A Model Developed to Predict the Internal Corrosion Rates of Wet and Dry Gas Pipelines

Frank Song

Southwest Research Institute

San Antonio, TX 78238

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Background

- In estimating reassessment or re-inspection intervals due to internal corrosion in wet or dry gas line, the same corrosion rate equations as developed for oil production systems are often used.
- Such a method for estimating corrosion rate is useful for wet gas lines but it can cause large errors if used for dry gas lines.
- For dry gas lines, only a limited solution volume exists and corrosion products can quickly saturate the solution and precipitate. This film of precipitate can greatly reduce the corrosion rate.
- There is a need to understand the difference in corrosion rate between in these two different gas lines and the mechanisms leading to this difference.

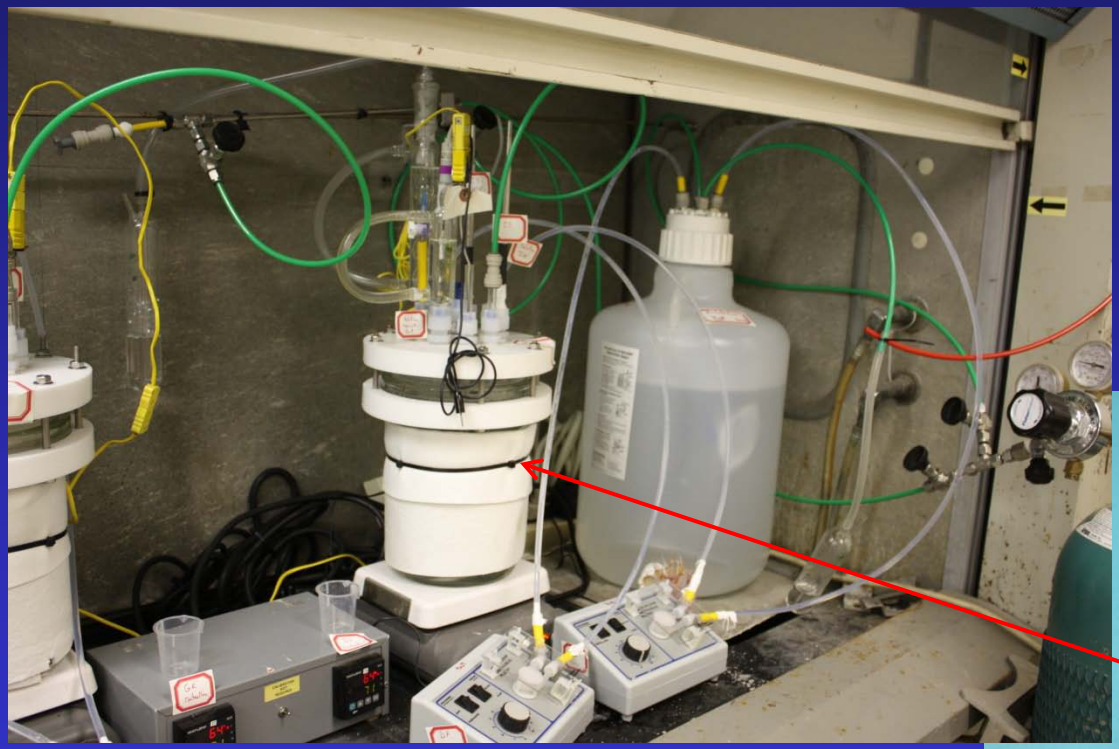
Goal

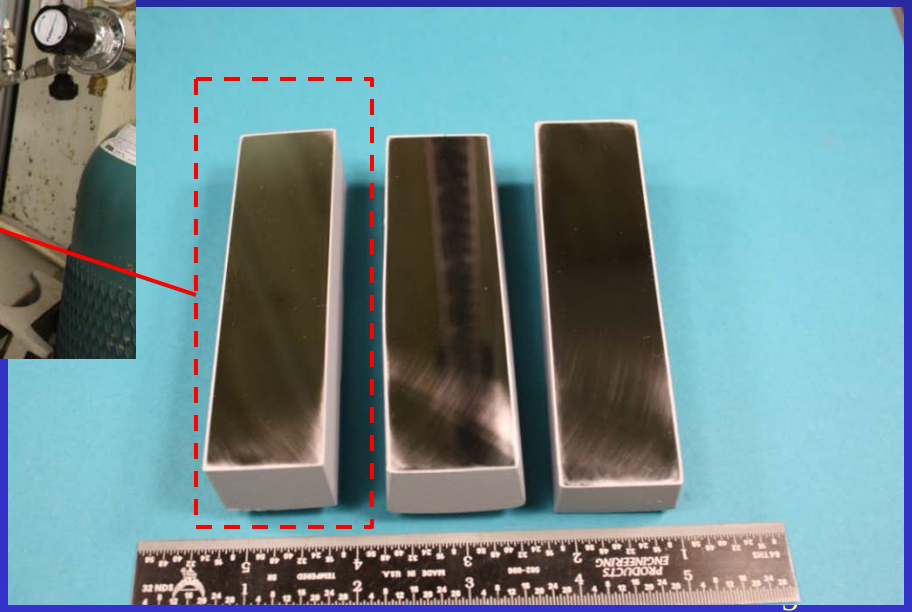
Develop modeling tools to predict pipeline internal corrosion rates for:

-- dry gas system, ***with limited solution volume***

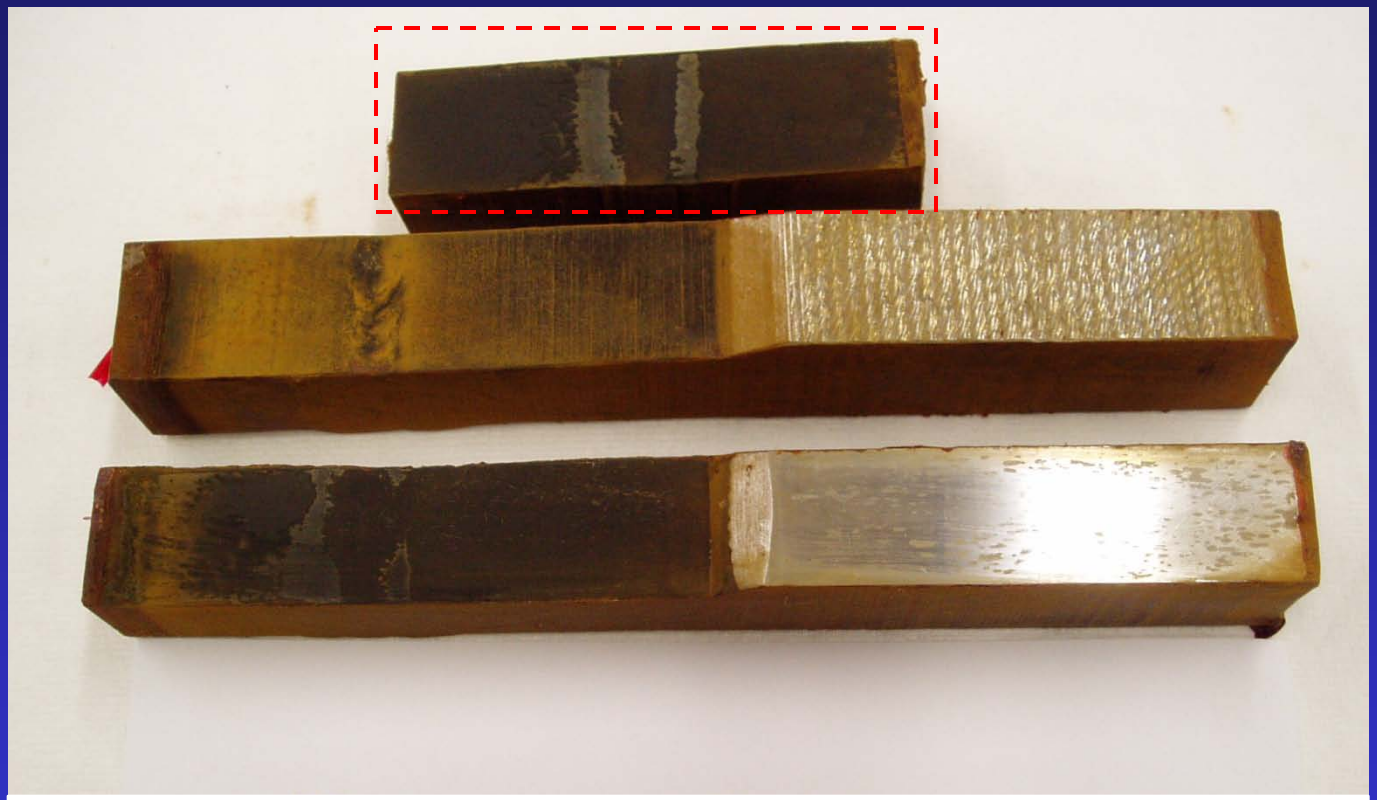
-- wet gas system, ***with infinite solution volume***

Wet-Gas/Production CO_2 Corrosion Test

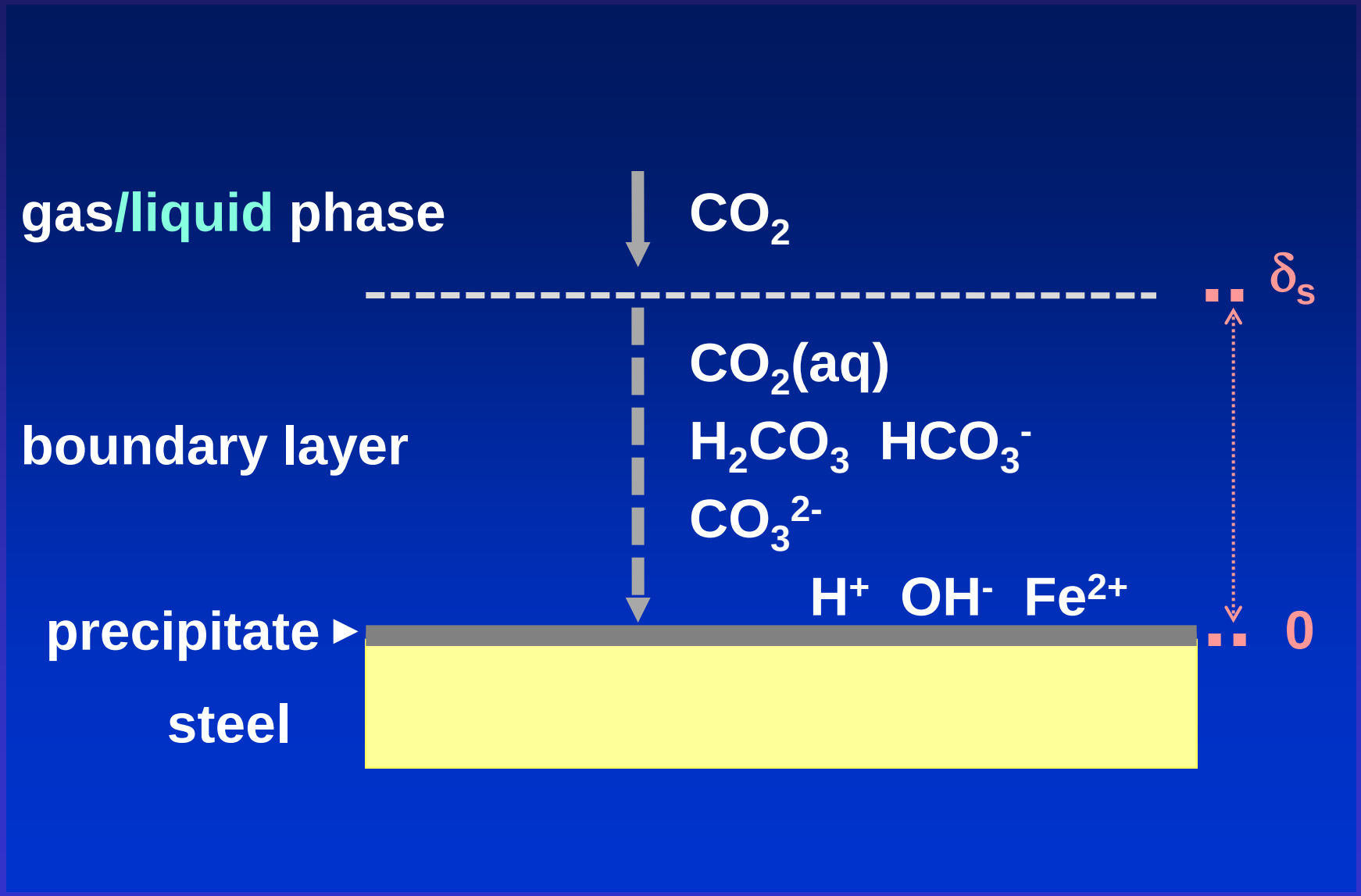




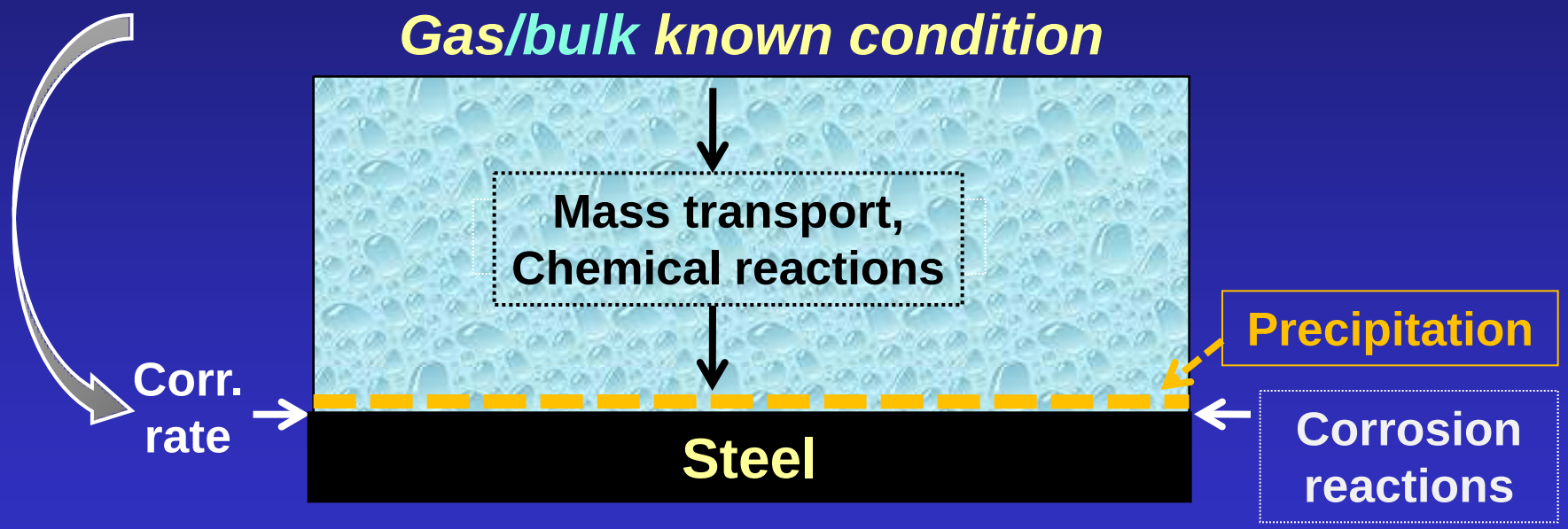
Post-Test Carbon Steel Specimen



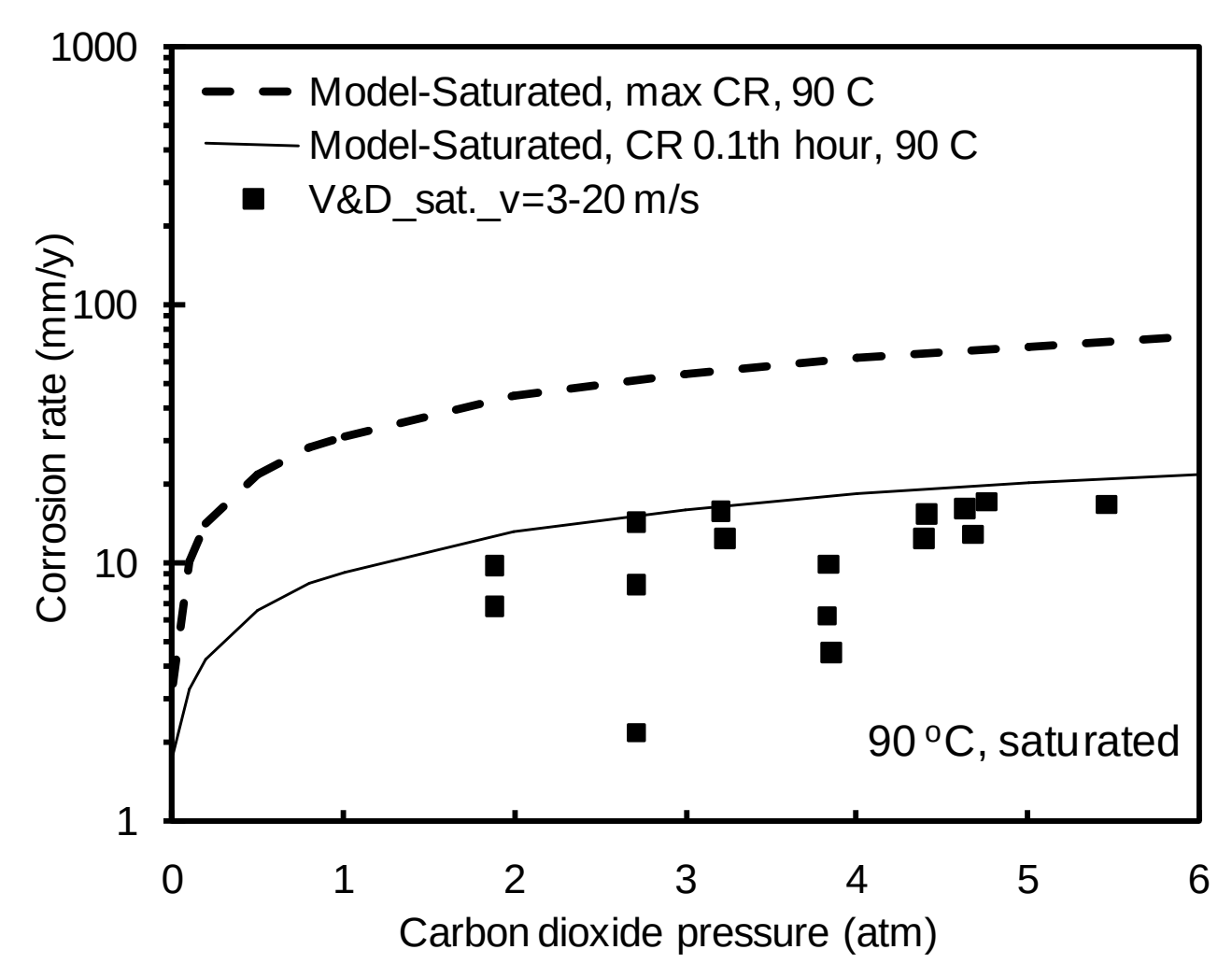
Model System to Simulate CO_2 Corrosion



Modeling Methodology

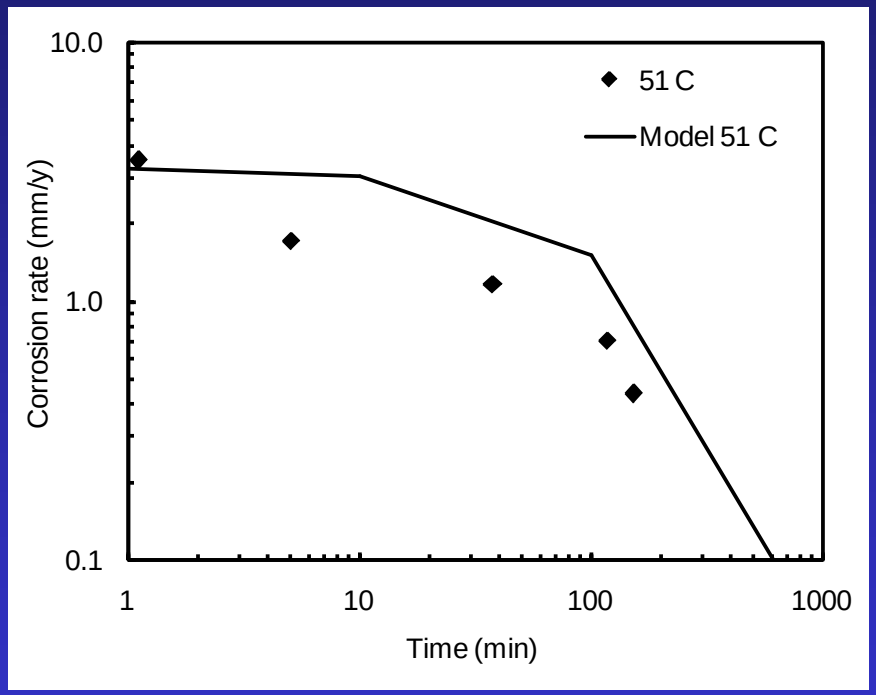


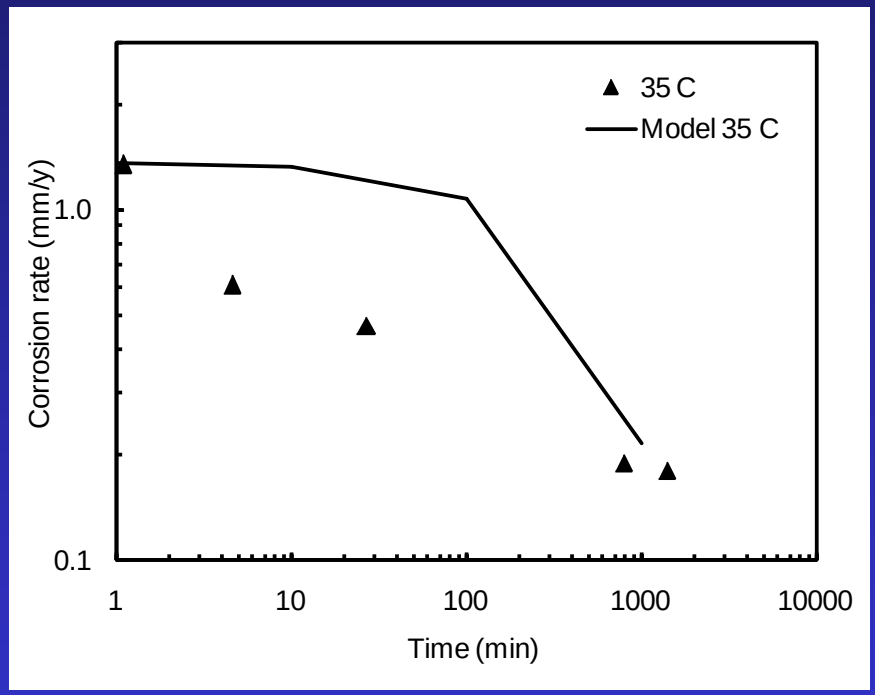
Wet Gas - Model Results vs. Experimental Data (Saturated Solution)



K. Videm, A. Dugstad, Materials Performance, April (1989) 46.

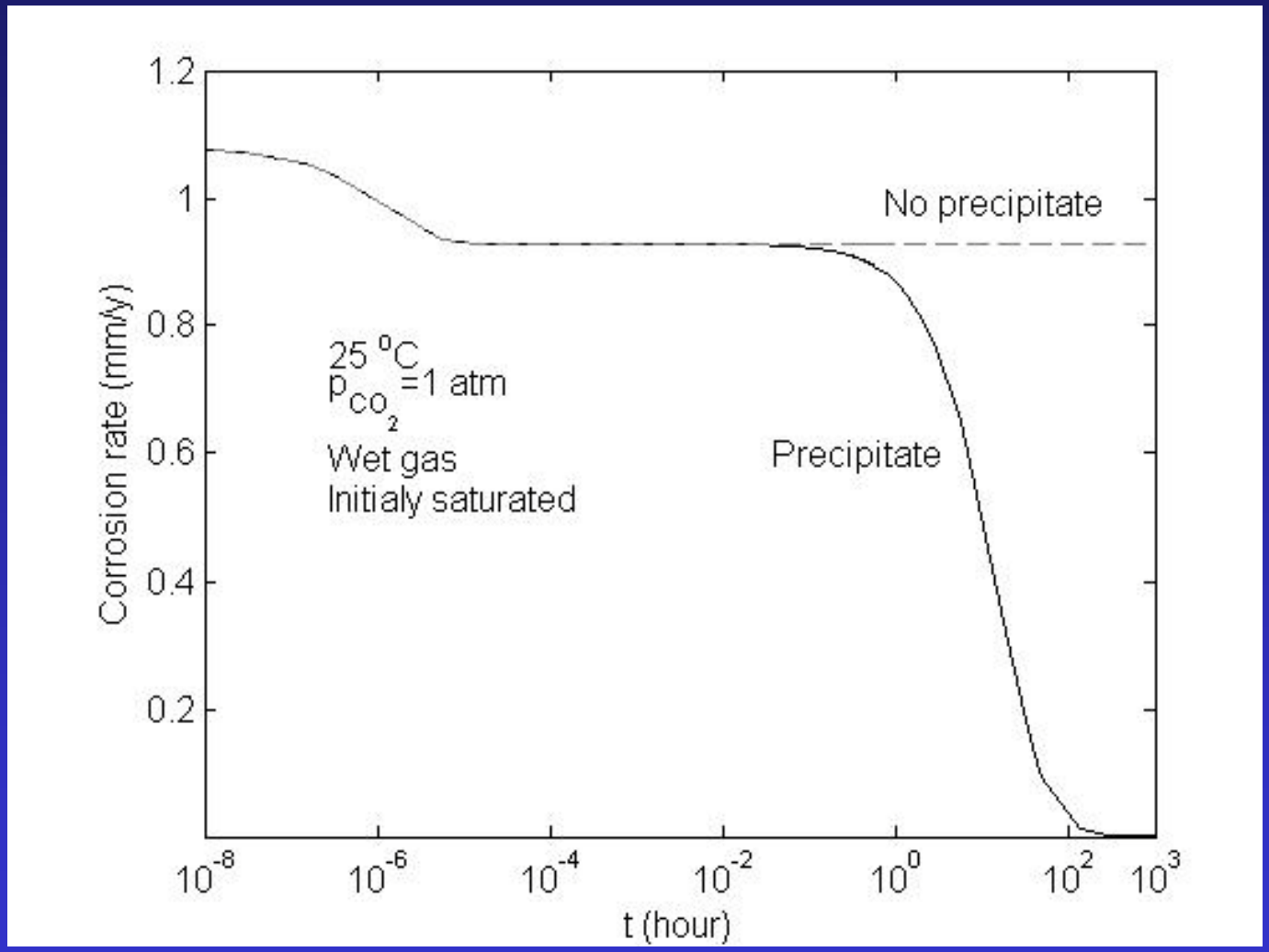
Time-Dependent Model Results vs. Experimental Data –Saturated Solution





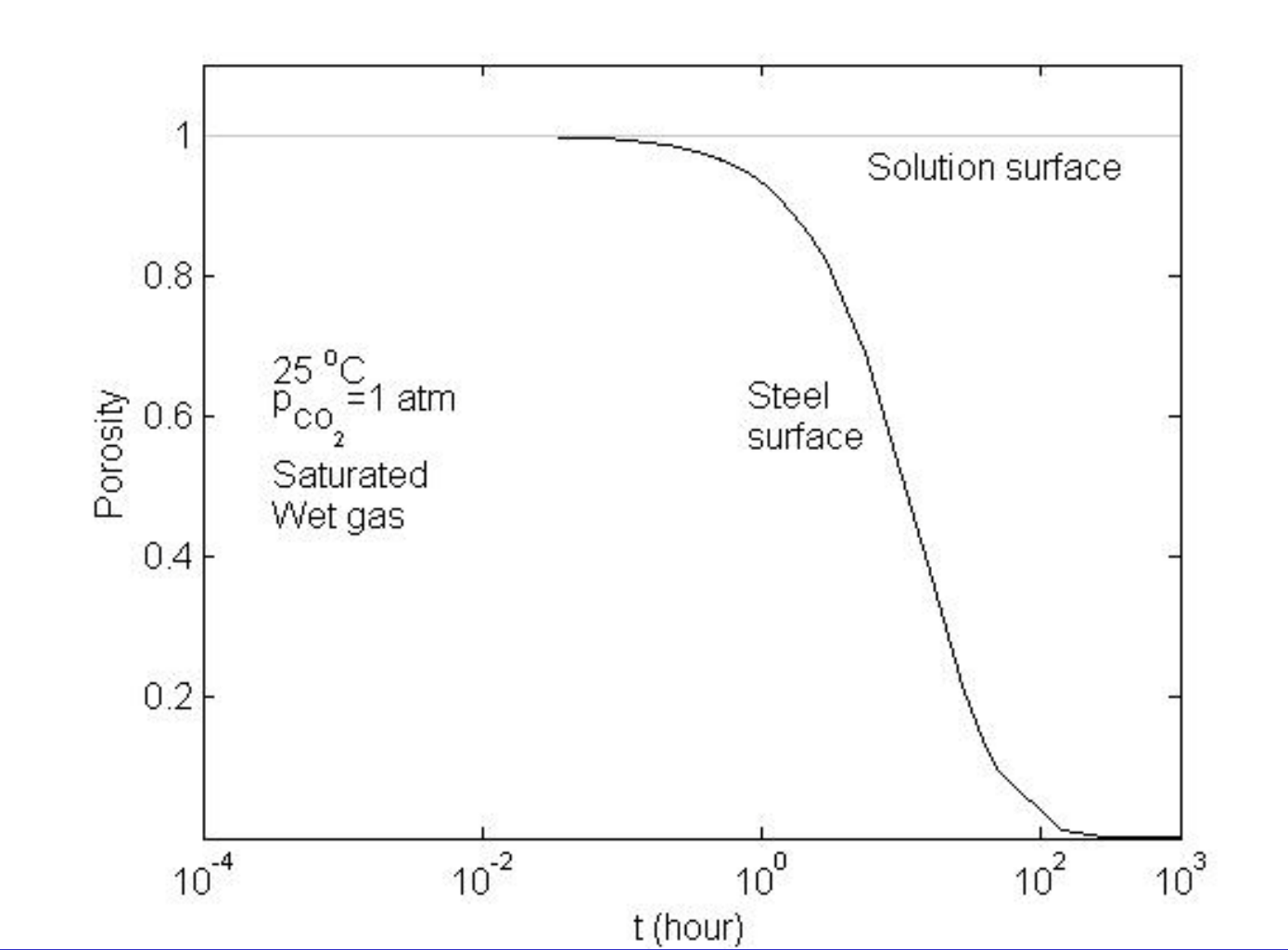
K. Videm, A. Dugstad, Materials Performance, April (1989) 46.

Model Results –Saturated Solution



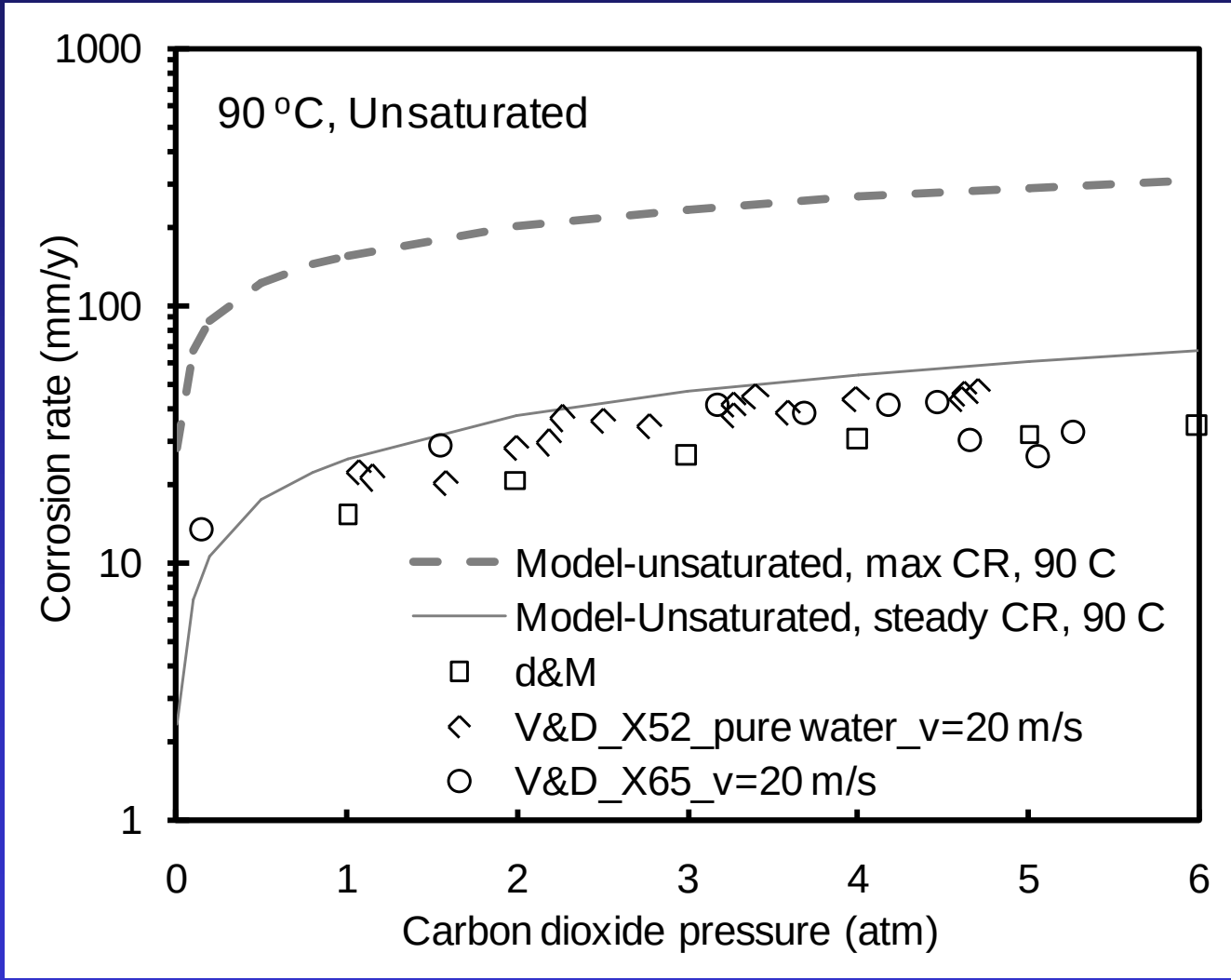
25 °C, p_{CO2}=1 atm, BLT=10 μm, wet gas

Model Results –Saturated Solution



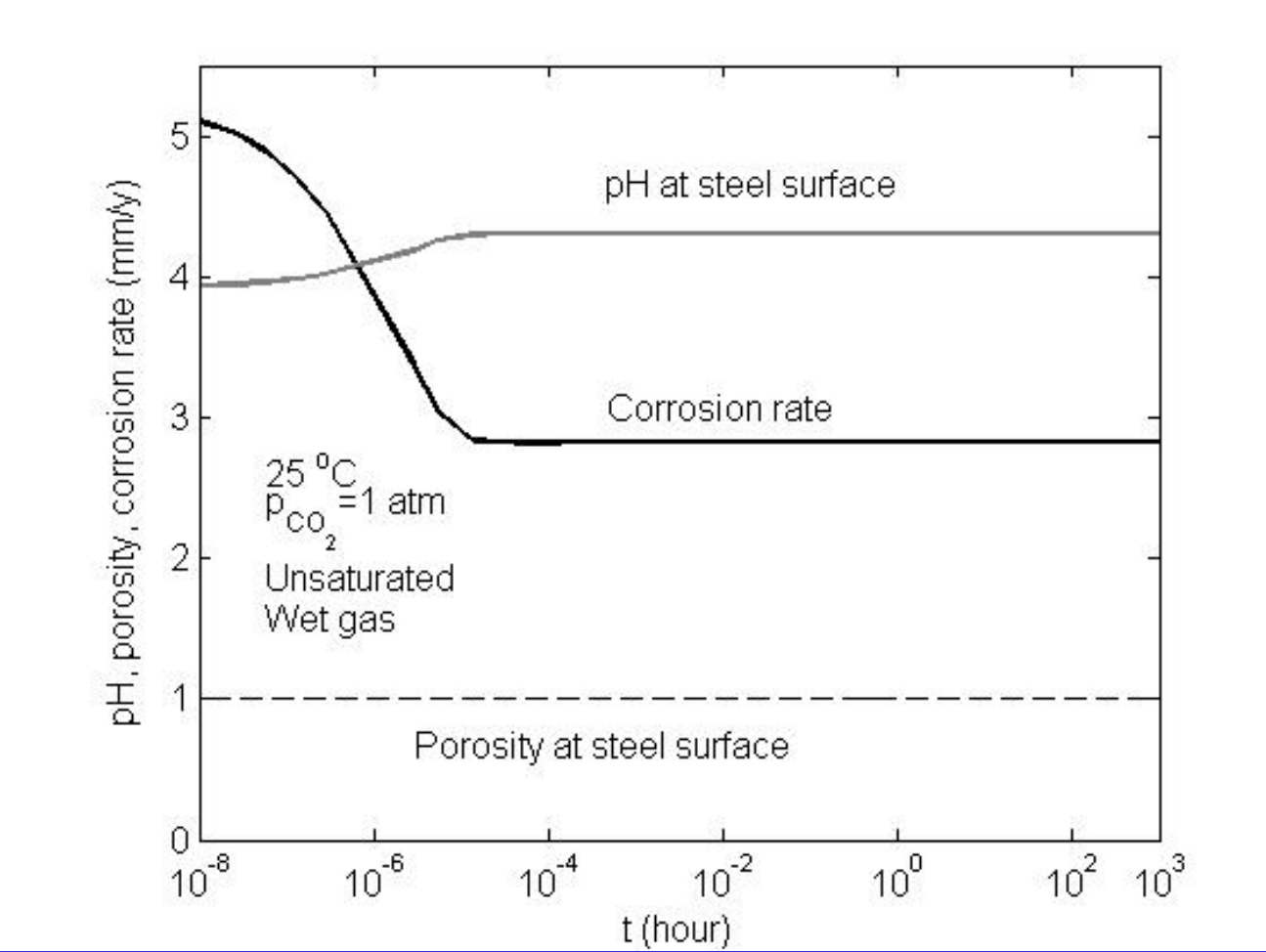
25 °C, p_{CO2}=1 atm, BLT=10 μm, wet gas

Model Results vs. Experimental Data –Unsaturated Solution



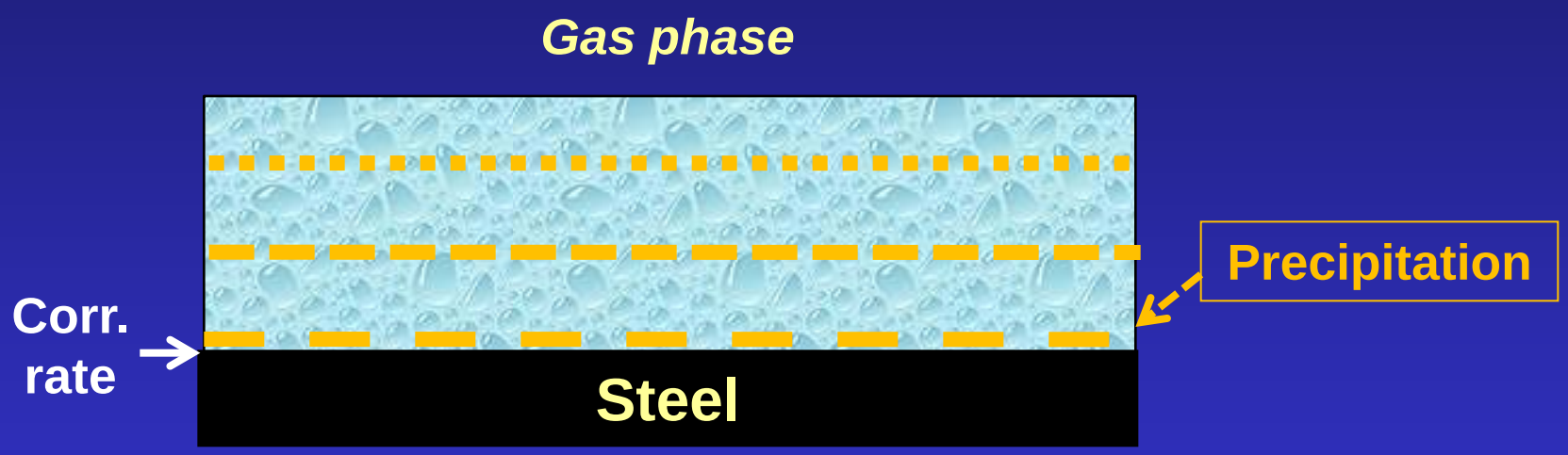
C. de Waard, D.E. Milliams, Corrosion 31 (1975) 177.
K. Videm, A. Dugstad, Materials Performance, March (1989) 63.

Model Results –Unsaturated Solution

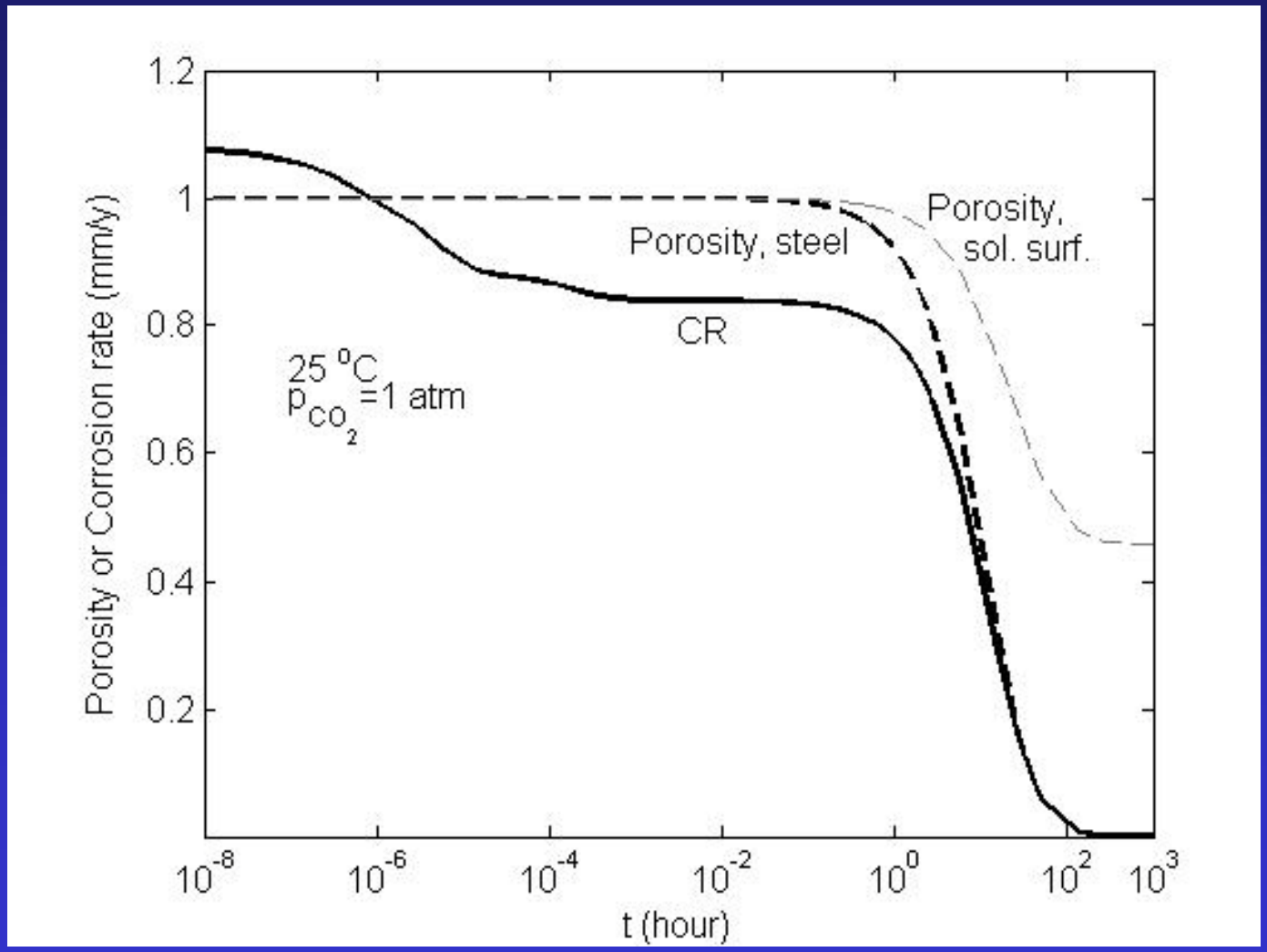


25 °C, p_{CO2}=1 atm, BLT=10 μm, wet gas

Dry Gas Internal Corrosion



Model Results – Saturated Solution



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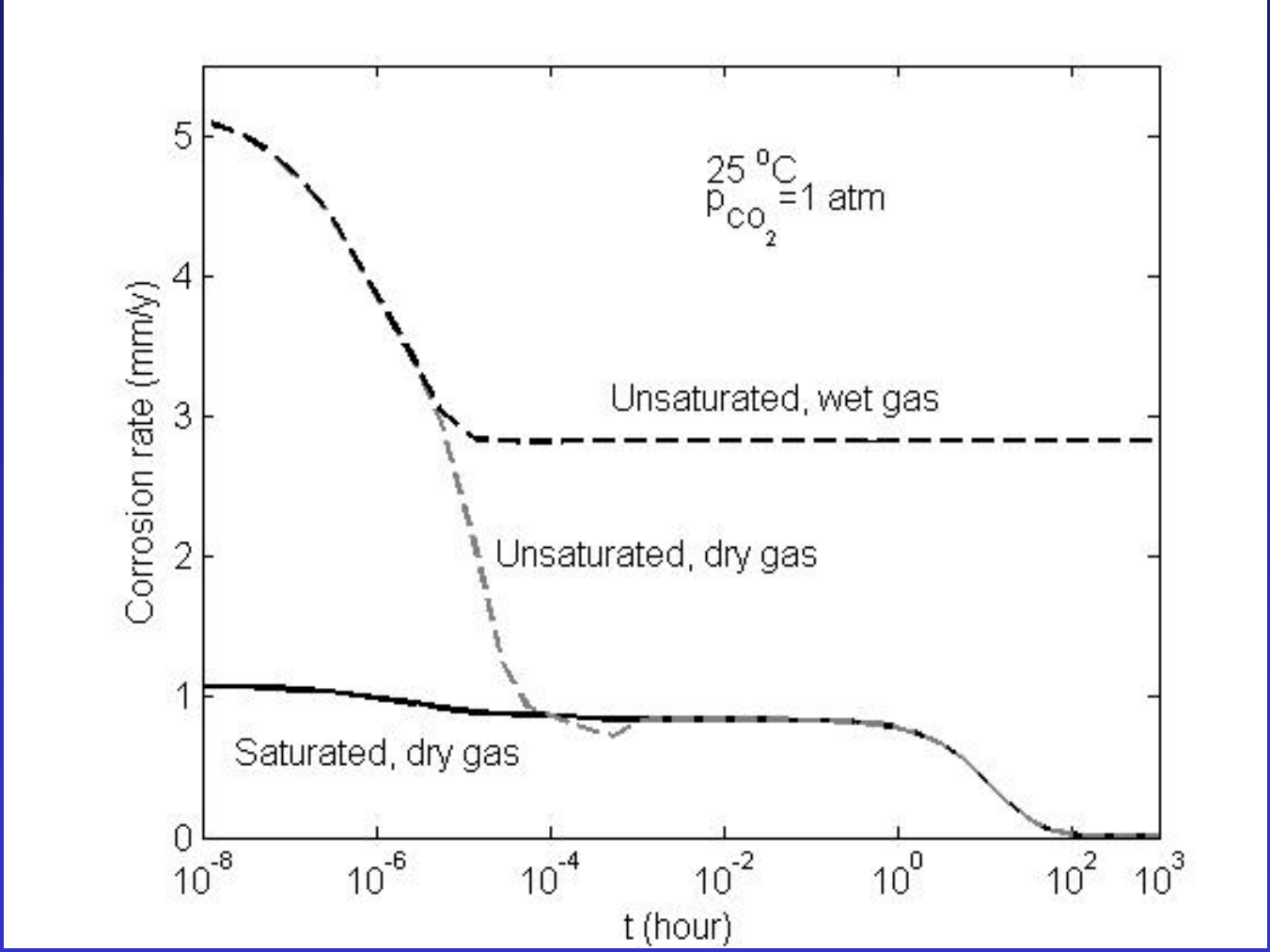
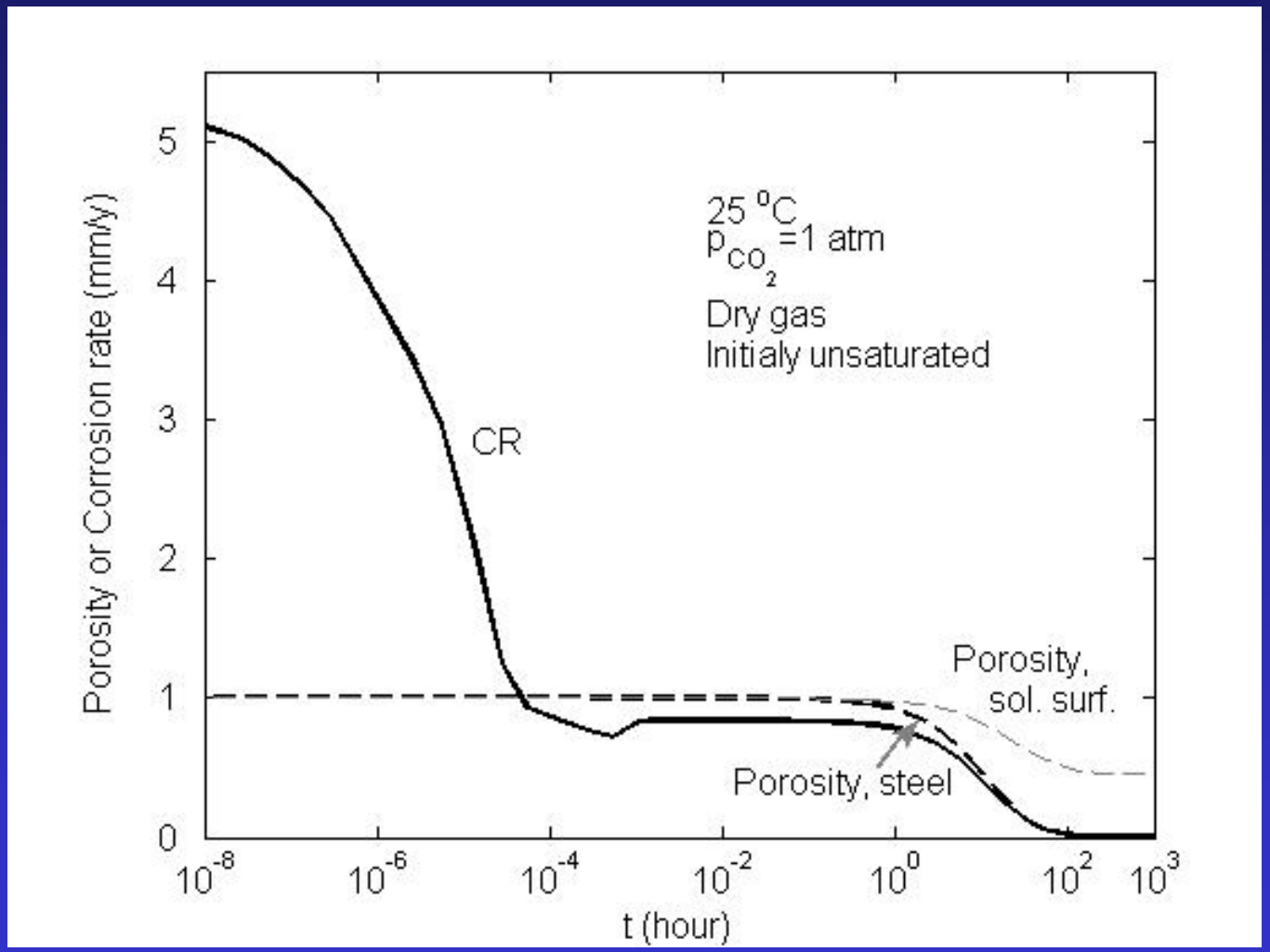
Model Results –Sat. and Unsat. Solutions



25 °C, p_{CO2}=1 atm, BLT=10 μm, dry and wet, saturated

Model Results –Unsaturated Solutions



25 °C, p_{CO2}=1 atm, BLT=10 μm, dry and wet, unsaturated

Conclusions (1)

- For dry gas lines, with a restricted solution volume to dissolve ferrous ions formed from corrosion, the solution can easily be saturated and precipitation starts. The porosity of the precipitate increases over time and the available area of steel for corrosion also decreases. Both decrease the corrosion rate.

- With an unrestricted solution volume from which ferrous ions can diffuse out into the bulk, the solution layer may never become saturated depending on the CO_2 partial pressure and the steel temperature. A steady state corrosion rate, much greater than in the dry gas condition, often results.

Conclusions (2)

- **When estimated for dry gas lines, a smaller corrosion rate is recommended.**

Questions?