

COLLOQUIUM

Group: Engineering Fluid Dynamics

As part of his MSc thesis assignment

E.W.H. Wijermars

will give a presentation, entitled:

Fluid flow and Transport Model of an Oxygen Transport Membrane Module for Oxyfuel Application in an IGCC

Date: Friday February 6, 2015

Time: 9:30

Room: Horst Building Room ZH-286

Summary:

The global strategy of Shell for CO₂ reduction consists of four major points: supplying more natural gas, implementing energy efficiency measures in operations, supplying low CO₂ emission biofuels for road transport and progressing CO₂ capture and storage technology. One way to provide CO₂ which is ready for transportation and storage is the combustion of hydrocarbons with pure oxygen instead of air. In a continuous effort to reduce costs of CO₂ capture and storage application, several process schemes and technologies are considered. In this research, membrane technology is used to separate the oxygen from the air for the production of oxygen, applied in an Integrated Gasification Combined Cycle (IGCC).

Previous research mainly focused on the oxygen transport through dense membranes on lab scale. Often, fluid flow aspects are neglected on this scale. In case fluid flow aspects are modeled; it considers the laminar flow regime. For scaling to industrial size, flow and mass transfer phenomena such as turbulence, depletion of oxygen in the feed flow and pressure drops are of importance. Modeling of a membrane module will give a good understanding in the resistance layers which hinder the transport of oxygen from the high to the low oxygen partial pressure side. An improved model of an Oxygen Transport Membrane module is proposed, this model includes fluid flow aspects and an oxygen transport model for the membrane itself. The turbulent feed flow is described using the Reynolds-Averaged Navier-Stokes equations, closed with the k- ϵ turbulence model. The gas phase transport through the porous support is described by the Dusty Gas Model.

Results of numerical simulations for an experimental set-up show agreement with results from permeation tests obtained from lab scale experiments. The resistance of the concentration polarization in the flow is 20% of the total resistance. The transport of oxygen through the industrial scale membrane module is dominated by the surface exchange kinetics and the dense membrane resistance, the resistance of the concentration polarization in the flows is 0.5%. A turbulent feed flow and a supported membrane lead to a smaller resistance. A tubular geometry is preferred, mainly because of manifold and mechanical reasons. A parameter study showed that the resistance of concentration polarization in the flow becomes more important for an increased oxygen flux.

Assessment committee:

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