附件1

2019 年度中车外部联合研发机构合作项目研究需求

CRRC Project Work Statement for Collaborative Research and Development 2019

《400 公里高速动车用新型 R744 冷媒制冷与热泵系统双向循环关键技术研究与应用》

The key technical research and application of R744 refrigerant for 400km/h high speed train refrigeration and heat pump under HVAC two mode circles

1. 项目背景 Project Background

1.1 产业需求分析 Business Sector Analysis

- 该项目所处产业板块现状

  In which business sector is the research and what is its status?

  当前，轨道车辆空调通常采用 HFC134a 或 HFC407C 作为冷媒，这些制冷剂排放到环境中会有明显的温室气体效应。Currently available HVAC for train are commonly using either HFC134a or HFC407C as working fluids which have a significant goble warming potentail when released into the environment. These units typically rely on inefficient direct electrical heating.

  DB 铁路公司对过去几年的车辆能源消耗进行了分析。30%

以上的能源消耗在客室空调系统。R744 冷媒具有 ODP 为 0，GWP 为 1 的环保特点。新开发高效绿色 R744 空调已经在德铁进行装车测试。因此，开发制冷、热泵双向系统将是未来发展方向。

Deutsche Bahm has analysed the energy consumption of their railway rolling stock in detail over several years.Up to 30% of their total energy consumption has to be spent to the operate the HVAC unit of the passenger trains in Germany.the Refrigent R744 has the character of GWP=1 and ODP=0. The Newly developed energy efficient and environmentally friendly HVAC unit applying R744 will be monitored during bench tests in Germany. Therefor R&D the two mode circle (refrigeration and heat pump)is the orientation in the furture.

- 中车产业发展的相关性

How is the research correlated to the CRRC's business? (Product/Technology)

R744 冷媒空调单向制冷系统研发中车大连所具有先发优势。目前中车大连所认为有必要对双向循环系统进行研发。

DLRI has the first mover advantage to develop the R744

HVAC single evaporating compressor unit.Now DLRI believe that it is the time to develop the two mode circle HVAC unit.

1.2 技术需求分析 Technology Analysis

➢ 技术研究现状

Technology research status (difficulties/inadequacy/which stage, etc.)

如技术瓶颈、难点、空白，处在哪一技术阶段。

制冷、热泵双向 R744 循环目前在公开资料只在欧洲有厂家开发，在国内仍是技术、产品空白。项目主要难点在系统理论计算、试验验证及高效室内、外换热器的开发。目前制冷单向循环系统大连所公司已经完成样件制造，热泵循环系统大连所还没有开发经验，双向一体化开发还没有公开样件展示。

The research and test of R744 refrigerant for train refrigeration and heat pump under HVAC two mode circles have some public thesises in Europe,but it still have gap in China.The project focus on theoretic calculation,CFD verify under high speed circumstance ,high effiency HX proposal and design meeting the project target.CRRC DLRI has finished the test smaple under refrigeration condition.Now we want to develop the high speed train refrigeration and heat pump under HVAC two mode circles in one unit.

- 对外部科研资源的要求

  Demand on the resources that necessary (similar research/ papers published/technology transfer)

  如相关领域科研项目承担情况、论文发表情况、技术转移情况。
  无

  None

1.3 合作情况 Collaboration

- 拟申报项目所在外部联合研发机构

  In which collaborative CRRC R&D Center?

  伊利诺伊大学香槟分校

  UIUC(University of Illinois at Urbana-Champaign)

- 合作对象 Partners

  College of Engineering or other college

2. 研究目标 Research Objective

为 XXX 产品 XXX 技术 XXX 性能提升，进行 XXX 的关键技术研究，或加强 XXX 的研发能力建设，或发展一种 XXX 新技术。注明实现了以下哪项：支撑海外区域市场开拓，削减成本，提升质量，优化产品，培育新产业。

- 该项目目标主要是对高速车辆空调系统双向循环的系统理论计算、CFD 验证以及工程化基础的研究。通过该项目有助于大连所公司进一步加快 R744 冷媒在制冷、热泵一体化研究工作，保持国内领先水平。

  The objective of the project is to research and application of R744 refrigerant for high speed train refrigeration and heat pump under HVAC two mode circles. It’s included the theoretical calcultion, CFD verify and fundmental of engineering.The project may help the CRRC DLRI keep the leading position at the R744 application field.

3. 主要研究内容 Main Research Contents

分项陈述为了达到研究目标及预期技术指标所进行的具体研究内容。

（1） 开展R744冷媒双向循环系统理论计算；

Doing the theoretic calculation research of R744 refrigerant dual direction circle

（2） 空调系统性能、可靠性、适应性研究；

Evaluation the HVAC unit performance, reliability and adaptability

（3） 开展在高速运行工况下，空调系统在制冷、热泵工况时，换热器理论计算研究；

Under the high speed circumstance, doing the research and calculation of HX theoretic calculation

（4） 开展管路及关键部件研究；

Doing the research and design of tube system design and key components

（5） 开展系统及室内、外换热器的制造结构设计和优化研究。

Doing the practical construction design of optimization the inside and outside HX.

4. 技术指标 Technical Indicators

- 现有技术指标

单蒸汽压缩循环，制冷量≥44kW,能效比≥2.27

Single evaporation compressor circle;Q ≥ 44kw,COP≥2.27

- 预期技术指标

在额定工况

制冷循环，制冷量≥44kW,COP≥2.5

热泵循环，制热量≥30kW,COP≥3

At the rating state:

Under refrigeration condition,capacity≥44kW,COP ≥2.5

Under HP circle condition, capacity≥30kW COP≥3

5. 工作计划 Work Plan

总研发周期：24 月

预期研究成果：

如技术报告、设计标准、专利（PCT 进入国）、样件、论文（SCI、EI）。

1、 论文（SCI）

2、 月度工作汇报

3、 在时速450km/h下和静止状态下，系统计算报告，换热器理论计算和有限元分析报告、空调流场分析和计算报告。

4、 技术方案和可行措施

5、换热器图纸

1. Thesis(SCI)

2. Monthly technical report

3. At speed 0km/h and up to 450km/h system calculation report,system HX theoretical calcultion and CFD analysis report,system CFD flow field analysis and theoretical calcultion report

4. Proposed technical approaches and solutions

5. HX drawing into the unit

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