Energie mit Zukunft.
Umwelt und Verantwortung.

DBI GUT
Gas- und Umwelttechnik GmbH

Inorganic Membrane for Gas purification

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DVGW

Comparison of organic and inorganic membranes

- advantages of polymeric membranes
- commercial successes/applications
- low cost membranes - ease of manufacture
- membranes for H_2,CO_2 and O_2/N_2 separation are highly developed
- disadvantages of polymeric membranes
- membrane plasticization – reduction of membrane performance
- competitive sorption (BTEX, CO_2)
- liquids/drops must be removed,
- Joule-Thompson-Effect – hydrocarbon condensation - membrane damage possible
  - clean feed is necessary

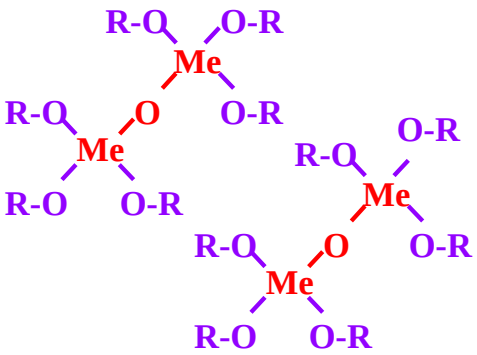
Disadvantages can be obviated with inorganic membranes.

Types of inorganic membranes

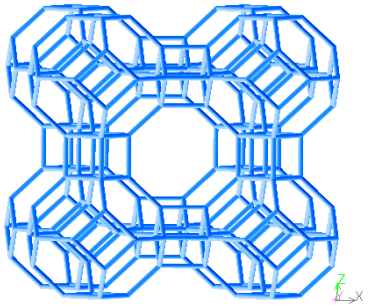
Membranes

Amorph

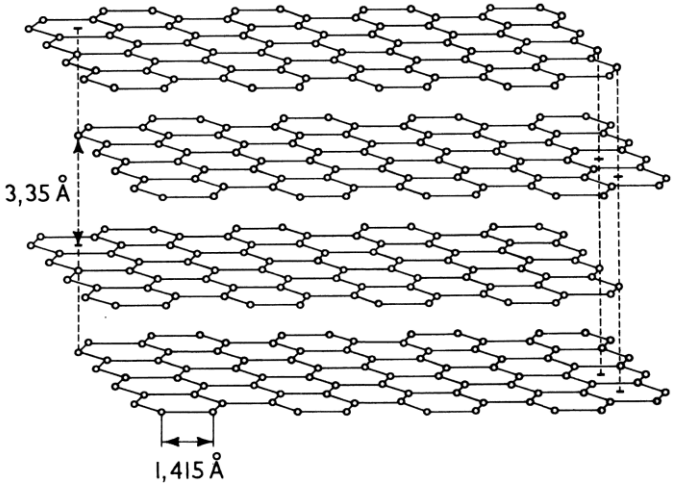
(liquid filtration in industrial appl.)



Zeolite (A, MFI)



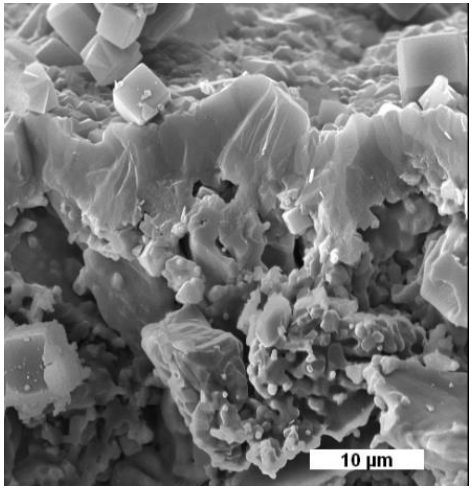
Carbon



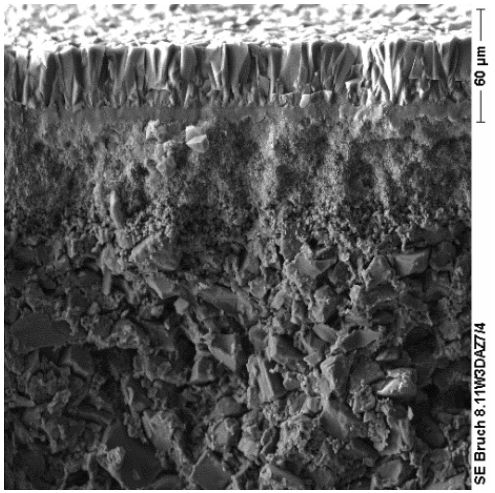
- differences occur e.g. in structure, pore diameter and pore structur, hydroth. stability, hydrophilicity

Nanoporous Membrane

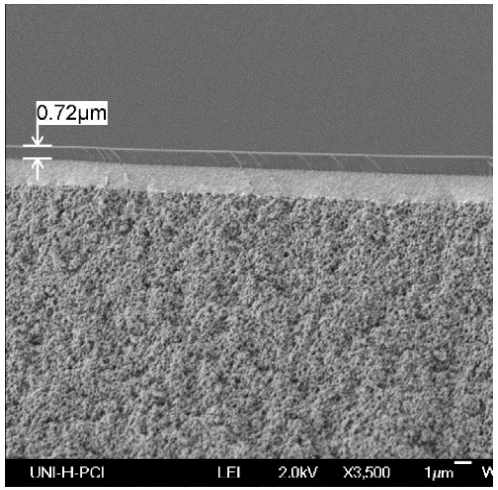
NaA

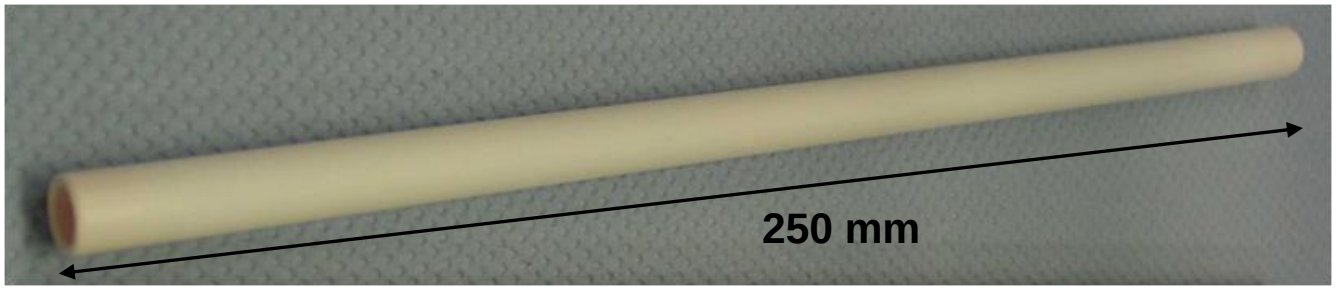


ZSM-5



Carbon



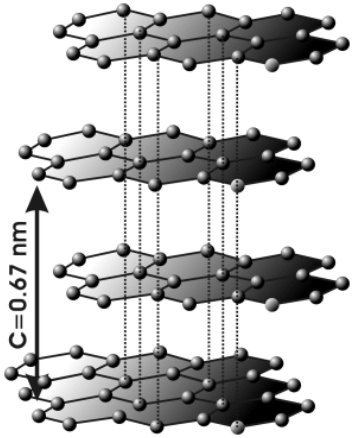


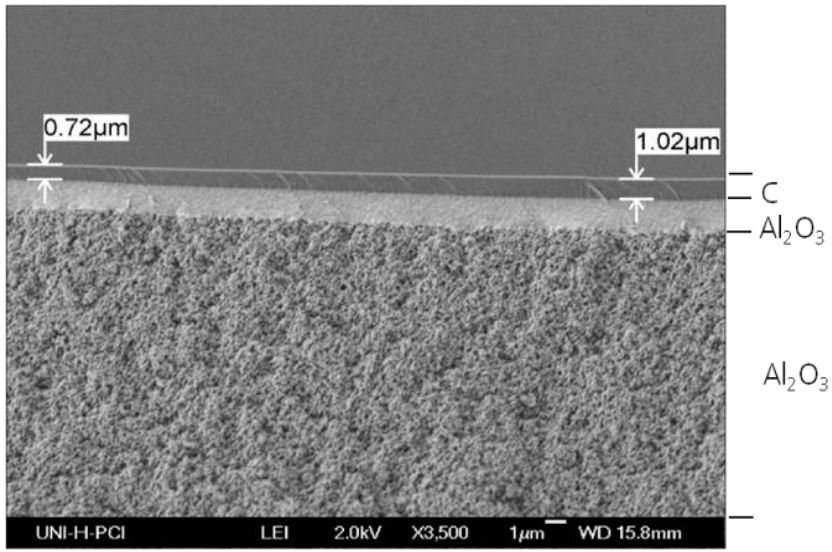
- for test purposes the preparation take place inside of porous ceramic tubes between 250 mm and 1200 mm length

Preparation - Molecular sieving carbon membranes (MSCM)

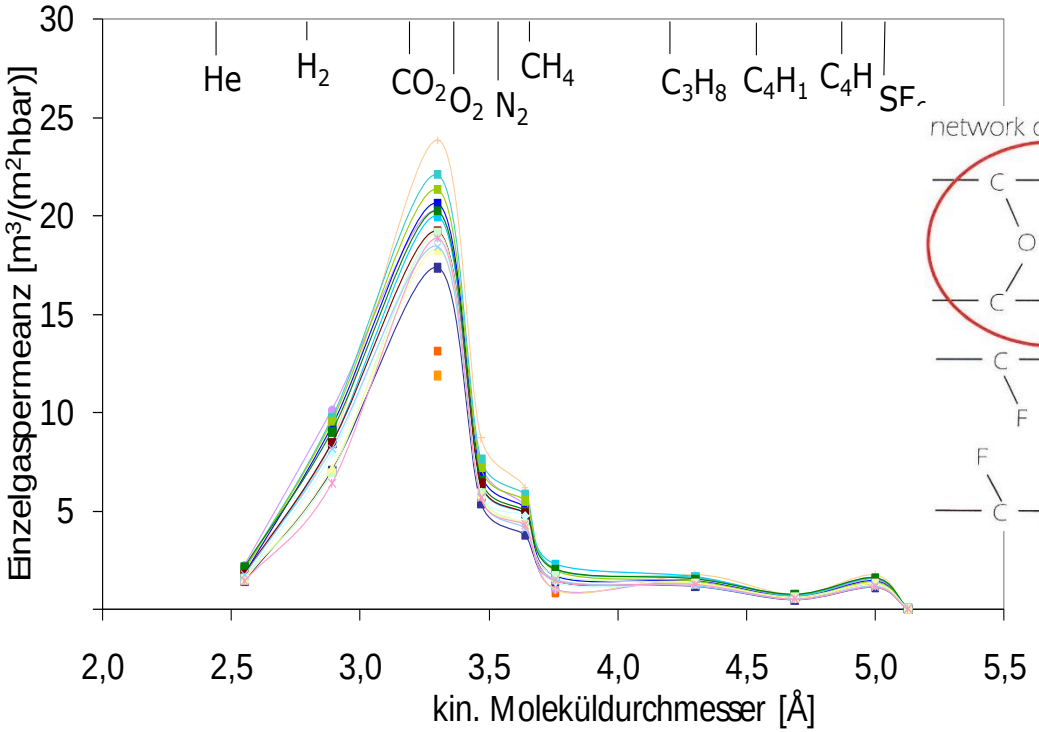
- Ceramic support
- Coating (polymeric precursor)
- Polymerisation
- Pyrolysis
- Post Treatment

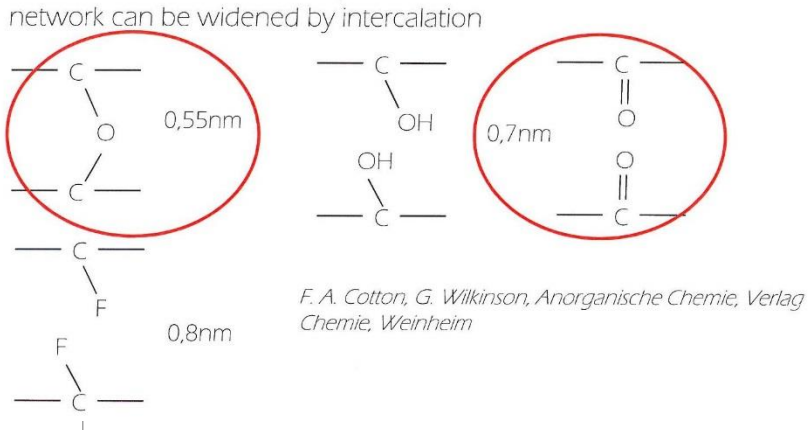
-Polyimide
- Polyfurfurylalkohol
-Phenolharze
- Polysaccharide
- Polyester
- Cellulose ....





Characteristic - Molecular sieving carbon membranes (MSCM)

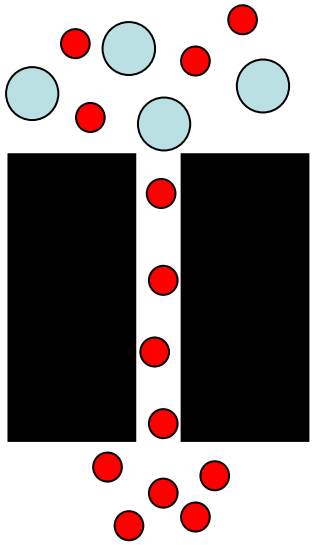




- gas permeation through the lattice plane distances of carbon
- very high ideal selectivity in H_2/C_3- and CO_2/CH_4-separation
- CO_2/CH_4 selectivity increases in mixed gas measurement
- adsorption selective separation behavior (ASCM) after thermal post treatment in oxygen due to the widening of lattice plane distances

Carbon membranes

- pore size and transport properties of carbon membranes can be tuned
  - interesting candidate for different industrial gas separation methods
- development of membranes for gas separation,
  selectivity based on adsorption and/or difference in size(mole sieving)
- The separation factor ά in real natural gas (e.g. for CO_2/CH_4 or N_2/CH_4) are >> 10, in two component gas mixtures ά > 100 is available
  - In some years N_2 and He separation are realistic
- H_2S-Concentration up to 200 mg/m³ is possible
- Working conditions
  - up to 100 bar –
    - Flux increase, the selectivity decrease
  - temperature up to 100°C
    - Flux increase, selectivity increase
- high influence of module design



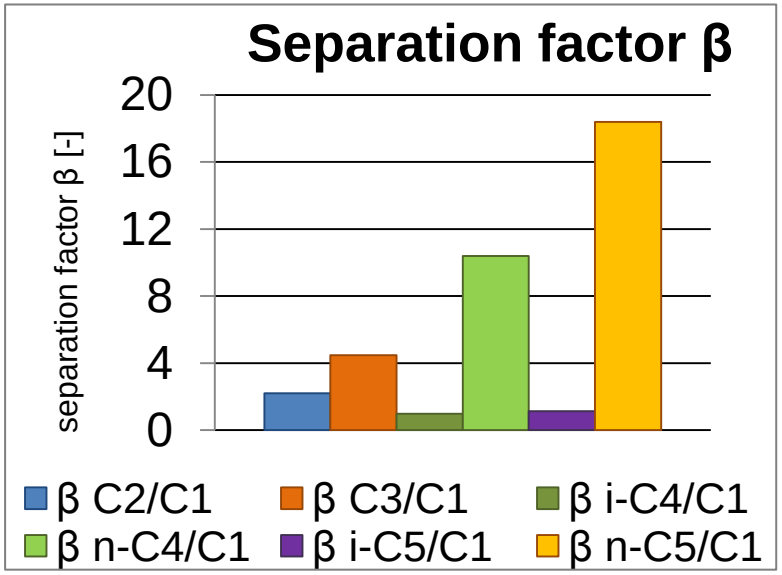
Comparison inorganic membrane - polymeric membrane

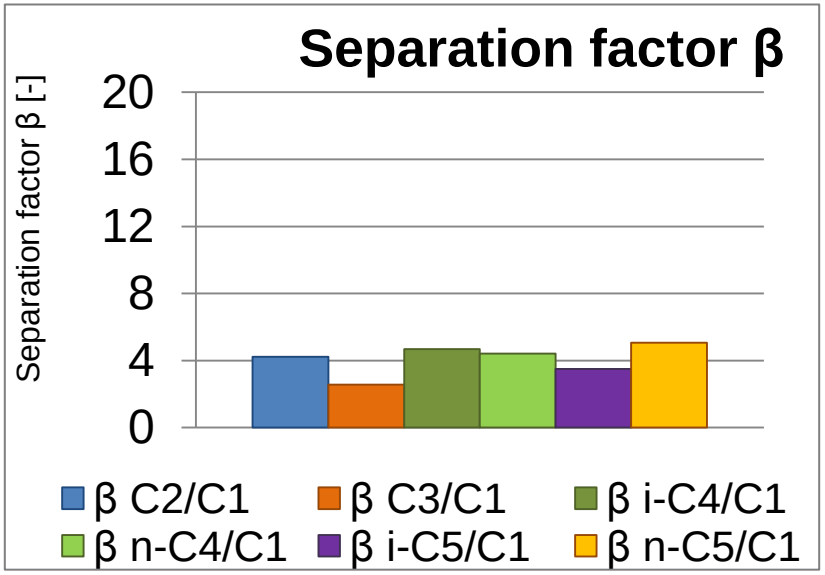
inorganic membrane

- very high selectivity for C_4/C_5 – increase with C-number

polymeric membrane (like PDMS)

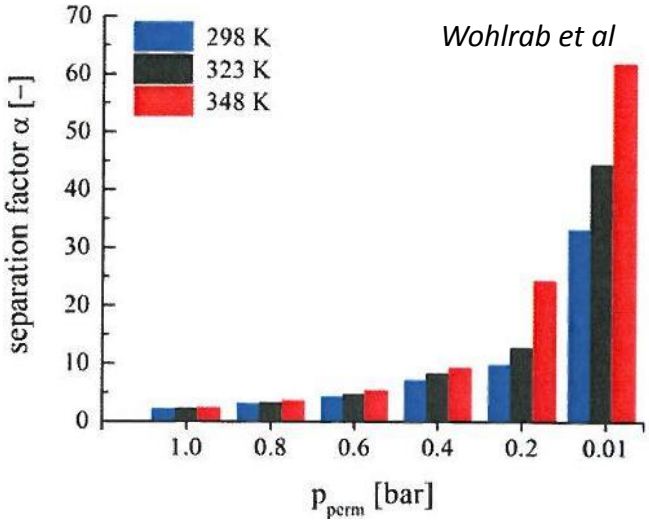
- separation factor similar for all components





Hydrocarbon removal – conclusions and outlook

- higher selectivity in combination with a stabile type of membrane is necessary
- The interaction of the zeolite membrane with adsorbed molecules must be understood
  - The graph demonstrates the influence of permeate desorption on the separation factor n-C4/C1



- actually membrane with a length of 0.6 m is produced and tested
- next step is to produce and test membrane-capillaries

Liquid handling in gas industry

- examples where the use of inorganic membrane for liquids is applied include
  - waste water cleaning , decolouring
  - retention of catalysts, separation of aromas
- Some technical liquids are used by the gas industry, partly those liquids can be regenerated/dried by membranes
- it is possible to dry glycols with a molsieve membrane
  - necessary to dry up to around 0,8 % water
  - very dirty liquid

- background:
  - lower temperature – less energy consumption
  - less demand of TEG
  - higher flexibility

Membrane for Glycol Dehydration

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Thank you for your attention!

For further information and questions please contact

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