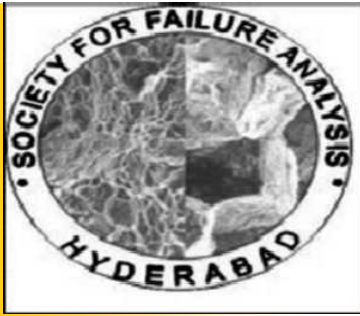




About SFA

Objectives

Local centers

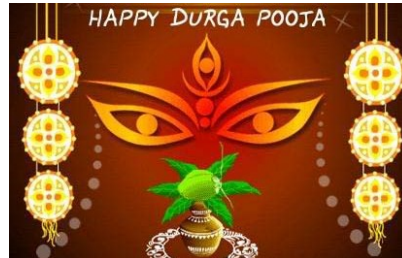
Welcome you all to join as members of SFA! Please find the membership form inside; kindly fill in and contact Secretary of SFA through email.

Experts and experiences:

- Prof. V S Raja,
IIT, Bombay
- Dr. Amarnath Kosgi
CEMILAC, Bangalore



SFA Newsletter



Message from our President

Dear readers,

Warm greetings to all of you. I am happy to inform you that three SFA centres were inaugurated, one at each - Coimbatore, Jamshedpur and Warangal, and a large number of members joined these centres. I wholeheartedly welcome all the newly joined student members as well as the academicians and members from industrial background for their keen interest. Now it is the right time that regular meetings and events are arranged at our centres once in three or four months to interact and discuss issues of relevance, in addition to conducting theme meetings, workshops and seminars.

While I contemplated over the important issue of failure analysis, a train of thoughts crossed my mind. I thought I must share my thoughts with the esteemed readers of this newsletter, as they too share a wealth of information with us. Failure analysis is an important discipline which involves the process of collecting and analyzing data to determine the cause of a failure of a component, function or process. The role of a failure analyst is equally important in unearthing the true cause of the failure. Therefore, a failure analyst must be a serious scientist with a gift of keen observation. In fact a parallel can be drawn between the failure analyst and a coroner performing an autopsy on a person who suffered an unnatural death; the only difference being that the former works on parts or assemblies that have had an unnatural or premature failure. Failure analysis can be done in a multitude ways. But, in this connection, Jim Glancey has suggested a method of Failure Modes and Effects Analysis (FMEA). In this analysis procedure, equipment/components and their associated single point failure modes, consequences and safeguards are tabulated. Identification/assessment of risk is derived from looking at each component (or machine). An FMEA can be implemented using a hardware or functional approach, and often due to system complexity, be performed as a combination of the two methods. Hardware = loss of a component and Functional = loss of a function or feature. All in all, I personally feel that failure analysis involves three cardinal principles which can be described as 3P and they are, 1) Principles: failure analysis must be done clearly in accordance with the scientific principles, 2) Perseverance: one must work doggedly to gather the evidences to string the loose ends in order to arrive at a scientific and logical conclusion, and 3) Practicality. In the end, I must say that, those who work with these 3P, would certainly be successful, even while analyzing a failure (analysis)!

I found the current newsletter very interesting to read and I specially thank the editors for it. I request all readers to send their feedback to the editors as well as useful articles describing their experiences for publication in the newsletter. It is generally said that: "Minds are like parachutes – they function only when open."

Best wishes & Season's Greetings to all the readers!

T.Jayakumar
PRESIDENT, SFA



From the Desk of Editors

Warm greetings to all! We are happy to present you the 9th issue of the Newsletter of Society for Failure Analysis (SFA). We express our sincere thanks to Dr.T.Jayakumar, President, SFA, who has been motivating us to improve the quality of newsletter with respect to its content and readability as well as organize activities of relevance to industries and so on.

In order to popularize and invigorate the society, efforts were made consistently over the last three years, prominent among them were, 1) accomplishment of several activities by our local centres at various places, 2) organizing workshops for inspiring the young engineering students in association with various other professional bodies, and 3) bringing out the Newsletter. As a result of these efforts, three centres of SFA were inaugurated in succession at Warangal, Coimbatore and Jamshedpur in the last three months. The glimpses of the inauguration programs at these places are highlighted in this issue.

We have solicited articles from experts in the important area of corrosion. An interesting article entitled, "Do Principles of Corrosion Matter in Corrosion Failure Investigations?" describes how ignorance of corrosion knowledge can lead to catastrophic industrial failures.

We thank the authors for their invaluable contributions which give the readers an important insight into their experiences. We take this opportunity to appeal to the

scientists, engineers and technicians of Indian industry to use SFA as a forum to share their experiences and practical ideas on troubleshooting. An impressive way to add relevant information to this newsletter is to include a calendar of upcoming events. The details of important forthcoming international and national events are included; also the information about recently published books on this subject is added.

We value your comments, which really boost our enthusiasm to perform better. Therefore, as always, your views and comments, mailed to pujar@iqcar.gov.in or param@iqcar.gov.in are welcome. We wish you all a joyful life free from failures! You may visit our web site for posting your comments/suggestions or any queries: www.sfaindia.org

Kalpakkam (M.G.Pujar)

30-09-2013 (P.Parameswaran)

Editors



We encourage you to join the society, Kindly fill up the application form (enclosed at the end of the newsletter) and contact secretary:, post your application with a DD (in favour of SFA, Hyderabad) to Dr. N.Eswara Prasad, Regional Director, RCMA (Materials), CEMILAC, Kanchanbagh, Hyderabad, 500 058



About the society

Aims and Objectives of Society for Failure Analysis

The aims and objectives of the Society shall be:

To serve as National Society to promote, encourage and develop the growth of "Art and Science of Failure Analysis" and to stimulate interest in compilation of a database, for effective identification of root causes of failures and their prevention thereof.

To serve as a common forum for individuals, institutions, organizations and Industries interested in the above.

To disseminate information concerning developments both in India and abroad in the related fields.

To organize lectures, discussions, conferences, seminars, colloquia, courses related to failure analysis and to provide a valuable feed back on failure analysis covering design, materials, maintenance and manufacturing deficiencies / limitations.

To train personnel in investigation on failures of engineering components and their mitigation.

To identify and recommend areas for research and development work in the Country relating to failure analysis.

To establish liaison with Government, individuals, institutions and commercial bodies on failure analysis, methodologies and to advise on request.

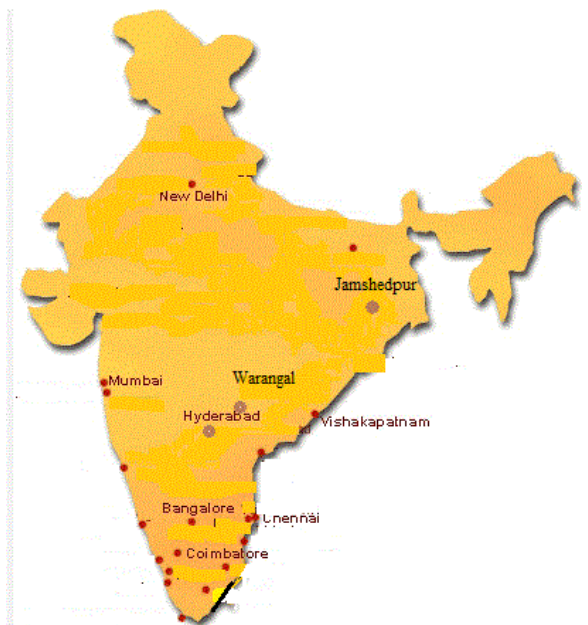
To cooperate with other professional bodies having similar objectives.

To affiliate itself to appropriate international organization(s), for the promotion of common objectives and to represent them in India.

To organize regional chapters in different parts of the country as and when the need arises.

To do all such other acts as the Society may think necessary, incidental or conducive to the attainment of the aims and objectives of the Society.

Know your local centers



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Editors of Newsletter:

Dr.M.G.Pujar, IGCAR
Dr.P.Parameswaran, IGCAR





Inauguration of Society for Failure Analysis (SFA), Jamshedpur Centre

The Jamshedpur Centre of Society for Failure Analysis was formally inaugurated on 30th August 2013 at Jamshedpur. Mr A M Misra, Vice-President, Shared Services, Tata Steel Ltd, graced the inaugural programme as the chief guest and inaugurated the Jamshedpur Centre of Society for Failure Analysis as well. Mr Misra, in his speech, expressed the expectations from the failure investigation fraternity and emphasized on the requirement of a right kind of diagnostic and remedial journey and simulation.

In the inaugural programme, Mr. B.K. Das, Chairman of the organizing committee and Dr. Sandip Bhattacharya, Co-Chairman of the organizing committee discussed about the objectives of this initiative. Mr. S.K. Roy, Chief of Blast furnaces, Tata Steel and Dr. T. Venugopalan, Chief Technology Officer, New Projects, Tata Steel were also present amongst the other dignitaries.

On this occasion, SFA Jamshedpur Centre organized a one day workshop on failure investigation, named as 'Failure Analysis Clinic',

at TMDC Auditorium in association with The Indian Institute of Metals, Jamshedpur Chapter, Indian Society for Non-destructive Testing and Society for Failure Analysis.

The idea of organizing this failure analysis clinic was conceived with a view to bridge the gap that presently exists between the experienced & the beginners' in the field. The clinic provided a platform for understanding and discussing failure phenomena. Around 100 plant engineers, R&D material scientists, young graduate engineers and authorities dealing with regulations participated in the programme. Six eminent personalities from Industry, Research Institutes and Academia presented their experiences in the sessions. List included Prof. K.K.Ray, IIT Kharagpur, Dr. Parameswaran Padmanabhan, R&D-IGCAR, Dr. S. Tarafdar, NML, Dr. Sandip Bhattacharya, Tata Steel and Mr. J.C. Pandey, Consultant NDT Specialist. The workshop concluded with a panel discussion.





Inauguration of Society for Failure Analysis (SFA), Coimbatore Centre

The Coimbatore Centre of Society for Failure Analysis (SFA) was formally inaugurated on 6th September, 2013 at Dr. Mahalingam College of Engineering and Technology (MCET), Pollachi. During the inaugural programme, Dr. Ranga Palanisamy, Principal, MCET welcomed the gathering and spoke on the importance of the subject not only to mechanical engineers but to all those of other disciplines like aerospace, civil, electrical and electronic engineering streams as well. In his presidential address, Dr. Vijayarangan, Director, MCET briefly recollected his association with National Aeronautical Laboratory (NAL) and described the importance of usage of recent methodologies in understanding

fatigue failures in the industry. Gracing the inaugural occasion and lighting the Kuthuvilakku (ceremonial lamp) and declaring open the SFA centre of Coimbatore, Sri. K.V.Kasiviswanathan, former Associate Director and currently Raja Ramanna Fellow at IGCAR, Kalpakkam emphasized the need for awareness among the budding engineers on the subject as the current trends in design are trying to reduce the margins of factors of safety. Convener, Dr.P.Parameswaran, IGCAR briefed the audience on the various advantages of becoming a member of SFA and also briefed on the workshop.





Inauguration of SFA, Warangal Centre

The SFA Chapter was inaugurated at National Institute of Technology (NIT), Warangal on July 19, 2013. The event took place at the Seminar Hall of Metallurgy and Materials Engineering (MME) of NIT Warangal. Prof. M.K. Mohan of the Dept. of MME delivered the welcome address. Dr.N.Eswara Prasad, General Secretary-SFA & RD-RCMA (Mat), CEMILAC, Hyderabad briefed the audience about the Society for Failure Analysis and its recent activities. The Chief Guest Dr. T. Jayakumar, President- SFA and Distinguished Scientist & Director (MMG), IGCAR, Kalpakkam inaugurated the Warangal Chapter. The Chief Guest and Guest of Honor Professor T Srinivasa Rao, Director, NIT, Warangal and Chairman-SFA, Warangal Chapter emphasized the need to propagate and nurture the subject of failure analysis among the students pursuing engineering degree who will be the

leaders of tomorrow in materials development and production as well as component design, fabrication and service. The renowned failure analyst Dr.A.Venugopal Reddy, Founder President of SFA, Hyderabad delivered the keynote technical lecture on "Fatigue Origins & Fatigue Failures" during the occasion. The event was attended by as many as 100 participants which include the senior scientists of Hyderabad based DRDO laboratories, young faculty members, research scholars and students of NIT Warangal. Other SFA executives such as Dr.M.Srinivas, Vice President, SFA, DMRL, Hyderabad and Shri.B.Jana, Treasurer, SFA, RCMA (Mat), Hyderabad were also present during the event and have actively contributed to the discussion.





Do Principles of Corrosion Matter in Corrosion Failure Investigations?

V. S. RAJA

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Engineering, medicine, business, architecture and painting are concerned not with the necessary but with the contingent - not with how things are but with how they might be - in short, with design.

—Herbert Simon

Corrosion in the field can spring surprises. The science behind most of the corrosion failures is investigated, analyzed and documented. Yet engineers “commit blunders” and invite the wrath of corrosion fraternity causing serious problems for economy, environment and safety among other things. Nevertheless, there could be a few “unanticipated” failures. One might have seen red rust appearing even on galvanized steel although it could have been adequately covered with zinc coating. Wittingly or unwittingly, anodic member of dissimilar metal joints is often painted only to find later that the very anode coated with paint perforate much more rapidly than it could have, if left unpainted. In the field, corrosion failures occur either due to (a) lack of knowledge (b) lack of willingness to analyze the problem as production is paramount to engineers (c) leniency towards “ad hocism” and too much empiricism

among other causes. Whatever be the compulsions, corrosion is unforgiving and causes failures, for corrosion follows the principles of basic science and that manmade metals and alloys are thermodynamically unstable in chemical environments and would like to go back to their original state such as oxides, chlorides and sulfates with the support of free energy they release. The corrosion failure reported herein resulted in a chemical company which optimized energy consumption for boilers producing steam for a steam turbine for generating electricity. As would normally happen, the company waited for three different boilers to drip during service one after another, before it could decide that a thorough investigation was warranted and thus the problem was handed over to me. Presentation of the study in detail here would be beyond the scope of this magazine and I shall narrate only the salient features that led to proper conclusions and recommendations,





which of course were implemented and the boilers are working fine till date even after a decade of implementation. The article hopefully drives home the point that understanding corrosion principles is paramount in investigating the corrosion failures.

The three gas-fired steam boilers in question were operating at 100 bar pressure and dripped one after another during service at high operating pressures. On examination, the boiler tubes made of Cr-Mo steel were found to be leaking (Fig.1). As the failure could be due to (a) over-heating and consequent creep (note: about 50% of overall heat is transferred in boiler tubes) (b) corrosion (due to different mechanisms) (c) other failures (such as manufacturing and fabrication defects). The microstructural examination such as grain size and decarburization (Fig.2) and inspection of the contours of the outer surface of the tube ruled out the first possibility. That is, the boilers did not fail by creep. There were no apparent manufacturing defects as well. The other possibility, namely corrosion was analyzed. The nature of oxides formed on the leaked area was examined

through X-ray photo electron spectroscopy (XPS) and energy dispersive spectroscopy (EDS). Only the important data that led us to conclusions are presented in Figs.3 and 4. As the boiler water was treated with co-ordinated phosphate treatment, the presence of phosphate (as detected by Fig. 4) was not surprising. The Ca (Fig. 3) could have come from total dissolved solids (TDS) of the boiler feed water. However, the presence of Cu and Mg is the most striking, as they are not expected in the boiler feed water. Appropriate analysis is required at this stage. Quite often investigators get tied up to the location of the failure to find answers. Sometimes they assume only anodic area is responsible for corrosion, forgetting the fact that cathodes do contribute to the corrosion and there could also be other associated areas that are responsible for corrosion failures. Copper deposition had induced galvanic corrosion. However it was necessary to find where it came from. In any thermal power plant, condenser is an important unit as the steam that comes out of a steam turbine needs to condense into water. This condenser was made of cupronickel alloy and the





slow dissolution of copper from condenser which was carried through by the condensate and circulated through the boiler to produce steam again from this condensate water (Condensate polisher was not operational to remove these ions). Should the condenser suffer severe corrosion it would not only release copper ions but also cause leak letting the cooling water, which could contain Mg, in the condensate. The suspicion was confirmed on inspecting the condenser and found it to be leaking.

While the cause of boiler leak was identified to be due to Cu deposition, it was not clear why the condenser leaked. What happened to it during the intervening period of planned shutdown, when inspection was carried out on the condenser and found it to be in good condition, and the time the boiler started to leak, which was relatively a small duration? Here comes the glitch. The management went for all volatile treatment of boiler feed water to replace the coordinated phosphate treatment which was employed till then, because of the fact that the former reduced the sludge in water;

so less water blow down and more energy saving due to this change. The decision makers in the production department, who took this decision to save the production cost, were oblivious to corrosion consequences. Little did they realize that all volatile treatment lacked the buffering action offered by cooperative phosphate treatment and hence demanded a more stringent feed water quality control in the absence of which the various units including condenser, suffered from corrosion. So a comprehensive corrosion control regime must be put in place. For that, a thorough review of pros and cons should be made keeping in mind the metallurgy employed in all units and the likelihood of the environment causing unexpected levels of corrosion. Of course in the present case, the company was advised to change the metallurgy of the condenser tubes from cupronickel to duplex stainless steel and ensure stringent feed water chemistry for all volatile treatment, a win-win situation for production and maintenance personnel.



Fig. 1: Photograph showing the nature of corrosion attack. Deep corrosion pit is seen



Fig. 2: High magnification optical micrograph of the cross-section of the failed tube from the waterside region. Not much decarburization and grain growth was observed.

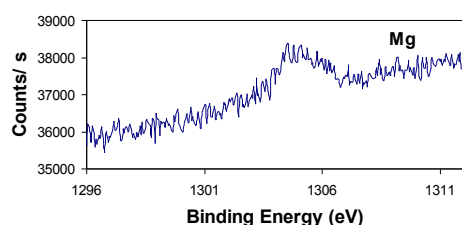
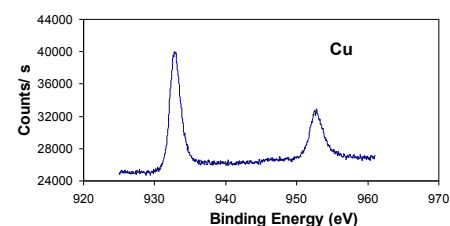
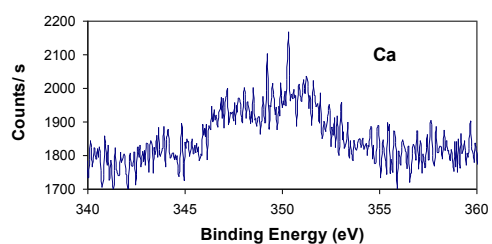
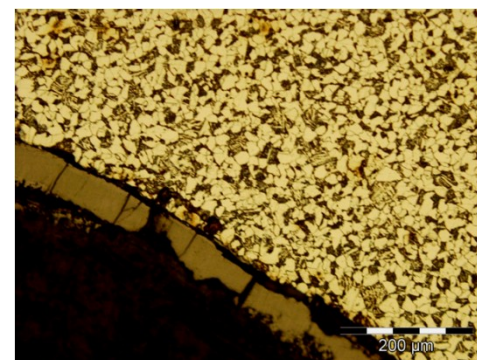


Fig. 3 Typical XPS spectra of obtained on the sputtered surface showed the presence of Ca, Cu, and Mg

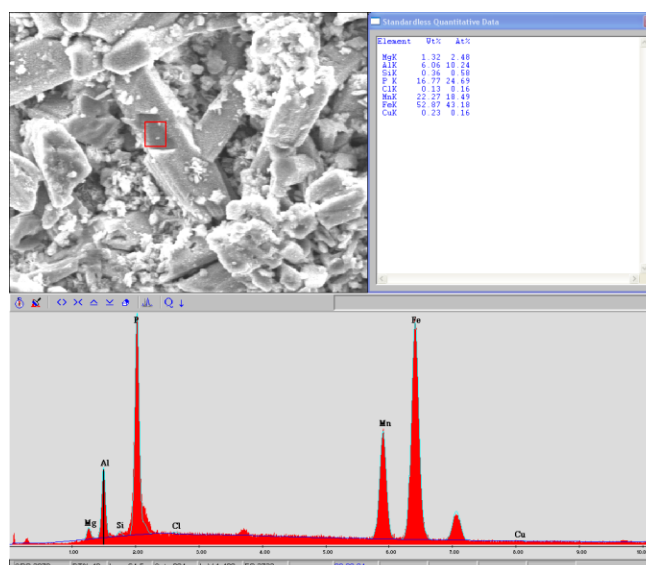


Fig. 4 Crystalline morphology of oxide scale at some location and the presence of P in the crystallites as detected by EDS.



Predictive Oil Analysis to prevent aeroengine failure

Amarnath Kosgi,

CEMILAC, Defence R&D Organisation, Bangalore

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Lubrication of aeroengines and Wear Debris particle generation

Military aircraft are sophisticated engineering systems that require meticulously devised maintenance programs to ensure reliable performance for effective operational readiness. Aeroengines have several interacting surfaces in relative motion, predominantly gears and bearings, which are lubricated with synthetic / mineral based oils for long endurance and high amplitude cyclic loads. For an aeroengine, after the break-in running period post manufacture, the stabilized operations lead to steady generation of wear particles at the interacting surfaces caused by load and relative motion. These wear debris particles are carried away by the flowing lubricant in the closed loop oil-circuit. Over a period of time, various mechanical abnormalities such as the onset of fatigue, corrosion, abrasion, misalignment, lubricant starvation and cavitations, etc. may arise influencing the wear mechanisms and formation

patterns of wear debris.

Wear debris characterization and Root cause analysis for defect identification

The type of wear debris is identified by its shape, size, texture, surface features and colour. A particular wear mechanism typically generates a characteristic type of wear debris and for each type there may be slight variation in particles depending on the severity and rate of wear. A holistic analysis of all these features of wear debris provides very meaningful insights on the actual wear mechanism; based on this suitable preventive / corrective measures can be taken well in advance. This capability of in-situ oil analysis to predict the impending catastrophic engine failures makes it a very useful prognostic health monitoring tool in aeroengine maintenance. Analytical ferrography is a state-of-the-art predictive maintenance





technique based on wear debris analysis and provides a comprehensive non-intrusive evaluation of the health of lubricated components while the aero-engine is in service. The wear debris (ferrous and non-ferrous), present in a sample of oil-in-service are precipitated on a glass micro-slide, observed using advanced microscopy and these micrographs are processed using image analysis software. The image data on shape, size, concentration and colour of wear debris particles is recorded and compared with the library database, which is collected from thousands of operating hours of that particular aeroengine.

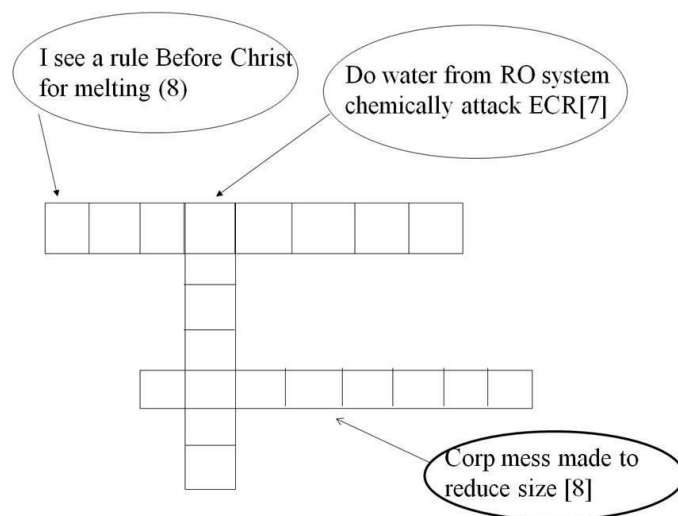
Oil analysis for prevention of

impending failures in aeroengine components

Some important deductions from ferrography are wear mode (*viz.*: abrasion, impact, fatigue, erosion, corrosion, scuffing, severe sliding, etc), wear rate, severity and location of wear particle generation. The concentration of wear debris indicates typical rate of wear whereas the size distribution of debris particles gives insights on the severity of wear. The composition of particles identifies the type of metal / alloy which pinpoints the affected component(s) amongst the oil-wetted surfaces of the system.



Cross word on failure analysis terminologies





Attention readers:

In this issue onwards we are planning to add a column on the latest articles published in the leading journals relevant to failure analysis area. Kindly click the links holding control and the under lined hyperlink;

Recent articles in the Engg failure Analysis Journal:

see the following link: <http://www.sciencedirect.com/science/journal/13506307/33>

“Every great mistake has a halfway moment, a split second when it can be recalled and perhaps remedied.” -Pearl S. Buck

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 Article**Failure Analysis and Mechanical Performance Evaluation of a Cast Aluminum Hybrid-Iron Golf Club Hosel**

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Christopher A. Walton, Benjamin E. Nesbit... in *Journal of Failure Analysis and Prevention* (2013)

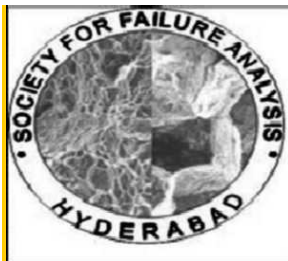
» Look Inside

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 Article**Experimental and Numerical Failure Analysis of Vertical Rods Used in Paper Molding Machine**

A failure investigation has been conducted on the vertical rods which used in paper molding machines. The vertical rods are important elements for paper molding machines to support press forces. Each of the ve...





Society for Failure Analysis

Application Form

Society for Failure Analysis

C/O Centre for Military Airworthiness & certification, RCMA (Materials)
Hyderabad 500 058

Phone: 040-24340750; 24348377;

Fax : 040-24341827

E-mail: rdrcma.mat@cemilac.drdo.in

Affix a passport size photograph

Please ✓ applicable

member ☐

Life Member ☐

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First

Middle

Last

2. Date of birth

3. Father's Name/ Husband's Name

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Mobile:

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7. Professional Experience:

8. Endorsement by SFA Member

Name	Membership No.	Signature

9. Primary Field of Interest: (please mark 1,2,3 in the in order of preference)

Strategic ☐	Power ☐	Foundry ☐	Welding ☐	Heavy industry ☐	transport ☐
Design & Failures ☐	Quality control ☐	Petrochemical ☐	Consultancy / services ☐	Materials and manufacturing ☐	Education ☐

10. Name of the Chapter you intend to be attached

(Please refer to Chapters' list)

11. Subscription details:

Payment should be made by cheque / DD favoring "Society for Failure Analysis", payable at Hyderabad. Outstation cheques not accepted.

Amount Rs. Cheque / D.D. No Dated

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Category	Amount Payable		
	Admission Fee (One time)	Yearly Subscription	Total on joining
Member	----	Rs.200 (annual)	Rs.200/-
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12 Declaration by the applicant

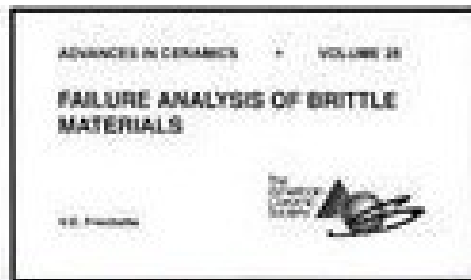
If elected, I agree to accept to pay the prescribed yearly subscription, to abide by the Articles of Association of the Society and to promote its aims and objects.

Signature of the Applicant

13.	Office Use Only				
	Membership No.		Date of Enrolment		Chapter
	Amount Paid (Rs)		Receipt No. / Date		



Books/ new journals



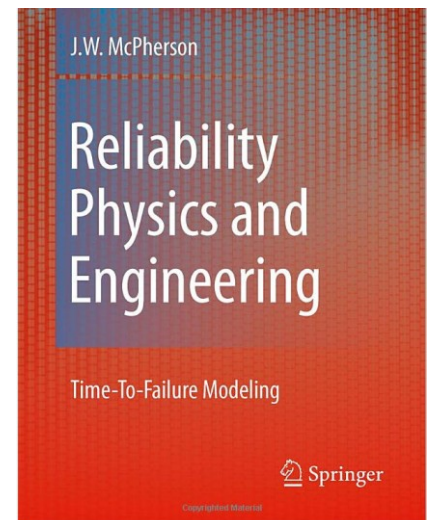
Author : V. D. Frechette

Publisher : American Ceramic Society (1990090

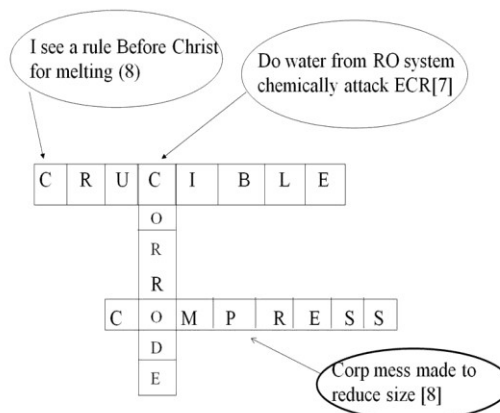
Fractures are discussed theoretically and practically. This book represents a conscious effort on the part of the author to detail the \"life\" of a crack, from its inception, through its growth, to its culmination. The author is careful to define all key terms within the text, making this book an excellent reference for anyone working with brittle materials.



This book is very good for electrical and mechanical engineers who should appreciate the materials science and its relevance to reliability. Since proper materials design can be critically important, reliability factor which is distinguished from quality as time-dependence material or device degradation, it is very relevant to the practicing engineers.



Answer to Cross word





Events in the pipeline

REGISTRATION

The registration fee for participation in ICONS-2014 is as follows:

Foreign delegate	400 US\$
Indian delegate	Rs. 7000
Academic institute delegates	Rs. 6000
Members of IIM and SFA	Rs. 6000
Students & Research Scholars	Rs. 4000

The payment can be sent as a demand draft or by on-line bank transfer, as given below:

IFSC code:	SEIN2219
Account name:	SFA Chennai Center
Bank:	State Bank of India, Kalpakkam, INDIA
Account Number:	92817077729

SOUVENIR

A Souvenir with abstracts of papers to be presented in ICONS-2014, messages, industry-related articles and advertisements from sponsoring organisations will be published and will be provided to all the delegates. The souvenir will be circulated to all the industries/companies across India. For more details concerning sponsoring and advertisements, icons2014@igcargov.in may please be contacted.

IMPORTANT DATES

Submission of abstracts:	July 30, 2013
Acceptance of abstracts:	August 15, 2013
Submission of full of papers:	October 15, 2013
Registration of delegates:	November 30, 2013

CORRESPONDENCE

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<http://icons2014.com>

<http://icons2014.com>

“The most successful men in the end are those whose success is the result of steady accretion.”

— Alexander Graham Bell

Plan of SFA events for the current year (2013-14)

Theme meeting on Stainless steels for Power Sectors (SSPS-2013), at IGCAR, Kalpakkam **20-21, Oct. 2013**

National Workshop on Failure Analysis (NWFA)
Anna Univ. Chennai **28-29, Oct. 2013**

Workshop on materials selection for failure prevention
DMRL, Hyderabad **Nov. 8, 2013**

Two day workshop on failure analysis of materials (FAMM)
Bangalore **Jan. 27-28, 2014**

Two day workshop on failure analysis of materials (FAMM)
Hyderabad **Jan 29-30, 2014**

Special lecture* on Antique silver by
Dr. R J H Wanhill, The Netherlands,
at IIT Madras **Feb, 2014**

*The exact dates would be announced later;



**ASME 2013 GAS TURBINE INDIA CONFERENCE**

DECEMBER 5-6, 2013 • BANGALORE, KARNATAKA, INDIA

ASME Gas Turbine Chapter of India, supported by ASME International Gas Turbine Institute (IGTI), announces the **ASME 2013 Gas Turbine India Conference** in **Bangalore, Karnataka, India** on December 5-6, 2013 at the **CSIR-National Aerospace Laboratories**

HIDA-6 Conference, Nagasaki, Japan, 2-4 December 2013*Conference theme: Life/ Defect Assessment and Failures in High Temperature Plant*

Dear Colleague

The Updated **Programme** (including the Registration Form) for the HIDA-6 Conference being held in Nagasaki, Japan, on 2-4 December 2013 can be accessed at: <http://www.etd-consulting.com/our-services/training-conferences/hida-6-nagasaki-japandec-2013/> The programme promises an excellent international gathering of industry engineers, experts

We are on the Web ! Please visit www.sfaindia.org

6th International Conference on Tribology in Manufacturing Processes & Joining by Plastic Deformation: Darmstadt, Germany: June 22-24, 2014**7th International Conference on Fracture of Polymers, Composites and Adhesives: 14 - 18 September 2014: Les Diablerets, Switzerland*****For Private circulation only****To*

From
Society for Failure Analysis (SFA)
C/O Centre for Military Airworthiness &
Certification, RCMA (Materials)
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