WEAR NEWS

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Wear of Materials Conference

Venue

The twentieth International Wear of Materials Conference was held from April 13 to 16 in Toronto Canada. This is the premier wear event that is held every two years to address the engineering materials aspect of friction, wear and erosion. Lubrication details and related chemistry and fundamental aspects of lubrication are considered outside of the conference scope and papers are not accepted in these areas. The conference is only for the materials aspects of tribology.

About 320 delegates from 35 countries attended the conference which was held in meeting rooms at the Sheraton City Center Hotel. There were three or four concurrent sessions each day and each day had a keynote speaker. A commercial exhibit was part of the conference as was a poster session that was held in the exhibit area. There were over 100 poster presentations and this part of the conference has grown to almost match the oral presentation part. Poster subjects ranged from biochemistry to water droplet erosion.

Keynote Speakers

Peter Blau, tribology consultant and coeditor of WEAR, presented the plenary lecture on the first day. His talk was about wear transitions. Does steady-state wear ever exist? Are "steady –state " observations merely wear plateaus in an ever-changing tribosystem? Do wear mechanism change throughout the life of a tribosystem? Peter's message was that wear tests should be designed to deal with the issue of changing wear mechanism.

Ashlee Martin from the University of California Merced, presented a lively keynote on Tuesday on using molecular dynamics to model a single asperity on a surface. The single asperity is simulated by the tip of an atomic force microscope. She explained how to use parallel replicate dynamics, which was over my head, to produce a model that can include surface films like oxides.

The day-three keynote was presented by Stephan Jacobson from the University of Uppsala in Sweden. He told us how tribology plays a role in the sport of curling. Sweeping raises the temperature of the ice and adds melting as a tool to change the stone/friction characteristics and alter its travel path and speed.. Of Couse, this is the essential part of the sport.

The last keynote on Thursday was presented by Professor Thierry Blanchet from Renssalear Polytechnic Institute in the USA. He presented lots of useful information on the role of fillers in altering the tribological characteristics of PTFE.

Content

With 170 papers and more than 100 posters it is not possible to discuss new ideas and info from

each, but the following are some "nuggets" that I took away.

- Tribology literature is being overwhelmed by studies using the pin –on-disk test (15 to 18 %) which some claim, does not represent any real tribosysem.
- People are using three or more test loads in the dry sand rubber wheel abrasion test
- A copper/resin wheel is the best lapping material
- Two-body abrasion produces higher roughness and removal rate than three body.
- Fixed abrasive media is being made with abrasive particles that are agglomerates of smaller particles
- Hot forming of high strength auto parts is creating a need for high temperature tribocouples and abrasion tests
- Water droplet erosion testing is alive and well
- A pin-on-disk in slurry can be a slurry test to compete with ASTM G 75
- Piston/ring friction can be reduced by multiple honing: one to create lay, one to flatten the lay peaks.
- Railroad wheels contain finer pearlite than the tracks.
- The electrical output of gas turbine generators is at a minimum at noon because it is the hottest time of the day and the turbine/s efficiency is a function of inlet air temperature.
- WC/Co thermal-spray coatings do not resist droplet erosion well.
- The criterion for scuffing is a coefficient of friction greater than 0.25
- Particle erosion tests should have a metric of wear volume/mass of impacting particles
- Solid particles achieve carrier gas velocity as long as the gas velocity is less than 100m/s.
- A fretting friction force loop under stick conditions is at least an order of magnitude smaller in area compared with a loop under slip conditions for the same couple/test.
- Automotive exhaust valves need a substantial adhered tribofilm to survive and certain oil additives can prevent formation of the necessary tribofilm
- The G 65 sand abrasion test can be done hot (800C) with a steel wheel in place of the rubber wheel.

Summary

This was my twentieth Wear of Materials Conference. I presented "Wear of Tool Steels" at the first one in Saint Louis in 1977. I think that I presented a paper at all 20, but I do not have the time to check. Some of the people who presented papers at the first WOM were the tribology rock stars of their time. Here are some of the "Rock Stars" who presented at the 1977 WOM:

David Tabor
Ken Ludema
Don Buckley
Ernie Rabinowicz
Dave Rigney
Bill Glaeser
R. B. Waterhouse
Bill Schumacher
V. A. Belyi
Howard Avery
Jorn LarsenBasse
Bill Ruff
T. S. Eyre
Peter Engle
Norm Eiss
K. Tanaka
N. Myshkin
Brian Brisco
Etc.

Many of these wrote books on tribology subjects. Unfortunately some of our mentors are now dead. My personal mentor and the founder of this conference, Ken Ludema died during the 20th WOM. We were all shocked with the news of his passing at the conference. Ken did not attend because of poor hearing, and his death was sudden and not expected. We who knew him will miss him for his wisdom and knowledge. His students will miss him for his ability to teach and the field of tribology will miss his many contributions to the field.

To end on a lighter note, I found it curious that there were sessions on "lubricated wear" in the 1977 WOM and that this subject was banned from

the 2015 WOM (only materials, not lubricants). I do not remember many details of the first WOM, but David Tabor's keynote address ended with a lament: "The constant challenge to predict system wear from material properties and operating conditions is unlikely to be surmounted for many years"

Forty years later we can see some successes in this area, but models that seem to work only apply to specific tribosystems and materials. David, we will keep trying.

Overall the 20th WOM was a resounding success and all who were involved in making the conference a success are owed a debt of gratitude. It is the premier conference on the materials aspects of tribology. The next one will be in Long Beach, California , USA, in 2017. Plan to attend.

70th Annual Meeting of STLE, Spring 2015

Venue

The Omni Hotel in downtown Dallas was the site of the 70th annual meeting of the Society of Lubrication Engineers and Tribologists. The hotel was very classy and the meeting rooms were large, not cramped like some conferences. There were about 1500 delegates (300 from outside the USA), from at least 35 countries and there were four days of papers (450) and posters and a well-attended commercial exhibit.

Content

There were concurrent sessions that covered all of the traditional aspects of lubricated tribology. The STLE conference does not ban talks that have no lubricants involved, but most involved the use of lubricants.

The technical sessions covered all of the usual subjects: gears, seals, vehicle drive trains, metal working fluids, lubricant chemistry, lubrication fundamentals etc. Some new to me sessions were: Biotribology, In situ Tribology, Wind Turbine Tribology, and Enviro-Friendly Fluids. I never attended any of these sessions so I cannot define In situ Tribology, but the others are self-explanatory.

The starting keynote talk was presented by a US Navy Captain who trained for months to solve a wear problem on the international space station. She had to do a spacewalk to give a grease job to a large ring gear that was part of the system that allows the solar panels to track the sun. Of course she had spectacular photos of the earth and the space station. It was one of those talks that you remember. The message was also extremely important: things work better with enough lube.

Commentary

The STLE tried to do their part in bringing young people into the field by staging a STEM event concurrent with the annual meeting. STLE volunteers set up 10 demonstrations on tribology subjects with 2 or 3 volunteers per table. About 60 local high school students were invited to sign up for these different experiments. The experiments varied from friction measurement to surface wetting. The students seemed very enthusiastic and STLE gave them refreshment and a "I love Tribolgy" tee shirt.

Of the 60 or so students that I saw in the room, about 20 were young women, 6 were white males and the remainder were non-white males. This may be the demographics of the future tribology workforce. It is predicted that the USA will need one million more STEM graduates in the next decade. Exxon Mobil gave 25K to STLE for their STEM-related scholarship program.

Congratulations to STLE for their efforts to interest young people in what we do. Congratulations to STLE for another fine meeting.

Take-away nuggets from the 70th STLE annual meeting:

- Atomic friction decreases as temperature increases

- Friction measurements from an AFM apply only to these instruments; this tribosytem does not exist outside of these instruments.
- ID surface textures do not help plain bearings operating under hydrodynamic lubrication conditions.
- Counterface softening occurs in the rolling path of rolling element bearings
- The block on ring test is a viable simulation for ranking couples for use as cams and followers
- People are embedding carbide particles into wear surfaces using friction stir welding equipment.
- The life (L10) of the grease in a rolling element bearing is only one fourth the life of the bearing, but the film thickness is still thicker than with oil
- The FZG machine is a popular test for scuffing; they measure % scuffing on the teeth.
- In a reciprocating test, the shorter the stroke, the higher the standard deviation
- Line contact gives more believable results in a continuous sliding test than pin on disk
- Start and stop cycles help mimic actual wear systems and should be added to lab tests.
- Rubbing DLC in water converts the rubbed surface to amorphous carbon
- Krytox is perfluoropolyether oil and PTFE particles
- Titanium intermetallic compounds can yield a hardness of 60 HRC and can be used for ball bearings
- Aristotle identified the friction force in 350 BC
- Max Phase materials (Ti2AlC etc.) are being widely studied since they can be very hard and useful in tribosystems
- In elastomers, COF is proportional to percent slip in rubbing contact
- White etching cracks (WEC) in turbine bearings is caused by electromagnetic effects. Bearings become magnetic with repeated rolling.
- The "white" structure in WEC is fine pearlite

. ASTM G2 FRICTION, WEAR AND EROSION ACTIVITIES

The ASTM G2 Committee on Wear and Erosion met in Toronto on April16, and 17 after the Wear of Materials Conference. The following are summaries of the various task group and subcommittee meetings.

Twist Compression Test Task Group

This task group is Chaired by Greg Dalton (Tribsys) and they have been working on the development of this test which is essentially a galling test usually run under lubricated conditions. The test metric is a friction "event" rather than threshold galling stress.

Greg reported that the test method was balloted in 2013 and received enough persuasive negatives to withdraw the ballot and revise the standard to address the negatives. A revised version of the standard will be sent to the task group members for review in September, 2015

G02.20 Data Acquisition Activities

Chair Greg Dalton reported that the scope of the subcommittee needs review and revision. It was initially formed to develop a format to put wear and erosion data into a computerized data base. This activity started before spreadsheets like "Excel" became commonplace and the "Standard tribology database" no longer exists. Greg proposed the integration of the ASTM G 190 standard on wear test selection, with G 188 on data format, and G 163 on digital data acquisition. There is still a need for this work since there is still not a standardized way of reporting erosion and wear data and the details for measuring friction forces need to be standardized. Greg will make a proposal on integration of the subcommittee's standards at the next meeting. He will also ask Senad Disdin to produce a strawman for a friction

mapping guide. Greg will also work with ASTM to develop a website showing inactive/withdrawn standards.

G02.5 Friction Activities

Ken Budinski (Bud Labs USA) chaired the subcommittee meeting. He reported that he reviewed the standards needing review and determined that they all should be balloted for reapproval without changes. The use of friction force versus load curves for the determination of friction coefficient was discussed. Chair Budinski reported that a recent study on coatings did not produce a reasonable COF result. The friction coefficients obtained with this method did not correlate with the COF determinations from continuous recording of friction forces. Test loads of 100, 500 and 1000 g (masses) were used in the friction tests. It appeared that the highest force test produced a tribosystem that was different from the 100, and 500 g tribosytems.

Steve Shaffer (Bruker) will make pins and counterfaces for inter-laboratory tests. It will be a designed experiment using the Bruker test rig.

Greg Dalton reported that he will gather historical data on coefficient of friction results produced on the twist compression test rig. He will present this at the next meeting.

A discussion was held on the possibility of a friction workshop. It will be held. at a future meeting with the D2 committee.

Ken Budinski will request ASTM staff (Brian) to transfer ASTM G203 and G 181 to the Friction Subcommittee.

G02.3 Abrasion Activities

ASTM G 65 sand abrasion test - John Hadjioannou (ESP) ran the meeting in the absence of Chair Brian Merkel. There was considerable discussion about adding a recent interlaboratory study to the standard to allow the use of neoprene wheels in place of the currently specified chlorobuty rubber (CBR). The issue on the use of CBR was not resolved at the meeting and it appeared that another ballot may be necessary.

The issue of availability of CBR wheels was discussed and John Hadjioannou reported that "Timco" can supply CBR wheels that are acceptable for use.

The issue of availability of sand for the G65 test was also discussed. Ken budinski reported that Agsco Co. can custom sieve sand to meet the G 65 standard. John Hadjioannou agreed to send Bud Labs a neoprene wheel from the ILS to see if it will produce the required mass loss on D2 tool steel.

Scratch hardness - Peter Blau offered to send specimens to collaborating labs to allow the use of profilometry as well as optical microscopy to measure scratch width for the G 171 scratch hardness standard.

G02.4 Non-Abrasive Wear Activities

Fretting -John Hadjioannou chaired the meeting in the absence of Chair Nick Randall. Negatives were discussed on the revision of the G 204 fretting test to add results of a recent interlab study (ILS). Peter Blau withdrew his negative at the meeting; a negative from Bill Ruff on having a minimum of six labs participate was voted non-persuasive; we were not able to find six labs with the necessary equipment. The G 204 standard will proceed to the next reapproval stage.

Galling - A discussion was held on the replacement of the G 98 galling test with a reduced version (fewer samples) of G 196. Ken Budinski voted negative on the proposed abbreviated G 196 test since the reduced sample G196 could easily be a second procedure in the current G 196 test. The negative was voted persuasive by attendees. Scott Hummel (Lafayette College)will decide on path forward

Reciprocating wear test – Brian Milewski, the G2 Staff manager reported that the reviews on the G 133 reciprocating tests and G 119 pin on flat test are overdue for review for reapproval. It was the

consensus of those in attendance to send both standards to reapproval ballot as is.

New Test – Fred Wolf (Anton Paar) made a presentation on the use of a viscometer as a pin on disk friction tester. The unique feature of the test is that the viscometer can ramp up the force tending to move the pin on the disk at such a rate as to determine the pre-sliding characteristics of various sliding couples/. Essentially it will rank the elasticity of a couple contact. A computer does the ramping and the computer can control the sliding after breakaway as desired.

Fred will draft a strawman of a proposed standard and submit it to Nick Randall for review and consideration for subcommittee balloting. Fred will also establish a work group on the proposed test.

Erosion Activities

Chair John Hadjioannou reported that the G 73 droplet erosion test is up for review and reapproval. Visitors from Concordia University reported that they have a droplet erosion rig and that they will review the standard for reapproval. Joh Hadjaneau will contact them for the ire review.

Chair Hadjioannou reported that there is a work item to arrive at a reduced severity procedure for ASTM Solid Particle ersion test. Ken Budinski agreed to add a 15-degree impingement angle option to the G 76 test for consideration.

Professor Soyama (Tohoku University) reported on his continuing studies using the G 134 sbmeged jet cavitation test. He made a PowerPoint presentation on tests conducted five materials in four collaborating laboratories. : Tohoku University, Kukai University, Nihan University, and Dynaflow in the USA. It was determined that erosion rate is very dependent on the nozzle and specimen chamber conditions. Professor Soyoma recommended that allowable chamber dimension be included in the standard. He will reballot the standard as-is with a rationale showing the current ILS which in turn shows one lab to be an outlier. He was of the opinion that the outlier was due to a different chamber size at one lab.

Chair Hadjioannou ended the meeting with a discussion on the importance of droplet erosion testing for use in wind turbine work. Apparently propeller tips can produce velocities where droplet erosion of composite blade materials is a significant factor.

G02.1 Terminology Activities

Chairman Peter Blau (Blau Tribology) reported on the successful subcommittee ballot on two new terms: Friction log and bio-tribocorrosin. Negatives were discussed on “friction” Several negatives were considered to be persuasive and the term will be re-balloted with the definition:

Friction, n, resistance to motion in a tribosystem.

The term “burnishing” was discussed and a definite was crafted for balloting:

Burnishing, v, to produce a reduction in the height of surface features by plastic deformation with negligible material removal.

Peter reported that “polishing” received negatives and the group in attendance proposed balloting:

Polishing, v, to reduce the height of microscopic surface features by material removal.

Negatives were also received on “scuffing”. They were considered persuasive and the term will be redefined and reballoted.
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Miscellany:

Next Meetings:

December 9 and 10 with D2 in Austin TX USA

June 29 and 30, 2016 with D2 at the Hyatt Hotel in Bellville WA USA

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NOTE: Wear News is the informal account of selected tribology events and the activities of the ASTM G2 Committee on Wear and Erosion.

Contributed tribology articles and comments are welcome. Send them and other inquiries to:

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