Operating Plant and Systems Professionals

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SENIOR CORROSION, PIPELINE AND METALLURGY CONSULTANT

SUMMARY

David has a total of thirty-nine years in industry, serving as the chief metallurgist of three major corporate units: Aramco, The M. W. Kellogg Company and Fluor Daniel - Sugar Land; one year with an industrial testing laboratory. Fourteen years as an independent consultant, primarily to the downstream petroleum industry. Ten years of teaching and research in two state universities (tenured).

His experience includes:

- Preparation of materials of construction documents for major capital projects including gas and crude oil production (sweet and sour), commodity chemical plants, fertilizer plants, enzyme plants, gas plants, LNG plants, refineries, pipelines and terminals. Experience includes extensive work on the design of and materials selection for offshore pipelines, processing platforms, terminals and structures.

- Development of standards, specifications, technical practices and inspection procedures in support of the above major projects.

- Practice of corrosion control, fracture control, fitness-for-service evaluation and failure analysis. This experience included extensive field and fabrication site investigations and collaboration/participation with laboratory work.

- Management of technology innovations involving materials selection, welding, paints and coatings, cathodic protection, chemical cleaning, corrosion inhibition and laboratory testing.

- Development of corrosion manuals for upgrading facilities in support of an oil sands production/refining company.

- Fire damage assessment including determination of root cause, extent of damage and recovery planning for producing facilities, oil sands upgraders, refineries,

gas plants and pipelines.

- Served as an expert witness for three major metallurgy/corrosion-related law suits (all of which were won).

- Provided subrogation services for several insurance claims.

WORK HISTORY

Arabian American Oil Company (Aramco, in Dhahran, Saudi Arabia), 1975-1986.

Field Metallurgist for 18 months. Hands-on, on-site failure investigations of rotating equipment (primarily pumps and turbines, both steam and combustion gas); failure investigations of pipelines (including wild crude, partially degassed crude, processed crude, gas transport and water injection lines). The above experience includes both onshore and offshore facilities. Investigations included both hands-on and assisted metallographic laboratory work.

Chief Metallurgist (mid-1977 to 1986). Some failure analysis (high priority incidents such as major plant fires and major pipeline failures), but mostly worked in support of major capital projects (the capital budgets in the early 80's were on the order of $4 billion per year). The responsibilities of this position included corrosion control, fracture control and suitability for intended service (including anticipated upsets).

These projects include medium to very large gas-oil separating plants, crude processing plants, gas plants, LNG plants, pipelines, terminals and water injection facilities (both raw water and seawater). Offshore experience included major pipelines (mostly wild crude), production and processing platforms and a project that installed a 7-mile long elevated trestle to a LNG loading terminal.

- My capital project support work as Chief Metallurgist included developing materials selection and design criteria and documents to be used by bidding contractors and reviewing their recommendations. The job also included the development of materials-related technical practices, engineering standards and inspection practices to be used by project engineers in their areas of expertise. The development of a pipeline fracture control/materials selection/design standard is an example of the latter activity.

- Special projects undertaken included working with vendors and fabricators to resolve disputes and errors. For example, one job included a trip to Japan to find out why gas combustion turbine burner baskets contained hydrocarbon-contaminated welds.

- Other special projects included assisting senior management in evaluating

fitness-for-service of damaged plants and facilities. Establishing the maximum allowable operating pressure of damaged pipelines is an example.

- The Chief Metallurgist's job also included the management of a Metallurgical Unit, a Chemical Treatment Unit and a Cathodic Protection Unit. The group grew to include approximately 15 engineers and 15 technicians and a first-rate metallurgy laboratory. The Chief Metallurgist was expected to manage these groups with technical competence.

- Because of the often unique corrosive conditions encountered in both onshore and offshore facilities, the Chief Metallurgist was expected to lead creative efforts that developed new technologies. Internal coating of water injection pipelines, including the girth weld area, is an example.

Aramco's crude slate consisted of light to moderately heavy crudes with low to high gas/oil ratios. Most crude production was wet, with connate water containing about 300,000 ppm chloride. Most crude production (and processing) was hot, with wellhead temperatures often in excess of 212°F. Associated gases usually contained about 2-3% each of hydrogen sulfide and carbon dioxide. Incidental aeration of sour connate water generated corrosion rates of up to several thousand mils per year. If buried, pipelines were usually subject to saline sand that, in the absence of adequate corrosion protection, could corrode exposed steel at rates up to about 150 mpy. Steel structures, inadequately protected, exposed to the waters of the Persian Gulf (about 5% chloride) would typically corrode at up to 25 mpy, more in the splash zone. All of these conditions mandated the integration of corrosion control measures into materials selection and facilities design.

David reluctantly left this job, as Aramco could not provide in-kingdom schooling for his children.

Industrial Testing Laboratory (St. Louis, MO), 1986-1987.

Vice President. Supervised the work flow of all laboratory divisions (Environmental, Analytical and Metallurgical). Also worked as a general metallurgical failure analyst on insurance subrogation jobs (e.g., failed space heaters) and on industrial failures (e.g., failed utility pipelines). Served as an expert witness on one job involving a corroded manhole ladder.

David left this job when he was contacted by The M. W. Kellogg Company with a much better opportunity.

The M. W. Kellogg Company (Houston, TX), 1987-1991.

Chief Metallurgist. Supervised the work of two staff metallurgists whose primary

job was materials selection for refinery and chemical plant capital projects. Most of the work of this position, however, was on special projects involving various chemical plants and refineries.
Some of the more significant of these projects are listed below.

- Salvage of new, flawed large cast iron compressor case castings (needed to keep a major capital project on schedule).
- Condition assessment of a relatively new, large gas plant syn-gas furnace, the high-alloy tubes of which had been damaged by a wandering flame front.
- Failure analysis and remedial measures for a gas-cracking ethylene technology that developed rapid "metal dusting"-type carburization damage in its high-alloy tubes.
- Condition assessment and salvage of a jacketed vertical waste heat boiler.
- Salvage of a condensing steam turbine inadvertently damaged by caustic stress corrosion cracking, due to a caustic carryover.
- Failure analysis of a mal-designed vertical U-bend stainless steel heat exchanger.
- Suitability evaluation of non-specification LNG valves and heat exchangers in a LNG processing plant (that included an offshore loading trestle).

David left this job reluctantly. It required very extensive domestic and foreign travel at a time when he was needed at home.

Fluor Daniel Corporation (Sugar Land, TX), 1991-1998.

Technical Director, Metallurgy. This job involved minimal supervision (of only one or two highly qualified welding engineers and later, one cathodic protection engineer). This job primarily consisted of materials selection for mostly major capital projects involving refineries and chemical plants. A few jobs involved pipelining. Clients included Shell, Exxon, Mobil, Marathon, Valero, Union Carbide and Aramco. Examples of materials selection for facilities include hydrodesulfurizers, water treatment, crude processing (such as atmospheric and vacuum crude towers) and units such as fluid catalytic crackers, and cokers.

In addition to materials selection, I created an on-line library of materials selection standards and specifications for specific services (e.g., seawater, sulfuric acid,

sour service, wet carbon dioxide, amines, etc.). This effort was undertaken to allow various disciplinary engineers (e.g., Heat Transfer, Vessel, Piping) to do their own materials selection, thus reducing project costs and improving schedules. I also represented the Company on various ASME subcommittees (e.g., Special Work Group Toughness, Section VIII, Div. 1 and 2). The ASME effort permitted the Company to be in "front of the curve" on design and materials selection issues of major importance.

David retired from this job in August, 1998.

Independent Consulting, 1998-present.

David has undertaken many consulting jobs since retirement.

- Materials selection/corrosion control for an onshore capital project involved in gathering, processing and transporting crude oil for an ExxonMobil facility in Cepu, Indonesia.

- Materials selection/corrosion control in support of the design of an offshore floating storage and offloading facility that included all crude processing facilities, located in waters offshore of Angola (Kizomba). This was also an ExxonMobil capital project.

- Developed up-to-date design and materials selection standards for offshore structures, including offshore production manifolds, piping and pressure vessels for ChevronTexaco.

- Conducted an on-site damage assessment study for two gas plants in southern Louisiana to determine the extent of damage that was due to improper post-Katrina facility management; this job was done for Jacobs Engineering.

- Evaluated the suitability-for-service of a mothballed methanol plant; the job was also for Jacobs Engineering.

- Created Integrity Operating Windows/Safe Operating Limit spreadsheets for a number of different refinery operations (amine units, alkylation units, vacuum units, sulfur recovery units, hydrotreaters, etc.) for a number of clients.

- I have done several consulting jobs for Lloyd's Register Energy Americas (formerly Capstone) in Houston, TX. These jobs have included:

    1. Early LREA work included corrosion studies/corrosion manuals and miscellaneous support activities for Suncor Energy, a major oil sands producer in Alberta. Activities have included:

a. Development of corrosion manuals for 17 plants (including diluent recovery units, hydrotreaters, hydrogen production, units, amine units, sulfur recovery units, gas recovery units, delayed coker units, vacuum units and tank farms).

b. Fire damage investigation/recovery for two DRU fires and one hydrogen production unit fire.

c. RBI Level 2 corrosion studies for two SAGD (Steam Assisted Gravity Drain) facilities (including the gathering/processing systems and the supporting utility systems.

1. In addition, RBI Level 2 corrosion studies (including IOW/SOL spreadsheets) were done for several other North American refining companies.

2. Miscellaneous jobs include:

    a. Developed a corrosion management program for part of a middle-aged refinery.

    b. Provided corrosion rate analysis for a wet carbon dioxide handling system in a recycling plant.

    c. Failure analysis of a geothermal steam pipeline in the Philippines.

    d. Failure analysis of a buried product pipeline in Trinidad.

    e. On-site evaluation of current condition and fitness-for-service of several older refinery units, including a fluid catalytic cracking unit and a sulfur recovery unit.

    f. On-site evaluation of failing stainless steel heat exchanger bundles in a chemical plant.

    g. On-site evaluation of fitness-for-service of a PVC piping system for an ultra-pure water piping system in a bio-pharmaceutical plant.

    h. On-site RBI corrosion studies for three Petronas chemical plants in Malaysia.

    i. On-site damage assessment for fire-damaged equipment and piping for a gas pipeline company in Ohio.

j. Risk assessment (for personnel) of a leaking crude heater in a Philadelphia refinery.

k. Failure analysis of a drill string motion compensator for a Brazilian off-shore drilling rig.

l. Level 2 corrosion RBI corrosion studies and a corrosion monitoring study for a revamped refinery in Abu Dhabi.

m. Assisted LREA in drafting an API document on high temperature damage mechanisms ("Material, Fabrication and Repair Considerations for Austenitic Stainless Steels and Austenitic Ni-Fe-Cr Alloys, Subject to Embrittlement and Cracking in High Temperature (565 - 760°C/1050 - 1400°F) Refinery Services").

- As a consultant to Meridium Corp., developed RBI corrosion studies for an Indian refinery and critiqued several corrosion manuals for a CNRL, major Canadian oil sands company.

- As a consultant to The Welding Institute-North America, I have done two jobs.

  1. Corrosion damage assessment for an old Middle East NGL plant.

  2. Reviewed riser metallurgy/corrosion control for an offshore production platform, Nigeria.

David has also provided expert witness for three law suits (all of which were won).

- Improper initial materials selection and later weld repairs that resulted in fatalities due to a vessel rupture in a chemical plant.

- Improper materials selection and fabrication of an offshore production manifold for a major production project.

- Improperly designed and operated recirculating water system used in a stone cutting facility. The facility lost several million dollars of stone cutting equipment due to avoidable corrosion.

REGISTRATIONS

Professional Engineer, Texas

EDUCATION

B.A., Chemistry/Mathematics (Dual Majors), Magna Cum Laude

Yankton College, Yankton, SD, 1961

M.S., Physical Metallurgy (First Minor: Physical Chemistry; Second Minor: Solid State Physics)

Iowa State University, Ames, IA, 1964

Ph.D., Physical Metallurgy (First Minor: Physical Chemistry; Second Minor: Solid State Physics)

Iowa State University, Ames, IA, 1966

SUMMARY OF UNIVERSITY EXPERIENCE

Served on the mechanical engineering faculties of the University of North Dakota (Grand Forks) for three years and the University of Missouri (Columbia) for 6-½years, teaching metallurgy, materials science and thermodynamics (tenured at both Universities). Conducted research (graduate student assisted) in intermetallic crystallography and advanced biomaterials.

PUBLICATIONS

Eleven publications in refereed international journals. Nineteen industrial publications (all in engineering forums) on corrosion, failure analysis, pipeline construction, fracture control, materials selection and the creation/use of Integrity Operating Windows. Co-author of a chapter on materials selection in "Corrosion Engineering Handbook", ed. by Phillip A. Sweitzer. Principal co-author of a book entitled "Materials Selection for Hydrocarbon and Chemical Plants." Author of a chapter on materials selection for a chemical engineering handbook (*Albright's Chemical Engineering Handbook*).