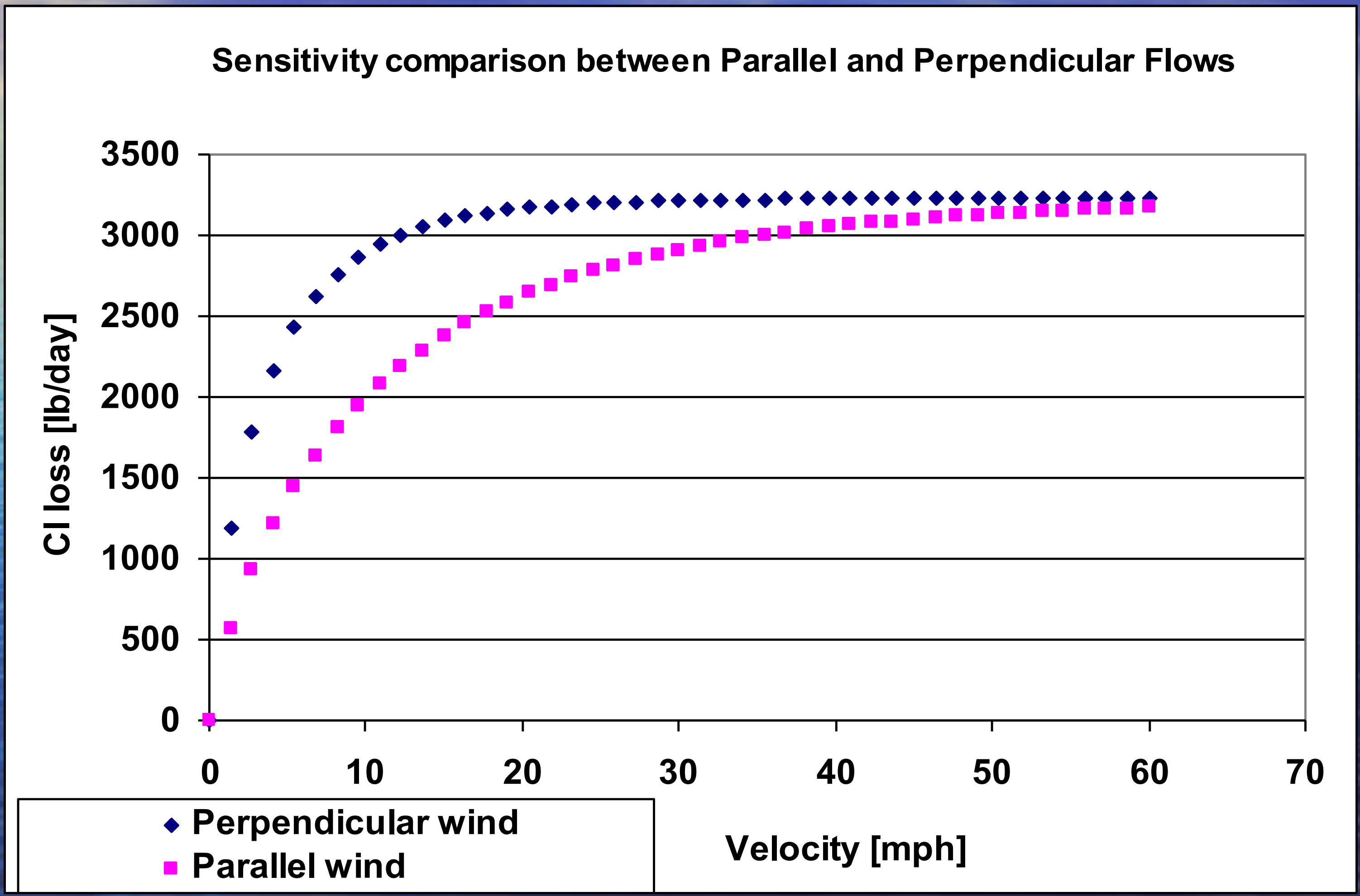
- The thicker boundary provides more resistance to mass transfer

Results

- Initial Chlorine added per day = 3200 lb

Wind Flow Direction	Perpendicular [lb/ day]	Parallel [lb/ day]
Channel 0	2600	1600
Channel 1	300	700
Channel 2	300	700
Chlorine Loss per day	3200	3000

Sensitivity of Wind Speed



Conclusions

- Small amount of residual chlorine projected to Puget Sound
- Wind direction has a big effect on mass transfer at high concentration

Recommendations

- To increase residence time of Cl2 in the channel, put a cover over the first channel
- alternatively, find ways to block winds from blowing perpendicular to the first channel