

## Report on the 10<sup>th</sup> Conference on Compressors & their Systems, 9<sup>th</sup>-13<sup>th</sup> September 2017

### Summary

The 10th biennial International Conference on Compressors and their Systems was held at City, University of London, from 9<sup>th</sup> to 13<sup>th</sup> September 2017. This series of conferences started in 1999 was initially organised by the Fluid Machinery Group of the Institution of Mechanical Engineers (IMEchE). Since 2009 the Centre for Compressor Technology at City, University of London, has taken over its management and these events have continued to go from strength to strength, supported by the IMechE, the International Institute of Refrigeration (IIR), and the Institute of Refrigeration (IOR) and sponsored by Holroyd PTG, Howden, Kapp Niles, Hoerbiger and Samputensili.

City's President, Professor Sir Paul Curran, welcomed delegates to the conference at the official opening on 11th September, emphasising the importance of the Conference to the Compressor Industry and the University's overall strategic plan.

The tone of the conference was set by four keynotes, two on each day of the conference, focusing on the history and key developments in the compression industry on the first day and on refrigeration on the second day.

The entire event consisted of three parts, namely:

- A Short Course on Computational Fluid Dynamics applied to Compressor Design
- The Main Technical Conference
- A day devoted to Industrial Concerns

In parallel with this, the Conference featured an exhibition and laboratory tours.



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**252** participants

from

**23** countries

**102** speakers

**4** keynotes

**22** parallel  
sessions

with

**92** podium talks

**13** short course sessions

**11** exhibitors

**8** Industry presentations

“There was an excellent selection of research papers and technologies presented at this very well organised conference”

Prof Pega Hrnjak  
Director at University of Illinois  
Refrigeration & Air Conditioning  
Centre



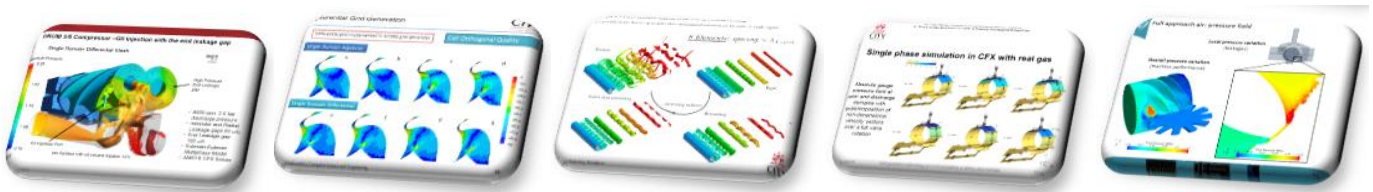
Delegates at the main conference

## The forum/short course

The 3rd Forum on Computational Fluid Dynamics (CFD) in Rotary Positive Displacement Machines was held at City, University of London on the 9th and 10th September. Fifty-six attendees from 12 countries were present. The course was delivered by 13 lecturers, 9 from academia and 4 from industry.

Day 1 was dedicated to the theory of CFD analysis in Positive Displacement Machines while Day 2 covered industrial applications. The course began with an Introduction to CFD analysis in Positive Displacement Machines. This was followed by modelling of leakage

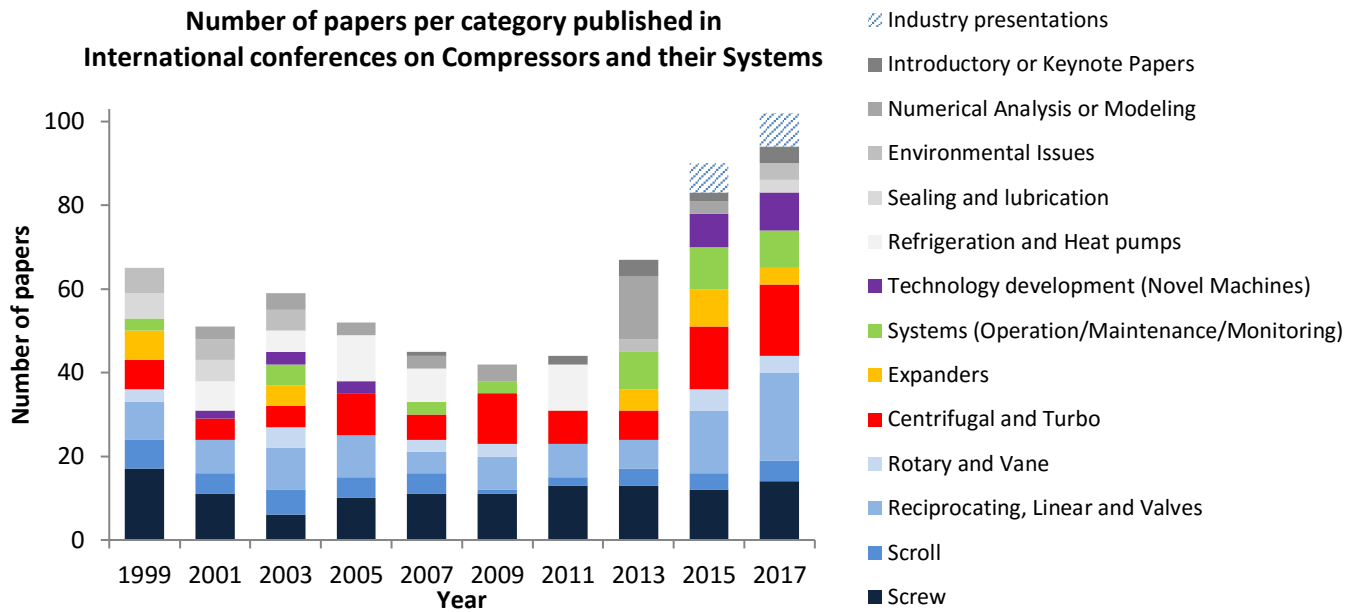
flows and multiphase flows in positive displacement rotary machines and the latest updates in turbulence modelling. Detailed talks included Grid generation for twin screw machines using the algebraic and differential grid generation methods, single screw and vane machines, and their CFD solution, modelling challenges in multiphase flows, the use of the Eulerian-Eulerian multiphase model with deforming grids, new techniques such as the immersed boundary method, key-frame re-meshing and Cartesian cut-cell re-meshing in commercial and Open-FOAM CFD tools. Two industrial presentations covered the application of modern grid generation and CFD solvers to process gas compression and refrigeration applications.



Delegates from the Short Course & Forum

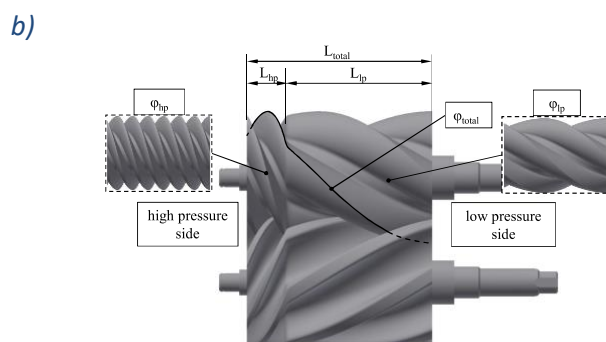
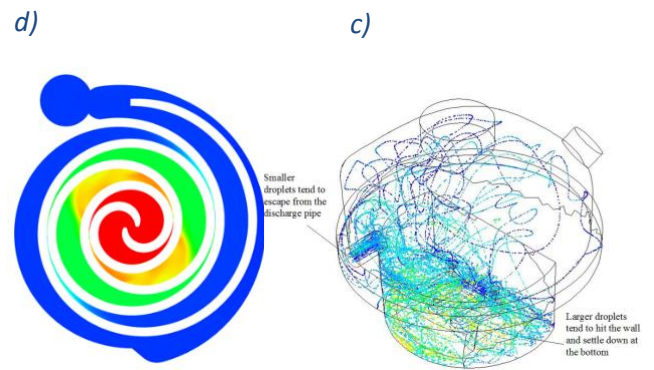
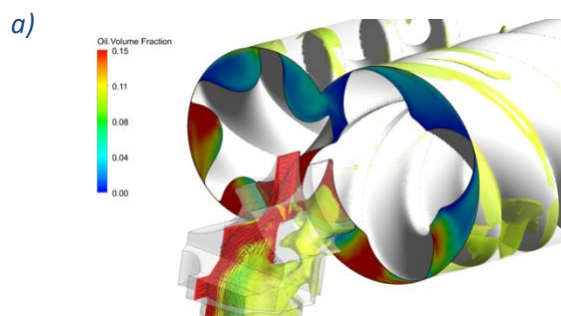
## Technical Sessions - highlights

At the Conference this year, 92 technical papers were accepted for presentation across a range of sessions, as summarised in following graph.

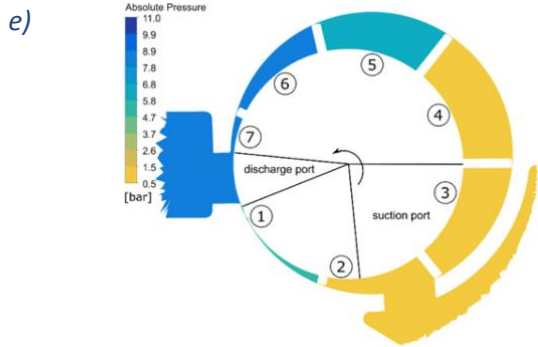


In the Screw Compressors sessions, topics included the consideration of algebraic and differential techniques for improved CFD grid generation (winner of the Best Paper award), the use of CFD to predict the effects of oil in oil flooded twin screw compressors, the theoretical analysis of dual lead rotors for compressors, and manufacturing approaches for variable lead rotors in vacuum applications.

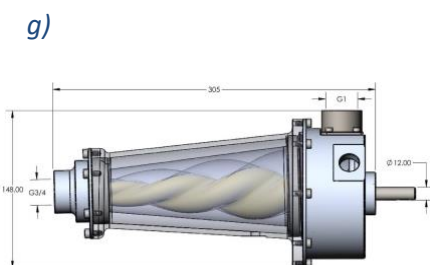
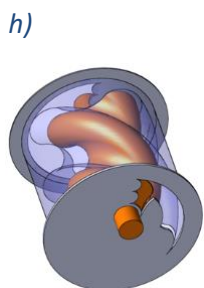
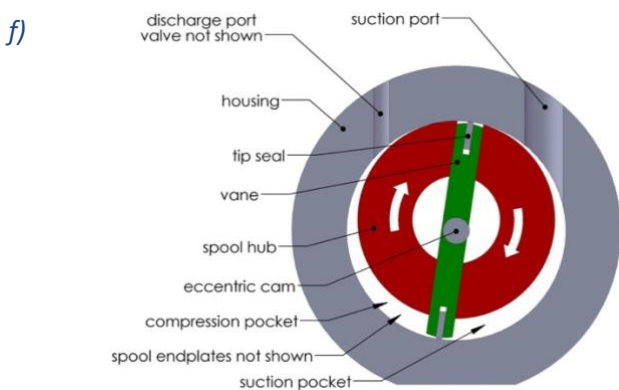
In the Scroll Compressors session, highlights included transient CFD simulation of real gas flows in scroll machines, flow visualization and CFD simulation results for oil droplet propagation in the compressor discharge chamber, and the effects of vapour injection on compressor performance in heating, ventilation, air conditioning and refrigeration systems.



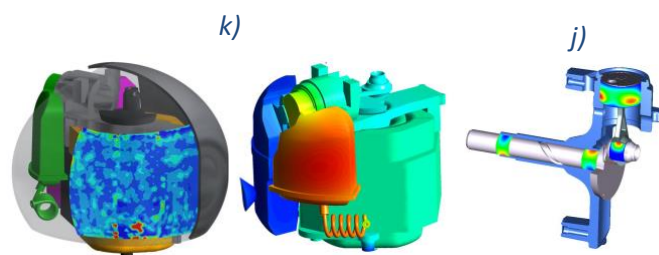
In the Vane Compressors session, interesting papers were received on topics including the application of intercooling to increase the energy efficiency of air compressors, and the use of CFD to investigate the performance of air compressors and organic fluid expanders.



There were several novel compressor mechanisms presented at the conference, with papers addressing the modelling, development and testing of a spool compressor, the performance of a conical oil free screw compressor, and experimental results for a prototype dual vane compressor. At a concept level, papers were presented describing the principles and analysis of a Z-compressor, an improved Wankel design focused on clearance volume reduction, and an internally geared screw machine configuration with stationary ported end-plates. At a system level, the performance of a novel form of gas-injection to a rotary compressor was investigated for air source heat pump applications.



As in previous years, a large number of papers on Reciprocating Compressors were presented across four sessions. Highlights included the theoretical and experimental investigation of heat transfer between the working fluid and the components, the prediction of leakage in oil-free compressors using computationally efficient models, the effects of rotational speed and oil viscosity on frictional losses, the use of CFD to find oil distribution and heat transfer in hermetic refrigeration compressor, and a theoretical and experimental investigation of fluid-structure interaction in these machines.



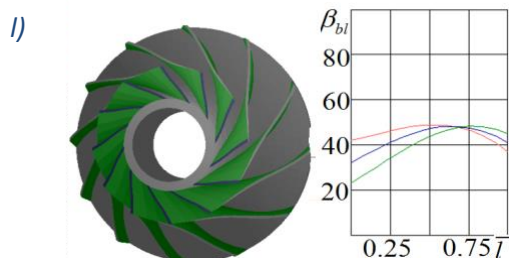
Several papers were received on the topic of valves for compressor applications. This included a study of a multi-cylinder reciprocating compressor, look at the effect of speed on discharge valve movement and overall compressor efficiency, a new valve system to allow operation in both compressor or expander modes, and a study of the reduction of suction losses through reed valves using a magnetic coil.

The research presented on compressor systems included an analysis of HVAC systems using combined single and variable speed compressors to optimise efficiency, and a method of increasing the efficiency of existing and newly designed complex pneumatic systems by the use of mathematical modelling.

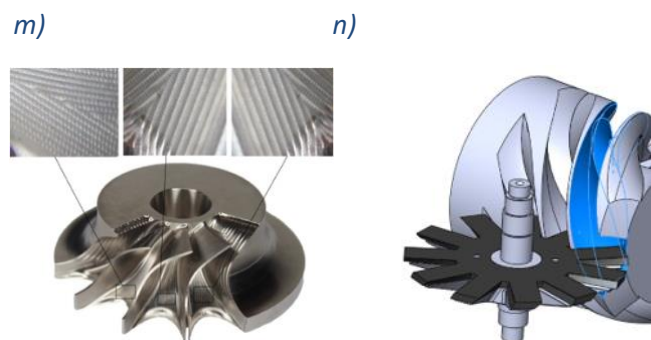
Several papers on measurement and control were presented, including a study of various methods of vapour mass fraction measurement for economized vapour injection applications, and the use of the Industrial Internet of Things approach to optimise compressor system operation and performance.

In the field of turbomachinery, a large number of papers was presented on CFD studies including the effect of impeller blade rake angle on the performance of centrifugal compressors, the optimisation of impeller geometry parameters, and the analysis of

resonant fluid-structure interaction to investigate critical conditions of a centrifugal compressor. Another highlight was the study of differences between 2D and 3D blades for centrifugal compressors, where the efficiency of different designs was evaluated using analytical and numerical methods with some supporting test results.



Papers relating to expanders included an investigation of the effect of riblets on the performance of radial turbines, and the development of a non-symmetric model of a single-screw expander. Two fundamental studies on the performance of twin screw expanders were also presented focussing on the effects of supersaturation of steam and delayed condensation in steam expanders (winner of the Best Student Paper award), and flash vaporization occurring during the expansion of saturated liquid.



## Industry Day

The third day of the conference was Industry day, dedicated to the challenges and opportunities for the compressor industry both nationally and internationally.

Seven selected exciting talks were delivered in three sessions by companies in the United States of America, Sweden, Germany, Austria, Romania and the United Kingdom. These covered a wide range of topics

including the design and manufacture of screw compressors, piston compressors, lubrication, sealing and materials issues.



The first session was related to design and manufacturing of screw compressors and seals delivered by Holroyd, Ergoseal and COMOTI.

The second session was dedicated to compressor valves in which Voestalpine Precision Strip AB from Sweden and Zapp Precision Metals GmbH from Germany talked about novel materials and successes in designing compressor valves.

The concluding session of the conference contained three presentations including a revolutionary cylinder lubrication system by Hoerbiger from Austria, a Lubricant Roadmap for Refrigerants by Shrieve Chemical Products from USA and an interesting talk about Hardide coatings, UK delivered by their director Yury Zuk.

## Social and Exhibition Programme

A welcome reception, sponsored by Hoerbiger, was held at the local City Bar to kick-off the main conference; giving delegates an opportunity to meet-and-greet casually in the evening before the 3-day intensive programme.

This year the conference dinner was hosted at the prestigious Royal Society. The evening was graced by a keynote speech delivered by Prof. Em. Kemal Hanjalic FEng from the Technical University, Delft, Netherlands. He is internationally renowned for his contribution to the development of turbulence models.

Towards the end of the programme, a social event was held at St Bart's Brewery where awards were presented for the best papers and presentations. The awards were presented by Carolyn Griffiths (President of the IMechE), Didier Coulomb (Director-General, of the International Institute of Refrigeration) and Stephen Gill (President, the Institute of Refrigeration). With a relaxed atmosphere, drinks and live music, the event was enjoyed by all.



In parallel with the conference, there was an exhibition of 11 companies, of which 5 were the sponsors without whose support the conference would not have been such a huge success. There was ample time during the coffee and meal breaks throughout the conference for delegates to visit the exhibiting stands and to network.

#### Exhibitors:

- Holroyd Precision
- Howden
- Kapp Niles
- Samputensili Machine Tools Srl
- Hoerbiger
- Convergent Science
- ANSYS UK Ltd
- PDM Analysis
- Gamma Technologies (GT-SUITE)
- FeTu
- Capvidia



#### Lab tour

As the conference was held at City, University of London, it was a perfect opportunity to showcase the current research projects at the university. The Centre for Compressor Technology organised a tour for the delegates to visit the laboratory of the Thermo-fluids Research Centre and the Aerodynamics Research Centre of the Department of Mechanical Engineering and Aeronautics. The Thermo-fluids Research Centre consists of three internationally renowned research groups, namely, the Centre for Compressor Technology, the Turbomachinery Research Group and the Multi-phase flow research group, dedicated to fundamental and applied research in the field of fluid flow with heat and mass transfer and supported by the state-of-the-art experimental facilities and in-house developed numerical tools and software.

The tour also entailed a display of 23 research posters which reflected the vast network of national and international collaborations over a wide range of engineering sectors receiving funding from the European Union, EPSRC, Innovate UK as well as industry.

**Winner of the best technical paper:**  
 Dr Sham Rane, City, University of London  
 Paper: Application of numerical grid generation for improved CFD analysis of multiphase screw machines.  
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**Winner of the best student paper:**  
 Manuel Grieb, Technical University Dortmund  
 Paper: Effects of spontaneous condensation in steam-driven screw expanders  
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**Winner of the best student presentation:**  
 Marcus Yiquan Lin, Nanyang Technological University  
 Paper: Working principle of new multi-chamber rotary compressor

## References

10<sup>th</sup> International Conference on Compressors and Their Systems web pages  
<https://www.city.ac.uk/compressorsconference>

IOP Conference Series: Materials Science and Engineering, Volume 232 2017  
<http://iopscience.iop.org/issue/1757-899X/232/1>

- a. **Application of numerical grid generation for improved CFD analysis of multiphase screw machines** 012017  
S Rane and A Kovačević
- b. **Energy potential of dual lead rotors for twin screw compressors** 012018  
Matthias Utri and Andreas Brümmer
- c. **Numerical analysis of the transient flow in a scroll refrigeration compressor** 012050  
Shuaihui Sun, Kai Wu, Pengcheng Guo and Xingqi Luo
- d. **Oil flow at the scroll compressor discharge: visualization and CFD simulation** 012051  
Jiu Xu and Pega Hrnjak
- e. **Grid generation methodology and CFD simulations in sliding vane compressors and expanders** 012053  
Giuseppe Bianchi, Sham Rane, Ahmed Kovacevic, Roberto Cipollone, Stefano Murgia and Giulio Contaldi
- f. **Improved design method of a rotating spool compressor using a comprehensive model and comparison to experimental results** 012056  
Craig R Bradshaw, Greg Kemp, Joe Orosz and Eckhard A Groll
- g. **Internally geared screw machines with ported end plates** 012058  
M G Read, I K Smith and N Stosic
- h. **Comparison of energy-efficiency and size of portable oil-free screw and scroll compressors** 012057  
Olly Dmitriev and Prof. Ian MacDonald Arbon
- i. **Performance evaluation of a novel dual vane rotary compressor** 012060  
A Shouman, A El Dein Hussin, A Hamed, M Serag El Din, N Mahmoud and A El Baz
- j. **Determination of the oil distribution in a hermetic compressor using numerical simulation** 012009  
S Posch, J Hopfgartner, E Berger, B Zuber, R Almbauer and P Schöllauf
- k. **Comprehensive 3D-elastohydrodynamic simulation of hermetic compressor crank drive** 012008  
S Posch, J Hopfgartner, E Berger, B Zuber, R Almbauer and P Schöllauf
- l. **2D and 3D impellers of centrifugal compressors – advantages, shortcomings and fields of application** 012040  
Y Galerkin, A Reksrin and A Drozdov
- m. **Effect of end-wall riblets on radial turbine performance** 012075  
M A Khader and A I Sayma
- n. **Non-symmetric approach to single-screw expander and compressor modeling** 012076  
Davide Ziviani, Eckhard A. Groll, James E. Braun, W. Travis Horton, M. De Paepe and M. van den Broek



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