KEY TECHNOLOGY TO MAKE RAPID EXPANSION OF CFRP STRUCTURAL APPLICATOINS

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1. Introduction

This year is the 40th anniversary of TORAYCA, which is the first commercialized PAN-based carbon fiber in the world. All researchers and engineers working for the product in 1971 had a same dream, "some day, black aircrafts will fly in the sky and black cars will run on the highway." The dream seems to come true a bit. However, new aircraft structures and automotive bodies in white with CFRP give us a lot of technological issues, such as technologies for quality assurance, for large volume production, for designing the thick-wall structures, and of course for cost reduction. This paper reviews the history of CFRP and illustrates an approach for contributions to CO_2 reductions with CFRP. It highlights on recent CFRP applications of aircrafts and automobiles.

2. History of carbon fiber innovations

Carbon fiber was invented in the 1950'. Thornel 25 was the first available fiber which was unfortunately too difficult to produce in large quantities. Toray Industries inc. started their first commercial series production of carbon fibers, TORAYCA, in 1971 based on both Dr. Shindo's new process and their own 10 years in advance R & D activities. Toray have kept research for the strongest fibers ever since. Now, Nano technology is the key to create new ones.

3. CFRP design & fabrication technology

Toray started R & D for design and fabrication of CFRP simultaneously, because carbon fiber manufacturers had to create new market with a set of new technologies; materials, design and fabrication. Prepregs became standard materials in the sporting goods and aircraft companies by means of forming process with autoclave. Toray has been interesting in FW, RTM, and press molding with prepreg, due to the possibility for large scale production., which is one of the most important issues in the industry.

4. LCM Approach

CFRP was looked with suspicion in terms of CO_2 balance. Cabon fiber factory exhausts a big amount of CO_2, however, substitution of existing materials by CFRP brings a large amount of CO_2 savings. The key approach is Life Cycle Management (LCM); combinations of Life Cycle Assessment of GHG (LCA) and Life Cycle Cost reduction (LCC.) The Japan carbon fiber manufactures association illustrated tremendous contributions of CFRP to the society in terms of reduction of CO_2 emission in the field of aircrafts and automobiles.

5 Aircraft applications

Last forty years, aircraft engineers applied CFRP into the structures by degrees. Empennage was the first target for new structural materials, main wings is the last one. The aircraft structures of Boeing 787 are made with CFRP; more than 50% weight. So many fasteners imply it that design technology for thick-wall structures and fastening technology must have more advancement.

6. Automotive applications

Porches Carrera GT, Toyota LF-A and other cars with CFRP monocoque bodies in white come in the market. Structural simulations for crash-test and molding technologies to fit complicated geometries are expected to improve. Even though there are big manufacturing cost issues, challenges of new materials application gear up. Thermoplastic materials with carbon fiber attract attentions due to short cycle process; however, design principles for the materials are still poor. Technology for safe and economical CFRP bodies is the final goal [1].

References

[1] I. Takeda, A. Kitano and M. Yamasaki "*Short Cycle Production Process of Automotive Body*". JISSE9, (2005) 68.