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**北京大学工学院**

 **航空航天工程系**

高能量密度物理数值模拟教育部重点实验室



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| **题目：** **Cryogenic Hydrogen Combustion** |

**报告人: Dr. Mike Kuznetsov**

**Karlsruhe Institute of Technology, Germany**

**报告内容摘要：**

A series of more than 100 experiments with hydrogen-air mixtures have been performed at cryogenic temperatures from 90 to 130K and ambient pressure. A wide range of hydrogen concentrations from 8 to 60%H2 in a shock tube of 5-m long and 54 mm id was tested. Flame propagation regimes were investigated for all hydrogen compositions at three different blockage ratios 0, 30% and 60% as a function of initial temperature. Piezoelectric pressure sensors and InGaAs photo-diodes have been applied to monitor the flame and shock propagation velocity of the combustion process. The critical expansion ratio σ\* for an effective flame acceleration to the speed of sound was experimentally found at cryogenic temperatures. The detonability criteria for smooth and obstructed channels were used to evaluate the detonation cell sizes at cryogenic temperatures as well. The main peculiarities of cryogenic combustion with respect to the safety assessment were that the maximum combustion pressure was several times higher and the run-up-distance to detonation was two times shorter compared to ambient temperature independent of the lower chemical reactivity at cryogenic conditions. It was found that factors of higher density and expansion ratio lead to higher hydrodynamic flame instability and compensate the lack of reactivity at cryogenic temperatures.

**报告人简介：**

Dr. Mike Kuznetsov is currently the Principal Researcher responsible for hydrogen combustion and detonation experiments at the HYKA test side of Karlsruhe Institute of Technology, Germany. Dr. Kuznetsov is an invited Professor at CNRS (Centre National de la recherche scientifique), Orléans, France He received his bachelor and master degrees in Nuclear Engineering at Saint-Petersburg Institute of Technology, and PhD degree in Physics of Combustion and Explosions at Kurchatov Institute, Russia. He was the Head of the Combustion Dynamics Laboratory at Kurchatov Institute, Russia. His professional experience covers more than 30 years. His current research focuses on large-scale experiments on hydrogen combustion and detonations with respect to hydrogen safety. He is a member of ANS, ASME, SMIRT, and the German section of Combustion Institute. He is a member of the Steering Committee of the International Atomic Energy Agency. The total number of scientific publications is more than 350, including 3 patents; 116 scientific papers in refereed journals and 246 scientific papers in refereed conference proceedings.

**时间：2023年12月7日（周四）上午9:00－10:00**

**地点：北京大学 工学院 1#楼210会议室**

（从北大东门 沿成府路北侧向东200米、再向北200米到工学院）

**欢迎校内外师生光临！**

联系人：陈正 **62766232, 13439589987**

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| **题目：激波诱导掺氢甲烷自发点火大涡模拟**  |

**报告人: 肖建军，博士**

**卡尔斯鲁厄理工学院(KIT)，德国**

**报告内容摘要：**

高压天然气管道掺氢是未来实现氢能大规模输送的重要途径。然而，高压掺氢甲烷泄漏至管道后与空气形成混合层，存在激波加热导致自燃的安全隐患，有必要对其机理进行深入研究。准确捕捉管道内诱导激波的三维结构以及局部可燃混合气体区域的形成，是成功模拟掺氢甲烷自发点火的重要前提。考虑到在三维大涡模拟中应用H2/CH4的详细化学动力学的复杂性和不切实际性，基于三维CFD程序GASFLOW大涡模拟框架，开发了简化的H2/CH4反应机理和点火延迟模型，研究了高压可燃气体在矩形管道内三维激波诱导自发点火行为。针对高压氢气，与实验观察进行对比，复现了反射激波和马赫反射诱发的管角、壁面中心和管道中心三个连续的自发点火，同时火焰快速蔓延至整个管道。高压掺氢甲烷泄漏后形成的激波强度显著降低，导致自发点火仅在管角处发生，火焰主要沿着管角逐渐向管壁蔓延。研究利用大涡模拟提供了高时空分辨率的三维可视化数值结果，包括激波结构，燃料空气混合区，激波诱导自发点火与火焰发展等，弥补了实验测量的不足，为深入理解激波诱导掺氢甲烷自燃现象提供了一种高效可行的三维数值分析方法，可为预防高压掺氢天然气管道泄漏自燃提供科学依据。

**报告人简介：**

肖建军，德国卡尔斯鲁厄理工学院（KIT）研究员（终身职位，Tenured Researcher），2001年获西安交通大学学士学位，2003年获清华大学硕士学位，2006年获清华大学博士学位。2006年8月起至今一直在KIT从事高性能流体科学计算工作，专注于能源科学与工程领域的数值模拟和仿真应用，担任KIT三维全流速CFD软件GASFLOW研发团队负责人。采用统一的基于压力的半隐式全马赫数求解算法研究气体燃烧的相关行为，数值模拟研究范围涵盖层流火焰，不稳定性，湍流燃烧，火焰加速，燃爆转变，激波诱导自发点火，爆轰等。同时致力于推动CFD在真实尺度实际工程问题中的应用，强调研究成果的实用价值。2013-2018年，多次受国际原子能机构（IAEA）邀请担任氢安全专家，2018-2021年担任欧盟燃料电池与氢能安全专家组成员。近10年来，发表学术论文与专著共计60余篇，培养博士后、访问学者与交流博士生20余名。

**时间：2023年12月7日（周四）上午10:00－11:00**

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