Oliver
Müller

Student	Oliver Müller
Examiner	Prof. Dr. Andreas Häberle
Co-Examiner	Dr. Haller Michel
Subject Area	Solar thermal technology

HybridStock feed

Designing, building and testing of a continuous feed device for an aluminum-water reactor

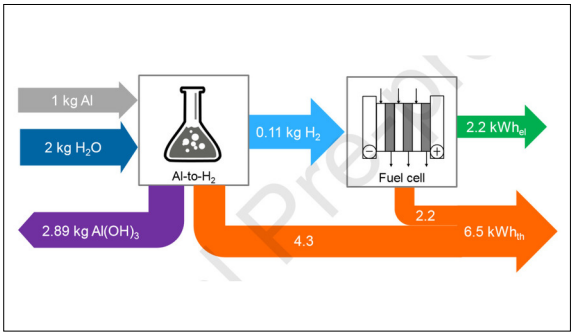

Figure 1: Producing heat and electricity from aluminum
Seasonal energy storage in aluminium [..], M. Haller et. al.

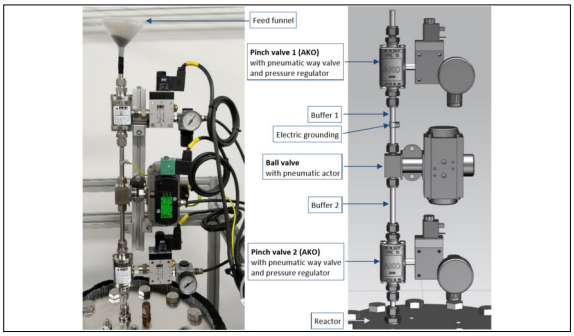

Figure 2: Double valve lock system applied on reactor (left) and CAD assembly (right)
Own presentment

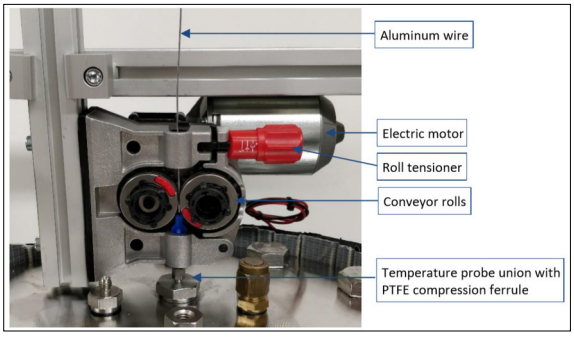

Figure 3: Wire feed system applied on reactor
Own presentment

Introduction: Aluminum can be used as a seasonal energy storage. In an exothermic chemical reaction aluminum and water are converted to hydrogen, heat and other reaction products. The produced hydrogen is used in a fuel cell to generate electricity, the generated heat of both the chemical reaction and the fuel cell are used for space and water heating.
An automated feeder system is required to convey the aluminum continuously into the reactor from an outside storage container. The system must be gas tight and designed to avoid the escape of hydrogen while introducing aluminum into the reactor.
The goal of this work is to design, build and experimentally test two fully automated aluminum feeder systems. The systems are compared in terms of safety, feasibility, hydrogen loss and costs. If the better solution is approved it will be integrated into the test converter in the further project.

Approach / Technology: The double valve lock system (Figure 2) contains a cascade of 3 pneumatic valves that have the functionality of a sluice and are controlled by a LabVIEW control. Opened one after the other granulated aluminum is conveyed stepwise from an outside storage into the pressurized reactor, keeping the system closed at all times. The tubes between the valves act as a buffer storage from where the granule is dispensed into the reactor.
The wire feed system (Figure 3) feeds the reactor with an aluminum wire. A wire feeder pushes the wire through a temperature probe union. The 24VDC electric motor drives the rolls, which convey the wire through the sealing. The roll tensioner allows to adjust the force on the wire.

Result: The double valve lock system is able to convey aluminum granule fully automated into the reactor. At a reactor gauge pressure between 0.5 bar and 2.5 bar 0.05 % - 0.4 % of the target H2 production escapes during the feed due to the sluice-like system design. No additional leakage through the feed system occurs. The redundancy of the sealing components provides the safety that is necessary for hydrogen handling. The maximum gas gauge pressure which the system is designed for amounts to 2.5 bar.
The wire feed system contains a trade-off between gas tightness and the function of the wire drive. The contact between the wire and the compression ferrule depends on the tightening torque of the fitting. A full area contact provides gas tightness but increases the friction between plastic and wire strongly, so that the wire drive is not able to start up. Only in a small range of torque, both the wire drive functions and the sealing is gas tight. Small deviations like imperfections of the wire geometry or abrasion of the ferrule make the motor fail or enable hydrogen escape. The wire system at this stage of development cannot be considered as fully automated or safe in terms of hydrogen handling.
The double valve lock system is rated "good" by a technical assessment and recommended to be applied in the further project. It is superior to the wire feed system which is rated "insufficient"