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Development of the exhaust smoker for Korean tank K1A1

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Abstract.

Background/Objectives: The defense budget for purchasing weapons is increasing every year. In line with these changes in the defense industry, it is necessary to develop new weapon parts. In order to protect the abrasion of the fabric, it is essential to install an exhaust smoker.

Methods/Statistical analysis: An exhaust smoker for tanks was developed using glass fiber, carbon sheet, and adhesive. It was confirmed that the manufactured exhaust smoker withstands a pressure of 500psi by measuring the pressure in a closed space. This is a value that satisfies the pressure condition when designing a tank. The specific gravity obtained 1.74.

Findings: The standard process required for manufacturing has been established. First, make a split mold and a fixed mold, connect a stainless steel pipe, and apply a separation inducing agent on it. The resin-coated glass fibers are crossed over and attached to each other. It complements the carbon sheet between the glass fiber thickening. The glass fiber support layer is hardened, polished, separated, coated with paint, and dried. Appropriate pressure conditions and specific gravity were obtained from the experimental sample.

Improvements/Applications: This method is applicable to the exhaust smoke of Korean tanks such as K2 tanks.

Keywords: tank, smoke, glass fiber, carbon fiber, adhesive.

1. INTRODUCTION

Our country is now proud to be the 6th largest military power in the world. However, most of the weapons depend on or import imported parts. Therefore, the development of materials related to weapon development is of paramount importance. This study is to develop exhaust smokers used in tanks, and the related materials are glass fiber, carbon sheet, and adhesive. Glass fiber is widely used as a plastic blending agent because of its good insulation and strength (1-9). Because of its high tensile strength, carbon fiber is widely used as a reinforcing material in the fields of construction, civil engineering, and machinery (10-15). Adhesives have different properties for each material, and are used in various fields (16-18). In general, a tank refers to a combat vehicle equipped with a cannon or machine gun with high power, a vehicle body protected by thick armor, and a powerful propulsion engine and a driving device capable of maneuvering even in fields without roads. The tank's barrel fires powerful shells, so it must be able to withstand firing pressure. An exhaust smoker is essential for abrasion and protection of the fabric. The exhaust smoker of the tank is installed so as to be located in the middle of the barrel of the main gun, and serves to discharge the combustion gas from the gun barrel to the muzzle after shooting. It is installed on the gun barrel. When a shell is fired from the barrel, the inside of the barrel is instantly vacuumed. At the moment when the shell leaves the barrel, the vacuum disappears and air flows into the barrel. At this time, not only air but also foreign substances such as dust and dust are introduced. do. However, if you make small holes around the barrel and install the flue smoker to cover these holes, when the shell is blown away, gas enters momentarily, until the shell completely leaves the barrel, and it spins round and round in the flue smoker. The moment air flows in immediately after passing through the end of the flue gas, the gas from the exhaust gas comes out as the vacuum in the barrel is released. At this moment, when air and gas meet, air can no longer enter the barrel, and due to this action, dust or dust is prevented from entering the barrel, thereby preventing the cloth steel from being worn. Because the tank's exhaust smoke is mounted on the barrel, it must have a lightweight yet sturdy structure that can withstand gas pressure. Therefore, a great deal of effort is being made in the development of an exhaust smoker to satisfy this need. In this study, while providing a sturdy structure to withstand gas pressure, etc., it is conducive to light weight. Figure 1 shows the exhaust smoker installed on a tank.

Figure 1. Exhaust smoker

2. MATERIALS AND METHODS

2.1. GLASS FIBER

The material used in the experiment was 158B-2400 (Single End Roving for Filament Winding and Pultrusion) from OWENS CORNING. The standard tension of this glass fiber is 2450 MPa and the dry shear strength is 68.3 MPa. Single-end roving is produced by directly pulling each glass fiber made from a bushing and then winding it in a roll unit on a winder for easy handling and transportation, and packaged in a roving type Is supplied. The sizing is applied very uniformly to the glass fibers, which further strengthens the binding force of the strands and ultimately ensures a perfect bond between the resin and the glass fibers. The 158B roving product is specially designed to be used effectively in the filament winding process and pultrusion process in epoxy resin (EP) systems. In addition, 158B roving products can be used in phenolic resin systems, and are especially widely used in products that require high bursting strength, and are suitable for high pressure container production. Table 1 shows the performance characteristics of the glass fibers used in the experiment.

Table 1: Properties of the glass fibers used in the experiment

Characteristics	Unit	Value	Inspection method
Tex	g/km	20447	LO-TM-401
Moisture	wt%	0.01	LO-TM-401
Solid	wt%	0.61	LO-TM-401
LOI	wt%	0.62	LO-TM-401
Fuzz	g/lb	0.0017	LO-TM-404

2.2. CARBON SHEET

A high-strength carbon sheet was used. The specific gravity of the fiber used in the carbon sheet is 1.8 and the standard construction thickness is 0.6mm. The tensile strength of the carbon sheet is 590kgf/cmw and the strain at break is 1.5%.

2.3. GLUE

The test was performed using Huntsman's Aradur HY 906. ARADUR® HY 906 has a viscosity of 175–350 mPa.s, a molecular weight of 178, and is a Nadic methyl anhydride for high Tg complexes and potting applications. The viscosity dynamic at 25°C is 223mPa.s, the free acid 0.1%, the setting time at 80°C is 135 minutes, and the glass transition Tg 1/2 is 146°C. In addition, it was tested using Huntsman's Araldite GY 6005. The viscosity dynamic at 25°C has a value of 7670 cps and weight per epoxide 190. In addition, the test was performed using Huntsman's Accelerator DY 062. The viscosity dynamic at 25°C has a value of 0-10mPa.s and a color index of APHA7.

3. DESIGN AND MANUFACTURE OF EXHAUST SMOKERS

3.1. BASIC DESIGN OF EXHAUST SMOKER FOR TANKS

The exhaust smoker for a tank includes a stainless steel tube, a carbon layer and a glass fiber resin layer. Figure 2 shows the longitudinal section and cross section of the exhaust smoker.

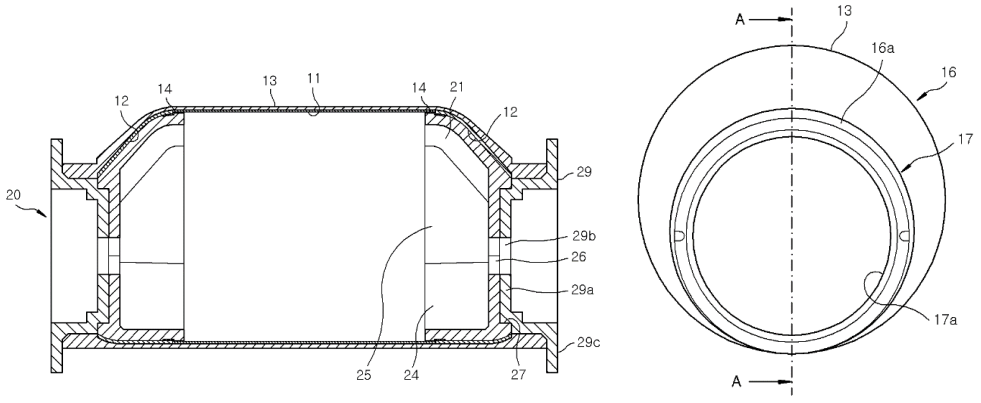

Figure 2. Exhaust smoker design drawing (left: cross section, right: longitudinal direction)

Each sign is as follows. 11: stainless steel pipe, 12: carbon layer, 13: glass fiber resin layer, 14: adhesive member, 16: curved pipe portion, 16a: external step, 17: second straight pipe portion, 17a: chamfer, 20: mold, 24, 25: split mold, 26: opening, 27: insertion groove, 29: fixed mold, 29a: insertion part, 29b: through hole, 29c: flange.

3.2. MANUFACTURE OF EXHAUST SMOKER FOR TANKS

3.2.1. Part Production

The split mold was designed and manufactured in a fragmented structure because the exhaust smoker had to be molded and taken out to the outside. Figure 3 shows the split mold for testing.

Figure 3. Splitted mold for test

Stainless steel pipes are composite materials and require precision manufacturing because they remain intact even after they are manufactured through a high-temperature firing process after external winding work. Figure 4 is a stainless steel pipe to be located in the center of the exhaust smoker.

Figure 4. Stainless steel tube for test

The fixed mold is a part that is connected to the barrel and is designed and manufactured in a single structure. It does not need to be sculpted, but requires a high degree of precision. Figure 5 shows the fixed mold.

Figure 5. Fixed mold for test

3.2.2. Manufacturing process

- Install and fix the molds on both ends of the stainless steel pipe, and apply a separation inducing agent to the outer surface of the mold. Figure 6 shows the combination of the test fixed mold, split mold and stainless steel pipe.

Figure 6. Test fixed mold, split mold and stainless steel pipe combination

- Apply adhesive on glass fiber and wrap around the mold in a zigzag manner. Figure 7 is a scene of glass fiber adhesive mixed winding.

Figure 7. Fiberglass adhesive mixed winding scene

- To reinforce the strength, attach the carbon sheet around it.
- Apply adhesive to glass fiber on the reinforced carbon sheet and wind the mold around in a zigzag manner.
- Heat treatment at a temperature of 80℃ in a polymerization furnace.
- A glass fiber resin layer is formed by attaching resin-coated glass fibers to stainless steel pipes, carbon layers, and molds.
- Harden the glass fiber support layer.
- Polish the glass fiber support layer.
- Remove the mold.
- Paint and dry the outer surface of the glass fiber support layer. Figure 8 shows the manufactured test exhaust smoker.

Figure 8. Manufactured test exhaust smoker

4. RESULTS AND DISCUSSION

3.3. TANK EXHAUST SMOKE PERFORMANCE TEST

A test exhaust smoker was manufactured and a pressure test was conducted to test the performance of the product. Fig. 9 is a picture of the pressure measuring device of the test exhaust smoker. 500psi was obtained as a result of measuring the pressure of the test exhaust smoker. This value satisfies the national defense standards of the Republic of Korea.

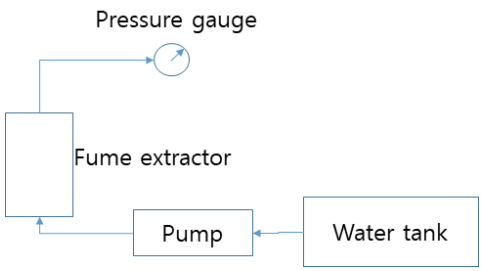

Figure 9. Test exhaust smoke pressure measurement method and device diagram

- The exhaust smoker made of composite material can be made lighter than when using metal. The specific gravity of the prepared sample was 1.74 compared to the specific gravity of iron 7.876.

5. CONCLUSION

An exhaust smoker used in Korean tanks was fabricated using glass fiber, tasso sheet, and adhesive. A method of cross-winding was used by mixing an adhesive with glass fiber. The strength was supplemented by winding a carbon sheet in the middle of winding the glass fiber. The standard process required to manufacture the exhaust smoker has been established. It was confirmed that it withstands 500psi through the water pressure measurement of the manufactured test specimen, and the specific gravity was 1.74. This is a value that satisfies the quality required by Korean tanks K1A1 and K2, and can be applied to various types of exhaust smokers in the future. This can contribute to fostering the Korean defense industry.

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