

Intelligent Future Building Skins – Studies on a Flat Plate Photobioreactor Prototype

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Abstract

Algae growth on building facades would usually be a cause for frustration among the majority of building owners. But what if microalgae were cultivated intentionally on facades as a future building concept for energy or domestic warm water supply? A team of German scientists and technicians consisting of ADCO Technik GmbH, ARUP Deutschland GmbH, Frener & Reifer GmbH, SSC Strategic Science Consult GmbH and Technische Universität Dresden is developing flat panel bioreactors made of glass for building skins. This paper presents the construction of a photobioreactor prototype. It describes the design approach including the structural design and flow simulations. The mechanical, physical and chemical loads are characterized and experimental studies on adhesive materials are presented.

Keywords: glass, facade, photobioreactor, CFD simulation, structural adhesives, tensile tests.

1 Introduction

Microalgae are photoactive organisms that produce biomass by performing photosynthesis. The microorganisms are cultivated in open systems like lakes and raceway ponds or they are processed in closed systems. A special type of closed systems are flat panel photobioreactors that could be integrated into a building skin. The German research team FABIG (Fassaden mit Algenbiogeneratoren aus Glas) is investigating flat panel photobioreactors and strives to design structurally sealed modules with improved flow and design properties.

This article introduces the construction of the flat panel, illustrates the results of computational fluid dynamic (CFD) simulations and describes the structural design including associated studies on

structural adhesives. Finally, the paper concludes with a concept for a prototype to scale.

2 Construction Concept

A pilot project called 'BIQ – Das Algenhaus' in Hamburg Wilhelmsburg, Germany with flat panel bioreactors preceded the research work of FABIG (Figure 1). The conceptual smart material house was built during the International Building Exhibition (IBA) in 2013 as a residential building. Photoactive panels facing southward serve as an external shading system. The produced biomass can either be used for heating and warm water supply inside the building or it can be processed by the pharmaceutical or food industry. The case study house in Hamburg is the starting point for FABIG's new design approach. [1]