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USAGEOF HYDROGEN IN VEHICLES

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ABSTRACT
Today, increasing energy demands, decreasing resources, rising energy costs make researchers look for alternative energy sources. Parallel with the increase of usability of this alternative energy sources, machinery and systems for this sources are also increasing. Addition to developing energy systems- wind and solar energy source- another developing alternative energy source is hydrogen.The most intensive work about the usage areas of hydrogen as an alternative energy source is done in the automotive sector. In this context, almost all automotive manufacturers are working on the hydrogen powered hybrid vehicle prototypes. Hydrogen vehicles have already in the traffic in many countries. All necessary legal arrangements are done and gas stations have hydrogen refueling parts. Majority of hydrogen powered vehicles for public transportations are attracting attention.In this study, information related to "Production of High Pressure Resistant Composite Hydrogen Tank", supported by the Ministry of Industry is given. At this final stage of the Project, information is given about the next steps. Important information about usage areas of hydrogen tanks are transferred as a result of intensive R & D work, creating added value. Safety criteria that hydrogen storage tanks need to ensure are discussed. Widespread usage of hydrogen in public transportation, incentives researchers to use hydrogen energy..
Key Words: Hydrogen energy, alternative and clean energy resources, high pressure resistant composite hydrogen tanks, the technology supply contracts

1. INTRODUCTION

Recently, design and production of the hybrid vehicles has been accelerated in the world. The use of hydrogen in transportation for passenger cars and public transport is growing faster. Since the beginning of 2000s works on the use of hydrogen vehicles are being made. In this context, several prototype vehicles were made and released after tests were completed. Hydrogen refueling stations are already being used in many countries. 27 Hydrogen powered buses that Mercedes Company has developed are being used in 9 European countries. Total hydrogen storage capacity of the bus is 205 liters, 47 kg with 9 tanks fixed as batteries in parallel, on the bus. Tanks are composite products with 350 bar working pressure and made of aluminum. R & D activities are conducted and first prototypes for high pressure resistant hydrogen storage tanks are produced. In this study, mechanical and microstructural properties of 6000 series Al-Mg-Si alloy materials are examined which are used in the manufacturing of tanks. Hydrostatic pressure tests are managed for each prototypes produced from different alloys. In this study primarily nine different protype tubes are produced in order to investigate cases of three different heat treatments for three different alloys.
In this study, the following activities were applied to nine prototype hydrogen storage tanks;

- Optical microscope examination of microstructure,
- Microhardness (Vickers) measurements,
- Mechanical tests (tensile test),
- Hydrostatic pressure tests

2. EXPERIMENT

In parallel with the results of these experiments the most ideal alloy is selected from three different types of alloys.Three different heat treatments is subject to availability for samples which are used in experiments;

- F: The version after fabrications (manufactured) This condition; without any further action in order to change the strength or stiffness, refers to the physical structure after being manufactured.
- T4: Solution heat treatment is applied and brought to steady state with natural aging. (500-525 ° C - 5 hours - rapid cooling in water)
- T6: Solution heat treatment is applied and hardened with artificial aging (thermal heat treatment) (170-175 ° C - 12 hours of rapid cooling in water.

The hydrogen storage tank prototype which is produced under R & D project is made in pilot scale since it requires minimum of cost and investment. Dimensions of the tanks used in the experiments is shown in Figure 1.

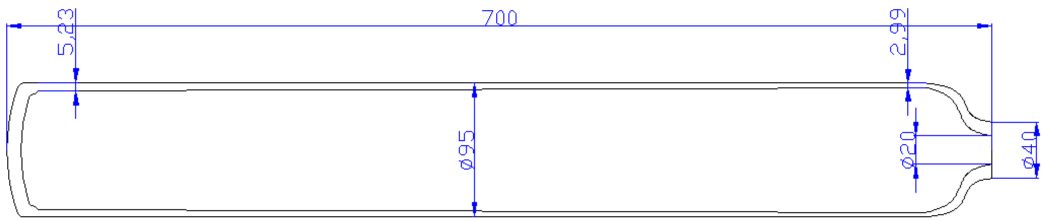

Figure 1. Linear dimensions of the hydrogen storage tank prototype.

Metallurgical properties after primer production of 6XXX series aluminum alloys which is prepared for using in the experiments.

2.1. Tensıle test

Pulling curves are obtained by preparing tensile specimens from the prototype tank. Samples were prepared in wire erosion machine. Three samples were taken from the surface of a tank in longitudinal direction and the averages are calculated. Tensile test was carried out in Zwick/Roell brand 5 ton tensile test device. Yield points were obtained from tensile tests of three different types of alloys and three different heat treatment conditions.

2.2. Mıcrostructure analysıs

For microstructural investigations samples are taken from 4 different sections of each tank. The sections are exterior surface, interior surface, straight sections in longitudinal direction and neck of the tank. Microstructures of prepared samples were examined under optical microscope. Grain growth, directed grains and the different phase structures were observed in this study. The 200 times enlarged photo of the tank which is made of Al 6063 alloy, not subjected to heat treatment but subjected to hot and cold deformation and it is shown in Figure 2.

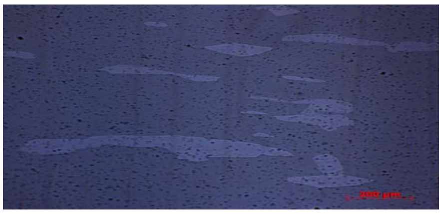

Figure 21 The microstructure photo of the cross section tank without heat treatment (200X)

2.3. Mıcrohardness analysıs

Microhardness values of the nine samples which are prepared of three different alloys and three different heat treatments are measured by Future-Tech brand FM-700 model microhardness device. Vickers hardness of the material section is measured from exterior side through interior side to determine the hardness ditribution in order from outside to inside. 5 different measurements were taken from each section and surface and the values having high and low standart deviation are disregarded. Hardness distribution of outside, inside, cross and neck section of the tank obtained by three test results. The most ideal conditions are calculated as 1 gf for dipping head and 10 seconds for timing.

2.4. Hydrostatıc pressure tests

Hydrostatic pressure tests for samples were carried out in Aygaz facilities in Gebze. Sample application for the tear results obtained from the test (Al 6082 alloy and T6 heat-treated prototype tank).Burst pressure- heat treatment state of hydrogen tube prototype produced from 6000 series aluminum alloy is shown in Figure 3.

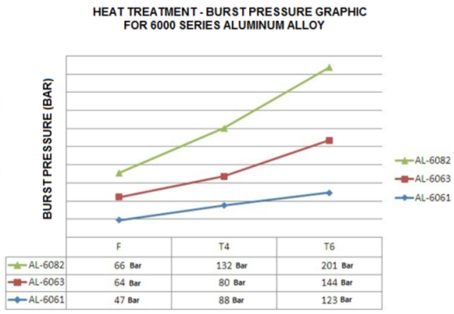

Figure 3. Hydrostatic test results

3. CONCLUSIONS AND SUGGESTIONS

Hydrogen production, storage and usage can be accepted as main research subjects regarding energy and trasportation phenomena for future studies. Hydrogen storage subject mainly reseached in this study during manufacturing high pressurized hydrogen vessels. Hydrostatic pressure test result is the average of the all test results which are calculated by multiple tests of each sample. For correct test results two pressure tests were performed for each species. Results are the avarage values. When the average microhardness results are examined, the hardness of the sections are higher than the interior and exterior surface hardness. The hardness of the interior side is increased during the shaping of material depending on the flow of interior surface and exterior surface.In general, the hardness of exterior surfaces of the tube is greater than interior surface hardness. It is also generally observed that the material hardness distribution is decreasing from outside towards inside.When the microstructures examined differences have been observed in the phases of the material depending on heat treatments. XRD (X-Ray Diffraction) analysis will be done for the identification of these grains. Then, depending on the XRD results with SEM (Scanning electron microscope) images situation will be explained clearly.Aluminum alloy 6082 has the best strength properties for T4 and T6 heat treatments and also without heat treatment. Highest hardness values obtained from T6 heat treated Al 6082 alloy in both tensile test and hydrostatic test.In this study it has been determined that the strength properties of high resistant, thin walled cylindrical Al alloy tubes are limited at 200 atmospheric pressure. With composite coil winding, these tubes can become resistant at 1000 atmospheric pressure. A study has been done about this and expected results were obtained. Product has been produced with only local facilities and now avaliable to use.

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