Bulletin Board

May 22—24, 2007
Holland, Michigan
United Dynamics Corporation
Presents
2007 Northern Techniques Conference
Hampton Inn Holland (888)933-8500
The seminar includes breakfast, lunch, snacks, a manual, and 3 days of educational instruction with one of the industry's highly regarded experts, John M. Cavote.
$1275 Per Person
Discounts for multiple attendees from the same facility!
www.udc.net
(502) 957-7525

Tidbits

Did You Know?

David N. French Metallurgists is a Woman Owned Enterprise!

A number of our clients may be unaware of the fact that we are a Woman Owned Enterprise. Today, many companies are required to contract for services with a percentage of company's annually which are Minority Owned Enterprises or Woman Owned Enterprises. David N. French Metallurgists may be just the right avenue for fulfilling your organizational percentage requirements. Laurie L. Cavote, our President, has industry related experience of over 27 years. She is active in the daily operations of not only one but two successful corporations which operate under her direction, with the utmost integrity of services and customer satisfaction. One more great reason David N French Metallurgists is the best choice for all your metallurgical service solutions.

DAVID N. FRENCH METALLURGISTS
Corporate Headquarters
2681 Coral Ridge Road
Brooks, KY 40109
Phone: 502.955.9847 Fax: 502.957.5441
www.davidnfrench.com

Electric Power Conference
May 1—3, 2007
Chicago, IL

The Donald E Stevens Convention Center

Come and visit us at our booth # 1749 We would be delighted to have the opportunity to visit with you at the conference. We will have on hand valuable information for **David N French Metallurgists** and our sister Corporation, **United Dynamics "AT" Corporation.**

We hope to see you there!

«*AddressBlock*»

DAVID N. FRENCH METALLURGISTS
2681 Coral Ridge Road
Brooks, KY 40109

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View From the Penthouse

Second Quarter 2007

Caustic Attack

Caustic attack or caustic gouging of carbon steel occurs as a result of:

1. An upset in boiler chemistry in which too much caustic (NaOH) is added.
2. Steam blanket formation on the fire side of the furnace-wall tube that concentrates the hydroxide so that metal attack can occur.

Caustic could concentrate if the rate of bubble formation exceeds the rate at which the tube is washed off. Alternatively, caustic can accumulate if heavy corrosion deposits increase the temperature of the wall underneath the deposit and allow hydroxide to concentrate there. Conditions for caustic attack are most likely to be present in zones of high heat flux where waterside flow is slowed by:

- deposit accumulations
- flow disruptions like backing rings at butt welds or weld penetrations where flow separation from the wall may occur and departure-from-nucleate-boiling (DNB) can develop in a small area
- flow in horizontal tubes

DAVID N. FRENCH METALLURGISTS

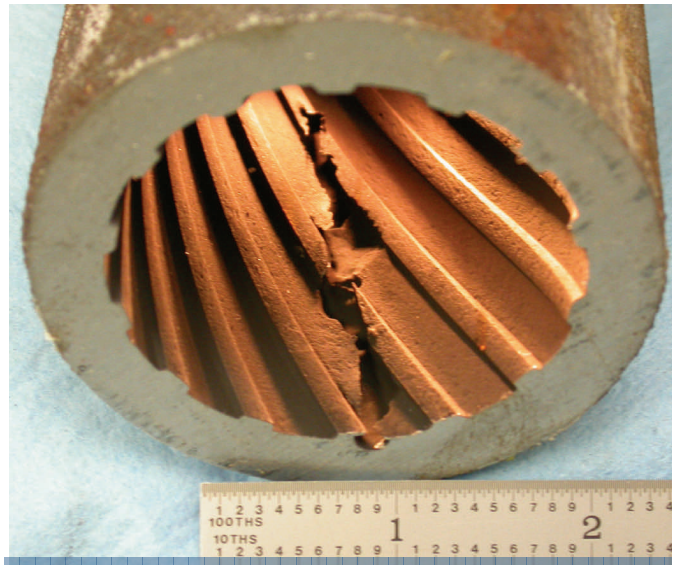
View From The Penthouse

Ph 502.955.9847 ***The DNFM Quarterly Newsletter*** DAVID N. FRENCH METALLURGISTS Fax 502 957 5441

Dr. David N. French

Dr. David C. Crowe

CAUSTIC ATTACK



Caustic attack in a furnace division wall tube at a burner elevation

Mechanism

Caustic removes the protective magnetite film by the reaction:

$$4\ NaOH + Fe_3O_4 = 2\ NaFeO_2 + Na_2FeO_2 + 2\ H_2O$$

With the protective magnetite removed, the bare steel reacts via:

$$Fe + 2\ NaOH \rightarrow Na_2FeO_2 + H_2$$

At the recent NACE Corrosion 2007 conference, Shalaby (Paper 07453) concluded that the first step in caustic attack is that the magnetite loses its protective nature as a result of localized high heat flux. A non-protective, porous magnetite scale forms by reaction of the steel and oxygen-bearing species. Growth of the scale at the metal surface in turn causes further increase in the heat transfer resistance across the tube wall. That non-protective scale presents an environment for concentration of hydroxide. This description does not depend on DNB to concentrate caustic and break down the magnetite. Rather, the high heat flux causes the magnetite form to be non-protective.

Topic Ideas ?

Please email inquiries@davidnfrench.com

Appearance

Caustic gouging results in shallow, usually hemispherical, depressions in the tube surface that are shiny and fairly smooth, sometimes with an undulating appearance. In the case of under-deposit attack by caustic, hard deposits are frequently present but often are washed off by the time the tube is removed for failure analysis. The deposits are layered, and may contain sodium ferroate or ferroite crystals. The failure will occur at an area thinned by corrosion, and the fracture edges will be thinned. No microstructural degradation is associated with this type of corrosion.

Often, nickel oxides and copper are observed in gouged areas. These metals originate from corrosion of condensers and are deposited on the outside of iron oxides as they are reduced through oxidation of iron.

Boiler Chemistry

Caustic may be added intentionally for pH control under caustic treatment, or as part of all-volatiles or phosphate water treatment plans, but at unintentionally excessive concentrations. Over use may also occur during start-ups. Caustic gouging will not usually occur under congruent phosphate treatment. Caustic may be accidentally added from regeneration of ion exchange resins in the condensate polisher or demineralizer. Under unusual conditions, there may be in-leakage of process chemicals. Once the caustic is in the system, it may be concentrated by deposits or steam blanketing.

Prevention

1. *Good Water Chemistry* – Maintain the caustic at low levels consistent with the water treatment strategy and the pressure of the boiler. Testing and control procedures should be implemented as needed. Ensure that process in-leakage cannot occur.
2. *Clean Waterside* – Chemical cleaning may be necessary to remove heavy deposits underneath which caustic corrosion occurs. Analysis of waterside deposits and measurement of deposit weight density is recommended to track this before problems occur, and David N. French Metallurgists offers this as a service.
3. *Minimize High Heat Flux* - Review firing practice in areas with problems. Burner alignment or control may need to be improved, or firing practice modified.
4. *Good Circulation* - Improve water flow in low flow tubes.

Inspection and Repair

The extent of damage from caustic should be determined if a failure occurs. Ultrasonic thickness surveys will aid in identifying areas which have suffered corrosion. Areas of high heat flux should receive focused inspections. Scanning methods to identify thin spots must be used instead of point-by-point measurements which could miss the problem.

Repairs have to be done carefully to avoid heating adjacent areas that may be contaminated with caustic. If heated during welding, contaminated areas could experience caustic stress corrosion cracking. Pad welding should never be performed, and window welds must be avoided in these circumstances. Careful cleaning adjacent to the weld, thorough inspection to make sure that any cracking is removed, and good weld practices are very important to avoid subsequent problems.

April 2006

Dr. David C. Crowe Dr. David N. French

Cross-section of caustic attack