Intelligent hypermedia corrosion information tools

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Intelligent hypermedia corrosion information tools

What is a hypermedia system?

- the basic concepts of hypermedia
- why use hypermedia for corrosion engineering?

The Active Library® on Corrosion

- the goal of the system
- an overview of its functionalities

The GRACE™ system

- the goal of the system
- an overview of its functionalities

Conclusions
WHAT IS A HYPERMEDIA SYSTEM?

The basic concepts of hypermedia

**Hypermedia = hypertext + multimedia**

- hypertext = nodes + links
  - non-linear vs. linear
  - navigation vs. query
- multimedia
  - images, sounds, video, …
WHAT IS A HYPERMEDIA SYSTEM?

Why use hypermedia for corrosion engineering?

Corrosion engineering

- *corrosion diagnosis* based on the consultation of many different and dispersed information sources
- *corrosion recognition* is based on a visual comparison with corrosion phenomena identified in related incidents
- *corrosion prevention* requires the identification of the correct measures for a given material / environment / corrosion type
- *materials selection* is based on the careful examination of relevant criteria from a vast assortment of materials data

Hypermedia support

- swift and intuitive access to different information sources
- capability of displaying high resolution corrosion pictures
- capturing the relatedness between materials information
  - greater interactivity in the retrieval of the appropriate data
  - intelligent support for typical corrosion engineering tasks
The Active Library® on Corrosion

The goal of the system

**System design objectives:**

to build an easy to use CD-ROM based hypermedia system for providing access to corrosion prevention documents and materials engineering data, that can be used by both beginning and expert materials engineers

**System information functionalities:**

- 3-D Cube of Contents
- Corrosion Atlas
- NACE International books
- NACE International and Elsevier Science journals
- Databases (NACE International's COR.SUR ® and COR.SUR2 ® materials selection databases)
The Active Library® on Corrosion

Functionalities

3-D Cube of Contents

Click bold labels along axis to select
Click 'View' button to read
The Active Library® on Corrosion

Functionalities

Corrosion Atlas

Material

System

Phenomena

Material: Aluminium (AlMg3).
System: Transport piping system.
Part: Welds in 6" pipe.
Phenomenon: Weld defects.

Appearance: Intergranular cracking in weld HAZ (melt cracks).
Time to Failure: 30 years.
Environment: Inside air with B/C granules.
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Functionalities

**COR.SUR ® database**

![Image of the COR.SUR ® database interface with options for corrosion and metal selection, along with a graph showing concentration and temperature ranges for various corrosion rates.]
The GRACE™ system

The goal of the system

System design objectives:

to build an on-line hypermedia system using the World-Wide Web for providing access to materials engineering data and support from intelligent corrosion assistants

System information functionalities:

- **Global**: available to anyone with Internet access
- **Reading**: storage and sharing of data and documents
- **Accessing**: smart retrieval of relevant data and documents
- **Corrosion**: corrosion and materials engineering information
- **Expertise**: virtual, on-line centre of corrosion competence

System modules under development:

- Reference Manual on Corrosion Engineering
- Failure Analysis Assistant acting as a “virtual expert”
Goal:

- to extend the functionalities of the ALC
- to facilitate typical materials engineering tasks
- to experiment with knowledge-based hypermedia

Design:

- hypermedia documents generated “on the fly”
- using domain knowledge: corrosion and materials expertise
- responsive to reader (beginner, professional, expert) and task (recognition, diagnosis, treatment, prevention) profile
The GRACE™ system

The Global Reading & Accessing of Corrosion Expertise (GRACE) system is a first attempt at trying to make a large body of knowledge and expertise on materials and corrosion engineering problems and their possible solutions available on-line through the World-Wide Web (WWW). It represents the culmination of several years of research efforts of the Materials Information Processing Systems group (MIPS) into the design and development of hypertext and hypermedia tools and techniques to provide intelligent access to materials and corrosion engineering information.

The information accessible through the Global Reading & Accessing of Corrosion Expertise system is divided into two sections of information:

Public access information sections
These sections of the GRACE system contain information which is freely accessible to all members of the research community, the business world or the general public which have free access to a WWW browser.

Restricted access information sections
These sections of the GRACE system contain information which is only accessible to persons or institutions which have registered with the GRACE system maintainers and which have authorized access to a WWW browser.

If you want to browse through to the restricted access information sections, you have to fill in a registration form first.

Public access information sections of the GRACE system:

- **General corrosion knowledge**
  This section of the GRACE system contains general knowledge on corrosion problems and their solutions, directly taken from the primary literature or carefully derived from various publicly available information sources.

- **Dictionary and glossary**
  This section of the GRACE system provides alphabetical access to a comprehensive selection of typical corrosion jargon, offering a brief explanation for the most widely used corrosion and materials terms and expressions.
The GRACE™ system

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- **Dictionary and glossary**
  
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- **Background information and help**
  
  This section of the GRACE system contains background information on corrosion and materials engineering, and offers help on the use of the GRACE system and the different information sources contained in the GRACE system.

Restricted access information sections of the GRACE system:

- **Cube of Contents**
  
  This section of the GRACE system provides a three-dimensional table of contents, where you can specify a combination of corrosion, material and environment to locate a specific document in the GRACE collection of documents.

- **Failure Analysis Assistant**
  
  This section of the GRACE system provides access to a "virtual expert" which will assist you in the interactive analysis of the possible causes of a materials failure. The Assistant will systematically guide you through the analysis process.

- **Quick reference**
  
  This section of the GRACE system contains an extensive set of valuable look-up tables with corrosion and materials background information, such as various conversion tables and detailed information on widely-used standards.
The Global Reading & Accessing of Corrosion Expertise (GRACE) system is frequently updated and improved. If you want to be notified of all recent changes and want to enjoy continued access to the restricted access information sections of the GRACE system, please fill in the following registration form:

- **Name:**
- **Position:**
- **Department:**
- **Organisation:**
- **Address:**
- **Post/zip code:**
- **Country:**
- **Telephone:**
- **Fax:**
- **E-mail:**
- **Type of access:** Public access Restricted access
- **How did you find out about the GRACE system?** (check all that apply):
  - By browsing around on the WWW
  - By reading about the GRACE system
  - By hearing about the GRACE system

[Form buttons: Send this form, Reset and start over]
The GRACE™ system

Cube of Contents

The Cube of Contents of the Global Reading & Accessing of Corrosion Expertise (GRACE) system is an intelligent interface to all the information (data, tables, figures, etc.) available in the GRACE system. It allows you to have direct access to any document in the GRACE system for a given combination of phenomenon, material and environment.

From the available information in the GRACE system, a careful selection will be made of information that best satisfies your reader, task and document profile.

PROFILE:

- Type of reader: ◆ beginner ◆ professional ◆ expert
- Type of task: ◆ recognition ◆ diagnosis ◆ treatment ◆ prevention
- Type of document: ◆ data ◆ table ◆ figure ◆ background ◆ case study

REQUEST:

- Type of phenomenon: [Pitting]
- Type of material: [Stainless steel]
- Type of environment: [Seawater]

Send this query  Reset and start over
Pitting Corrosion of Stainless Steel in Salt Water & Seawater

The behaviour of stainless steel in contact with salt water, and seawater in particular, is apt to be erratic, with corrosion often taking the form of pitting rather than general attack.

The chromium-nickel steels of the 18-8 type are the members of this class which have been most extensively used for piping materials, and their failures have been the most spectacular.

Influencing factors:

- When these alloys are fully submerged, they are not apt to corrode seriously, provided that the water is well aerated and is moving vigorously enough to keep the metal surface scrubbied clean. If the exposure is only partial, pitting may be encountered adjacent to the water line, and, when the exposure is intermittent, pitting is apt to occur at scattered points on the periodically exposed surface. If the surface is allowed to dry between periods of exposure, pitting is apt to develop beneath clumps of salt crystals which may appear after evaporation of the water.
- Accumulations of solid materials, organic or inorganic, which adhere to the metal surface may encourage pitting of the metal beneath such deposits. The presence of corrosion products or other solid material may cause the setting-up of oxygen concentration cells which enhance extremely rapid (pitting) corrosion and eventual perforation of the wall. In general, it should be permissible to use stainless steels with salt water under controlled conditions which do not involve any of the hazards mentioned above.

Examples:

- Corrosion by Halides of Stainless Steel in Cooling Water Systems

See also: Pitting Corrosion of Stainless Steels In Water
The GRACE™ system

Failure Analysis Assistant

Goal:

• ad-hoc availability of corrosion failure expertise
• valuable independent second opinion
• interactive “check-list”

Design:

• based on MTI “Atlas of Corrosion and Related Failures”
• analysis steps cross-linked to general corrosion information
• generic approach, extendible to other materials problems
e.g. paint failures
The GRACE™ system

Failure Analysis Assistant - Step 1

Examination of Failed Plant Item

1. General site investigation
2. Identify failed component
3. Identify nature of failure
4. Identify origin of failure
5. Identify relation to plant geometry
   Optional: NDT examination of plant item(s)
6. Hardness testing
7. Analysis determination
8. Sampling
9. Metallographic examination
   Optional: Mechanical tests on specimens
   Optional: Environmental tests on specimens

Notes on: Documentation & Reporting

SHORT-CIRCUIT Procedure
3. Identify Nature of Failure

**FINDINGS:**

Failure is

- restriction or blockage
- swelling or other form of distortion
- fracture or leak originating from wall thinning or other form of distortion
- leak...
- fracture in a previously undistorted wall
- blind crack, pit or cavity, possibly detected by NDT
- no failure detected, but further investigation is instructed...

NEXT Procedural Step

SHORT-CIRCUIT Procedure

Document: Done
3. Identify Nature of Failure

FINDINGS:

Failure is

- restriction or blockage
- swelling or other form of distortion
- fracture or leak originating from wall thinning or other form of distortion
- leak ...
- fracture in a previously undistorted wall

DEDUCTIONS: Crack may have developed by a corrosion process, metallurgical change, fatigue, creep or from locked-in stresses.

ACTIONS: Turn to section on Cracks in Metals or to section on Physical Degradation for guidance in establishing the origin of failure.

- blind crack, pit or cavity, possibly detected by NDT
- no failure detected, but further investigation is instructed ...

NEXT Procedural Step

SHORT-CIRCUIT Procedure
Physical degradation

Aside from corrosion processes, a number of other phenomena may lead to degradation and, eventually, fracture of metals or metallic components. The most important of these phenomena are listed below.

- Creep, Creep Rupture, Creep Fatigue, and Stress Relief Cracking
- Fatigue Cracking

*Notes on: Temper Embrittlement*
Fatigue Cracking

Introduction: Fatigue cracking is caused by repetitive loading with, in the majority of cases, a tensile constituent at some stage in the cycle. Fatigue may initiate failure or constitute a secondary failure mechanism propagating from a defect or notch produced by design, fabrication or corrosion during service. Unless interrupted by an imposed or self-induced change in stress, a fatigue crack will usually propagate until a terminal failure mechanism is initiated.

See also: Corrosion Fatigue

Types:

- High Cycle Fatigue (elastic strain)
  - Causes and recognition
  - Fractography

- High Strain Fatigue (plastic strain)
  - Causes and recognition
  - Fractography

Prevention: Prevention of Fatigue Cracking
High Cycle Fatigue - Fractography

Surface appearance  Metallographic section

Fracture low mag  Fracture high mag
CONCLUSIONS

Using hypermedia for corrosion engineering

The Active Library® on Corrosion

+ proof of suitability of hypermedia for corrosion engineering
  – lacking true intelligent support for navigation and retrieval

The GRACE™ system

+ broadening access and extending functionality of the ALC
  – gathering / validating of general and industry-specific data

Future developments:

• second edition of the Active Library® on Corrosion
  ü new information: water treatment, oil and gas industry
  ü new books & primary literature (e.g. “Corrosion Science”)

• public availability of the GRACE system
  ü basic research into intelligent hypermedia navigation
  ü first attempt to build a virtual community of corrosion experts

http://www.mtm.kuleuven.ac.be/MIPS/GRACE/