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REFRIGERATION AIR CONDITIONING HEAT PUMPS

11th International Conference on **Compressors and their Systems**

9th - 11th September 2019
City, University of London

Preceded by a short course on Computational Fluid
Dynamics in Rotary Positive Displacement Machines
7th - 8th September 2019

Post conference report

Background

The International Conference on Compressors and their Systems series began in 1999 as a result of industrial consultation and need for academic collaboration. At the time the conference was organised by the Fluid Machinery Group of the Institution of Mechanical Engineers (IMechE) with support from Holroyd. From 2009 the Centre for Compressor Technology at City, University of London took over its management and the Conference is now one of the main conventions, taking place biennially in the UK, becoming world-renowned for its place in industry and academia to gather and discuss a broad range of topical issues related to compressors and compression systems. The IMechE remains a longstanding partner, along with the International Institute of Refrigeration (IIR), and the Institute of Refrigeration (IOR).

The Conference has three Committees:

1. Organising Committee
2. International Liaison Committee
3. Programme and Scientific Review Committee

The Conference is chaired by Prof Ahmed Kovacevic, and is steered and organised by the Organising Committee which consists of staff from the Centre for Compressor Technology, the events team at City, University of London, senior representatives from partner institutes and representatives of the Platinum and Gold sponsors.

The International Liaison Committee is a consortium of eminent members from industry and academia who principally advise the organising committee on trends and topics in the compression industry which would be of interest to the conference delegates. They also promote the conference in their parts of the world.

The Programme and Scientific Review Committee, chaired by Dr Matthew Read, is integral to the conference. Its function is to ensure we have an outstanding programme and the highest quality of research papers are presented at the Conference.

Since 2012, the main conference is preceded by a two-day Short Course & Forum on CFD in rotary positive displacement machines, led by Dr Sham Rane

250+ attendees **24** countries **23** parallel sessions **94** technical papers **25** student papers **10** exhibitors

Summary

The 11th Conference in the series was held from 9th to 11th September at City, University of London, United Kingdom, attracting over 250 registered delegates from across the world representing various sectors.

City's President, Professor Sir Paul Curran, welcomed delegates to the conference at the official opening on 9th September, emphasising the importance of the Conference to the Compressor Industry and the University's overall strategic plan. The objectives of the conference were to provide a platform for academics, students and professionals interested in Compressors and related areas to share current research, develop new ideas, and share best practices.

The Conference achieved these objectives through the delivery of keynote presentations and a number of technical parallel sessions. The tone of the conference was set by the keynotes from three world experts Prof. Andreas Brummer talked about "Leakage Losses in Twin Screw Machines" on the first day, Prof Yunho Hwang challenged us in the second plenary session with the talk on "Compression without Compressors" and Prof Mehrdad Zangeneh gave a keynote on the Industry day about the design system for centrifugal chillers with low GWP refrigerants.

The conference delivered four streams of parallel sessions, with presentations on following topics:

- Screw Compressors
- Reciprocating Compressors
- Compressor Systems
- Expanders
- Measurement and Control
- Turbocompressors
- Valves
- Vane Compressors
- Novel Compressors
- Single Screw and Roots Machines
- Linear Compressors
- Scroll Compressors
- Rotary Compressors
- Waste Heat Recovery

Conference delegates also had the opportunity during conference breaks to mingle amongst exhibition displays by companies.

The Organising Committee of the Conference are grateful for the support provided by our partners to deliver the 2019 Conference and for the financial assistance provided by our sponsors Holroyd Precision (platinum), Howden (gold), silver sponsors Kapp Niles, Samputensili Machine Tools Srl, Convergent Science, FeTu, and Vert Rotors, CompressorTech2 (industry day sponsor) and Megger (gala dinner sponsor).

IOP
Publishing

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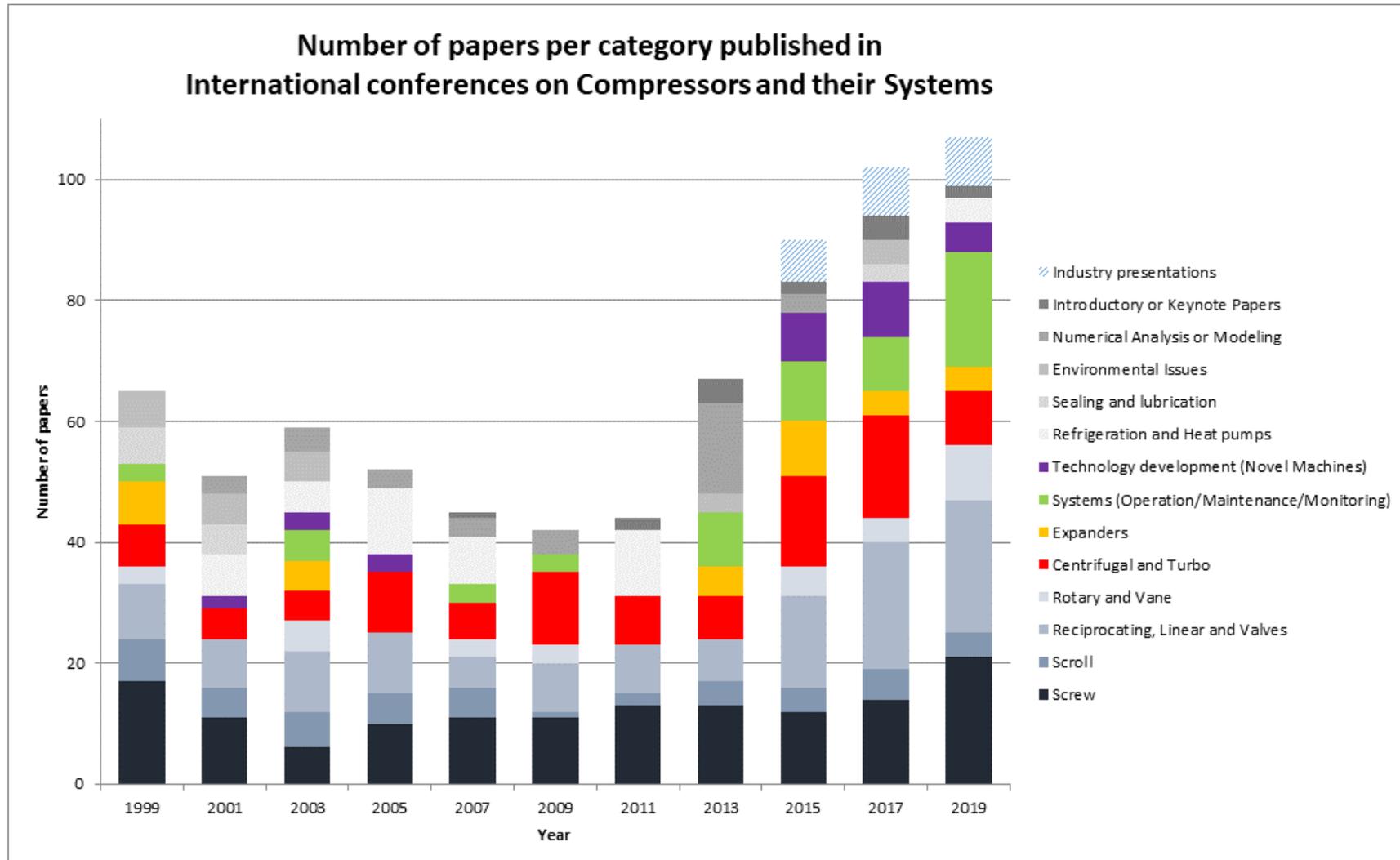
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Megger



Technical Program

At the Conference this year, 94 technical papers were accepted for presentation across 23 sessions during the first two days of the conference. 85 of these papers were published by the renowned Institute of Physics' (IOP) Conference Series: Materials Science and Engineering and 11 papers published by the Journal of Process Mechanical Engineering. There were 25 papers submitted and presented by students.



Screw Compressors

Screw Compressors were covered in a number of sessions, with topics including design and optimisation of rotor and machine geometry, noise and vibration suppression methods, and computational methods for investigating oil dispersion and heat transfer. Studies were presented covering applications from air compression, refrigeration and heat pump systems to mechanical vapour compression.

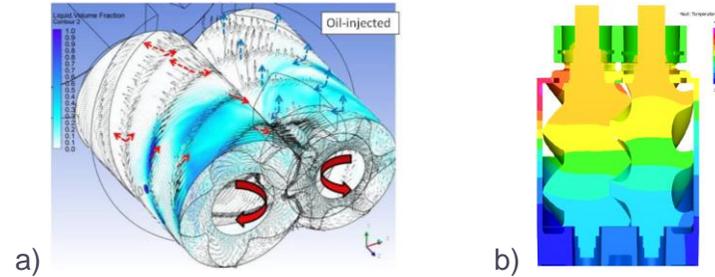


Figure 1: a) gas velocity and liquid volume fraction in oil-injected air compressor (Zhang et al., 2019), and b) temperature distribution through section of oil-free air compressor (Ding et al., 2019)

Reciprocating Compressors

Presentations focusing on reciprocating compressors included topics such as vibration balancing in star-type configurations, mechanically assisted suction valves, and the control of valves in swash-plate compressor systems for vehicle air conditioning. Numerical modelling was presented investigating the effect of heat transfer, refrigerant outgassing and pressure pulsations on compressor performance, and the influence of thermal stress and deformation. Valve design and leakage flows were considered in several papers, with a description of experimental work on pneumatically forced actuated compressor-expander valves winning the Best Student Presentation prize.

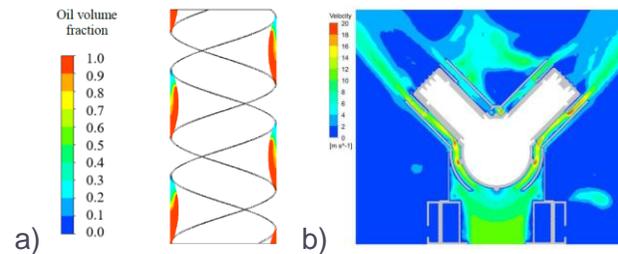


Figure 2: a) outgassing of refrigerant in pump of hermetic compressor (Braga et al., 2019), and b) velocity distribution of air for cooling of oil-free reciprocating compressor (Tang et al., 2019)

Other Compressor types

The design and performance of a number of vane compressor configurations were presented including novel twin-chamber, coupled-vane & rotating-sleeve variants. Several novel compressor developments were also presented including performance test results on a roticulating compressor, and theoretical studies of double-swing vane, rotary cylinder compressors, and gerotor-type screw machines, along with new research on the design and performance evaluation of single-screw machines. Research on the electrical systems and control of linear compressors was discussed, along with a numerical analysis of gas bearings for oil free applications which received the Best Student Paper prize.

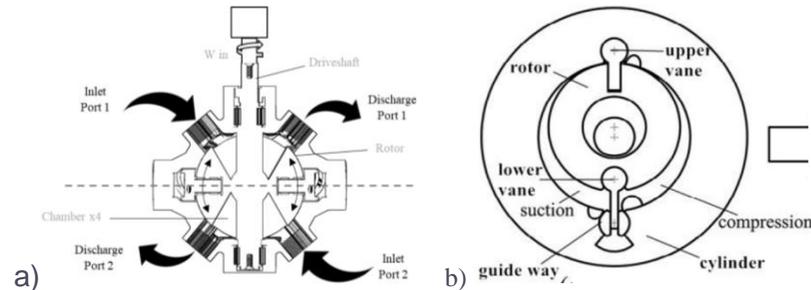


Figure 3: Novel configurations for a) roticulating compressor (Zhang et al., 2019) and b) double swing vane compressor (Zhong et al., 2019)

The analysis of two-phase effects in expander operation was considered in a number of presentations for dynamic, reciprocating and twin-screw machines. Waste heat recovery was discussed in papers describing current implementations using vane expanders, and the potential optimisation of expander operating conditions in cascaded organic Rankine cycle systems.

Compressors Systems

Compressor systems covered topics ranging from outsourcing of compressed air to developments in compressor manufacturing methods and lubricant performance. Novel methods of oil separation were presented, along with studies illustrating system optimisation and pulsation and noise reduction methods.

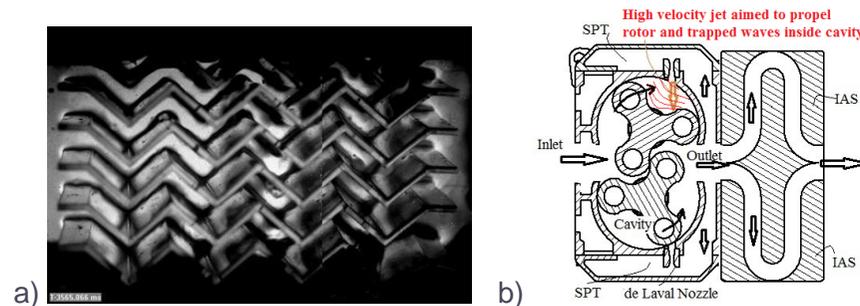


Figure 4: a) Oil flow through a wavy plate separator (Xu and Hrnjak, 2019), and b) integration of an absorptive silencer into a nozzle based SPT to limit noise and pulsations (Huang and Yonkers, 2019)

Turbomachinery

In the turbomachinery sessions, studies were presenting for optimisation of rotors and diffusers in industrial, gas pipeline, gas turbine and refrigeration compressor applications. The study of a novel turbo compressor for heat pump applications using water was also presented and received the Best Paper prize at the conference.

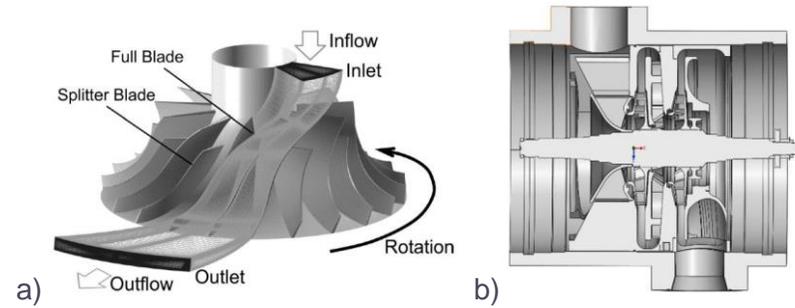


Figure 5: Illustration of a) turbo compressor for a water refrigerant heat pump (Shoyama et al., 2019), and b) 2-stage gas pipeline centrifugal compressor (Borovkov et al., 2019)

Industry Day

The 3rd day of the conference was dedicated to industrial presentations where eight world leading experts talked about their company's journey and industrial challenges.

Mr Jack Sauls and Prof Chris Holmes (Holroyd) talked about history of compressors and best practices for engineers which was well received by the audience, while Dr Billy Milligan (Howden Compressors) presented the use of technology through Data Driven Advantage which will enhance development of compressors and their systems.

Industry day was sponsored by renowned trade journal COMPRESSORTech2.

Keynotes



Prof. Dr.-Ing. Andreas Brümmer, Head of Chair of Fluidics at TU Dortmund University addressed the audience about 'Leakage Losses in Twin-Screw Machines'.



Prof. Yunho Hwang, Associate director of the Center for Environmental Energy Engineering (CEEE) at the University of Maryland talked about 'Compression without Compressors'.



Mehrdad Zangeneh, Professor of Thermofluids at University College London and Founding Director of Advanced Design Technology, Ltd, talked about 'A Design System for the Design of new range of High COP Centrifugal Chillers with low GWP Refrigerants'.

Social & Exhibition Programme

Alongside the technical program, a number of social events were held to allow delegates to network and enjoy the conference.

Welcome reception

A Welcome Reception 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.

Gala Dinner

The Gala Dinner was hosted on the first day at the exquisite Royal Horseguards Hotel; a venue rich in history and a Victorian masterpiece, located on the city's Embankment with views of the River Thames. The guest speaker was the Baroness Brown of Cambridge, Julia King.

The Baroness Brown is one of the most senior British women engineers with many prestigious appointments in the public sector as well as in industry and academia and is the recipient of a number of very distinguished awards including the royal award of Dame Commander of the British Empire. She is presently Chair of the Carbon Trust. She is a member of the Committee on Climate Change, served on the Airports Commission, and as the UK's Low Carbon Business Ambassador for 10 years, was a non-executive Director of the Department for Business, Innovation and Skills.

Baroness Brown addressed the audience on the very topical subject of climate change, the challenges of addressing climate change and what that means for the compressor industry.

The keynote presentations and Baroness Brown's speech can be viewed via the conference webpage:

<https://www.city.ac.uk/compressorsconference>

Exhibitors

Ten companies exhibited at the conference. Coffee and meal breaks provided ample time for delegates to interact with the exhibitors and network with other delegates.

- Holroyd Precision
- Howden
- Kapp Niles
- Samputensili Machine Tools Srl
- Convergent Science
- FeTu
- Vert Rotors
- Gamma Technologies (GT-SUITE)
- PDM Analysis
- CompressorTech2

Poster exhibition

A Poster Exhibition was also organised to showcase research from the Thermo-fluids Research Centre at City, University of London. Display of 40 research posters reflected the various national and international collaborations over a wide range of engineering sectors receiving funding from the European Union, EPSRC, Innovate UK as well as the industry.

Seminars on SCORG and GT-SUITE

Companies PDM analysis and Gamma Technologies jointly held interactive seminars, demonstrating their software SCORG and GT-SUITE which can be integrated to allow fast simulation of screw machines. The developments in the software and its usage in case studies was a recurring theme in several papers throughout the 5 days.

Social evening event

At the end of second day, and with popular demand, a social event was held at St Bart's Brewery with live music by The Hot Keys and Joe Perkins, alumni of City, University of London. During this evening, best paper and best presentation awards were presented to three winners:

Best Paper Award + £500 Amazon Voucher

Novel Turbo Compressor for Heat Pump Using Water as Refrigerant and Lubricant

Tadayoshi Shoyama¹, Bunki Kawano¹, Takeshi Ogata¹, Masaru Matsui¹, Masato Furukawa², Saeid Dousti³

¹Panasonic Corporation, Japan; ²Kyushu University, Japan; ³Rotor Bearing Solutions International, USA

Presented by Dr Colin Brown, Chief Executive of iMechE

Best Student Paper Award + £250 Amazon Voucher

Numerical Analysis of Gas Bearings in Oil-free Linear Compressors

Xinye Zhang, Davide Ziviani, James Braun, Eckhard Groll
Purdue University, United States of America

Presented by David Paget FInstR, Chair of the Technical Committee of the IOR and Fellow of the IOR.

Best Student Presentation Award + £250 Amazon Voucher

Experimental testing of pneumatically forced actuated compressor-expander valves

Christian Stoeckel; Christiane Thomas; Joerg Nickl; Ullrich Hesse
TU Dresden, Germany

Presented by Prof Eckhard Groll, Head of Mechanical Engineering, Purdue University

4th Short Course and Forum

CFD in Rotary Positive Displacement Machines

A short Course and forum on the use of CFD tools for the detailed analysis of rotary positive displacement machines was held on 7-8 September 2019 at City, University of London with the objective of addressing the increase in its use for this purpose in recent years. 54 attendees from 6 countries were present and the course included presentations by 16 lecturers, 13 from academia and 3 from industry. The course focused on subjects such as:

- Advances in grid generation, CFD tools, and new techniques for PD machine analysis.
- Modelling of leakage flows and conjugate heat transfer.
- Prediction of clearance gap sizes during operation and the application of modern FSI computations.
- The stability and accuracy of multiphase flow calculations in PD machines.

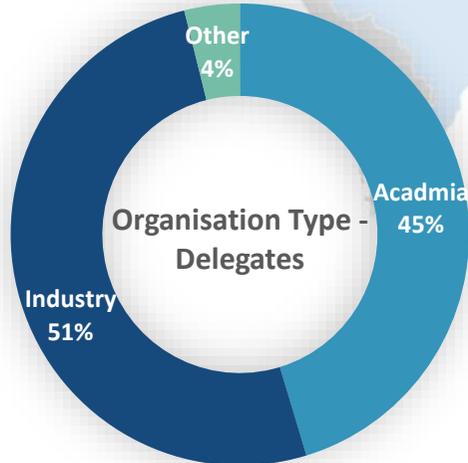
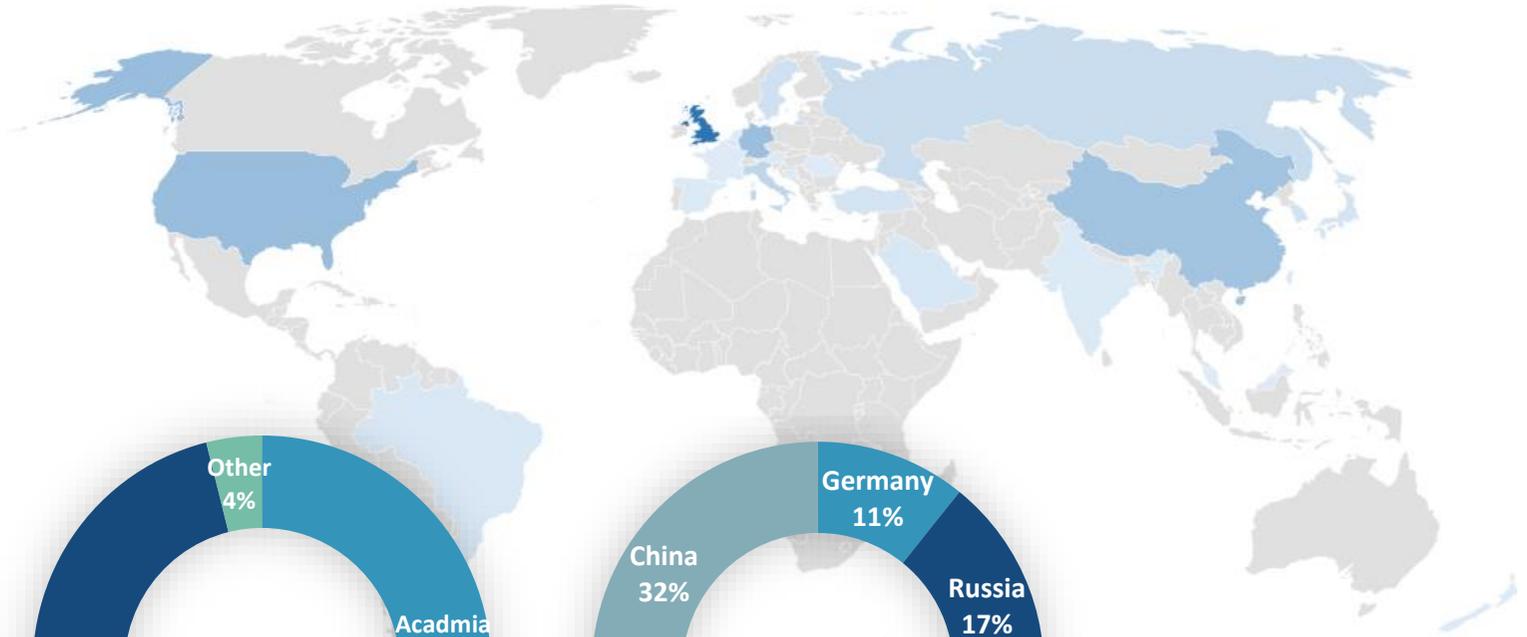
These subjects were supported by provision of test data for twin-screw dry air and oil injected air compressors, provided by the Centre for Compressor Technology and a single-screw expander test data provided by Purdue University. Presenters at the course used these test cases to demonstrate new CFD techniques and validate their findings.

The introduction session on Day 1 focused on CFD implementation using the Finite-Volume Method specifically for moving, deforming domains and the associated solver features. Following this, novel research in the area of CFD in rotary positive displacement machines was presented over the two days of the course. Subjects such as full 3D transient analysis of single-screw machines, quantitative comparison of CFD results with PIV data, new solvers such as ANSYS FLUENT, OpenFOAM, One-way fluid structure interaction in scroll machines and novel grid generation techniques such as iso-geometric analysis framework (IGA), algebraic and differential grid generation, Turbulence and Multi-Phase flow modelling were examples of significant advancements in technology. An integrated modelling approach such as SCORG and GT-Suite to improve the reliability of the thermodynamic and fluid flow solution from chamber-system type of models also caught attention. A variety of rotary positive displacement machines presented ranged from conventional twin-screw compressors to vane machines, single-screw machines, scroll machines and also some non-conventional machines such as variable lead and variable profile or conical rotary machines.

Some of the research presented in this Short Course is published in the special Issue on "[Modelling, Analysis, and Design of Positive Displacement Machines](#)" in the Journal of Design, published by MDPI.

https://www.mdpi.com/journal/designs/special_issues/pdm2019

Delegate breakdown



Website traffic

14,084 views between Oct 2017 – Sep 2019



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185 users

SAVE THE DATE

6–8 September 2021 | London, UK

The 12th International Conference on Compressors and their Systems will be highly influential conference once again in 2021. Save the date and join us for your biennial gathering in London, UK. Reconnect with your peers and leaders from the industry to experience some of the most outstanding innovation in the Compressors world.

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