Double layer textile covers for biogas storage systems under environmental impacts

Rosemarie Wagner*, Kai Heinlein†

* KIT - Department of Building technology
Englerstrasse 7 76131 Karlsruhe
e-mail: rosemarie.wagner@kit.edu, web page: http://fgb.ieb.kit.edu/

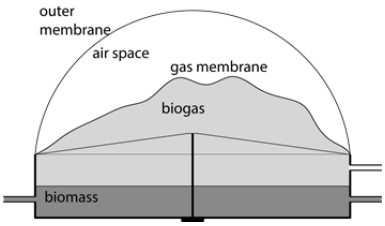
† KIT - Department of Building technology
Hertzstrasse 16 76187 Karlsruhe
e-mail: kai.heinlein@kit.edu, web page: http://fgb.ieb.kit.edu/

ABSTRACT

Textile biogas storage systems with suitable technical design represent an economically attractive and technically sensible method of biogas storage due to low investment and maintenance costs. A typical system is a double layer inflated membrane structure. The outer membrane acts as weather and environmental protection and is kept under tension by an internal pressure acting also onto the gas membrane as the gas tight enclosure of the fermenter in a biogas plant. However, according to the state of the art, a reliable load-compliant design of the these covers is till now limited, since neither the loads acting due to weather influences and operating conditions onto the gas membrane nor their transmission and distribution to individual system components such as valves, ventilators and pressure control units are known in their interaction. In a double layer textile membrane covering the fermenter of a biogas storage plant the behaviour of the outer and gas membrane is hardy to describe without knowing the influences of the gas production and extraction, temperature, internal pressure and control devices in relation to the surrounding and operation conditions. The major difference to inflated structures is the time-temperature and volume depended gas and air pressure in the two chambers.

Outer Membrane

Gas membrane



Scheme of the cross section

In a 1:1 pilot plant the interactions had been examined with a large number of measuring technology and peripheral components, and the associated possibility of collecting and analysing data. On this basis, insights and derived developments could be achieved for the structural behaviour of the double layer membrane. Operation conditions had been tested and compared with numerical simulation. The simulation is a highly non linear calculation based on the gas law, non conservative loads of wind and internal pressure and the geometrical nonlinear of the membranes itself. The reason for simulating the behaviour was to catch critical operation situations such as gas extraction leading to an under pressure in the air space and instability of the outer membrane during higher wind loads or a nearly full gas space, high temperature and sudden wind gusts followed by the contact between the membranes and extremely small volume of the air space. Another challenge is to model the gas membrane if the difference between air and gas pressure is equal or only little higher to the weight of the gas membrane and environmental conditions.