Study on the Combination of Low-Pressure Hydrogen Cylinder and Non-sintered Ceramic Wall to Solve Water Permeability

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Abstract. Global green energy development by many technological breakthroughs, so that the new composite materials modified and designed, so that new energy has a new look, this study to improve people’s high-pressure hydrogen storage of hydrogen energy technology hazards and hidden worries, so design and improve the local low-pressure hydrogen storage combined with secondary building wall design, and sustainable environmental thinking. The use of waste ceramic reuse technology, combined with low-pressure hydrogen bottle design to form a new composite material structure, and the best parameters to solve waterproof non-sintered ceramic clad metal material research, and OM, salt spray, perspective X-RAY observation with metal now ceramic anti-corrosion permeability, the future use of geotechnical engineering, building diversification. More so that hydrogen in non-high pressure, more in people’s life circle and local hydrogen storage and PC use. Thank partially support by the MOST 108-2221-E-343-001.

Keywords. Secondary structure hydrogen energy wall; hydrogen storage bottle; recycling ceramics; non-sintered ceramic technology; anti-corrosion technology.

1. Introduction
This thesis takes the past three experiments as the discussions, which are ceramic synthesis, ceramic metal circuit protection, and hydrogen storage wall. Through the statistical analysis of the firing cycle and the effect of the bulk density of the tile [1]. As a result, the main factors that cause the tiles to overfire are the short firing cycle and relatively low density of ceramic embryos. At the same time, these factors contribute to the heterogeneous development of product microstructure expression and may also contribute to the expected overburning. To study the potential of using recycled powder (RP) [2]. To study the potential of using recycled powder (RP). This report shows a comprehensive
experiment to study basic properties and chloride ion permeability RPC. The experimental results indicate that the addition of RP has higher fineness and activity, and replacing cement with RP will reduce the freeze-thaw resistance of concrete. The study describes the development of various intumescent coating formulations to study the effect of fly ash hollow spheres on the thermal insulation of intumescent passive fireproof coatings during fire tests. Test for 1 hour at a temperature close to 950°C. The results show that the coating formation is stable with good adhesion to the substrate. Through various analysis results, it can be concluded that the hollow spheres increase the oxidation resistance of expanded carbon [3]. This paper studies the comprehensive utilization of fibers (WCF) in high-strength concrete (HSC) from recycled waste ceramics (RWCA) and waste carpets. Concrete mixtures containing different percentages of RWCA and according to research have found that structurally enhanced HSCs have excellent compressive and tensile strength, possibly through the use of specific doses of RWCA [4].

The purpose of this research is to show good service performance for 10% and 20% of mortar brick powder for a long time, and the microstructure has been studied by nondestructive impedance spectroscopy [5]. The results obtained are superior to those made with ordinary Portland cement. Recycled ceramics are inorganic insulating materials to ensure flame retardancy and energy-saving analysis of building performance [6]. The simulation results save 18.6% of building energy consumption and have flame retardancy. Concrete made from ceramic coarse materials recovered from industrial brick waste. Polymerization of natural coarse aggregate, natural coarse aggregate and ceramic recycled coarse aggregate. Compressive, flexural, tensile strength and density in the hardened state. The results show that the amount of partially replaced natural coarse materials with the polymer recycled coarse aggregates is accompanied by the increasing number of natural coarse aggregates replaced by the ceramic recycled coarse aggregates, which will reduce the mechanical properties of concrete [7].

The hydrogen storage cylinder is the earliest and widely used hydrogen storage container. Fatigue cracks are easily induced and grown under hydrogen pressure, which threatens the safety of users. Although hydrogen will affect the occurrence of fatigue and crack development, a reasonable cylindrical structure will make the stress distribution more reasonable and reduce the possibility of cracks from the source [8]. The multi-center concave bottom of the hydrogen storage bottle is studied in this paper. The geometric design parameters determine the cardinality of the new base end by the orthogonal design method. This study investigated the resistive effect of sodium silicate solution on sodium silicate. Stress corrosion cracking on the weld surface is due to the infiltration of hydrogen into the microcracks. The coating effect of sodium silicate uses hardener, curing method, coating thickness and baking temperature. Taguchi analysis is used to determine the optimal parameters and then used to effectively improve the corrosion resistance of the weld zone [9]. Corrosion resistance when magnesium oxide was added as a group increased the hardener to 200% without the hardener compared to the group to which sodium silicate was added. The penetration depth of the test group with talc added was also increased to 20% for the hardener. Study on the generation of negative hydrogen ion antenna in an externally driven RF-driven long pulse source. External antennas with various geometries, drivers for Faraday shields and magnets at the rear flange were inspected [10]. H-beam extraction through a single emission aperture is performed in source-pure hydrogen mode without the need for external addition of alkali additives. H ion emission current density is as high as 5 mA / cm² and the energy is higher. 75 keV is regularly obtained in a 1s pulse in pure hydrogen mode. Hydrogen evolution can occur during processing steps prior to electroplating or hydrogen can diffuse into the material during electroplating to produce brittleness [11]. This phenomenon is analyzed by metallographic, fractal, mechanical and chemical analysis. The results confirmed the following hypothetical hydrogen embrittlement.

The purpose of this study is to solve the problem of increasing the recovery rate of waste ceramics and the optimization ratio of synthetic use of non-sintering technology. The further extension is combined with the anti-corrosion state of hydrogen bottle coating to solve the research and development of the future low-pressure hydrogen storage wall. The surface of the hydrogen bottle and the ceramic contact surface can replace the cladding with metal wire, observe the minimum arc of non-
sintered ceramic combination, to solve the water permeation ceramic, salt spray anti-salt environmental analysis and metal corrosion observation.

2. Experimental Design and Principle

According to the industry-academia cooperation, we understand the social issues that enterprises urgently need to solve today, and expect technology to quickly integrate into the industry, as shown figure 1.

In order to solve the problem of ceramic waste recycling, non-sintering technology was used to find the best ceramic tile ratio through experiments and learned that the recovery rate was about 50%. The sample was immersed in water by a salt spray tester, and then sliced, mounted and observed under the OM.

According to the ceramic synthesis experiment, it is known that the recycled ceramic tiles have a certain anti-erosion state. The ceramics are inlaid into the metal circuit to simulate the hydrogen cylinder inlaid into the ceramic wall, and the experiments are performed by using a salt spray tester and an X-ray machine.

![Diagram](image1)

**Figure 1.** Experiment process.

2.1. Instrument Used

The object of an optical reflection microscope is generally opaque. Light is shining on the object from above, and the light reflected by the object enters the microscope. It is mostly used in the fields of engineering and materials. In the upright microscope, this type of microscope is also called metallographic microscope.

The salt spray test machine is a kind of 5% sodium chloride aqueous solution that is used in a certain volume of space at 35 °C. The spray salt environment in the test chamber determines the corrosion resistance according to the length of its resistance time. Environmental testing to evaluate the corrosion resistance of products or metallic materials.

X-ray machines use cathode emission to fly straight to the anode. If an obstacle is encountered, a shadow can be formed. The gas in the tube is different, and the characteristics of X-rays with different
colors. For a denser object, the smaller the penetration ability and the smaller the gas in the tube, the higher the ray penetration. Let’s observe the coating of metal objects in the brick.

3. Results and Discussion

3.1. Non-Sintering Technology Applied to Waste Ceramic Powder

This is a discussion on the optimization of non-sintering technology for waste ceramic powder technology.

1. Front-end processing: The building waste laterite bricks are ground through a machine into two different laterite powders of different thicknesses.
2. Blend: Mix the recovered laterite fine powder and recovered laterite coarse powder with lime and cement, then add a little water and mixing agent to stir to make it appear clay.
3. Stereotype: After mixing, pour it into the mold without using pressure to make it naturally form in the mold, and then place the mold in a cool place to wait for drying.
4. Mosaic: Copper wires and metal plates are combined with non-sintered porous ceramics. (5) test: The dried laterite ceramics are immersed in water for 4 hours. After the time is up, they are taken out and placed at the edge of the container.
5. Embed: The test pieces subjected to the salt spray test were cold-buried and ground.
6. Analysis: Use a high-magnification OM microscope to observe the water infiltration status of the ceramic inside the test piece.

As shown in figure 2, a non-sintered ceramic composite coated metal wire sample is used. After immersion experiments are used to simulate the corrosion phenomenon, the slice is used to observe the intrusion status using OM. In the figure, the structure A area is a non-sintered ceramic tile, which has penetrated into the water erosion area, and the water intrusion can be clearly seen, while the structure B area is also a non-sintered ceramic tile, and the water has not penetrated into it. But only in structural penetration area A. The water immersion test could not erode the copper wire solder layer in area C. Although the ceramic is porous, the density can block water.

![Figure 2. Continuous picture of erosion under light microscope.](image)

3.2. Discussion on Protection and Corrosion Resistance of Ceramic Coated Wire

Ceramic clad metal wire and corrosion resistance, the front treatment is the building waste red brick through the machine grinding into the same particle size of the recovery powder. After using the mixed powder recovered clay, lime and cement mix, add a little water and stirred chelating agent. Then a mixture of copper and a metal plate were poured into a mold, molding it in a mold naturally. After waiting for the mold cool place drying. Put the test piece into the salt spray test machine and set the number of hours for corrosion test. After salt spray test, the test piece is cold buried and grinded on the surface. Observe the interior of the ceramic and copper corrosion test piece using a high magnification microscope OM.

Table 1 shows the situation of salt mist erosion for 3 hours. It can be seen in the lower left of table 1
that although there is a black seam in the center of the metal wire and the ceramic, the copper wire is not oxidized (green or green-white) in the condition of the ceramic-coated metal wire. The right side of table 1 is a microphotograph of the ceramic sheet after six hours of salt spray test. It can be seen from the figure that although the black seam has become larger, the copper in the metal wire still has no oxidation. On behalf of non-sintered ceramics, it has a good coverage and corrosion resistance instead of the metal wire outer plastic tube and the metal wire.

**Table 1.** Anti-corrosion analysis schedule for non-sintered ceramic-clad metals.

| Sample          | 3 hr | 6 hr |
|-----------------|------|------|
| Corrosion resistance analysis under OM | ![Image](image1.png) | ![Image](image2.png) |

3.3. X-ray Analysis Instructions

As shown in figure 3, the contact surface between the hydrogen cylinder and the ceramic is the same as the contact surface in which the metal wire is embedded in the ceramic, which is the contact between the metal and the ceramic.

![Image](image3.png)

**Figure 3.** Ceramic coated hydrogen bottle.

X-ray analysis coverage, using plastic granules mixed with white cement to combine with ordinary household electrical wires, the over molding situation is shown in figure 4 below. As shown in figure 4b, it can be clearly seen under the X-ray analysis that the plastic particle slurry is completely coated on the surface of the wire after mixing.
Figure 4. (a) Plastic granules mixed with white cement and combined with general household wires to form a drawing. (b) X-ray analysis of waste plastic particles. (c) Entity picture of hydrogen energy wall.

As shown in figure 4b, the two white vertical lines are metal wires covering and recycling ceramic tiles. Observing that there is a clear continuous line at the junction between the recycled ceramic tiles and the metal wire, it means that the ceramic tiles made of plastic particles have good covering properties.

3.4. Design and Preliminary Development of Future Hydrogen Energy Wall

This research study on the development of innovative structural hydrogen storage wall technology, mainly using the research of construction waste, slag and aluminum bottles to explore the maximum internal volume and internal pressure changes. Basic research on high strength and internal corrosion resistance of housing demand is shown in figure 4c.

4. Conclusion

From the discussion of the preliminary experimental conclusions:

1. Ceramics recovered by non-sintering technology not only have a 50% recovery rate.
2. Combined with the hydrogen cylinder structure experiment, it has the ability of anti-corrosion.
3. Solve the structure of the metal layer and ceramic encapsulation of the hydrogen bottle.
4. Increase building availability and reduce concerns about high-pressure hydrogen cylinders.

On this basis, the preliminary design of the future hydrogen storage wall has obtained preliminary results, and will continue to break through the current technical level and application direction of hydrogen energy research.

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