汤冠琼,秦皓,李林,林宇震,李继保.非定常条件下喷嘴结构对燃油流量脉动的影响[J].航空动力学报,2015,30(4):831~837

非定常条件下喷嘴结构对燃油流量脉动的影响

Nozzle structure's influence on fuel flow oscillation in unsteady conditions

投稿时间：2013-11-09

DOI： 10.13224/j.cnki.jasp.2015.04.009

中文关键词: 非定常 直射式喷嘴 喷嘴结构 燃油流量脉动 关系模型 节流级数 节流面积

英文关键词:unsteady plane orifice nozzle nozzle structure fuel flow oscillation correlation model throttling stage throttling area

基金项目:

作者	单位
汤冠琼	北京航空航天大学 能源与动力工程学院航空发动机气动热力国家级重点实验室,北京 100191
秦皓	北京航空航天大学 能源与动力工程学院航空发动机气动热力国家级重点实验室,北京 100191
李林	北京航空航天大学 能源与动力工程学院航空发动机气动热力国家级重点实验室,北京 100191
林宇震	北京航空航天大学 能源与动力工程学院航空发动机气动热力国家级重点实验室,北京 100191
李继保	中国航空工业集团公司 商用航空发动机有限责任公司,上海 200241

中文摘要:

假设油路处于小脉动条件下,燃油流量连续,以流量数为中间变量,推导了燃油流量脉动关于喷嘴结构的关系模型.得出结论:当外部激励一定时,燃油流量脉动与流量数成正比,与平均燃油压降的0.5次方成反比.通过喷嘴标定得出了减小流量数进而减小燃油流量脉动的方法:增加节流级数、减小节流面积,并用脉动试验证明了此方法的正确性,为喷嘴设计者在面对不稳定性问题时提供了一般的设计步骤.

英文摘要:

Assuming that fuel flow is continuous under small oscillation conditions, a correlation model about fuel flow oscillation and the nozzle structure was derived with flow number as an intermediate variable. Under this model, conclusion are made as follows: fuel flow oscillation is proportional to the flow number, and inversely proportional to the 0.5th power of average fuel pressure drop when the external excitation is given. Methods of decreasing fuel flow oscillation by decreasing flow number are obtained by nozzle calibration: increasing the throttling stage, decreasing throttling area. This method is validated through oscillation experiment. A general design procedure is suggested for nozzle designers in face of the instability problem.

查看全文 查看/发表评论 下载PDF阅读器

关闭

参考文献(共21条):

[1] Crocco L, Cheng S I.Theory of combustion instability in liquid propellant rocket motors[M].Cambridge:Cambridge University Press, 1956.

[2] Kendirck D K, Anderson T J, Sowa W A.Acoustic sensitivities of lean-premixed rule injectors in a single nozzle rig[R].ASME Paper 98-GT-382, 1998.

[3] Lieuwen T, Torres H, Johnson C, et al.A mechanism for combustion instabilities in premixed gas turbine combustors[J].Journal of Engineering for Gas Turbines and Power, 2000, 123(1):182-189.

[4] Cho J H, Lieuwen T.Laminar premixed flame response to equivalence ratio oscillations[J].Combustion and Flame, 2005, 140(1):116-129.

[5] Nguyen Q V.Measurements of equivalence ratio fluctuations in a lean premixed prevaporized (LPP) combustor and its correlation to combustion instability[R].ASME Paper GT-2002-30060, 2002.

[6] Lieuwen T, Zinn B T.The role of equivalence ratio oscillations in driving combustion instabilities in low NOx gas turbines[J].Symposium (International) on Combustion, 1998, 27(2):1809-1816.

[7] Lieuwen T C, Yang V.Combustion instabilities in gas turbine engines:operational experience, fundamental mechanisms and modeling[J].Progress in Astronautics and Aeronautics, 2005, 210:657-665.

[8] Yi T, Santavicca D A.Determination of the instantaneous fuel flow rate out of a fuel nozzle[J].Journal of Engineering for Gas Turbines and Power, 2009, 132(2):021503.1-021503.7.

[9] Yen C Y, Koeglmeier S M, Sisco J C, et al.Combustion instability of gaseous fuels in a continuously variable resonance chamber (CVRC)[R].AIAA-2008-4657, 2008.

[10] Society of Automotive Engineers.Handbook of aviation fuel properties[M].3rd ed.Warrendale:Society of Automotive Engineers, 2004.

[11] Karabeyoglu A, Stevens J, Cantwell B.Investigation of feed system coupled low frequency combustion instabilities in hybrid rockets[R].AIAA-2007-5366, 2007.

[12] 杨立军, 张向阳, 高芳, 等.液体喷嘴动态特性数值模拟[J].航空动力学报, 2004, 19(6):866-872. YANG Lijun, ZHANG Xiangyang, GAO Fang, et al.Numerical simulation of liquid injector dynamics[J].Journal of Aerospace Power, 2004, 19(6):866-872.(in Chinese)

[13] 李龙飞, 陈建华, 周立新, 等.补燃循环火箭发动机气液同轴式喷嘴声学特性研究[J].火箭推进, 2004, 30(6):5-10. LI Longfei, CHEN Jianhua, ZHOU Lixin, et al.Investigation on acoustic characteristics of gas-liquid coaxial injector of staged combustion rocket engine[J].Journal of Rocket Propulsion, 2004, 30(6):5-10.(in Chinese)

[14] Huang Y, Yang V.Dynamics and stability of lean-premixed swirl-stabilized combustion[J].Progress in Energy and Combustion Science, 2009, 35(4):293-364.

[15] Huber A, Polifke W.Impact of fuel supply impedance on combustion stability of gas turbines[R].ASME Paper GT-2008-51193, 2008.

[16] Yi T, Santavicca D A.Flame transfer functions for liquid-fueled swirl-stabilized turbulent lean direct fuel injection combustion[J].Journal of Engineering for Gas Turbines and Power, 2009, 132(2):021506.1-021506.6.

[17] Lichtarowicz A, Duggins R K, Markland E.Discharge coefficients for incompressible non-cavitating flow through long orifices[J].Journal of Mechanical Engineering Science, 1965, 7(2):210-219.

[18] Lefebvre A H.Atomization and sprays[M].Boca Raton:CRC Press, 1989.

[19] Asihmin V I, Geller Z I, Skobel\'cyn Y A.Discharge of a real fluid from cylindrical orifices[J].Oil Industry, 1961, 9:135-172.

[20] Kim H, Lai M C.Effect of pressure pulsation on performance of airblast atomizer and micro-machined fuel injectors[R].AIAA-2002-4227, 2002.

更多...

相似文献(共20条):

[1] 韩百顺.节流流量计测量脉动气流平均流量的研究[J].上海理工大学学报(社会科学版),2000(1):25-28.

[2] 韩百顺.节流流量计测量脉动气流平均流量的研究[J].上海理工大学学报,2000,22(1):25-28.

[3] 李杰.TAPS燃烧室燃油喷嘴设计特点分析[J].航空发动机,2010,36(5):59-61,55.

[4] 陈俊,张宝诚,马洪安,刘觊.某型航空发动机燃油喷嘴的试验研究[J].燃气涡轮试验与研究,2006,19(3):40-43.

[5] Jong Sung Lee, Huey Dong Kim, Toshiaki Setoguchi and Shigeru Matsuo.Unsteady shock-flow characteristics in an over-expanded rocket nozzle[J].热科学学报(英文版),2010,19(4):332-336.

[6] 郑学著,黄袖清,陈艳芳,蒋万里.燃油喷嘴主要性能参数的影响因素及调试技术[J].航空制造技术,2014(22).

[7] 王忠,高宗英.节流轴针式喷油嘴的喷雾特性研究[J].内燃机工程,1996(4).

[8] 贾锡印,杨敏.柴油机喷嘴结构参数对流通特性的影响[J].哈尔滨工程大学学报,1989(4).

[9] 刘宇陆.明渠非定常水流的垂向结构实验研究[J].上海力学,1993,14(3):64-70.

[10]袁彪,田静,于彬,鲍文.喷嘴切换时间对高温管道流动特性的影响研究[J].科学技术与工程,2014,14(12):304-308.

[11]刘闵钊,吴伟亮.脉动压力下旋流喷嘴流动特性的数值模拟[J].动力工程,2012(7):538-541.

[12]张国臣,刘波,杨小东,曹志远.叶栅安装角异常的非定常流场数值模拟[J].航空动力学报,2014,29(10):2450-2456.

[13]王乐勤,王循明,徐如良,李江云.自激振荡脉冲喷嘴结构参数配比试验研究[J].工程热物理学报,2004,25(6):956-958.

[14]李杰.TAPS燃烧室燃油喷嘴结构设计特点分析及思考[J].航空科学技术,2010(1).

[15]Shaojuan Geng,Feng Lin,Jingyi Chen , Chaoqun Nie Institute of Engineering Thermophysics,Chinese Academy of Sciences,P.O.Box ,Beijing ,China.Evolution of Unsteady Flow near Rotor Tip during Stall Inception[J].热科学学报(英文版),2011,20(4):294-303.

[16]陈志敏 徐敏.超音速气流粉碎机喷嘴的结构设计研究[J].机械科学与技术(西安),1995(1):77-82.

[17]张辉亚,冯明志,王锋,浦卫化,闫萍.高压共轨燃油喷嘴空穴流动的非稳态模拟[J].柴油机,2011,33(2):26-29,35.

[18]房建峰,杜慧勇,刘建新,李民,宗永平,王峰.喷油嘴流量系数对燃油喷雾及柴油机性能的影响[J].河南科技大学学报(自然科学版),2004,25(2):24-27.

[19]胡献国,王国丰,沃恒洲,徐玉福.微乳化生物质燃油在喷嘴内部的空化流动特性[J].机械工程学报,2011,47(12).

[20]朱冬,杨庆俊,包钢.气动系统二维非定常流场计算[J].机床与液压,2010,38(15).