iPR-Series

Process-Refractometer

- Immediate concentration monitoring / control in liquids directly in the process steam (Inline real time with measuring intervals < 1 sec.)

- Applications:
  - Concentration monitoring
  - Product interface detection
  - Deviation from the nominal value (Quality control)
  - Crystallization monitoring
  - Dosage control

- Industries:
  - Food / Beverage
  - Chemistry
  - Pharmaceuticals
  - Sugar production
  - Textile and paper
  - Semiconductors
  - Cooling / lubbricant agents

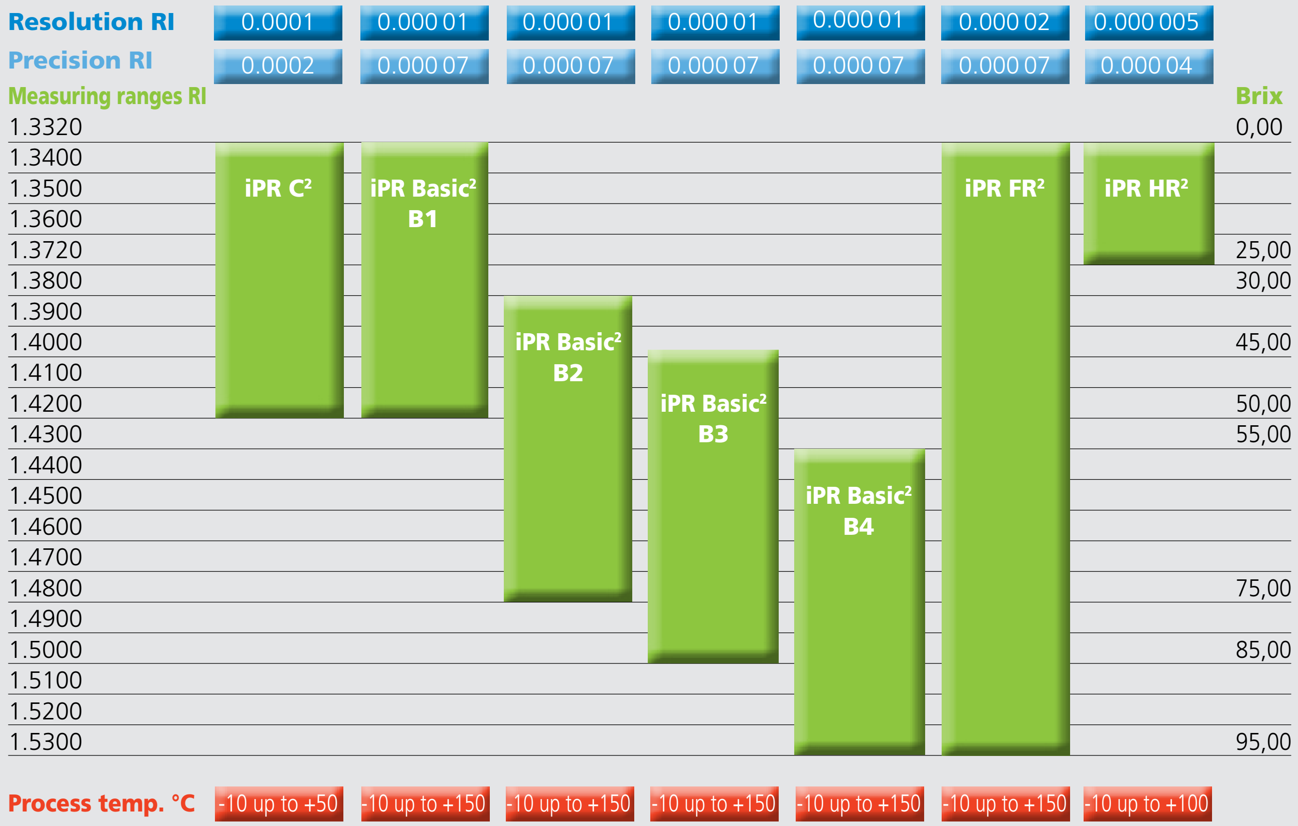
SCHMIDT + HAENSCH

Opto-electronic measuring device since 1864

iPR Process-Refractometer

Smart **heads** with Integration competence

Demonstration of the function of a Process Refractometer



For more than **30 years** inline Process Refractometers iPR from SCHMIDT+HAENSCH have been used successfully in the process analytical measuring technology.

iPR's continuously measure the refractive index and determine thereby the concentration of dissolved solids in solution and/or the mixing proportion of binary or quasibinary liquid mixtures.

The measurement is independent of turbidity, colour and absorption as well as viscosity and is free of signal drifts, granting high precision and better process control. The Brix measurement is temperature-compensated for the process stream conditions, reliably generating both high resolution and high precision.
The measurement is temperature compensated for process conditions, so that both high resolution and high accuracy can be achieved.

The stainless steel measuring head is resistant against chemicals, complying with regulations in food, beverage and pharmaceutical industries. CIP and pipe pig use is possible. The iPR measuring head can be installed in pipes, reactors, vessels, mixing tanks, kettles, boiling pans and evaporators, using different weld-in flanges.

The new generation of iPR measuring heads is equipped with additional - enhanced features:

- Stainless steel sensor meets the hygiene requirements of the food and pharmaceutical industries and tolerates temperatures up to 150°C*
- Temperature measurement close to the sample (process stream) within the sapphire prism
- Temperature compensation (eg, Brix scale) for indivi dual products
- User settable digital limit switches (1 A)
- Galvanic isolated 4 - 20 mA outputs*
- User programmable scales with temp. compensation
- All sensors are integrated in the unit
- Multiple error read out at user display*
- Electronic moisture sensor included
- Internal desiccant bag inside the unit for increased life span of electrical and optical components
- Light Source 589nm LED, extremely long lifetime 50 000 h
- Process connection with Varivent (Tuchenhagen), TriClamp, APV, bypass
- High quality „Made in Germany", advice and services on site upon request

*Exception: IPR-Compact²

iPR In-Line sensors can be used as a standalone solution with integrated display, which can be connected directly to a PLC, or visualized a Data Logger which can also record the results.

The iPR measuring heads opens the opportunity to construct an intelligent sensor station combining various process sensors e.g. O_2, CO_2, pH or conductivity.
The digital limit switches of the iPR's can remotely control pumps, valves and signals (visual or acoustic alarm), thus allowing a direct, real-time control of the process. Digital output switch handless up to 1 A.

iPR measuring heads are made of stainless steel and include a prism made of synthetic sapphire or YAG, which is both mechanically stable and chemically resistant to acids, sludge and solvents meeting the requirements of the food industry. The standard sealing material is Viton, special sealing (gasket) materials are available (eg Kalrez).

For measurement of highly concentrated acids or corrosive substances in which the contact with stainless steel is not desired, special PTFE in-line housings for the iPR are available.
The preferred process connection from SCHMIDT - HAENSCH is the VariVent inline housing. The VariVent connection will handle pressure up to 10 bar* and is hygienic while minimizing dead space.
The standard installation enables the use of pipe pigs.

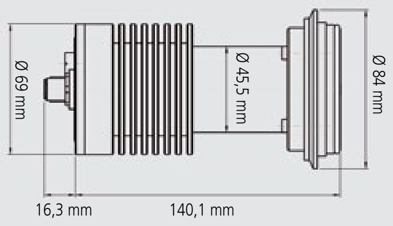
The iPR is also available in an intrinsically safe version (ATEX class ib II A T4).

For processes, where the **substances cause fouling on the prism surface**, a cleaning device using water, steam or solvent is available. For processes where such additions are not allowed, a **proprietary ultra sonic cleaning** device is available for the VariVent mounting.

Technical data iPR-series

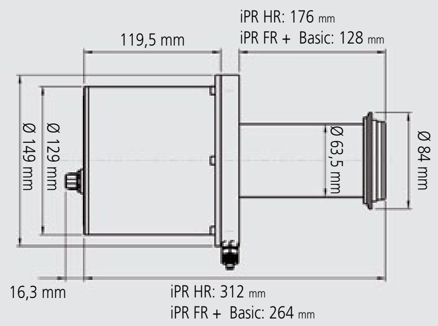
iPR Compact²

Measuring range:	1.3320 - 1.4209 RI / 0 - 50 Brix
Brix-range with ATC:	0 - 50 °C
Resolution:	0.0001 RI / 0.05 Brix
Precision:	± 0.0002 RI / ± 0.15 Brix
ATC range:	10 - 50° C
Process temperature:	-10 up to +50°C
Process pressure (max.):	1 MPa (145 psi, 10 bar)
Power supply:	24 V DC
Light source:	589 nm LED
Interfaces:	1 output 4 - 20 mA, 1 digital output switch (up to 1 A) 1 serial output (RS232, alternativly RS485 or USB)
Dimensions:	150 x ø 65 mm
Weight:	1000 g



iPR Basic²

Measuring range:	B1: 1.3320 - 1.4200 RI / 0 - 50 Brix B2: 1.3800 - 1.4800 RI / 30 - 75 Brix B3: 1.4000 - 1.5000 RI / 45 - 85 Brix B4: 1.4200 - 1.5300 RI / 55 - 100 Brix
Resolution:	0.000 01 RI / 0.01 Brix
Precision:	± 0.000 07 RI / ± 0.05 Brix
Process temperature:	-10 up to +150°C (with water cooling installed)
Prozess pressure (max.):	1 MPa (145 psi, 10 bar)
Process contact material:	Saphir or YAG, Stainless steel, optional: PTFE
Power supply:	24 V DC
Light source:	589 nm LED
Interfaces:	2 insulated 4 - 20 mA analog outputs 2 digital output switch (up to 1 A) 1 serial output (RS232, alternativly RS485 or USB)
Mounting accessories:	VariVent (Tuchenhagen), APV or TriClamp



iPR FR² (Full Range)

Technical data as like iPR Basic², deviate:

Measuring range:	1.3320 - 1.5300 RI / 0 - 100 Brix
Resolution:	0.000 02 RI / 0.02 Brix
Precision:	± 0.000 14 RI / ± 0.1 Brix

iPR HR² (High Resolution)

Technical data as like iPR Basic², deviate:

Measuring range:	1.3320 - 1.3720 RI / 0 - 25 Brix
Resolution:	0.000 005 RI / 0.002 Brix
Precision:	± 0.000 04 RI / 0.02 Brix ± 0.01 Brix (range up to 2% Brix concentration)
Process temperature:	-10 up to +100°C (with water cooling installed)

iPR EX (Ex proof version)

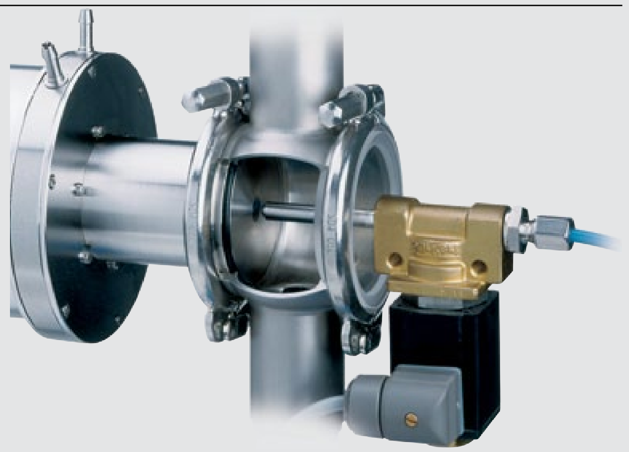
Technical data as like iPR Basic², deviate:

Ex proof:	Intrinsically safe, ATEX class ib II A T4
Control unit:	Splash proof IP 65 (NEMA 4)
Power supply:	85 - 260 V / 50 - 60 Hz
Others:	Measuring head without display, electronic unit seperately neccessary

Mounting accessories for process integration

iPR Inline housing

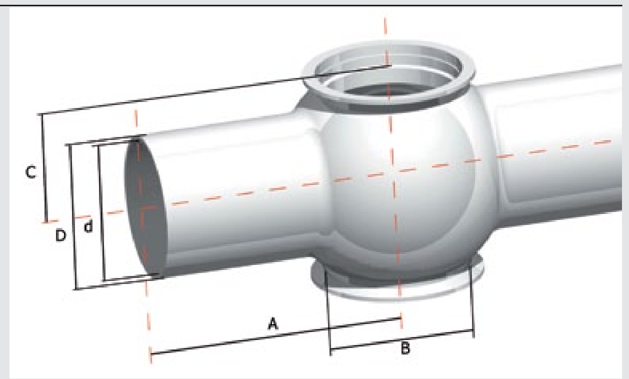
Inline housing from SCHMIDT+HAENSCH are perfectly suitable for hygienic installations of processes in vessels or pipes.
The VariVent joint system allows easy installation of iPR instruments through a plug-in and clamping method.
The Inline housing can be used with process pressure up to 10 bar.
Some processes may require cleaning of the sensor face. SCHMIDT+HAENSCH offers an optional cleaning nozzle (see picture) or an ultrasonic cleaning device.
For pipe size not shown in the table other combinations of bypass lines or reducers can be incorperated into the design.



iPR with Varivent/TriClamp and steam cleaning unit

Inline housing VariVent / welded

For the installation of an iPR in pipes by welding flange



Metric
Outside diameter to DIN 11850, series II, DIN 11866, series A

Nominal-wide d	A	B	C	D	Order No.
DN 40	90	68	36	41	**08211**
DN 50	90	68	42	53	**07223**
DN 65	125	68	50	70	**08628**
DN 80	125	68	57,5	85	**08629**
DN 100	125	68	67	104	**08631**
DN 125	125	68	79,5	129	**08632**

Inch
Outside diameter in accordance with ASME-BPE-a-2004, DIN 11866, series C

Nominal-wide d	A	B	C	D	Order No.
1 ½“	90	68	34,5	38,1	**02796**
2“	90	68	40,75	50,8	**02634**
2 ½“	125	68	47	63,5	**10993**
3“	125	68	53,5	76,2	**01113**
4“	125	68	65,75	101,6	**10995**

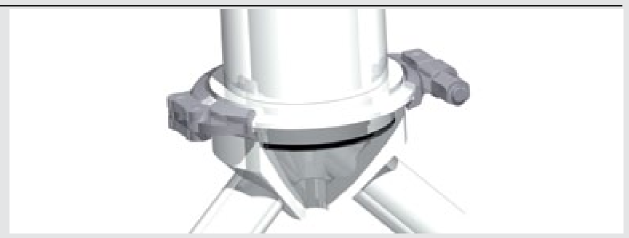
VariVent / welded

For the installation of an iPR in vessels

VariVent housing connection T, Order No. 07516

Bypass

For the installation of an iPR in small volumes, with hose and pipe connections



Case type	Order No.
BE Stainless steel housing	**07284**
BT PTFE housing	**07283**
BV1 VariVent stainless steel housing, 1“ pipe c.	**01495**
BV2 VariVent stainless steel housing, ½“ pipe c.	**10328**

Inline housing VariVent / TriClamp ends

For installation in pipes with TriClamp connection

Metric
Outside diameter to DIN 11850, series II,
DIN 11866, series A

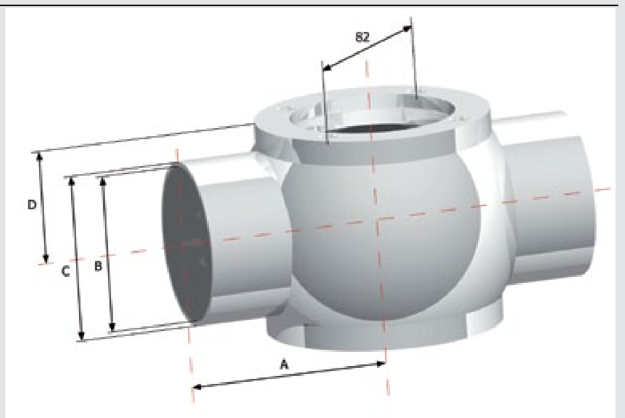
Pipe diameter	B	C	D	Order No.
DN 40	68	36	41	**11004**
DN 50	68	42	53	**11005**
DN 65	68	50	70	**11006**
DN 80	68	57,5	85	**11007**
DN 100	68	67	104	**11008**
DN 125	68	79,5	129	**11009**

Inch
Outside diameter in accordance with ASME-BPE-a-2004,
DIN 11866, series C

Pipe diameter	B	C	D	Order No.
1 1/2"	68	34,5	38,1	**11055**
2"	68	40,75	50,8	**11056**
2 1/2"	68	47	63,5	**11057**
3"	68	53,5	76,2	**11058**
4"	68	65,75	101,6	**11059**

Inline housing APV / welded ends

For installation of iPR in pipes by welding flange



Metric
Outside diameter to DIN 11850, series II,
DIN 11866, series A

Nominal-wide d	A	B	C	D	Order No.
DN 25	68	26	29	25,5	**02735**
DN 40	67	38	41	31,5	**02490**
DN 50	72	50	53	37,5	**01667**
DN 65	85	66	70	45,5	**11060**
DN 80	98	81	85	53,0	**02667**
DN 100	111	100	104	62,5	**11009**
DN 125	130	125	129	75,0	**11014**
DN 150	150	150	154	87,5	**10996**

Inch
Outside diameter in accordance with ASME-BPE-a-2004,
DIN 11866, series C

Nominal-wide d	A	B	C	D	Order No.
1"	68	22,9	25,4	24,0	**03324**
1 1/2"	67	35,1	38,1	30,0	**11080**
2"	72	47,8	50,8	36,4	**11081**
2 1/2"	85	60,3	63,5	42,5	**11082**
3"	90	72,9	76,1	48,5	**01068**
4"	111	97,6	101,6	61,3	**11084**

Data Logger

- Electronic data storage with up to 6 inputs
- The system allows network connectivity and data transmission via RS232 / RS485 (Modem) and USB
- Inputs galvanic isolated from the system
- Optional Profibus DP slave, housing IP 65

About Refractometry

The speed of light and the refractive index
In a vacuum, light travels at a maximum speed of about 300.000 km/s while travelling through water, the speed is about 225.000 km/s, which is 25% less. In a sapphire it will only reach 170.000 km/s.

A **refractometer** is a measuring instrument for the speed of light. The result will not be indicated directly but related to the speed of light in air. This comparison is called **refractive index (RI)**.

The indication, that a certain material has a refractive index of 1.5 thus means, that the speed of light travels 50% faster through air than through this material.

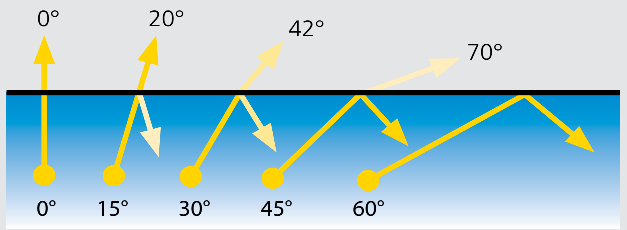
The practical advantage of the refractive index
The refractive index is a value specific to a material. It depends on temperature and wavelength (λ = colour) of the light. Thus using a refractometer, will enable you to determine the concentration of a material, if temperature and wavelength are known. But it is also possible, that different materials have the same refractive index at various concentrations. Thus a clear determination of liquid substances may only be successful with binary mixtures (Mixtures consisting of two compounds).

In practice, the refractive index determines the mixing ratio also of multicompound solutions quite exactly and easily as in general only the concentration of one of the componends needs to be determined. Thus it is a quantitative measurement.
There is a definite correlation between the refractive index and the composition of many two-compound solutions. The best known example for such a mixture is a solution of sucrose in water, which has been studied throughly. A refractometer can be grated in a way that the value may be indicated directly as dry substance %RTS. For sucrose, this unit is also named **Brix** (abb. Bx).

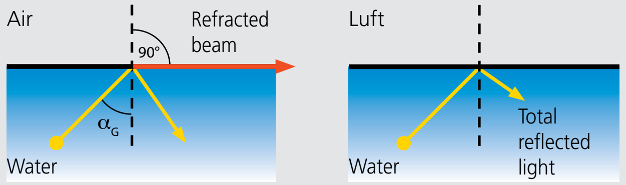
Measuring the refractive index
To understand total internal reflection, we begin with a thought experiment.
Suppose that a laser beam inside of a water tank aims towards the air-water boundary. Then suppose that the angle at which the beam directed upwards is slowly altered, beginning with small angles of incidence and proceeding towards larger and larger angles of incidence.

The principles of boundary behaviour let us expect that we would observe both reflection and refraction. We would also observe that the intensity of the reflected and refracted rays do not remain constant. At angle of incidence close to 0 degrees, most of the light energy is transmitted across the boundary and very little of it is reflected. As the angle is increased to greater and greater angles, we would begin to observe less refraction and more reflection. That is, as the angle of incidence is increased, the brightness of the refracted ray decreases and the brightness of the reflected ray increases.
Finally, we would observe that the angles of the reflection and refraction are note equal. Since the light waves would refract away from the normal, the angle of refraction would be greater than the angle of incidence.

In case the incident angle is 60° there will be no refracted ray any more, we would say: light is totally reflected.

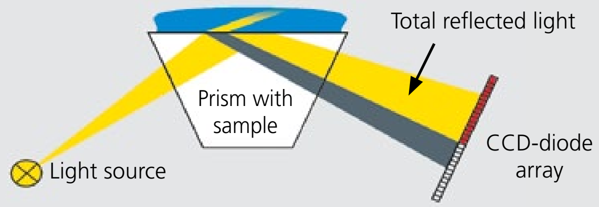


A more detailed picture below shows the case where light impinges under such special angle that the refracted beam makes an angle of 90° with the surface normal.



Critical angle | Total reflexion

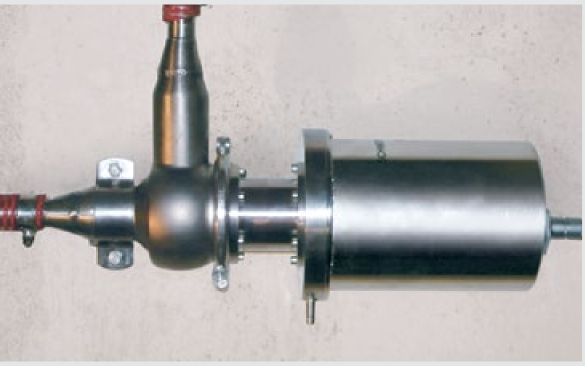
There comes a time when all of the rays are reflected, this happens when the angle of incidence is equal to or greater than the critical angle α_{crit}.
If one knows exactly the refractive index of the glass prism or made of artificial sapphire of the refractometer, then by measuring the critical angle of total reflection, one could find out the refractive index of the sample.



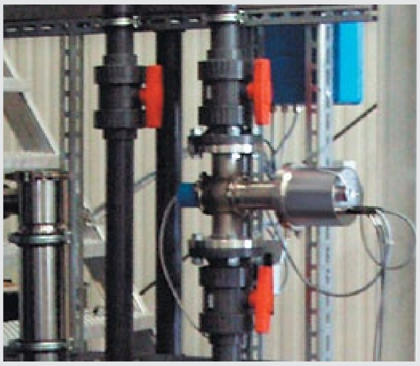
Since the light beam only probes a fraction of wavelength into the second medium very dark and turbid samples can be measured without problems. By inserting a drop of liquid on top of the measuring prism a very sharp line will appear dividing regions of below and above the critical angle.

Temperature effects
A solution of 40 g of sucrose in 100 g of water has a refractive index (RI) of 1.39986 at a temperature of 20°C. The same solution has a much lower RI value 1.39828 at 30°C.
The difference in the measured values is caused only by the change of the temperature and not by change of the concentration. The so called temperature correction therefore considers the influence of the temperature on the solution to be measured. This is generally a non-linear behaviour (matrix) in dependency of the different concentrations.

Herewith it is possible to dertermine a temperature correction for a substance and to program a refractometer in a way that it indicates only the concentration of this substance independent of the measuring temperature.



90° angle VariVent mounting with hose connection

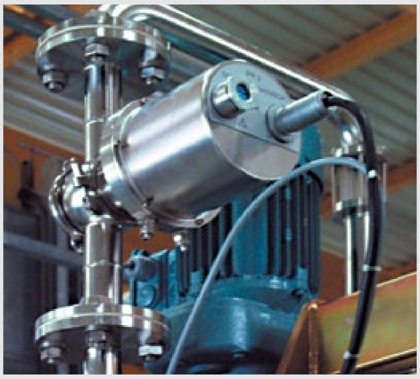


Inline installation (with bypass for maintenance work)

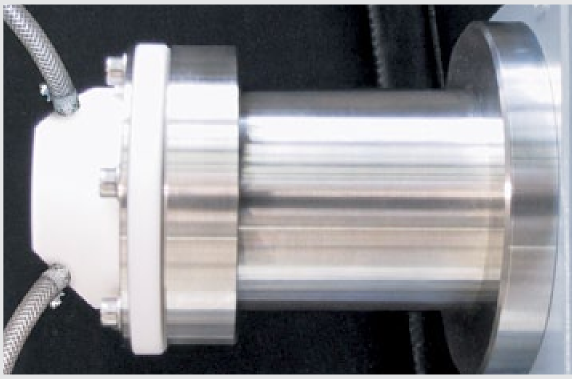
Installation in crystallizer (vessel flange)

Pipe work installation VariVent with ultrasonic cleaning

Installation in circulating process with pump



Teflon bypass for high corrosive liquids and semiconductor processes



Refractometer applications

Process Refractometers are used in many fields for measuring, process control and documentation

Chemical industry
Inorganic acids and bases
Fats and oils
Organic products and dissolvents
Salt solutions
Pulp and paper
Paints and glues

Petrochemical industry
Paraffins, waxes
Petrol chemical products (ex proof version available)
Resins
Semiconductor industry
Slurries, hydrogen peroxide, hydrofluoric acids

Vehicle- and engine construction
Antifreezer
Lubricants, oils

Food industry
Juice, fruit concentrate
Soft drinks
Vine, beer
Coffee, coffee extract
Milk products, yoghurt
Tomato pate, ketchup
Marmalades, jams, jellies, fruit processing
Candies, chocolate
Starch

Sugar industry
Raw juice, thin and thick juice
Massecuite, molasses
Liquid sugar, compressed water
Crystallization pans

Textile industry
Polyvinyl alcohol

Subject to modification without notice
Änderungen vorbehalten
10/10

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