Status on CO_2 corrosion prediction document

Rolf Nyborg

Institute for Energy Technology

Background

- Joint industry projects at IFE 1998 - 2008
  - Kjeller Field Data Project I (1998 - 2000)
    - Evaluation of CO_2 corrosion models and collection of field data
  - Kjeller Field Data Project II (2001 - 2003)
    - Development of internal corrosion field database
  - KICCME Project (2004 - 2008)
    - Kjeller Internal Corrosion Compilation and Models Evaluation
- An operators' group for preparation of a draft document for guidelines for CO_2 corrosion prediction was formed in parallel with the IFE joint industry projects
  - 9 meetings in 2003 - 2008

Results from IFE JIPs

- The various models can give very different results
- Main differences between the models:
  - Prediction of oil or water wetting
  - Effect of corrosion product films
- More than 80 different field data cases collected in a database
- Some of the results published at NACE conferences
  - Rolf Nyborg: "Overview of CO_2 Corrosion Models for Wells and Pipelines", CORROSION/2002, Paper No. 02233
  - Rolf Nyborg: "Field data collection, evaluation and use for corrosivity prediction and validation of models, Part II: Evaluation of field data and comparison of prediction models", CORROSION/2006, Paper No. 06118

Models evaluated in Kjeller Field Data Projects

- de Waard et al (Shell)
- NORSOK model (Statoil, Saga, Hydro)
- HYDROCOR (Shell)
- Cassandra (BP)
- CORMED (Elf)
- LIPUCOR (Total)
- CORPLUS (Total)
- KSC Model (IFE)
- ECE model (Intetech)
- SweetCor (Shell)
- OLI model (OLI Systems)
- PREDICT (InterCorr)
- Tulsa model (University of Tulsa)
- Jepson model (University of Ohio)
- MULTICORP (University of Ohio)
- Corpos (CorrOcean)
- ULL model (University of Louisiana at Lafayette)
- DREAM (Oklahoma State University)

Document for corrosion prediction

- Guideline for Corrosion/corrosivity Prediction in Oil and Gas Production Systems
- Objective
  - Guideline for CO_2 corrosion prediction
  - Provide engineering companies, contractors and suppliers with guidelines for corrosion prediction during design
- Draft document submitted to EFC for consideration as an EFC document
- Presented at EFC WP13 meeting in Maastricht in 2006
- Decided at WP13 meeting in Freiburg in 2007 not to publish as an EFC document

Severity levels

- Focuses on severity level rather than predicted corrosion rate

Table 1: Severity levels

Severity level	Unmitigated corrosion rate (mm/yr)		
1		<	0.01
2	0.01	-	0.1
3	0.1	-	1.0
4	1.0	-	10.0
5		>	10.0

Proposed steps for corrosion prediction

- Step I: Normally used for preliminary design or early assessment when only limited data are available

Factors to be considered	Input parameters	notes
Carbon dioxide	P_{Total}, $\%CO_2$, $f_{CO2}=a.P_{CO2}$	(1)
CO2 / H_2S ratio	P_{CO2}/ P_{H2S} > 500 - 1000	
Temperature	T	
calculated pH	HCO_3^- , P_{CO2}, P_{H2S}, total organic acid species	(2), (3)
Prediction model	P_{CO2}, T, pH	(4)

(4) Any model evaluated for this purpose. A brief description of some models is given in Appendix 1

Proposed steps for corrosion prediction

- Step II: Rigorous assessment of predicted corrosion rate for final design and assessment when more detailed data are available

Factors to be considered	Input parameters	notes
Protectiveness of the film	T and P_{CO2} for $FeCO_3$ film	(6)
Flow factors	Flow regime and velocity	(7)
Type of corrosion	Pitting or general	
Wetting effect	Oil/water wetting properties	
Organic acids impact	Total organic acid species, pH (Impact on the protectiveness)	(8)
pH effect	Total organic acid species, consistency check of formation water	(3) (9)
Prediction model	Operator defined	(4)

Appendix 1: Examples of models

- Listing and short description with references of models which have been evaluated in the IFE Joint Industry Projects
- Include all models which have been evaluated in these projects
- Not only a few selected models as in previous version of the document
- Choice of model left to the user

Status of the document

- Issue as an open document by IFE
- Will undergo a final review in the operators group with a meeting in November 2008
- Will be issued as an open IFE report early in 2009
- Will be put on IFE's website for free download: www.ife.no
- You can notify Rolf Nyborg if you want the document when it is finished: rolf@ife.no