수소버스 안전성 평가기술 및 장비개발
(4차년도 연구성과 발표)

수소상용차 충돌 시 연료시스템 안전성 평가기술 개발 연구 결과

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A Research Reasult About Developing the Safety Evaluation Methods of Fuel Integrity System of Heavy Duty Vehicle Equipped with a Compressed Hydrogen Storage Systems on Side Crash

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Key Words : Heavy duty vehicle(대형상용차), Full scale crah test(실차충돌), Post-crash safety(충돌 후 안전성), Sled test(충돌모의시험), Direct impact load(직접충돌하중), CHSS(Compressed hydrogen storage system, 수소내압용기)

ABSTRACT

The heavy duty vehicle have various installation types (location, etc.) of fuel system compared to passenger vehicles. In addition, especilially among the car-to-car side collision accidents, heavy duty vehicle like large bus is most likely to collide with heavy duty vehicle than passenger vehicle. Therefore, it is difficult to evaluate fuel system safety according to post-crash using only one methods (ex : UN R 95) same as passenger vehicle. The current test method of fuel system on post-crash conducts so-called ‘Sled test’ based on crash acceleration. Through this research it confirms that the sled test isn't possible to evaluate fuel system severity according to direct hard impact load to fuel systems during vehicle crash. In other wards, there is a need of new test methods considering both the characteristics of fuel system of the heavy duty vehicle and needs reflecting not enough to secure post-crash safety of fuel system. Therefore considering ahead of some difficulties conducting post-crash safety of heavy duty vehicle, this research was conducted to developing the types of fuel system component test instead of full scale crash test. The research aim of new fuel system component test has been developing test conditions (methods like impact speed or component installation) to reflect post-crash severity equal to full scale crash test. The results of this study can utilize the reference materials for developing new crash evaluation methods in terms of crash safety of heavy duty vehicle in the future.

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모터의 최고출력 테스트 방법에 대한 연구

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Research on the Maximum Output Test Methods for Motors

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Key Words : Maximum output test of motor(모터 최고출력 테스트), Maximum torque per ampere(MTPA, 최대 토크 당 전류), Field weakening(FW, 약자속), Maximum torque per voltage(MTPV, 최대 토크 당 전압). Motor output method(원동기출력법).

ABSTRACT

본 연구는 모터의 최고출력 테스트 방법에 관한 연구로, 특히 60kW급 모터를 대상으로 MTPA, MC, FW, MTPV 구간에서 각각의 테스트를 튜닝하는 방법과 원동기출력법과의 관계를 다룬다. 최근 전기자동차 및 산업용 모터의 성능 향상을 위해 모터의 최고출력 테스트 방법의 중요성이 증가하고 있습니다. 이러한 배경 속에서 본 연구는 최적화된 테스트 방법을 제시하여 모터의 성능을 향상시키고자 한다. 먼저, MTPA, MC, FW, MTPV 구간에서 각각의 테스트를 튜닝하는 방법을 소개한다. 이를 통해 모터의 효율과 출력을 극대화할 수 있는 조건을 찾아내고, 테스트 과정에서 발생할 수 있는 오류를 최소화하는 방법을 제시한다. 또한, 모터의 최고출력 테스트 시 안정성 및 내구성 면에서의 이슈를 고려하여 신뢰성 있는 테스트 환경을 구축하였다. 둘째, 원동기출력법과의 관계를 분석한다. 원동기출력법은 모터의 전력 및 토크 출력을 측정하는 전통적인 방법으로, 본 연구에서는 이를 최고출력 테스트 방법과 비교하여 그 장단점을 평가한다. 이를 통해 기존의 원동기출력법에 새로운 관점을 제공하며, 모터의 최고출력 테스트에 대한 이해를 높이기 위해 논문을 작성하였다

This study focuses on the maximum output test methods for motors, specifically targeting 60kW-class motors and exploring the tuning methods for MTPA, MC, FW, and MTPV sections as well as their relationship with the motor output method. Recently, the importance of maximum output test methods for motors has been increasing in order to improve the performance of electric vehicles and industrial motors. Against this backdrop, this study aims to present optimized test methods to enhance motor performance. Firstly, the study introduces the tuning methods for each test in the MTPA, MC, FW, and MTPV sections. Through this, the study identifies conditions that can maximize motor efficiency and output, and proposes ways to minimize errors that may occur during the testing process. Additionally, the study constructs a reliable testing environment considering stability and durability issues in motor maximum output testing. Secondly, the study analyzes the relationship between the motor output method and the maximum output test methods. The motor output method is a traditional way of measuring motor power and torque output. In this study, we evaluate the advantages and disadvantages of the maximum output test methods in comparison to the traditional motor output method. By providing new perspectives on the existing motor output method, this paper aims to enhance understanding of maximum output testing for motors.

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유한요소해석을 이용한 복합 소재 압력용기의 기계적 물성 평가 연구

이용우*

Study on Mechanical Property Evaluation of Composite Pressure Vessels Using Finite Element Analysis

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Key Words : Composite material(복합소재), Mechanical property(기계적 물성), Pressure vessel(압력 용기), Finite element method(유한요소법)

ABSTRACT

Type 4 pressure vessels used in hydrogen vehicles need to be robust enough to withstand high pressure conditions. Various studies have been conducted on hydrogen pressure vessels, but the mechanical properties of the composite material used in the pressure vessel can vary depending on the lamination method and process. Therefore, the mechanical properties of composite materials, which should be considered in the basic design of pressure vessels, are presented in various studies. However, confirming the prediction results under various conditions can be challenging due to experimental predictions. In this study, tensile and bending tests of composite materials were performed according to the experimental conditions of ASTM D3039 and D2344, and a finite element analysis model was constructed to predict the material properties through correlation analysis with experiments. The modeling of fibers and matrix was performed in the finite element model to reflect the characteristics of each lamination direction. The mechanical properties of each were presented through finite element analysis. The results of the analysis showed that the vertical modulus and shear modulus change depending on the direction as the stacking angle gradually increases. As the stacking angle increases, the vertical modulus gradually becomes smaller, and the shear modulus gradually increases and shows a tendency to drop somewhat near the angle of 90 degrees. The study confirms a change in the mechanical properties of composite materials depending on the lamination angle. And, the derived mechanical properties were compared with other studies. Based on the results, the authors intend to design composite pressure vessels according to the lamination conditions and evaluate the soundness of the pressure vessels due to internal defects in the future. The proposed methodology can be used to predict the mechanical properties of composite materials for other applications as well.

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고압수소저장용기에 대한 비파괴 검사

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Non-Destructive Inspection of the Compressed Hydrogen Storage Tank

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Key Words : Carbon fiber(탄소섬유), Composite(복합재), Non-destructive inspection(비파괴 검사), Hydrogen tank (수소용기), Laser ultrasonic(레이저초음파)

ABSTRACT

With the increasing use of hydrogen vehicles, the safety of hydrogen storage tanks has become a critical concern. The objective of this study is to investigate the use of non-destructive testing technology to identify defects in high-pressure hydrogen storage vessels accurately and efficiently. Various non-destructive inspection techniques, including AWS (Acoustic Wavenumber Spectroscopy), LUT (Laser Ultrasonic Testing), and AE (Acoustic Emission), were employed to analyze the PVC film inserted part and defects such as fiber cuts, cracks, and knots. The results indicate that AWS has difficulty detecting defects accurately due to high signal attenuation and the anisotropic characteristics of composite materials. In the case of AE, the frequency of defective and standard parts was the same, making it challenging to inspect. However, LUT was successful in measuring surface defects over a wide area, and further research is ongoing. LUT is expected to become a standard non-destructive inspection method for high-pressure hydrogen storage vessels.

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딥러닝을 이용한 THz파 기반 비파괴 검사 결과 분석

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Analysis of THz Wave-Based Non-Destructive Inspection Result Using Deep Learning

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Key Words : Deep learning(딥러닝), C-scan(C-스캔), Non-destructive inspection(비파괴 검사), Hydrogen tank(수소용기), Plastic liner(플라스틱 라이너), Terahertz wave(테라헤르츠파)

ABSTRACT

This study aims to develop a non-destructive testing method for detecting defects in plastic liners used in hydrogen tanks. Since identifying defects in plastic liners after carbon fibers are wound around them can be challenging, inspecting for defects before this process is essential. To achieve this, THz wave was used because of its effectiveness in detecting defects in materials like ceramics and plastics. Inspection data for the curved plastic liner were collected using THz emitter and detector at each measurement point by rotating and moving the plastic liner using a robot arm. By using a defect visualization technique, we concluded that defects in the plastic liner could be detected using THz wave. However, the interpretation of the results could vary based on the inspector's experience. To address this issue, we explored the use of deep learning to analyze the THz wave-based non-destructive inspection results. The performance of the deep learning was verified using a two-layered bonded structure made of acrylic, which successfully detected defects between the layers using THz wave and deep learning. Currently, we are collecting more data for the plastic liners and continuing the deep learning analysis. In the future, this research technology's potential application to plastic liner injection inspection could prevent explosion accidents caused by injection defects and ensure driving car stability.

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풍속 조건에 따른 수소 탱크 낙하 거동의 수치해석적 분석

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Numerical Analysis of Falling Hydrogen Tank Behavior by Wind Speed

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Key Words : Hydrogen tank(수소 탱크), Drop test(낙하 시험), Wind load(풍하중), Numerical analysis(수치해석)

ABSTRACT

Since hydrogen has a low density, hydrogen tanks are being developed to maintain the hydrogen inside the tank at a high pressure. Therefore, in order to use hydrogen tanks in vehicles, its durability must be sufficiently verified in the development stage. Among various evaluation tests of the hydrogen tank, the drop test is performed to verify whether the tank is deformed or damaged when a strong impact is instantaneously applied to the hydrogen tank. In addition, since the direction in which the impact is applied to the hydrogen tank may vary depending on the type of accident, the drop test should include experiments in which the hydrogen tank collides with the ground at various angles. However, if the drop test is performed outdoors with strong wind, there is a possibility that the safety and stability of the test may not be secured because the tank is dropped outside the designated range or collides with the ground at an unintended angle. Therefore, in this study, the drop test process of the hydrogen tank developed for the hydrogen bus was modeled, and the vertical, horizontal and rotational behaviors of the hydrogen tank while falling under various wind speed conditions of 0 ~ 20 m/s were analyzed through numerical analysis. Therefore, in this study, the drop test process of a hydrogen tank for hydrogen bus was modeled, and the vertical, horizontal and rotational behaviors of the hydrogen tank under various wind speed conditions were analyzed through numerical analysis. According to the analysis results of this study, the wind blowing into the hydrogen tank forms an asymmetrical pressure distribution based on the central axis of the hydrogen tank, causing the tank to rotate, which can affect the test results. On the other hand, the displacement of the hydrogen tank was within the controllable range with a maximum of 110 mm, and it was confirmed that there was almost no difference in the falling speed according to the wind speed.

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수소 모빌리티를 위한 수소저장 기술동향

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Technology Trend of Hydrogen Storage for Hydrogen Mobility

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Key Words : Hydrogen storage(수소저장), Hydrogen electric vehicle(수소전기차), Hydrogen mobility(수소모빌리티), Design for safety(안전설계), Composite materials(복합재료)

ABSTRACT

In this study, technology trend of hydrogen storage for various hydrogen mobility focusing on hydrogen electric vehicles. As for now, compressed gaseous hydrogen is the only commercialized hydrogen storage method for hydrogen mobility such as hydrogen electric vehicles. The design for safety of the composite overwrapped pressure vessels (COPVs) is very important in use of high pressure gaseous hydrogen and several design and analysis examples of COPVs are introduced. The cryogenic compressed hydrogen storage and liquified hydrogen storage for large vehicles such as hydrogen trucks and buses are discussed as well.

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