EROSION/CORROSION RESEARCH CENTER

E/CRC NOTES

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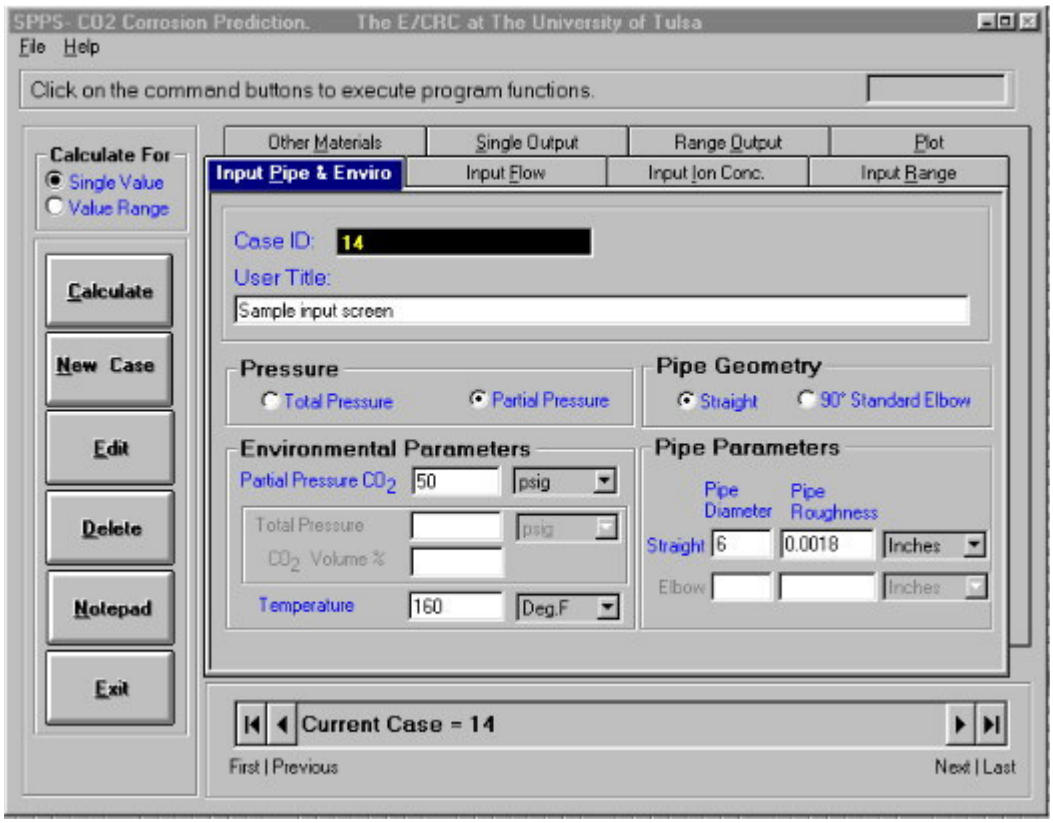
CO_2 Corrosion Prediction

Carbon dioxide (CO_2)corrosion of carbon steel components used in production facilities is one of the most severe problems encountered by the oil and gas industry. Remedies for this problem include facilities design, materials selection, use of corrosion inhibitors, and modifying operating practices. Knowing when remedies are needed and which remedies to apply requires an understanding of the CO_2 corrosion process and the ability to predict the corrosion rate.

For the past several years, the Erosion/Corrosion Research Center has been involved in CO_2 corrosion testing and CO_2 corrosion modeling. This work has resulted in a better understanding of the CO_2 corrosion process including how flow velocities and the formation of protective $FeCO_3$ (iron carbonate) scales affect CO_2 corrosion rates. This in turn has led to the development of a CO_2 corrosion prediction computer program based on a mechanistic model of the processes involved in CO_2 corrosion. The computer program is called SPPS (Sweet Production Pipe Saver): CO_2 and takes into account the various chemical equilibria, mass transfer rates, and rates of electrochemical reactions



SPPS: CO_2 corrosion rate of mild steel piping for any given set of conditions of CO_2 partial pressure, temperature, solution chemistry (or pH), ferrous ion concentration, pipe size, and flow velocity. Figure 1 shows a typical input screen in the user-friendly computer program. Pipe geometry and environmental data are entered through this screen. Other screens facilitate additional input.

Output is available as graphs of corrosion rate versus ranges of the various input parameters, and as tables of corrosion rate, concentrations and mass transfer coefficients for the various species, and electrochemical quantities such as Ecorr and current densities from electrochemical reactions. Corrosion rates predicted by SPPS: CO_2 compare well with field data provided by some of the oil and gas company members of E/CRC.

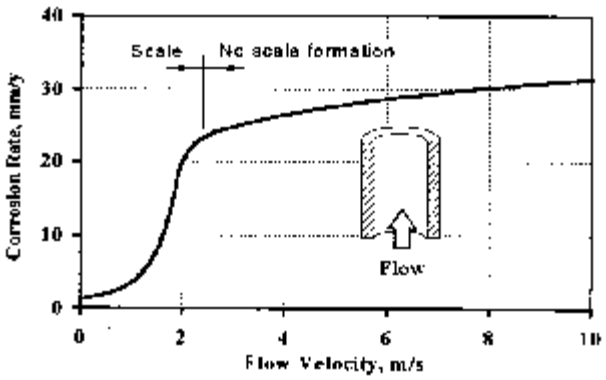


Figure 2. Sample corrosion rate plot

The computer program has the capability to predict the formation of protective $FeCO_3$ corrosion product scales on the metal surface, and predicts the CO_2 corrosion rate under those conditions. Figure 2 shows CO_2 corrosion rates predicted in a six-inch diameter carbon steel pipe for a CO_2 partial pressure of 50 psig and a temperature of 160_ F. $FeCO_3$ scale formation is possible for these environmental conditions, but not at all flow velocities.

Figure 2 shows predicted corrosion rates as a function of velocity. At low flow velocities SPPS: CO_2 predicts that protective scales will form, and the corrosion rates expected are therefore quite low. However, for these environmental conditions, at flow velocities greater than about 2 m/s, protective scales are prevented from forming, and corrosion rates are predicted to be very high.

Under some conditions, formation of iron carbonate scales can reduce corrosion rates to acceptable limits. However Figure 2 suggests that local increases in velocity caused by flow disturbances could prevent or remove protective scales at these points, and local corrosion rates could be extremely high.

Erosion/Corrosion Research Center News

CO_2 corrosion research is headed by Dr. Ethirajulu Dayalan. Dr. Dayalan's formal training is in electrochemistry. This background has allowed the E/CRC to develop the CO_2 corrosion model at a mechanistic level. Drs. Rybicki, Shirazi and Shadley also contribute to this multidisciplinary research in various areas ranging from equation solving techniques to hydrodynamics. Another area that benefits from Dr. Dayalan's expertise is erosion corrosion research involving carbon steel materials in a CO_2 environment and sand. Here technologies from erosion and CO_2 corrosion research are brought together

into a model that computes maximum safe flow velocities (threshold velocities) to avoid erosion-corrosion and predicts the material penetration rate. The Summer 1996 issue of *E/CRC NOTES* provided a summary of some results on how using a corrosion inhibitor can alter the threshold velocities.

We also have available a demonstration copy of our erosion prediction program "Sand Production Pipe Saver" (SPPS) on 3- 1/2" floppy disk. If you would like a copy to examine call our E/CRC administrative assistant, Tommie Sue Hampton at (918) 631-2997 or e-mail ME_TSH@centum.utulsa.edu. Or indicate your interest on the enclosed reply card by checking the box marked "other" and specifying the demo disk. Our next Advisory Board Meeting is May 14, 1997. We hope to see all our members there. If your company is not a member and you would like to come as a guest, please see below.

Brief Info on E/CRC

Erosion and corrosion are common problems to oil and gas companies. The Erosion/Corrosion Research Center (E/CRC) at The University of Tulsa was formed to address these problems. The goal of the E/CRC is to help companies identify and evaluate ways of controlling erosion and corrosion through the development of predictive tools and design and operating guidelines. Currently, the E/CRC is supported by seventeen companies from eight different countries. Semiannual meetings are held in May and November at The University of Tulsa. Members receive the results of the work in the form of presentations, reports, and user-friendly computer programs. Members provide input to the research through planning meetings and questionnaires. If you would like to receive information on joining The Erosion/Corrosion Research Center, please indicate on the enclosed reply card.

Reply Card

We are in the process of expanding our mailing list for the E/CRC NOTES and encourage you to return the enclosed reply card with the names and addresses of persons who would be interested in receiving the E/CRC NOTES.

If you would like to receive a three-ring binder in which to store your E/CRC NOTES, please so indicate on the enclosed reply card and return to E/CRC.

E/CRC Meetings

The spring E/CRC Advisory Board Meeting is to be held May 14, 1997, at The University of Tulsa. The fall meeting is scheduled for November 12, 1997. If you would like to attend a meeting as a guest, please return the enclosed reply card and indicate that you would like to receive further information on hotel reservations and the specific location If the meeting.