Modeling Internal Corrosion Rates of Pipelines Which Carry Wet or Dry Natural Gas

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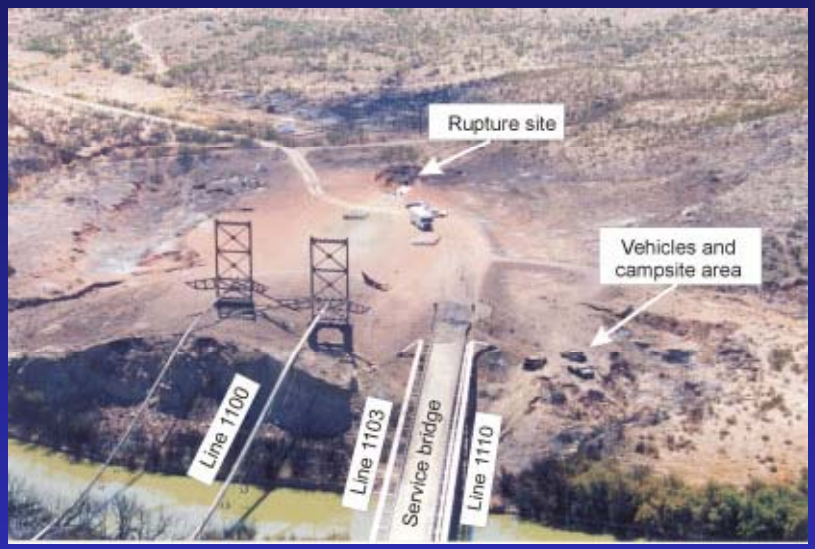
Background

- Pipeline is a significant and critical infrastructure for transporting natural gas and liquid petroleum and products.
- Two types of natural gas pipelines: wet gas (gathering lines) and dry gas (transmission or distribution lines).
- Internal corrosion is a threat to the pipeline integrity and safety.
- Although the mechanisms of internal corrosion can be different for the dry and wet gas pipelines, the models used to predict the corrosion rate are the same. The corrosion rate in dry gas systems is often overly predicted.

Incident, Dry Gas Pipe, El Paso Energy



Aug. 19, 2000, a 30” OD transmission line ruptured adjacent to the Pecos River near Carlsbad, New Mexico. The released gas ignited and burned for 55 minutes. 12 people who were camping under a concrete decked steel bridge that supported the pipeline across the river were killed. Two nearby steel bridges for gas pipeline crossing the river were extensively damaged. Property and other losses totaled at just below $1 million.

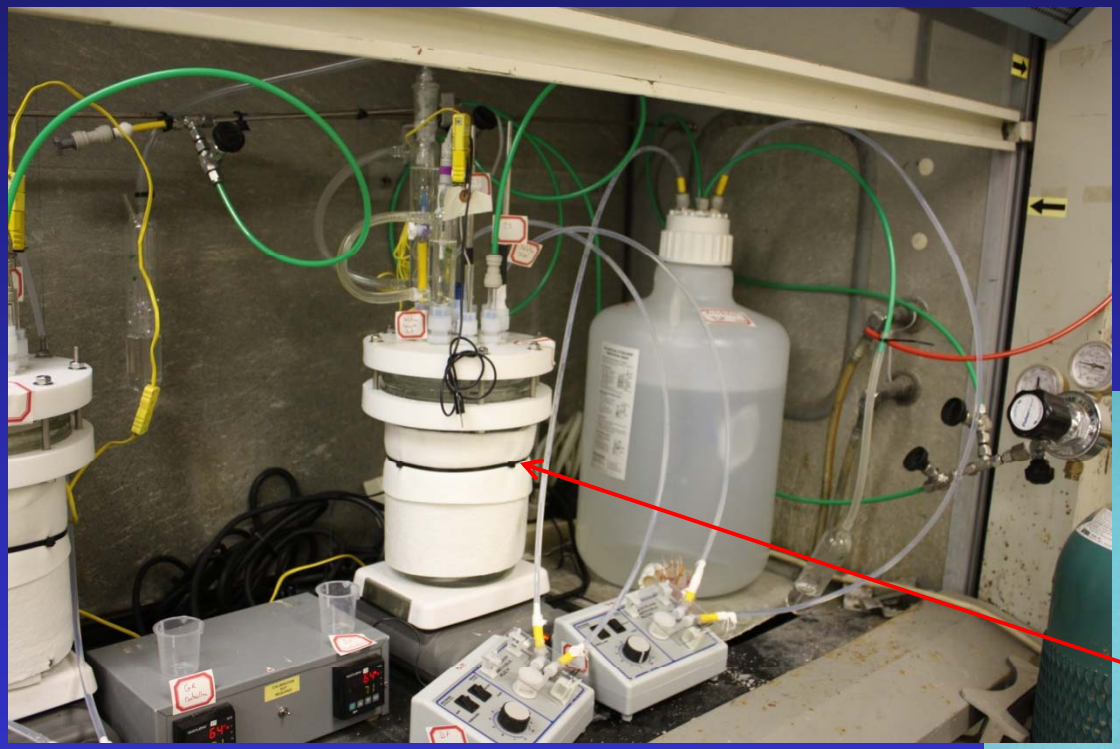
Goal

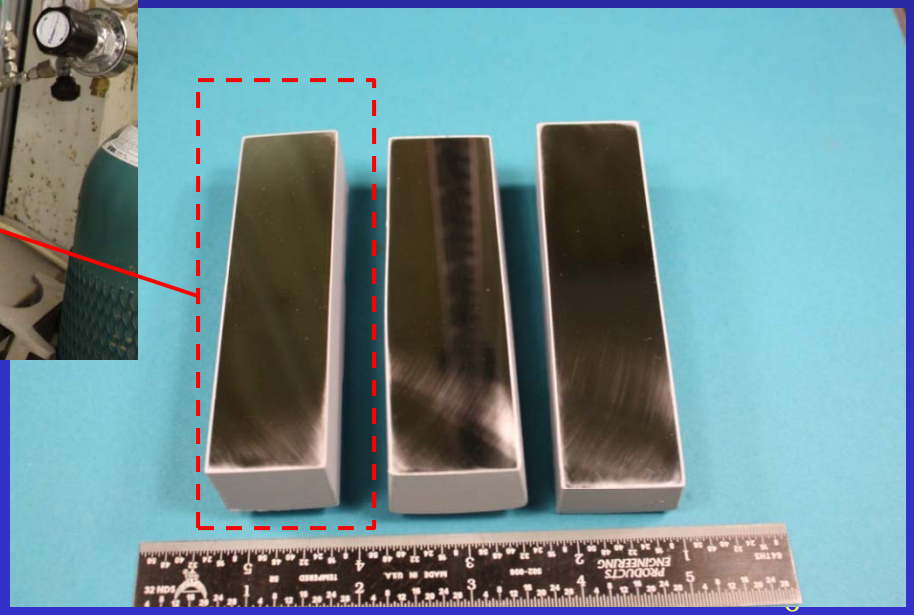
Develop modeling tools to predict pipeline internal corrosion rates with the understanding of the different corrosion mechanisms in:

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

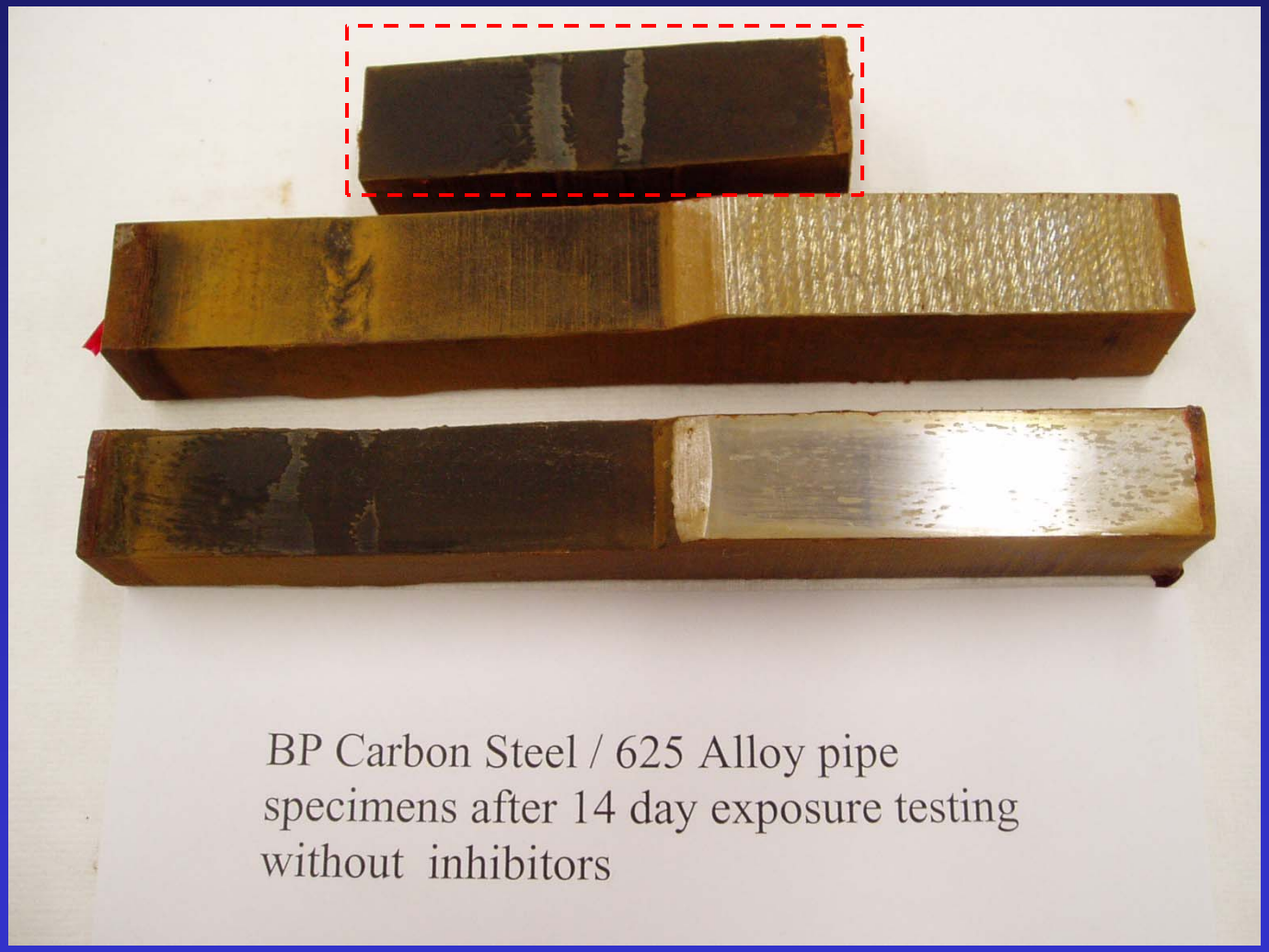
-- wet gas system, ***with infinite solution volume***

Wet-Gas/Production CO_2 Corrosion Test

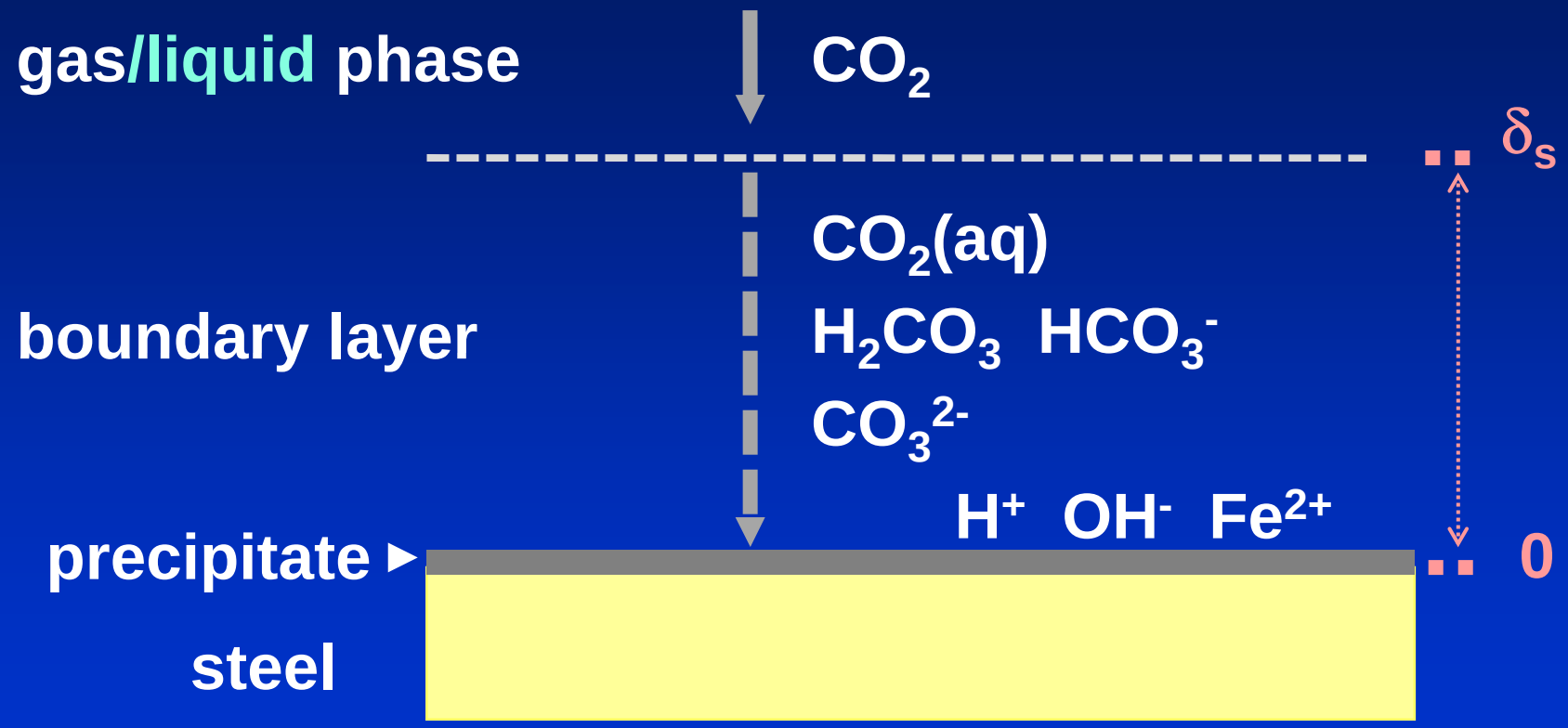




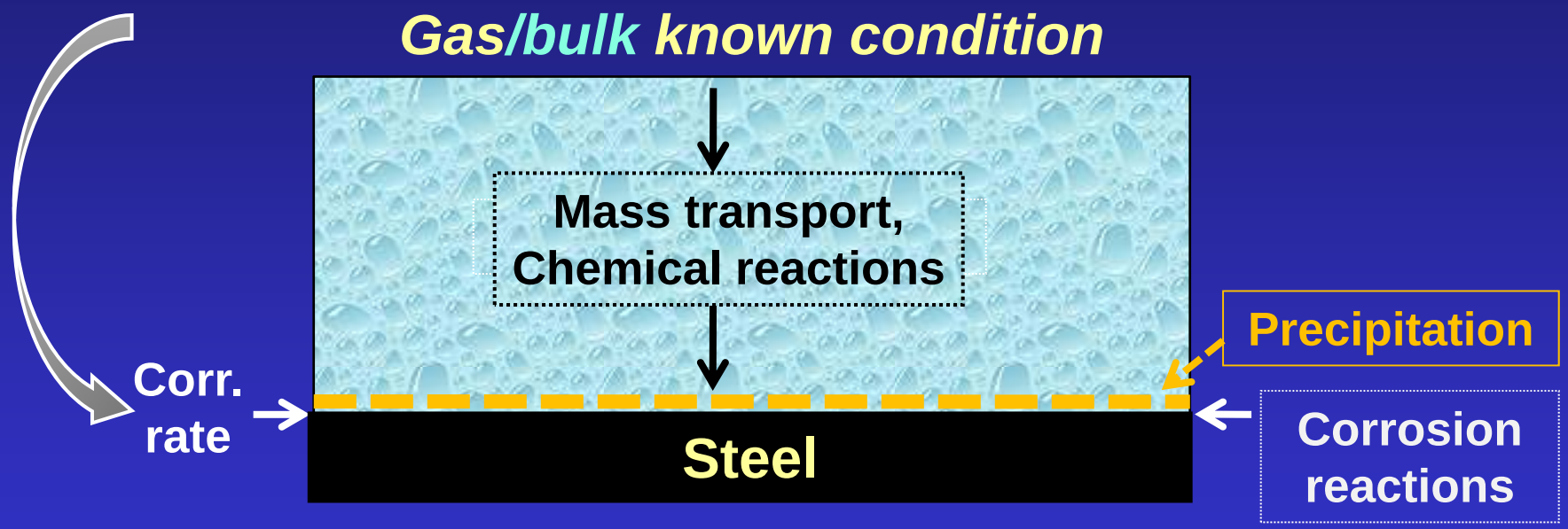
Post-Test Carbon Steel Specimen



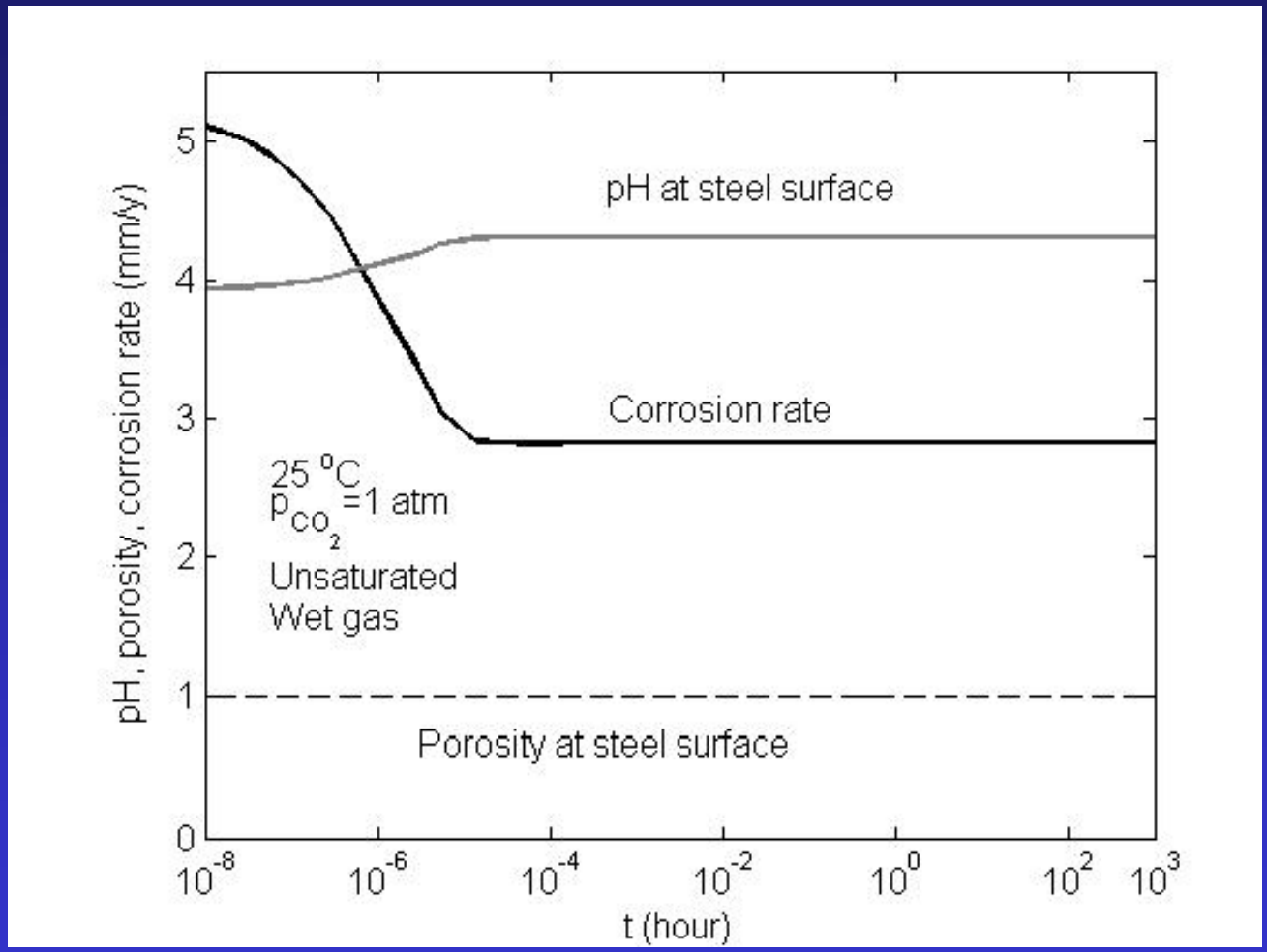
A Model System to Simulate CO_2 Corrosion



Modeling Methodology

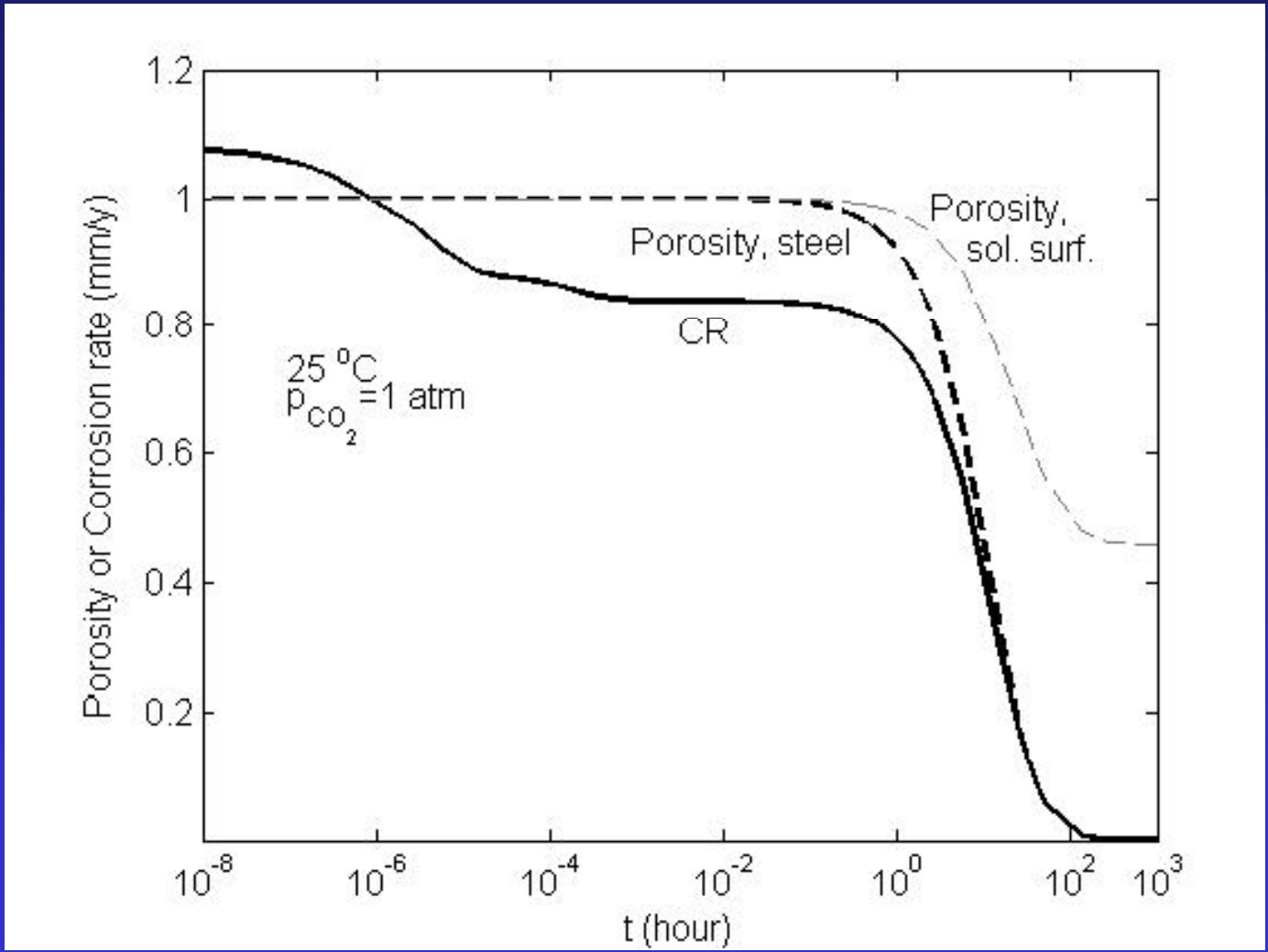


Model Results –Unsaturated Solution



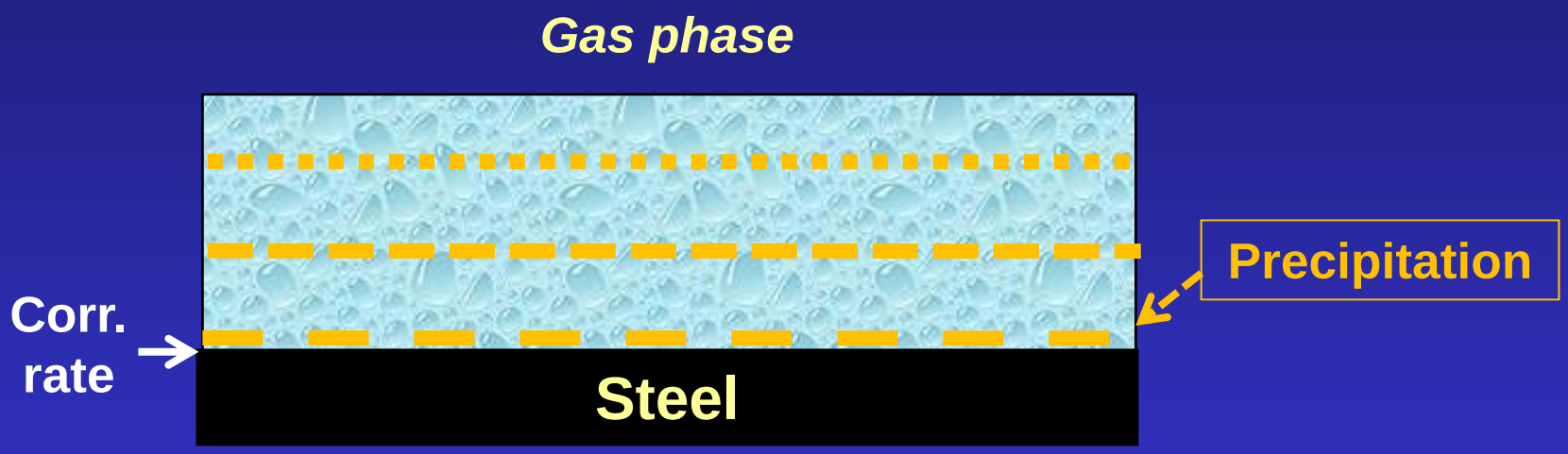
25 °C, p_{CO2}=1 atm, BLT=10 μm, wet gas

Model Results – Saturated Solution

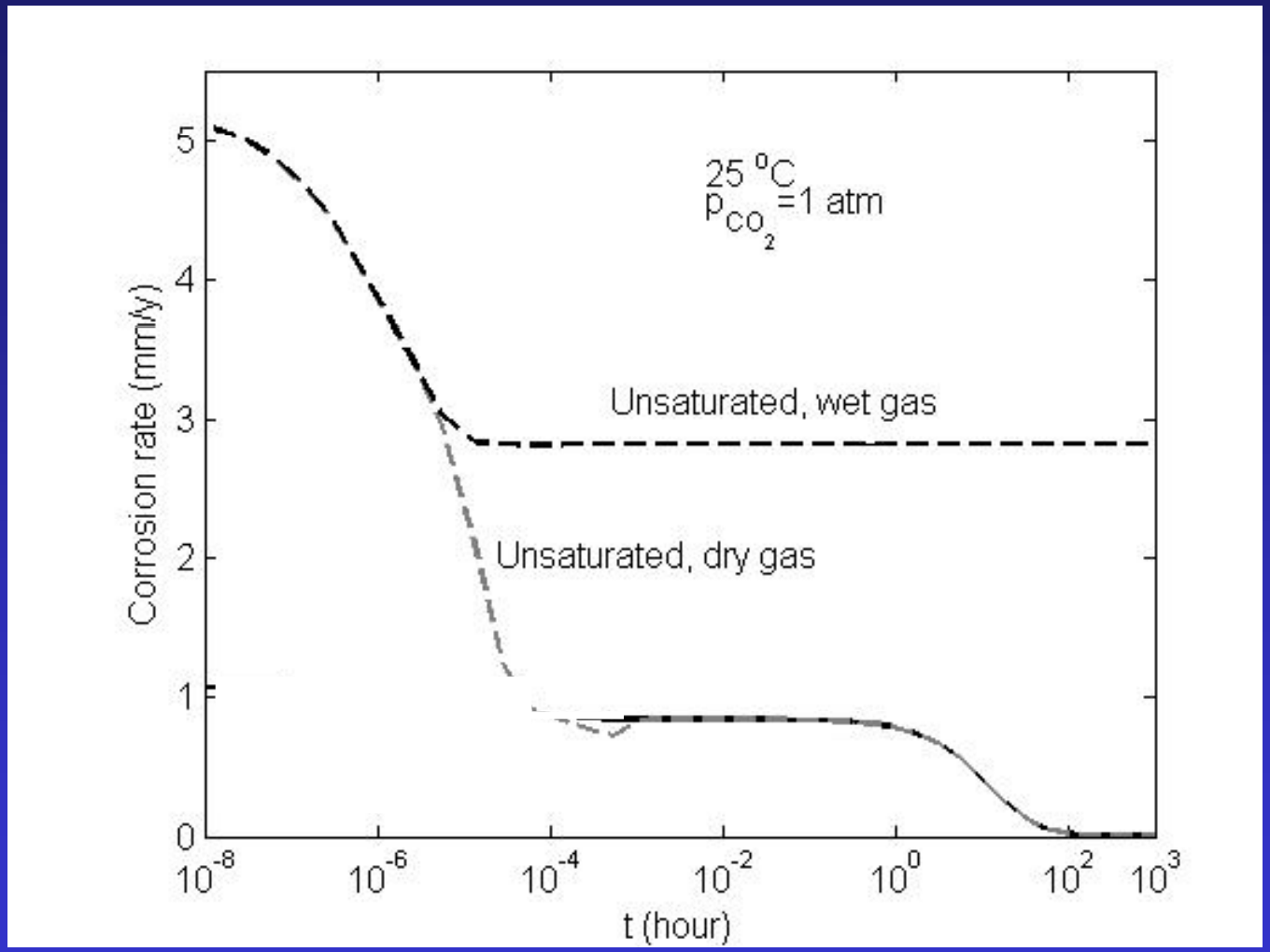


25 °C, p_{CO2}=1 atm, BLT=10 μm, dry gas

Dry Gas Internal Corrosion

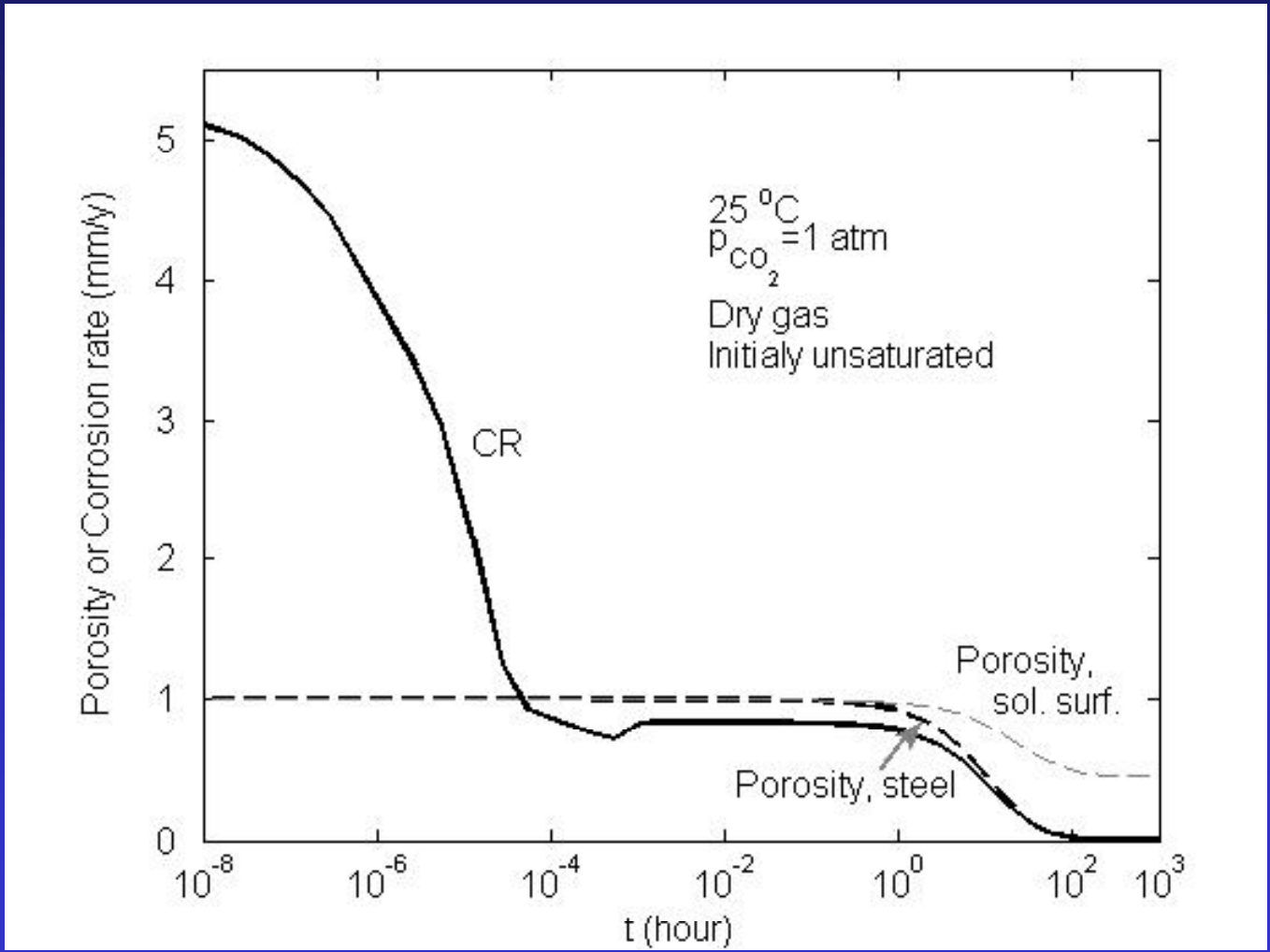


Model Results –Sat. and Unsat. Solutions



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, saturated

Conclusions

- For dry gas lines, with a limited solution volume, the quick saturation of the solution can significantly slow down the corrosion rate compared to wet gas.
- Model prediction should take that into account the effect of solid formation on the metal surface.
- For wet gas pipeline, depending on boundary layer thickness, chemical composition of the liquid water and temperature, precipitation may or may not form. The extent of saturation can determine the magnitude of corrosion rate.

Questions?