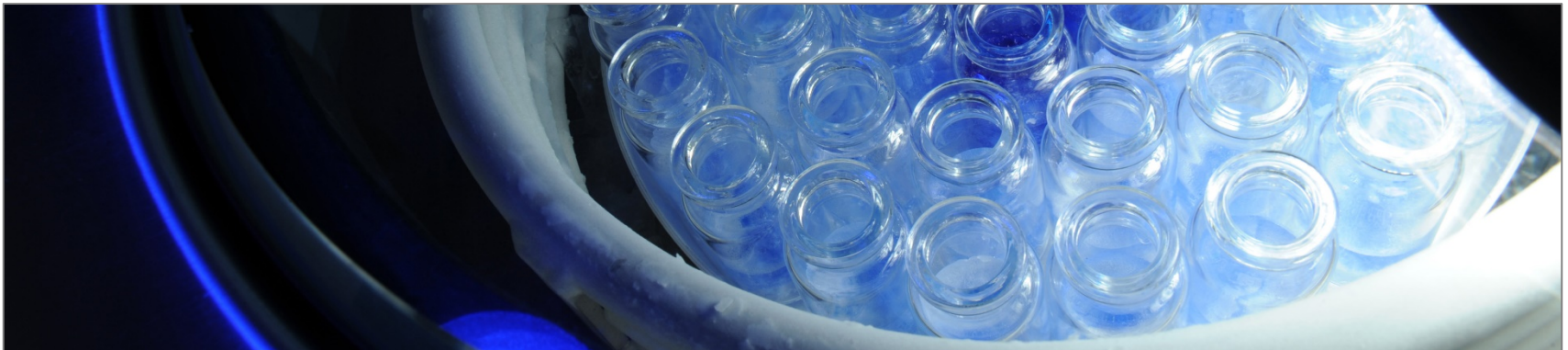

Practice 7, PDA-Seminar

Brief explanantion of the different stations

2018 PDA Europe
Freeze Drying in Practice



Agenda

Station 1

- Pressure Calibration > ATM

Station 2

- Vacuum Calibration

Station 3

- Temperature Calibration

Station 4

- Shelf-Mapping

The workstations





Pressure Calibration

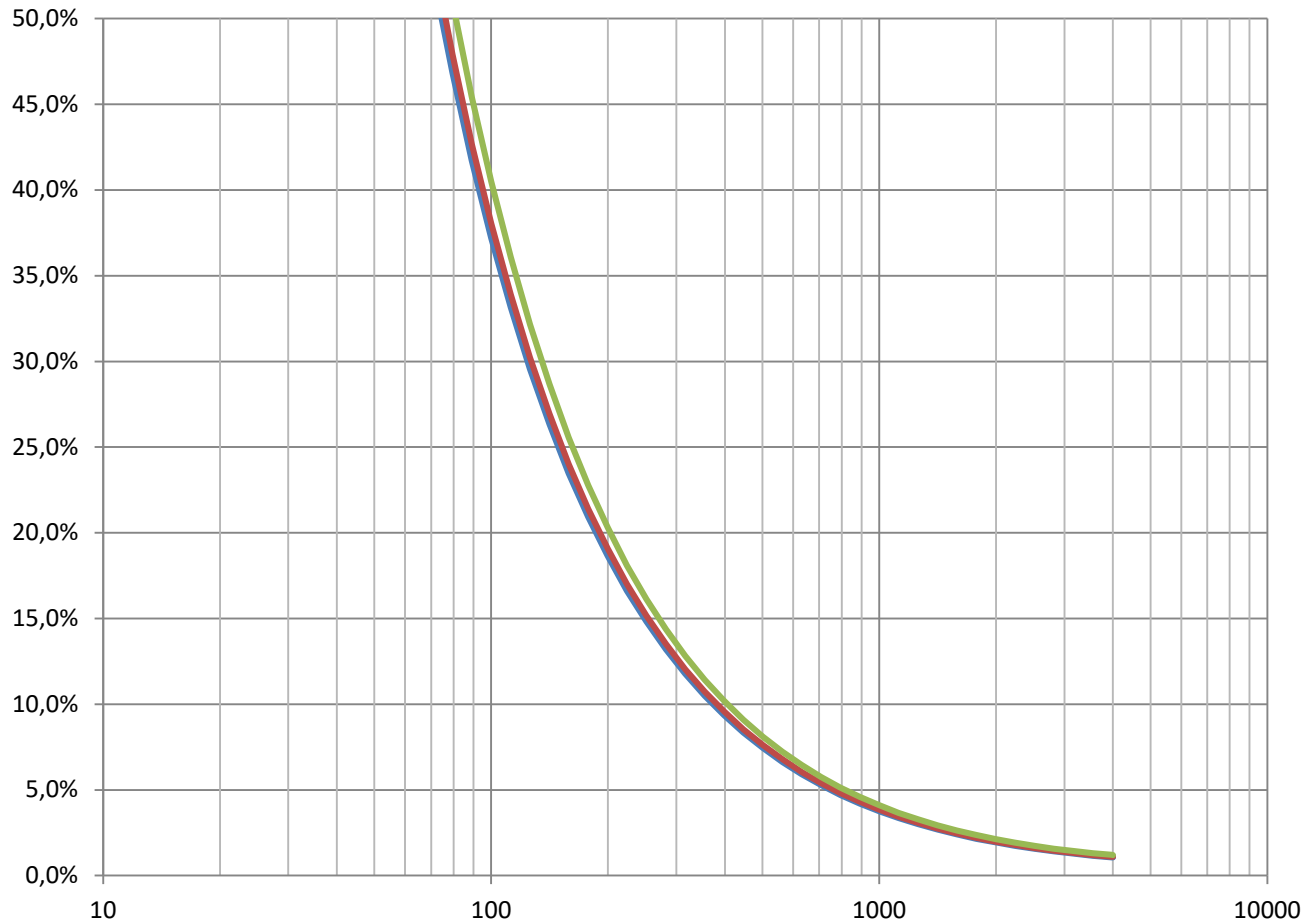


Pressure Sensors in use

- Device to be calibrated:
 - **piezo-resistive** pressure sensor
 - JUMO dTrans p31 pressure transducer
 - Measuring range 0 .. 1,6 and DS: 0 .. 4 bar, $\pm 0,54\%$ f.Rdg ± 15 mbar
 - Useful working range: > 70 mbar
 - Allowed media temperature up to 200° C
 - Application: SIP, Door closure, aeration
 - Features: robust, low price
- Determination of pressure indirectly via the deformation of an elastic element (membrane). Silicon crystal changes its electrical resistance.



Pressure Sensors uncertainty



Pressure Sensor Calibrator (reference)

- Mecotec reference display as calibrated standard (0 ... 4bar)



- Hand "pressure" pump for generating vacuum and overpressure



- Calibration vessel (recipient) for holding up to three sensors





Vacuum Calibration

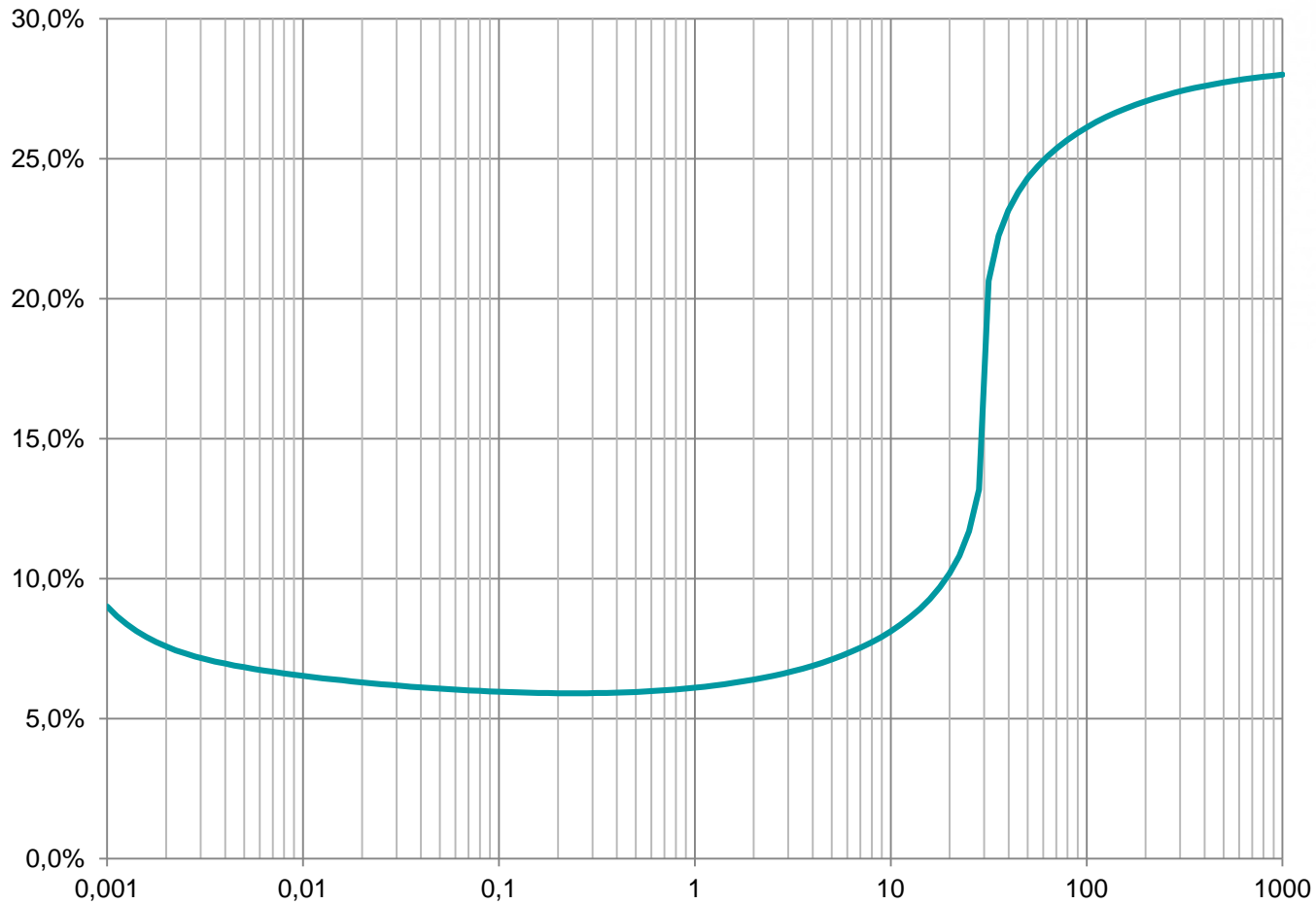


Vacuum Sensors -Pirani- in use

- **Pirani** probes (gas dependent) to be calibrated:
 - **Thyracont VCP63** Pirani sensor with Platinum/Rhodium-Filament
Measuring range: $5e-4$.. 1000mbar, 10 – 30% f. Rdg.
 - Useful working range 0,001 .. 20 mbar
 - **Pfeiffer TPR280**, $1e-3$... 1000mbar
- Used for comparative vacuum measurement and competitive application



Vacuum Sensors uncertainty



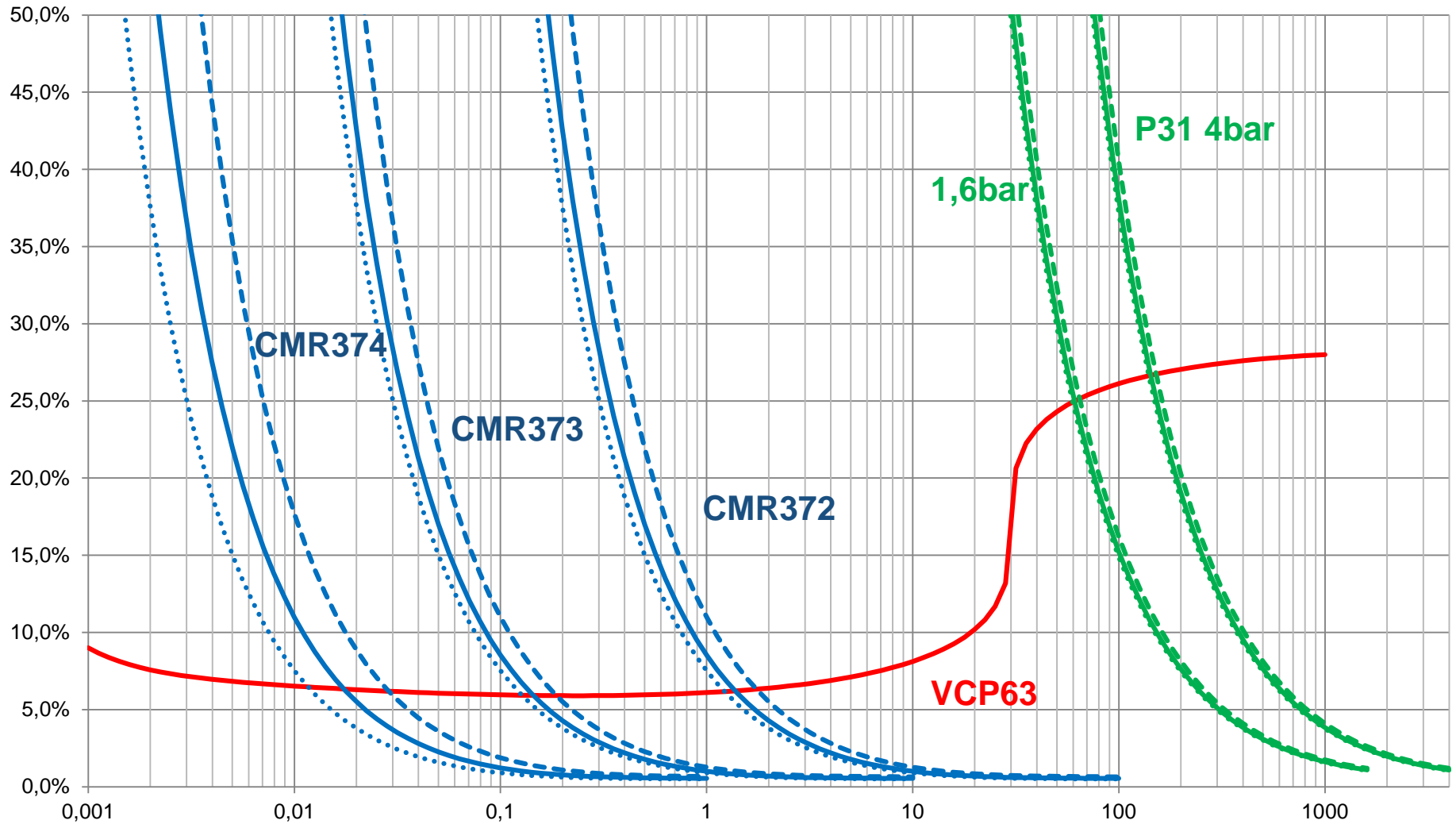
Vacuum Sensors -capacitive- in use

- **Capacitive probes** (absolute, gas independent probes, corrosive gas resistant):
- Discrimination: temperatur-controlled, temperatur-compensated, unregulated
 - **Pfeiffer CMR 363* / 364**** (temp.-compensated, $\pm 0,22\%$ of Rdg.)
 - **Pfeiffer CMR 373* / 374**** (temp.-controlled, $\pm 0,18\%$ of Rdg.)
 - **MKS 722B*** (unregulated, $\pm 0,64\%$ of Rdg. $\pm 0,009$ mbar)
 - **MKS 626B** (temp.-compensated, $\pm 0,47\%$ of Rdg.)
 - **MKS 627D, 631C** (temp.-controlled, $\pm 0,23\%$ of Rdg.)

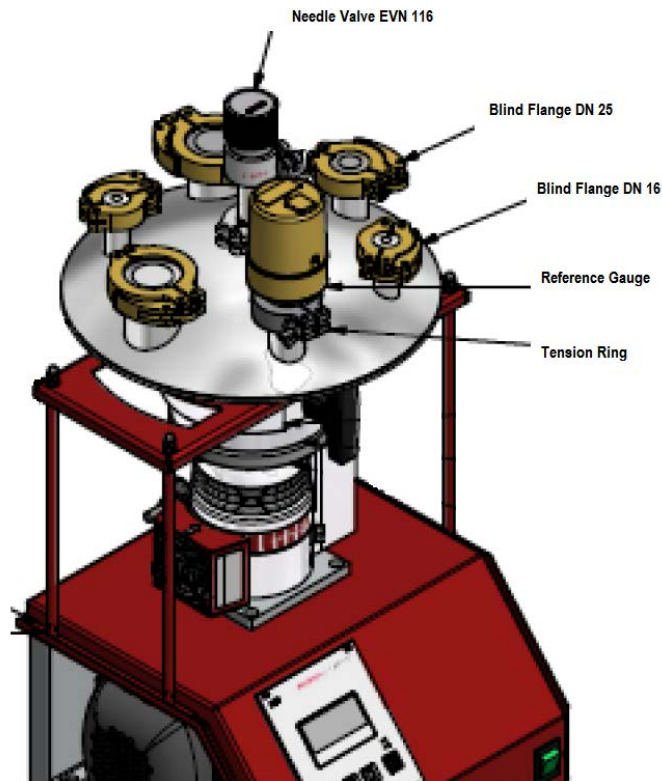
Useful working range: 2 decades i.e. $10^{-1} \dots 10^0$ mbar / $10^{-2} \dots 10^{-1}$ mbar



Vacuum Sensors uncertainty overview



Vacuum Sensor Calibrator (reference)



- turbo-molecular pump $1e-7$ mbar
- Rotary vane pump >1 mbar
- Reference gauge CMR372/374/375
- Calibration vessel (recipient) in symmetric shape
- Micro aeration valve



Temperature Calibration



Temperature sensors -wired- in use

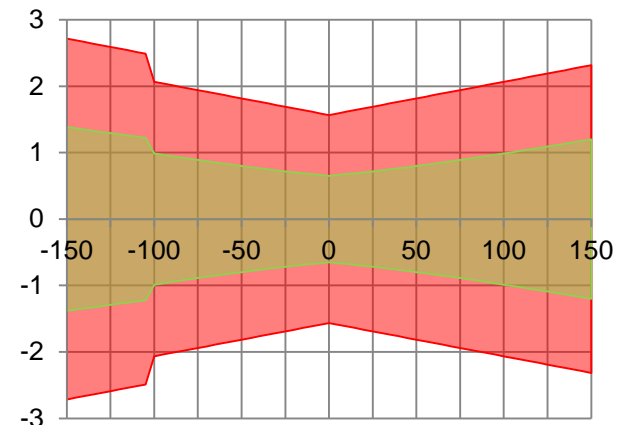
- resistance thermometer PT100
 - Platin Sensor - PTC (positive temp. coefficient)
 - 100Ω at 0° C
 - Measuring range: -150 .. +150° C, ±1.5K,
 - Working range: -100 .. + 50° C, ±1.0K,
 - Tolerance class and variance:
 - Class A: $\Delta T = \pm(0,15 + 0,002 \cdot t)$
 - Class B: $\Delta T = \pm(0,30 + 0,005 \cdot t)$



PT100 (class A)

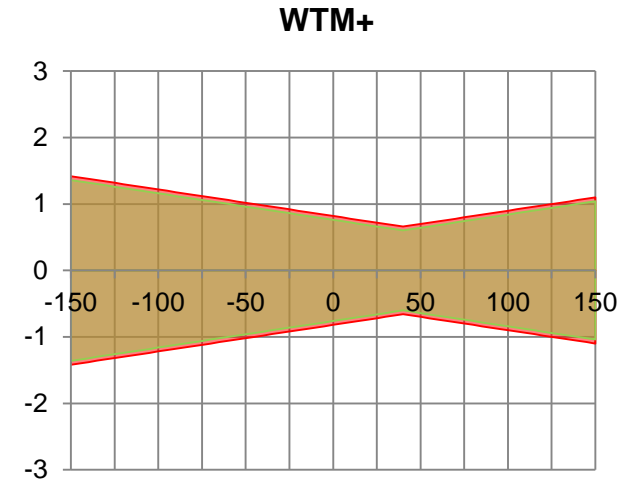


PT100 (class B)



Temperature sensors -wireless- in use

- WTMplus Wireless sensor
 - Quarz sensor
 - Measuring range: $-150 \dots +150^{\circ} \text{C}$, $\pm 1.3\text{K}$,
 - Working range: $-70 \dots +50^{\circ} \text{C}$, $\pm 1.0\text{K}$,



Temperature Calibrator

- Dry-calibrator i.e. AMetek, Isotech, etc.
- Temperature range $-70 \text{ .. } +140^{\circ} \text{ C}$
- Fluke thermometer with WTMpluck



Shelf temperature distribution (Shelfmapping)



Stellflächentemperaturverteilung - Aufbau

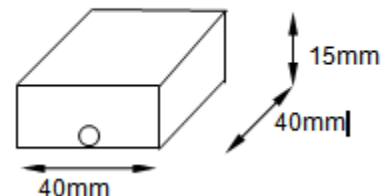
- Distribution of temperature probes on all shelves
- 20 channels (measuring points per recorder) placed on 1 + n shelves
- Position of each sensor is documented



- An exact, direct temperature measurement on the surface of the shelves is technically not possible. For this purpose thermal-aluminium-blocks are required
- To avoid heat convection, vacuum has to be applied : ca 1 mbar
- As per default distribution is measured at +20, -40, 0, +40° C
- Stabilisation time ~ 15 .. 30 min



Probenkörper :



Kontakt

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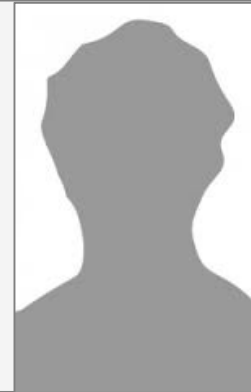


Foto & Diagramm Quellennachweis

- Jumo „Elektrische Temperaturmessung“ ISBN 13-978-3-935742-06-1
- Pfeiffer Vakuum Asslar “The Vacuum Know-How Book Vol II.“

