GEXCON

Minutes of meeting

FLACS User Group (FLUG) meeting

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FLUG meeting 22-23 May 2018

FLUG chairman: Olav Sæter (Statoil)

Day 1: Tuesday 22 May 2018

Welcome

Kjell Svellingen (Gexcon Software) welcomed the participants to the FLUG meeting.

Agenda

Olav Sæter (chair) presented the agenda for the meeting.

Technical Q&A from last FLUG meeting in London

Idar Storvik (Gexcon Software) led a Q&A session related to the last FLUG Meeting in London. Gexcon employs JIRA software to track FLUG wishes (both registration and follow-up). A question was raised about the use of the Ewan-Moodie pseudo-source model in FLACS. Lorenzo Mauri (Gexcon Software) mentioned that one test case with hydrogen indicates better results with the Ewan-Moodie pseudo-source model, and testing will be extended to other types of fuels. After extended testing, Gexcon will consider whether the Ewan-Moodie pseudo-source model should become the default option.

Idar Storvik (Gexcon Software) informed that there is ongoing work on testing the efficiency of FLACS-Cloud (benchmark test). A question was raised whether there is any restriction on the number of simultaneous FLACS simulations on the HPC service (FLACS-Cloud). Idar responded that there is not set any restriction by Gexcon, but FLACS users compete with other users employing the HPC cluster.

Helene Hisken (Gexcon Software) presented some FLACS validation work for a “gas house” explosion scenario (experiments) – a follow-up from a presentation given by Tim Jones (MMI Engineering) at the last FLUG meeting in London. The burning velocities of butane/iso-butene and propane are likely somewhat over-predicted in this case, and the overpressures seem to be very sensitive to the definition of pressure relief panels inside the enclosure. Updated burning velocity correlations in the new Flacs-3 solver are expected to provide more accurate representation of the mixture reactivity. Olav Sæter (chair) commented that such experiments are quite challenging to model. Olav Roald Hansen (Lloyd's Register) pointed out that the pressure relief panel model in FLACS is a very simplified approach for representing the effect of panels; it is therefore not straightforward to analyse the results from such validation studies.

Gexcon R&D – activities & prospects

Helene Hisken (Gexcon Software) gave an overview of ongoing R&D activities and prospects. New physics models are now integrated in the Flacs-3 solver which at some point will replace the Flacs-2 solver from 1992. Olav Sæter (chair) asked about sensitivity studies for realistic geometries when employing the new Flacs-3 solver, especially for large-scale, realistic geometries. Helene replied that Gexcon R&D performs verification, validation and sensitivity studies for the new solver continuously, and will continue the work to evaluate what is the best physical model for various application areas. The validation/verification database for Gexcon includes a range of realistic geometries, and simulations to compare results from different solver versions for these cases are performed regularly. Vincent Tam (Warwick University) pointed out the importance of investigating the impact of new models for the practical use of FLACS. Olav Roald Hansen (Lloyd's Register) expressed a wish that Gexcon in the future includes additional important validation cases related to e.g. hydrogen safety. Helene

commented that Gexcon has run a few hydrogen validation cases, but additional cases will be added as part of ongoing R&D projects.

HySEA: Pre-normative research on vented hydrogen deflagrations

Trygve Skjold (Gexcon Software) gave an update on the HySEA project (www.hysea.eu). The project receives funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 671461. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme and United Kingdom, Italy, Belgium and Norway. The aim of this project is to conduct pre-normative research on vented deflagrations in enclosures and containers for hydrogen energy applications. The results from two blind-prediction studies involving explosions in 20-foot ISO containers show that there is significant room for improvement of both CFD tools and user guidelines. Vincent Tam (Warwick University) asked whether repeated experiments have been conducted in the HySEA project. Trygve replied that a few repeated experiments have been conducted. A question was raised whether hydrogen tests in smaller scale has been considered. Trygve replied that University of Pisa performed small-scale vented hydrogen deflagration tests in the HySEA project, and Hefei University of Technology will perform tests in a 40-foot enclosure.

Gexcon Application Development - Activities & Prospects

Torstein Boge (Gexcon Software) gave a presentation on ongoing application development and future plans. The new FLACS v10.8 is planned to be released in this summer. The software products FRED, Shepherd and PIPA from Shell can now be licensed from Gexcon, using the same security solution as FLACS (Gemalto Sentinel LDK/EMS). This solution supports both HL keys (dongles) and SL keys (soft lock). New initiatives include (among others) FLACS-QRA (improved functionality for 3D quantitative risk analysis), and VR (virtual reality training with integration of FLACS results).

Torstein showed an organisational chart of the Software organisation. Olav Sæter (chair) commented that he is glad to see that Gexcon is expanding the organization.

FLACS v10.8 release

Djurre Siccama (Gexcon Software) gave a presentation on the new FLACS v10.8 release, as well as the future FLACS v11 release.

Djurre mentioned that Gexcon will upgrade several of the file formats for the new Flacs-3 solver. A question was raised whether the new file format for the scenario file will be text-based. Djurre replied that it is planned to use a text-based format (using JSON standard format) for the scenario file.

Olav Roald Hansen (Lloyd's Register) commented that FLACS users typically link to co-files, and cp-files (with the current Flacs-2 format), since this saves disk space when running numerous simulations. Djurre replied that Gexcon aims at keeping the typical disk usage on the same level as before with the new Flacs-3 format. It is likely that it still will be possible to link geometry files, but the porosity file may no longer be required.

Remi Martini (Lloyd's Register) commented that advanced FLACS users that use scripts to run many simulations will have to convert the old scripts to support the new format. Djurre replied that he understands the challenge, but hopefully the new FLACS python API will be helpful when converting existing scripts. Gexcon will try to streamline the transition to new file format for the users, and welcome feedback from the users. Olav Sæter (chair) encouraged Gexcon to propose solutions for the transfer to the new file formats and suggested to have a separate agenda point to discuss this at the next FLUG meeting.

Developments improving CAD geometry import, counting and porosity calculations

Djurre Siccama (Gexcon Software) presented ongoing work for improving CAD geometry import, counting and porosity calculations. The overall goal for the so-called “Perfect CAD” import initiative, is that all geometry objects that can be easily converted to base primitives (cylinders, boxes, etc.), will be converted, and other objects will be imported as Mesh. A CAD import verification study is scheduled prior to the next release.

Olav Roald Hansen (Lloyd's Register) commented on one of the examples shown by Djurre, where a 0.1-degree rotation of geometry, relative the numerical grid, resulted in a significant difference in results. Olav had previously seen examples where 45-degree rotation of geometry resulted in limited differences.

Flacs-3 Solver: Development and commercial release roadmap

Franz Zdravistch (Gexcon Software) gave an overview of the development and commercial release roadmap for the new Flacs-3 solver. He emphasized that Gexcon will not compromise on validation for the Flacs-3 solver.

Vincent Tam (Warwick University) pointed out the importance of investigating the impact of the new Flacs-3 for existing geometry models. Franz replied that the validation schedule includes investigations of realistic geometries. Chris Savvides (BP Exploration) commented that companies using FLACS can carry out tests on their own installations. Vincent Tam (Warwick University) expressed that it would be beneficial if the whole FLACS community contributes by comparing simulation results from Flacs-2 and Flacs-3 for realistic large-scale installations. Trygve Skjold (Gexcon Software) commented that Gexcon has presented comparisons between results obtained for realistic large-scale geometries and selected experiments with new versions of FLACS, and results obtained with the standard commercial version, for many years. For the release of Flacs-3, the comparison will be split into experiments, where both the new and old version of FLACS will be compared to experimental results, and realistic large-scale geometries, where the true value is unknown and the new version of FLACS can only be compared with older versions. It is not straightforward to define acceptance criteria for a new solver based on the performance for realistic geometries, and in practice the validation must focus on comparison with experiments.

FLACS-Fire: Status on deluge modelling

Deiveegan Muthusamy (Gexcon Software) presented the status for the modelling of deluge in FLACS-Fire, including new models for detector/activation, water droplet/mist and fire suppression, as well as improvements to the radiation model.

Vincent Tam (Warwick University) asked whether the mean droplet diameter is used in the modelling of deluge. Deiveegan confirmed that this was the case.

Olav Sæter (chair) asked when realistic cases involving deluge can be modelled. Deiveegan replied that it should be possible to model water curtains within about two months, and that realistic scenarios can be modelled and validated by the end of the year.

Øystein Spangelo (Gexcon AS) asked whether the presented models could be applied for a liquid fuel leak. Deiveegan replied that FLACS-Fire is currently not capable to model droplet spray fires.

Using the FLACS python API to streamline your FLACS workflow

Djurre Siccama (Gexcon Software) gave a presentation on FLACS python API (currently in beta-version) that can be used to streamline the FLACS workflow for the users. Feedback

from the audience indicated that the FLACS users would want more guidance on how to utilize FLACS python API, and Djurre said that a webinar on this could be considered.

Day 2: Wednesday 23 May 2018

LNG Releases QRA based on FLACS

Cao Jiaolong (China Classification Society) gave a presentation on QRA studies for LNG releases based on FLACS.

Vincent Tam (Warwick University) asked how many studies that are typically performed per year. Cao replied that in general there are more than ten studies per year.

Olav Sæter (chair) asked whether modelling of the temperature field for the geometry due to fire has been considered. Cao replied that CCS may consider using FLACS results as input to another tool for this. Deiveegan Muthusamy (Gexcon Software) commented that a one-dimensional heat conduction model has been implemented in FLACS (e.g. modelling heating of a wall), and in the future a two-way coupling between FLACS-Fire and another tool may be considered.

Effect of fin-fan coolers on pool fires

Hiroki Orihara (JGC) gave a presentation on effect of fin-fan coolers on pool fires. A focus of the study has been to look at optimal design of process modules with respect to safety. Chris Coffey (Gexcon UK) asked whether the effect of steady-state conditions for the fin-fan cooler has been investigated. Hiroki replied that this is something that can be considered for future studies. A question was also raised whether JGC has investigated the effect of the fin-fan cooler on radiation. Hiroki replied that this might be considered in future work. Ali Abbasov (Gexcon AS) asked whether ignition stage control has been considered. Hiroki replied that this has not been considered yet. Vincent Tam (Warwick University) commented that hot equipment generates its own flow.

Hydrogen safety for marine applications

Olav Roald Hansen (Lloyd's Register) gave a presentation on hydrogen safety for marine applications. In general, it is more challenging to obtain safe design with hydrogen as fuel, compared to LNG. Ali Abbasov (Gexcon AS) asked about which frequency model that has been used for release of hydrogen. Olav replied that LR used a frequency model proposed by Sandia National Laboratories combined with the approach employed by the Norwegian oil and gas industry. Vincent Tam (Warwick University) asked whether sprays of liquid hydrogen (LH2) is modelled. Olav replied that the aim has been to develop a proper source term for release of LH2 sprays, similar to the Flash utility in FLACS. Olav Sæter (chair) commented that it is important to look at critical assumptions when developing source term models.

Virtual Reality as a tool to support training of oil and gas personnel

Emilio Alvarez (ExxonMobil Research Qatar) gave a presentation on virtual reality (VR) as a tool to support training of oil and gas personnel. Currently there are few people creating content for VR related to training of oil and gas personnel. The cost to prepare VR content is typically in the order of 100 000 USD per installation. Djurre Siccama (Gexcon Software) inquired about the typical distribution of costs for various activities. Emilio replied that typically 80 % of the cost is spent on the story board and setting up the logic for the VR experience. A question was raised whether the VR experience incorporates a surprise element. Emilio replied that this was not included in current versions, but is should be considered in the future. A question was also raised whether AR (augmented reality) has been considered. Emilio replied that currently the focus is on VR and classroom environment, but in the future AR can be considered. Trygve Skjold (Gexcon Software) asked whether a generic story board can be utilized for similar installations, as a means of reducing costs. Emilio replied that this should be possible.

Evaluation of the Tianjin explosion and comparisons to the West Fertilizer Explosion

Chris Coffey (Gexcon UK) presented an evaluation of the Tianjin explosion and comparisons to the West Fertilizer explosion.

Olav Roald Hansen (Lloyd's Register) asked whether the numerical grid might have been too coarse for the FLACS-Blast simulation presented. Chris replied that the FLACS-Blast simulation was done as an exercise, and the numerical grid was probably not sufficiently fine. Bin Xie (Gexcon China) asked whether the second explosion had been simulated. Chris confirmed that the second explosion of ammonia nitrate was the one that had been simulated.

Estimating accidental leak rates utilizing FLACS

Olav Sæter (chair) presented case histories where FLACS had been used to estimate accidental leak rates. The examples showed fair agreement between FLACS simulations and recordings by gas detectors at the sites, taking into account the changing wind conditions during the releases.

Olav Roald Hansen (Lloyd's Register) asked whether, for the examples shown, there might have been a higher velocities and higher degree of dilution than in the scenarios simulated. Olav commented that this is something that could be looked at in the future.

Summary of results from 2018 Global User survey

Djurre Siccama (Gexcon Software) presented a summary of results from the 2018 Global User survey. The response emphasized the importance of thorough validation. A majority of the respondents used the Windows OS for running FLACS.

FLACS user dialogue and FLUG wishes

Djurre Siccama (Gexcon Software) led the session on FLUG wishes.

Concerning CASD:

Daniel Mahoney (Atkins UK) would like to have a new feature in CASD, where it is possible to "turn off" monitor points without deleting them (if some monitor points are deleted, the user typically would have to renumber remaining monitor points).

Remi Martini (Lloyd's Register) asked whether the problem that CASD crashes when many monitor points are defined is solved. Djurre replied that he assumed that this is solved in the latest FLACS release, but this can be tested.

Øystein Spangelo (Gexcon AS) would like to have a new feature in CASD, where a picture can be imported and placed on top of terrain.

Concerning Flowvis:

Olav Roald Hansen (Lloyd's Register) reported that in some cases it is difficult to find the index in Flowvis while analyzing results.

A question was raised whether it is possible (or could be made possible) to turn off a frame in Flowvis, when the frame seems too tick.

Øystein Spangelo (Gexcon AS) would like to have improved possibility to customize contours in Flowvis, e.g. when the user wants contours that are not filled.

Concerning the Flacs solver:

A wish was expressed that the 'FLACS Run Manager' should be improved, so that the user can easily see the directory structure and get the option to add all sub directories in a folder.

Olav Roald Hansen (Lloyd's Register) mentioned that it can be a challenge to recover simulations after a crash when running many simulations with the 'FLACS Run Manager'.

Jieun Choi (Gexcon AS) asked about the possibility to pause and restart FLACS simulations in the 'FLACS Run Manager'. Djurre commented that this feature is relevant for future development in FLACS.

A question was raised whether it is best to run FLACS on a Linux computer or on a Windows computer. Djurre commented that the answer will depend on the user. Some users prefer command line scripting on Linux computers, and some prefer GUIs.

Øystein Spangelo (Gexcon AS) asked whether relief panels can be modeled in FLACS-Blast. Idar Storvik (Gexcon Software) replied that panels can be used with the Flacs solver, but not with the ICE solver.

A question was raised whether FLACS-Exhaust has a parallel solver. Idar Storvik (Gexcon Software) replied that this is not the case. Djurre commented that the plan is to merge the key features from FLACS-Exhaust with the regular versions of FLACS.

Remi Martini (Lloyd's Register) asked whether it would be possible to define more than 10 monitor regions (with several "frozen cloud" equivalent release rates each) for the new Flacs-3 solver. Michal Folusiak (Gexcon AS) replied that this should be possible.

A wish was expressed that FLACS should be developed further to make it easier to see when panels fail (yield) during a simulation. Olav Roald Hansen expressed a wish for improved (more accurate) modelling of pressure relief panels (depending on the panel type) in FLACS.

Djurre asked the audience whether there is a need for additional pre-defined species (components) in FLACS. Øystein Spangelo (Gexcon AS) commented that he would like to have nitrogen included as a pre-defined species in standard FLACS (as part of the fuel composition).

A question was raised whether it is possible to simulate a warm BLEVE with FLACS. Djurre replied that this is currently not straightforward.

Olav Sæter (chair) commented that the presentations at this FLUG meeting included limited material on validation. Vincent Tam (Warwick University) said that validation is important for the FLACS tool and mentioned that the MEGGE protocol should be used. Helene Hisken (Gexcon Software) replied that the MEGGE protocol is indeed used for the validation work in Gexcon R&D, and there is ongoing work to prepare two-pagers that summarize the performance for each validation case. Some of these two-pagers are already included in the FLACS User's Manual. Vincent commented that the MEGGE protocol included four aspects: scientific description, scientific assessment, verification, and validation/range of applicability. Helene replied that all of these aspects should be covered in the User's Manual, except for code verification, which is part of the in-house development process.

The audience expressed a general wish to improve the user documentation for FLACS.

Venue and date for next meeting

Olav Sæter (chair) reminded the audience that the next FLUG meeting is scheduled for November 2018 and encouraged participants to volunteer to host the meeting.

Closing

Olav Sæter (chair) summed up some highlights from the presentations and discussions and closed the meeting.