INTRODUCING....

Frank Bazelmans
f.bazelmans@teesing.com

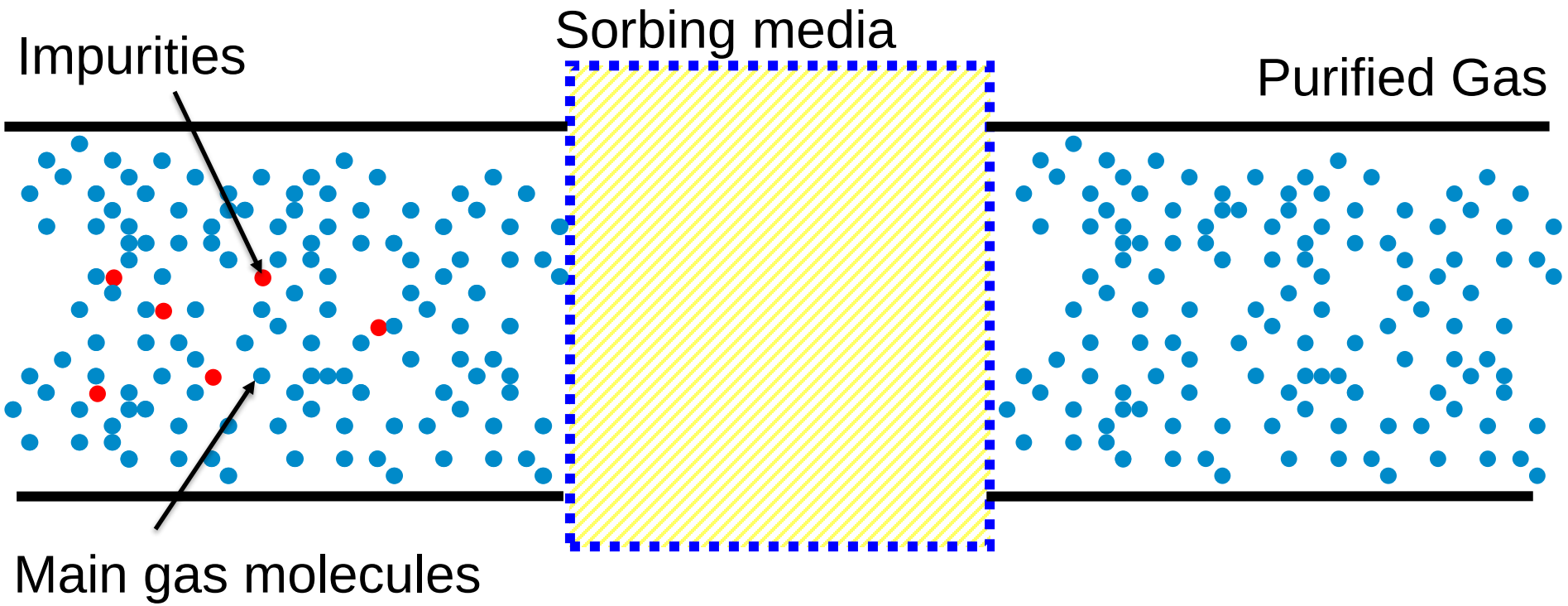
Mike Gijsbertse
m.gijsbertse@teesing.com

TOPICS TO COVER

- Introduction
- Gas Purification concept
- Technologies:
  - Getter
  - Reactive Catalyst
  - Catalytic
  - Adsorbers
- Media, Gas and Impurities table
- Bulk Purifiers
- Factors affecting cost
- Other topics to discuss

mott MISSION CRITICAL PRECISION TEESING

GAS PURIFICATION CONCEPT



- Sorbing (purification) media do not react with main gas molecules
- Gaseous impurities react and are trapped into the sorbing media and removed from the main gas stream

TEESING

PURIFIER EXAMPLES

MULTIPLE PURIFICATION TECHNOLOGIES

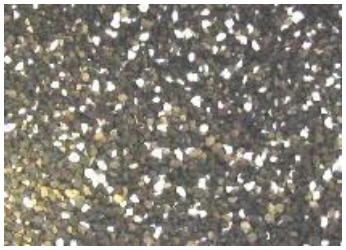
Alloy Getters



Typically Removes:
CO, CO_2, H_2, H_2O,
N_2, O_2, THC

Catalysts/ Reactive Catalysts





Typically Removes:
CO, CO_2, H_2, H_2O,
O_2, NMHC

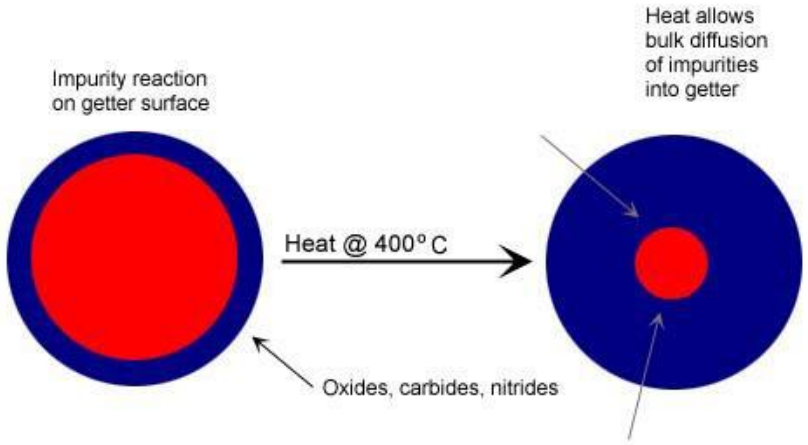
Asorbants/Adsorbers


Typically Removes:
H_20, CO_2, NMHC

TEESING

TECHNOLOGIES - GETTER

Zirconium Alloys



- Highly reactive with a variety of

gas species CO, CO2, N2, O2, H2

- Reactions occur on the surface, products diffuse into the bulk, but only under heated atmosphere.

- Hydrogen is reversibly dissolved into solution in the getter, as a function of temperature…cold=more capacity, hot = less capacity.

TECHNOLOGIES - GETTER

Zirconium Alloys

Advantages

- Best low temp technology that can remove N2 from inert gases
- Can be Nitrided or Hydrided for purifying N2, H2, and mixtures

Disadvantages

- Not regenerable, only replaceable
- Classed dangerous goods, spontaneously combustible
- High temperature operation (350 C), higher operational costs

TEESING

TECHNOLOGIES - GETTER

Zirconium Alloys

Applications

- Silicon & Silicon Carbide crystal growth –Argon
- Sputtering PVD –Argon/Nitrogen
- Analytical Instruments –zero gas
- Optical Fiber Mfg-Helium

TEESING

TECHNOLOGIES – REACTIVE CATALYST

Reactive Catalysts

- Transition metals; examples include Nickel and Copper
- Typically a high surface area metal deposited on inert substrates (alumina, silica, fluid purification/diatomaceous earth)
- Highly reactive with a variety of gas species
  - CO, CO2, H2, H2O, O2
- Reactions are surface area dependent

TEESING

TECHNOLOGIES – REACTIVE CATALYST

Reactive Catalysts

Advantages

- Operates efficiently at ambient temperatures
- Low COO as compared to getter technology
- Can be conditioned for purifying H2, wide gas compatibility (CO2, Halogens, Corrosives)
- Works with a wide range of gases, CO2, halogens, some corrosive and hydride gases

Disadvantages

- Limited capacity to remove light Hydrocarbons
- Classed dangerous goods, spontaneously combustible

TEESING

TECHNOLOGIES – REACTIVE CATALYST

Reactive Catalysts

Applications

- Any Inert gas not requiring N2 or light Hydrocarbon (Methane) removal
- Nitrogen gas purification for venting purging applications
- Hydrogen use not requiring light Hydrocarbon (Methane) removal

TEESING

TECHNOLOGIES – CATALYTIC

Catalyst

- Palladium/Platinum
- THINK--CATALYTIC CONVERTER!
- Low percentage of high surface area metal deposited on inert substrate
- Used to reduce THC, CO, H2, etc. from high PPM levels to low PPT levels
- True catalyst
  - Not consumed

TEESING

TECHNOLOGIES – CATALYTIC

Catalyst

Advantages

- No definitive lifetime
- No regeneration required
- Efficient removal of THC with no risk of exothermic reaction
- Many applications (CDA, CO2, O2, Noble Gases, etc)

Disadvantages

- Operates at elevated temperature
- Requires downstream adsorbers to remove byproduct impurities
- High capital expenditure, and high COO

TEESING

TECHNOLOGIES – CATALYTIC

Catalyst

Applications

- UHP O2 applications
- Hydrocarbon removal from O2

TECHNOLOGIES – ABSORBERS

Absorbers

- Molecular sieves, silica gel, carbon (charcoal)
- Highly efficient for certain impurities
  - CO2, H2O, Acids, Bases, Heavy Hydrocarbons, etc.
- Removes impurities through physical adsorption
  - Pore size dependent
- Reactions occur on the surface with no diffusion into the bulk
  - Highly porous to increase surface area

****"OX" Purifier is an example****

TEESING

TECHNOLOGIES – ABSORBERS

Absorbers

Advantages

- Operates efficiently at ambient temperatures
- Regenerable

Disadvantages

- Will not remove light Hydrocarbons (Methane)
- Some are NOT regenerable

TEESING

TECHNOLOGIES – ABSORBERS

Absorbers

Applications

- Nearly any gas where moisture is the primary impurity to be removed
- Calibrated, or “Zero” gas for instrumentation
- Efficiently removes acids and bases
- Optical component purging

TEESING

MEDIA, GAS AND IMPURITIES

Class	Gases Purified	Impurities removed	Removal efficiency	Regen capable
C	Ar, He, Kr, Ne, Xe, N_2, H_2	CO, CO_2, H_2, H_2O, NMHC, O_2	< 100 PPT	Yes
CA	Ar, He, Kr, Ne, Xe, N_2, H_2	CO, CO_2, H_2, H_2O, NMHC, O_2	< 100 PPT	Yes
F	C_2F_6, C_3F_8, C_4F_8, $CClF_3$, CCl_2F_2, CCl_4, CF_4, $CHClF_2$, CHF_3, CH_3F	CO, CO_2, H_2, H_2O, NMHC, O_2	< 100 PPT	No
OX	CDA, O_2	CO_2, H_2O, NMHC, Amines, NOx	< 100 PPT	Yes
T	BCl_3, BF_3, CL_2, ClF_3, F_2, HBr, HCl, HF, NF_3, SF_4, WF_6	H_2O	< 100 PPT	No
W	Ar, He, Kr, Ne, Xe, H_2, N_2	H_2O	< 100 PPT	Yes

GAS BEING PURIFIED

Not all gases that can possibly be purified with a given Class are listed. If you don’t see your specific used gas, please contact Teesing.

- Never use purifier for a gas not specified in the model number without contacting Teesing first.

WHAT INFORMATION DO WE NEED

- **Gas to be purified** – some gases don't react well to some medias
- **Impurities in the gas stream** – specifically which to be removed
- **Inlet gas purity** – typically limited to 5Ns or better
- **Nominal flow rate** – used in lifetime calculations, vessel sizing
- **Purifier duty cycle** – used in lifetime calculations, vessel sizing
- **Max flow rate** – vessel size, filtration options
- **Max line pressure** – vessel design, system component specs
- **Line diameter** – match with purifier to minimize pressure drop
- **Desired outlet purity** – used in lifetime calculations, vessel sizing
- **Particle filtration** – two options that impact max flow and pressure drop

mott MISSION CRITICAL PRECISION TEESING

SELECTION GUIDE

Physical aspects

- Diameter and length varies with nominal flow rates

- Inlet/outlet fittings
  - VCR is standard
  - Some purifier sizes offer optional sizes of VCR fittings
  - Weld stubs are optional

- Integral particle filtration
  - Sintered metal filter discs or sintered rod type filters are used to contain the media in the vessel
  - Inlet filters are always 0.1nm rated
  - Outlet filters can be either 0.1nm (-CR in the model number) or 0.003nm (-FP in the model number)

TEESING

BULK PURIFIERS

- 5Ns Inlet Purity Producing 9Ns or Better Outlet Purity
- PLC Automation, Optional Internet Connectivity for Upgrades, Service
- Menu Driven Touchscreen HMI, Multi-Level Password Access
- Versions for Protected or Unprotected Area Installation
- For Flow Rates to >5000 NM3/hr

mott MISSION CRITICAL PRECISION TEESING

BULK PURIFIERS

FACTORS AFFECTING COST

Vessel sizing

- Stand alone purifiers lifetime target is 1 year between regen / replacement
- Larger flow rates = larger vessels to meet purity requirements
- Higher inlet impurity load = larger vessel to meet purity requirement
- Nominal flow rating = 1 yr of 24 h/d operation at 5Ns inlet purity

Required flow rate

- Larger vessels required to handle larger flows
- Larger line diameter = higher cost components like valves, fittings etc

TEESING

FACTORS AFFECTING COST

Smaller particle filtration

- Costs more, also may require larger vessels due to max flow specs per filter

Uninterrupted flow requirement

- May lead to dual vessel fully auto regen to eliminate downtime for vessel change out/factory regen

TEESING

OTHER TOPICS TO DISCUSS

- Lifetime of purifiers / Regeneration methods (can you do it yourself?)

Thank you for your attention!

Frank Bazelmans
f.bazelmans@teesing.com

Mike Gijsbertse
m.gijsbertse@teesing.com