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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

《设备舱用新型过滤结构的研究开发》

Research and Development of New Type Filtering Structure of Equipment Cabinet

1. 项目背景 Project Background

1.1 产业需求分析 Business Demand Analysis

- 该项目所处产业板块现状

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

  近年来，空气过滤技术得到不断发展，国内外在过滤机理的研究、滤料的研制开发、过滤设备的开发应用等方面进行了大量的工作也取得了一定进展，在航空航天、车辆制造等领域得到了广泛应用。空气过滤技术的应用可以有效控制粉尘微粒的污染，提高空气清洁度。

  In recent years, air filtering technology gets sustainable development. China and other countries carried out mass research and development on filter theory, material and equipment, which is widely applied in aerospace, aviation and vehicle manufacturing. Air filtering technology is an

effective way to control dust particles pollution and improve air purity.

- 中车产业发展的相关性

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

  符合中车轨道车辆业务板块的发展需要，支撑高速动车组、城际动车组产品，对设备舱过滤结构技术进行攻关。

  The research conforms to development demand of rolling stock business of CRRC, support to tackle challenges on filtering structure for high speed EMU and intercity EMU.

1.2 技术需求分析

Technology Demand Analysis

- 技术研究现状

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

  目前设备舱过滤结构的清理周期较短，工序相对繁琐，需占用较多人力物力；另外，CRH2A\CRH380A\ CRH2G型动车组在运用过程中出现絮状物（主要为柳絮，集中在柳絮季节）易堵塞过滤结构，导致设备用风量不足（需要进一步缩短过滤结构的清理周期，增加清理维护成本），同时存在絮状物不易清理的问题，需采用火烧清理的方式。

Equipment cabinet filtering structure cleaning takes overmuch labor efforts and materials due to short clean interval and complicated procedures; CRH2A\CRH380A\ CRH2G EMU is easily blocked by floccule (catkin), therefore equipment air supply is insufficient (cleaning interval has to be further shortened, cleaning maintenance cost is increased). Moreover, the floccule has to be burned for cleaning due to cleaning difficulty.

- 对外部科研资源的要求

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

  具备相应空气过滤技术的相关专利，其产品拥有在多个行业的应用业绩，通过合作，空气过滤技术的相关专利可以转移给中车四方。

  The research provider has to possess air filtering technology patent, its products are widely used in various sectors. Through collaboration, the related patents could be transferred to CRRC Sifang.

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?

  中美轨道交通联合研发中心

Sino-US Joint Research Center of Rail Transit

- 合作对象 Partners

  美国伊利诺伊大学

  University of ILLINOIS

2. 研究目标 Research Objective

为提高动车组智能化程度，降低动车组日常维护成本，在满足设备舱用风量及用风清洁度基础上，研究开发具备自动清理免维护功能的新型设备舱通风过滤结构。

To improve intelligent of EMU and decrease daily maintenance cost, we aim to research and develop new type ventilation and filtering structure with automatic cleaning function for equipment cabin on the basis that air supply is sufficient and air is clean.

3. 主要研究内容 Main Research Contents

1、 深入分析设备舱既有过滤结构；

Further analysis of existing filtering structure of equipment cabinet;

2、 设计开发能够满足需求的新型过滤结构（具备自动清理功能的同时，满足现车使用条件）并进行仿真验证；

Design, development, simulation and validation of new filtering structure demanded (with automatic cleaning function and satisfying existing car application);

3、 制作新型过滤结构样件并进行地面验证试验。

Manufacturing new type filtering structure and conducting on-ground validation test.

4. 技术指标 Technical Indicators

- 现有技术指标

Existing technical index

既有动车组设备舱过滤结构的清理周期有两种分别为：每 4 天或运行 4 千公里清扫一次（CRH2A\CRH380A\ CRH2G）、每 20 天或 2 万公里清扫一次（CR400AF）。

Filtering structure of existing EMU is cleaned every 4 days or 4000kms （CRH2A\CRH380A\ CRH2G）, every 20 days or 20,000kms （CR400AF）.

- 预期技术指标

Expected technical index

设备舱过滤结构免维护。

Filtering structure of equipment cabinet is free of maintenance.

5. 工作计划 Work Plan

总研发周期：18 月

Overall research period: 18 months

预期研究成果：

Expected research achievements:

1、 既有过滤结构分析报告；

Existing filtering structure analysis report;

2、 新型过滤结构设计报告（包含理仿真验证）；

New type filtering structure design report (including simulation and validation)

3、 新型过滤结构地面验证试验报告。

On-ground validation test report of new type filtering structure

中国中车股份有限公司

CRRC Corporation Ltd.

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

《高速列车设备舱环境空气净化装置的研制》

《Development of Ambient Air Purification Device for High-Speed Train Equipment Cabin》

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?

随着国内动车组数量的增多，铁路总公司对于降低动车组使用维护成本，延长维护周期，以及提高动车组关键零部件的使用寿命等要求不断提高。动车组冷却系统作为动车组牵引传动系统关键辅助系统，多年运用结果表明：其冷却空气净化的优劣是影响冷却系统的性能、可靠性和维护成本的关键因素之一。

With the increase in the number of domestic high-speed trains, China Railway Corporation has continuously increased the requirements for reducing the maintenance costs of high-speed trains, extending the maintenance period, and improving the service life of the key components on high-speed trains. The high-speed train cooling system is the key auxiliary system of the high-

speed train traction drive system. The results of application for many years indicate that the cooling air purification is one of the key factors affecting the performance, reliability and maintenance costs of the cooling system.

目前，现有动车组使用空气过滤器由惯性过滤器（FSA 或 W 型）与填料（金属网）等两部分在组成，其滤尘效率小于 50%（不加滤料等情况下），滤水效率大于 85%，空气压力损失 450Pa 左右，其中滤尘效率小于 85%的设计要求。特别动车组在春季柳絮季节运用时，每 2 天就要对冷却系统中的空气过滤器进行清洗（用酒精灯去除动车组侧裙板过滤器中的柳絮等可燃物，用吸尘器和毛刷去除冷却单元空气过滤器中的柳絮和灰尘），否则将影响冷却系统的通风，导致冷却系统的冷却能力降低，电力电子设备温度升高，影响动车组正常运行，因此，动车组运用段清除冷却系统中杂质的工作量比较大，维护成本较高。

Currently, the existing high-speed trains use an air filter consisting of two parts, an inertial filter (FSA or W type) and a filler (metal mesh).Its dust filter efficiency is less than 50% (without filter material, etc.), and the water filter efficiency is greater than 85%. The air pressure loss is about 450Pa, and the dust filter efficiency is less than the design requirement of 85%. Especially when high-speed trains are used in the spring catkins season, the air filter in the cooling system should be cleaned every 2 days (use the alcohol lamp to remove the combustibles, such

as catkins in the side skirt filter on the high-speed trains, and remove the catkins and dust from the cooling unit air filter with vacuum cleaners and brushes). Otherwise, the cooling system will be ventilated, and resulting in a decrease in the cooling capacity of the cooling system, an increase in the temperature of the power electronics, and affecting the normal operation of the high-speed trains. Therefore, the workload of the railway running depot to remove impurities from the cooling system is relatively large, and the maintenance cost is high.

- 中车产业发展的相关性
- How is the research correlated to the CRRC business?

目前，中车大连所是中车集团唯一一个开展轨道交通移动设备用冷却系统的技术研究、试验检测和产品研发的企业，“中国中车换热技术研发中心”设立于中车大连所，具备为我国轨道交通移动设备提供冷却系统整体解决方案。

At present, CRRC Dalian Institute is the only company in the CRRC Corporation to carry out technical research, test detection, and product development for the cooling system for rail transit mobile equipment. The “China CRRC Heat Exchange Technology R&D Center” was established in CRRC Dalian Institute, providing a total solution for the cooling system for China's rail transit mobile equipment

高速列车设备舱环境空气净化装置是高速动车组冷却系统关键部件之一，其冷却空气净化的优劣是影响冷却系统的性能、可靠性和

维护成本的关键因素之一，冷却空气净化技术是冷却系统技术研究的一部分，该项目所研发的产品主要适用于高速动车组牵引传动冷却系统，例如：时速 250、350km“复兴号”中国标准动车组冷却系统等。

The high-speed train equipment cabin ambient air purification device is one of the key components of the high-speed train cooling system. The cooling air purification is one of the key factors affecting the performance, reliability and maintenance costs of the cooling system. Cooling air purification technology is part of the research on cooling system technology. The products developed by this project are mainly suitable for high-speed train traction drive cooling system, such as: 250km/h, 350km/h speed "Revival" China standard high-speed train cooling system, etc

1.2 技术需求分析 Technology Analysis

- 技术研究现状
- Technology research status

目前，冷却系统空气过滤器主要有管帏式空气过滤器（FSA）、迷宫式空气过滤器（MF5）、W 型空气过滤器和旋流式空气过滤器等五种结构形式的空气过滤器，其滤尘效率都比较低，其主要瓶颈和难点如下：

At present, the cooling system air filter has mainly five types of air filters, such as a tubular air filter (FSA), a labyrinth air filter (MF5), a W-type air filter, and a swirling air filter. Its dust filter efficiency is relatively

low, and its main bottlenecks and difficulties are as follows:

1）我国铁路线比较长，运用环境比较复杂。冷却空气中含有柳絮、塑料、树叶、灰尘和雨水（雨季时）等多种杂质；

1) China's railway line is relatively long and the operating environment is complicated. Cooling air contains many impurities such as catkins, plastics, leaves, dust and rain (in the rainy season);

2）目前，国内缺少针对于适用轨道交通移动装备用空气过滤器进行研究的科研院所；既有产品主要借鉴国外现有车辆用空气过滤器的方式，缺乏自主创新能力。

2) Currently, there is a lack of research institutes for the application of air filters for rail transit mobile equipment in China. The existing products are mainly drawn on the existing methods of air filters for vehicles in foreign countries, lacking the capacity for independent innovation.

- 对外部科研资源的要求
- Demand on the resources that necessary

1.长期从事空气净化技术研究，具备理论分析能力和试验验证能力，拥有对空气中杂质流动进行测试分析的仪器仪表；

1.long time engaged in air purification technology research, with theoretical analysis ability and test verification ability, and instruments for testing and

analyzing the flow of impurities in the air;

2.具有类似的成功案例；

2.with similar success cases;

3.中车大连所拥有知识产权；

3.intellectual property rights owned by Dalian Research Institute;

4.中车大连所实现产业化。

4. realizing industrialization for Dalian Research Institute.

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?

  美国伊利诺伊大学 University of Illinois at Urbana-Champaign
- 合作对象 Partners

  无 No

2. 研究目标 Research Objective

为了降低动车组牵引传动用冷却系统维护成本,减小运用环境对冷却空气品质的影响,提高动车组环境适应性(南方、北方、风沙等地区)，进一步优化产品综合性能，本项目将进行动车组牵引传动冷却系统用空气过滤器的空气过滤技术进行技术研究和产品研发。

In order to reduce the maintenance costs of the high-speed train traction drive cooling system, reduce the

impact of the operating environment on the quality of the cooling air, improve the environmental adaptability of the high-speed train application area (South, North, Sandy and other areas), and optimize product comprehensive performance further, the project will carry out technical research and product development for the air filter technology of the air filter for the high-speed train traction drive cooling system.

3. 主要研究内容 Main Research Contents

（1）调研分析

了解动车组牵引传动冷却单元分别在四个季节时期的冷却空气中的杂质颗粒度的分布，以及冷却单元的运用状况。

(1) Investigation and Analysis

Understand the distribution of impurity particle size in the cooling air of the high-speed train traction drive cooling unit in four seasons, and the operation status of the cooling unit.

（2）动车组设备舱空气流场分析

根据动车组的运行速度和冷却单元的空气流量,分析动车组设备舱的流场，从而确定冷却空气过滤器的设计方案。

(2) Analysis of air flow field in high-speed train equipment cabin

According to the running speed of the high-speed train and the air flow of the cooling unit, the flow

field of the high-speed train equipment cabin is analyzed to determine the design of the cooling air filter.

（3）空气过滤器加工工艺研究

(3) Processing technology research on air filter

（4）冷却空气过滤器中空间粒子测试

建立冷却空气过滤器实体模型,并根据冷却空气中杂质颗粒的含量及颗粒度的分布，利用空间粒子显速测速技术、高科技智能相机测试空气过滤器中颗粒流场表征。

(4) Space particle test in cooling air filter

The solid model of the cooling air filter is established. According to the content of impurity particles and the distribution of particle size in the cooling air, the particle flow field characterization in the air filter is tested by the space particle velocity measuring technology and high-tech smart camera.

4. 技术指标 Technical Indicators

- 现有技术指标

其滤尘效率小于 50%（不加滤料等情况下），滤水效率大于 85%，空气压力损失 450Pa 左右，在春季节，空气过滤器需每 2 天清理一次，其它季节 1 个月左右清理一次。

- Existing technical indicators

The dust filter efficiency is less than 50% (without filter material, etc.), the water filter efficiency is greater than 85%, and the air pressure loss is about

450Pa. In the spring season, the air filter needs to be cleaned every 2 days, and about once a month in the other seasons

- 预期技术指标

其滤尘效率不低于 85%，滤水效率大于 90%，空气压力损失 450Pa 左右，空气过滤器可实现自动排尘，增长维护周期，每半年清理一次。

- Expected technical indicators

The dust filter efficiency is less than 85%, the water filter efficiency is greater than 90%, and the air pressure loss is about 450Pa. Air filter is capable for automatic dust removal, increasing maintenance cycle, and needs to be cleaned every six months

5. 工作计划 Work Plan

总研发周期：__24 个__月

预期研究成果：

Total development cycle: 24 month

Expected research results: