

Development of Aircraft thermal acoustic insulation

Oct.23, 2001

Osaka Gas Co., Ltd.

1.Introduction

Aircraft insulation requires fire resistant and weight saving besides thermal and acoustic properties. Osaka Gas Co., Ltd. has started the development of carbon fiber based insulation material for an aircraft since 1992. It was impossible to produce fine carbon fiber insulation material at stable quality even using existing technology of carbon fiber.

Osaka Gas Co., Ltd. therefore applied the technology of existing product (diameter 13 micrometer to 18 micrometer) and finally succeeded in developing the new manufacturing technology of fine carbon fiber first in the world. Also there was no processing technology for insulation material by fine carbon fiber, but Osaka Gas also developed the method.

2. Manufacturing process

2-1.Outline

The manufacturing process has two phases. The first one is the fine carbon fiber manufacturing and the second one is the phase to make fiber into insulation form.

2-1-1. Process of fine carbon fiber

Process of fine carbon fiber consists of 3 process.

Pitch -> Spinning -> Infusiblization -> Carbonization -> Fine Carbon Fiber

1. Spinning Process: Pitch is provided in a pellet form. The pitch is heated, melted and pulled out by air jet from a small diameter nozzle. The wool-like substance is collected on a conveyer.
2. Infusiblization process: The oxidation treatment that prevents a melting of the wool during the carbonization process.
3. Carbonization Process: Carbonization of fiber (The bulk density of carbon fiber increases during the carbonization process.)

2-1-2.Process of Insulation

Process of Insulation consists of 3 process.

Fine Carbon Fiber -> Opening -> Molding -> Curing -> Insulation

1. Opening process: Disperse and make bulk density of carbonized fiber lower with a mat form.
2. Molding process: Binder is sprayed, and makes fiber blanket like form.
3. Curing process: Stiffening with binder.

Insulation passes through these processes and becomes insulation blanket. We established a pilot facility, which could produce insulation in succession by this production process.

2-2. Fine carbon fiber manufacturing technology

There are 3 points in terms of production technology development of fine carbon fiber.

2-2-1. Choice of raw material Pitch

There are two types of raw materials, Polyacrylonitrile (PAN) and Pitch. Because the PAN-based carbon fiber is produced by a continuous spinning process, it is unsuitable for small fiber diameter.

Pitch can be oil or coal tar based. Spinability differs remarkably by the type of pitch used, but we were able to produce fiber diameter less than 2 micrometer.

2-2-2. Development of fine pitch fiber spinning nozzle

A nozzle for the fine fiber was developed in order to produce fiber of diameter less than 2 micrometer. We draw out the pitch that is melted by heat air and thin it down, as the nozzle, which we developed, has two focuses of heat induced functions. Fiber thins down in the first focus and further thins down in the second focus preventing thread from breaking.

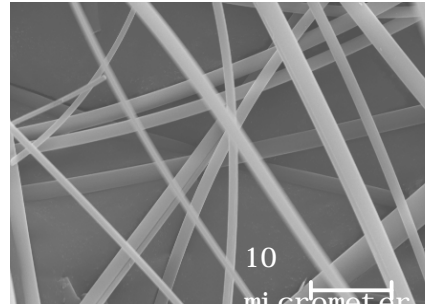


Photo.1 Fine Carbon Fiber

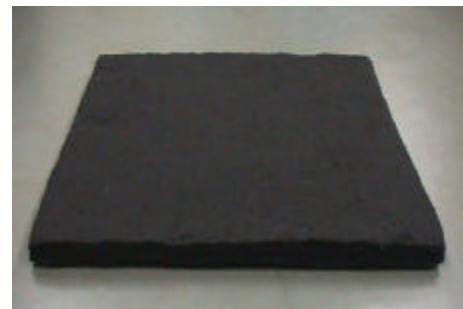
2-2-3. Examination of infusible condition

Infusibilization is the reaction by bridging carbon by oxygen to prevent spanned pitch fiber melted during carbonization process at high temperature. As for infusibilization treatment, it is important to find appropriate condition in order to minimize a cost of carbon fiber. The point is to find out the optimum condition for the infusibilization along with the temperature and its profile in a furnace and appropriate matching speed of the treatment. When treatment speed is too fast or temperature is too high, pitch fiber will be burnt in the furnace. If we make temperature low and slow down the speed, infusibilization can be achieved, but the production efficiency falls down remarkably. We examined the relation between the weight per unit area and production speed at the Pilot Plant and find the lowest cost condition. (the most suitable infusibilization condition)

2-3. Fine carbon fiber Insulation Processing Technology

Fine carbon fiber insulation processes are two points of technology development to process a fine carbon fiber of mat shape into insulation blanket form. They are developments of fiber opening method and spraying nozzle & binder.

Carbonized fine fiber which has a high bulk density needs an opening process. The conventional metal comb cannot do the job because the fiber is too fine for this method.



The first process: The cylinder with needles rotates at low speed.

The second process: The cylinder with needles rotates at high speed.

By these two processes, we have developed the process of opening fine carbon fiber without damaging it.

Photo.2 Insulation Blanket of Fine Carbon Fiber

We select the proper nozzle that makes atomizing particle as small as possible. As for the binder, phenol resin is most suitable on the physical properties, not metal corrosive, formalin free with work environmentally compatible and is the most economical.

3. Property of fine Carbon Fiber Insulation material

3-1. Bounthrough

The Burnthrough test results¹⁾ at the FAA in February 1999 is mentioned in Home Page of the FAA. Burnthrough time of fine carbon fiber insulation blanket was a result to be good for 300-340 seconds.

3-2. Acoustic Transmission Loss

Acoustic Transmission Loss shows that general-purpose fine glass fiber blanket of 0.42 PCF and fine carbon fiber Blanket of 0.3PCF show equal acoustic performance. Also thermal conductivity of fine glass fiber shows equal thermal performance.

3-3. Other Property

The smoke density in combustion is low, no toxic gas is detected and corrosion is not observed.

4. Reference

1) <http://www.fire.tc.faa.gov/ppt/bt2.ppt>