Kurzfassung

Aufgrund des spezifischen Eigenschaftsprofils weisen Faser-Kunststoff-Verbunde (FKV) wesentliche komparative technische Vorteile gegenüber den Konkurrenzwerkstoffen in einer Reihe von industriellen Anwendungsfeldern auf. Trotz des daraus resultierenden Marktpotenzials konnten sich die FKV noch nicht in dem erwarteten Maße durchsetzten. Ursache hierfür ist die im Allgemeinen zwischen FKV und traditionellen Materialien bestehende signifikante "Wirtschaftlichkeitslücke".

Um eine Lösung dieses Problems voranzutreiben, wurden neue Ansätze bei der Entwicklung innovativer FKV-Anwendungen erforderlich. Optimierungspotenziale sind möglichst früh im Entwicklungsprozess zu identifizieren und konsequent zu erschließen. Hierzu wird ein geeignetes Analyse- und Planungsinstrument benötigt. Die bisher zur Verfügung stehenden Methoden der Wirtschaftlichkeitsanalyse auf Basis von Herstellkosten erweisen sich als unzureichend, da innovative FKV-Anwendungen, die hohe Herstellkosten bedingen, aber gleichzeitig im Betrieb Kostenvorteile gegenüber herkömmlichen Alternativprodukten aufweisen, benachteiligt werden. Deshalb wurde ein neuartiges, werkstoffgerechtes Instrument der Wirtschaftlichkeitsanalyse für FKV entwickelt, welches sich auf die Methode der Lebenszykluskostenrechnung stützt.

Das neuartige Instrument wurde auf verschiedene Fallstudien aus den Bereichen Verkehrstechnik, Anlagenbau, Bauwesen und Offshore-Industrie angewendet. Dies diente der Modellvalidierung, dem Aufzeigen von Anwendungsoptionen der Methodik bzw. des Modells im Rahmen von konkreten FKV-Entwicklungsaufgaben sowie der Bereitstellung einer Grundlage für die abschließende Ableitung einer wirtschaftlichkeits- und damit zukunftsorientierten Entwicklungsstrategie für FKV.

Abstract

Composites are characterised by typical properties such as high strength, high stiffness, excellent corrosion resistance, low density and feasibility for integration of parts and functions. Though the combination of these characteristics is ideal for many industrial purposes, the volume of the world-wide composite market is relatively small compared to conventional materials. The growth of the composite market is far behind expectations. However, while the potential number of applications for these materials in mass markets (like automotive industry) could be extensive, to date only niche applications have been developed and introduced in these market segments. In general, the primary barrier preventing a wider application of these advanced materials in broader market fields is the high initial (acquisition) cost caused by raw materials and related processing technologies which are relatively costly compared to conventional materials and processes.

Calculations of manufacturing costs for potential composite mass products are indicating insufficient economic characteristics of composite technology for mass markets. But, economic assessment of composites exclusively focused on initial costs can be considered "short-sighted". It neglects the influence of life cycle cost advantages on the overall economic performance of innovative materials and for this reason restricts the development of many promising composite products. To overcome this problem, a consistent method to evaluate the life cycle cost effectiveness of innovative materials is needed.

Because composite materials can show

- on the one hand significant economic advantages of application (higher payloads, better fuel efficiency, less effort for maintenance, longer life cycle) due to their outstanding properties and
- on the other hand higher acquisition costs compared to conventional material technologies

a comprehensive life cycle cost model has been developed, validated and applied to show the main life cycle cost determinants and to uncover the potential and restrictions of these innovative materials to minimise life cycle cost of industrial products.

Life cycle cost is the total cost of a product during its life span. It embraces all costs associated with

- R&D-activities,
- production,
- operation (including maintenance, repair, replacement) and
- post use treatment (recycling, disposal).

Life cycle costing may be defined as an analytical process which considers all cost impacts throughout the product life cycle. A life cycle cost model is a model which reflects the technical life cycle of a product, calculates all costs associated with the life cycle and combines this data taking into account the impact of time.

The new composite materials life cycle cost model has been developed based on these definitions. It consists of four modules.

The four modules are reflecting the four relevant cycles of a composite product's life (R&D cycle, production cycle, operation cycle, post-use cycle). The life cycle costs of composites are determined by a cluster of complex technological and economical processes with a large number of variables. For a comprehensive description of these processes the complexity has to be reduced by definition of basic cost functions. Therefore the composite life cycle system was analysed and the relevant links between the system structure, system variables and the associated costs were extracted. Core of the model is a life cycle cost accounting system, which is based on established business management standards.

The composite life cycle cost model has been applied to several case studies to validate the method, to show different possibilities for usage within composite related R&D projects and to generate a basis for derivation of a general life cycle cost oriented R&D strategy for composites. As case studies actual potential composite applications in transportation, industrial equipment, infrastructure and offshore systems have been evaluated and compared to conventional material options. The results of these case studies combined with sensitivity analysis show potential and restrictions of composites to minimise life cycle cost of industrial products.

The feasibility of the new method to investigate the life cycle cost characteristics of innovative composite applications has been confirmed. The case studies demonstrated, that the composite life cycle cost model represents a multi-functional decision support tool. Two main approaches

to use the instrument have been identified:

- Application as an operative assessment and controlling tool to support decision processes within composite related R&D projects
- Application as a strategic planning instrument to set-up a economic efficiency oriented development strategy for composite technology.