Technical **Datasheet**

delta-controls

D-Series
## SMART Differential Pressure Transmitter with Two Diaphragm Seals
Models: DPR-2200

Key **Features**

- High accuracy ±0.1%

- 4-20mA analogue with digital communications

- Fully HART ® compatible

- Static pressure limit up to 420 bar

- ATEX certified (Intrinsic Safety, Flameproof)

- Fully welded sensor guarantees tightness of oil systems for long term usage

- Ability to locally configure measuring range

Series **Overview**

The D-Series pressure, differential pressure and temperature transmitters offer customers cost-effective and accurate solutions to their individual process requirements.
Available with a wide range of process connections and easily configurable via the D-Soft software, the D-Series can be used for a variety of applications where pressure, differential pressure, temperature, level or flow measurements are needed. Other models in this series include:

- DPR-2000G SMART Differential Pressure Transmitter for low ranges

- DPC-2000 SMART Pressure Transmitter

- DPT-2000 SMART Temperature Transmitter

- DPR-2000 SMART Differential Pressure transmitter
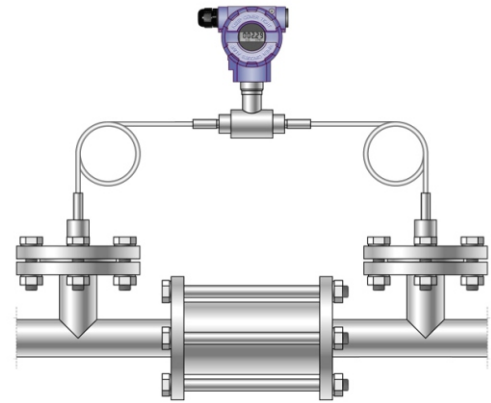
Product **Applications**
The DPR-2200 is suitable for a wide range of applications for measuring:

- Differential Pressure

- Level

- Flow

The choice of models available ensures that the DPR-2200 is:

- Suitable for use in corrosive atmospheres

- Resistant to chemical attack
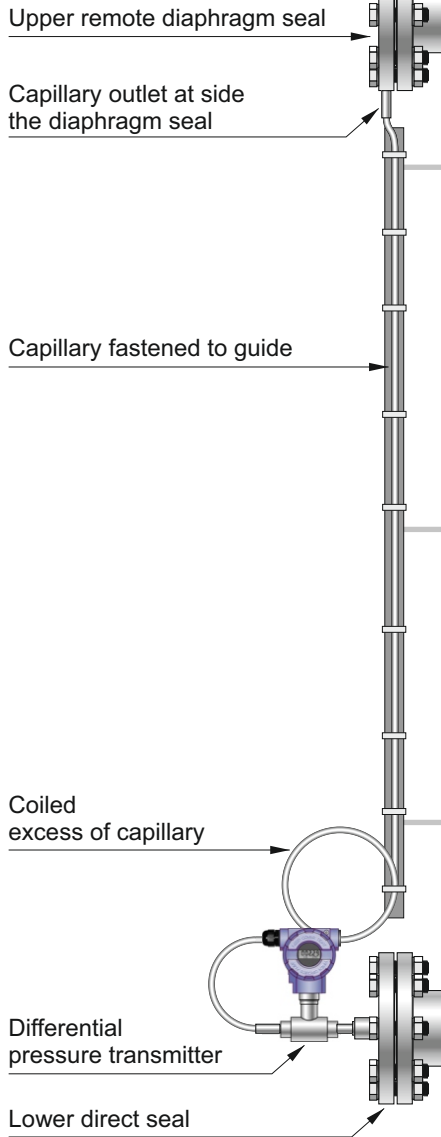
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+44 (0) 1252 729 140

D-Series
Models: DPR-2200ALW

Pressure Tank

Transmitter with two types of diaphragm seal:
direct diaphragm seal;
remote diaphragm seal

Upper remote diaphragm seal

Capillary outlet at side
the diaphragm seal

Capillary fastened to guide

Coiled
excess of capillary

Differential
pressure transmitter

Lower direct seal

Recommendations

The transmitter with a direct diaphragm seal (connected to the positive measurement chamber) and a remote diaphragm seal (connected to the negative chamber) is recommended for hydrostatic measurements of: level, density, phase boundaries and pressure differences (with differentiated height of pulse source points*)

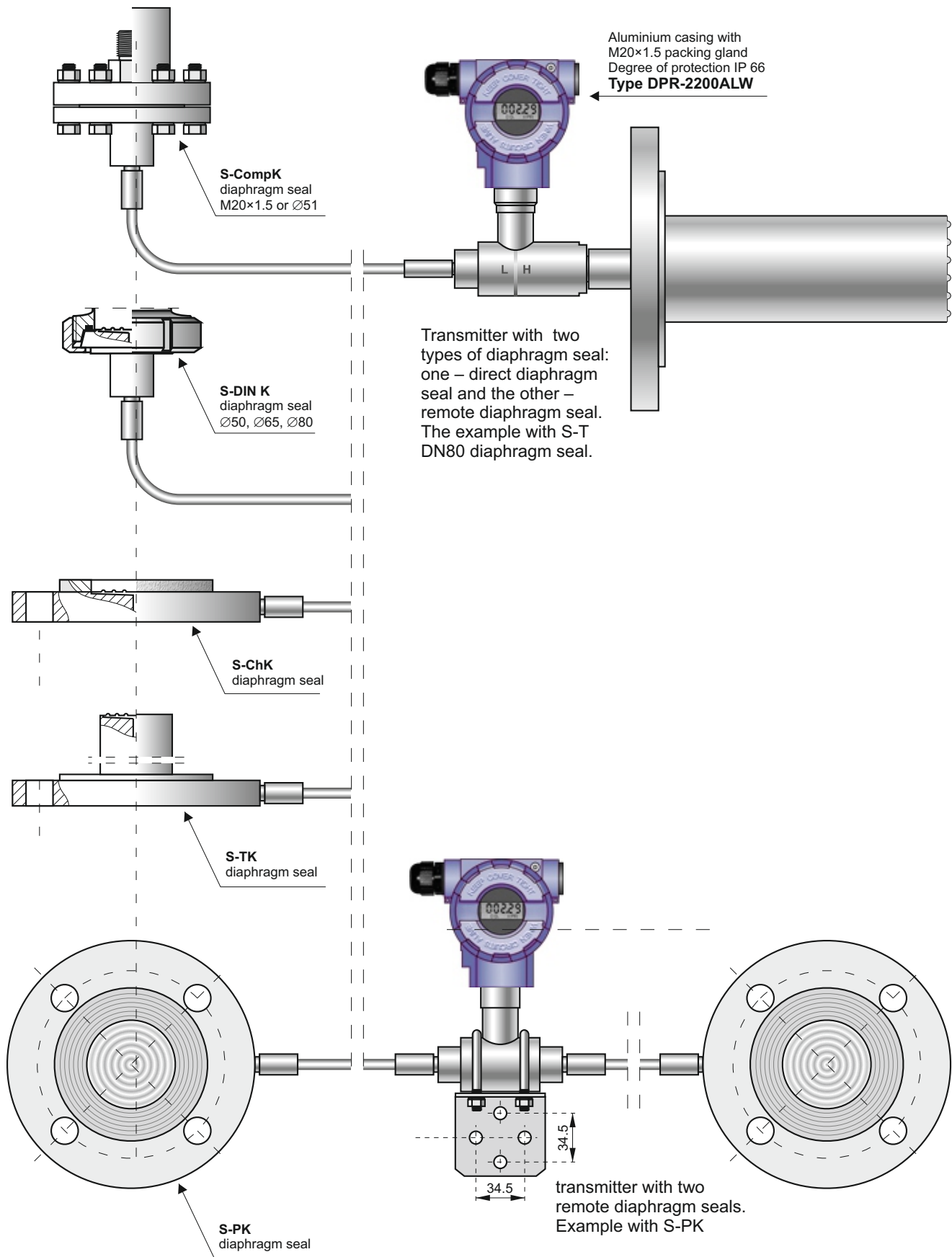In such a configuration, at ambient temperature changes, two opposite phenomena appear concurrently.

Thermal expansion causes the change in the volume (and hence also the change in density) of the manometric fluid in the capillary, which results in a change of the hydrostatic pressure related to the vertical spacing of the seals.

This phenomenon is counteracted by the elastic reaction of the diaphragm of the upper diaphragm seal, which is displaced by the change in manometric fluid volume. Based on tests and experiments, the Delta transmitters are provided with carefully selected seal diaphragms which guarantee compensation of errors caused by changes in ambient temperatures.

The best metrological results are obtained using the assembly which include DN 80, DN 100, A 109 and S-Comp diaphragm seals or S-Mazut, S-DIN and S-Clamp diaphragm seals with a diameter of at least 65 mm, where the length of the capillary is (1-1.3) x (vertical spacing of seals). It is recommended to use identical diaphragm seals at the both upper and lower connection points.

* The difference in height of pulse source points, at which the hydrostatic pressure of the manometric flued is comparable to or greater than the range of the transmitter

S-CompK
diaphragm seal
M20×1.5 or ⌀51

S-DIN K
diaphragm seal
⌀50, ⌀65, ⌀80

S-ChK
diaphragm seal

S-TK
diaphragm seal

S-PK
diaphragm seal

Aluminium casing with
M20×1.5 packing gland
Degree of protection IP 66
Type DPR-2200ALW

Transmitter with two
types of diaphragm seal:
one – direct diaphragm
seal and the other –
remote diaphragm seal.
The example with S-T
DN80 diaphragm seal.

34.5

34.5

transmitter with two
remote diaphragm seals.
Example with S-PK

Note: The appropriate configuration of the complete set of pressure transmitter, diaphragm seals and capillaries, as well as the proper selection of manometric fluid depends on several factors such as: the physical and chemical properties; the temperature range of the medium; the vertical spacing of the diaphragm seals; the measuring range; the static pressure range; the range of ambient temperatures; the technical specification for the mechanical connection of the diaphragm seals to the pressure devices.

Application & Construction

The differential pressure transmitter is applicable to the measurement of pressure differences of: gas, vapour and liquid, in cases where it is necessary to use seals and the pressure pulse source points may be several metres apart. Typical applications include the hydrostatic measurement of: level in closed tanks; density and phase boundaries; filter loss pressure differences between media in pasteurisers etc. The available range of the diaphragm seals allow measurement at great majority of media. The active element is a piezoresistant silicon sensor separated from the medium by a distance sealing systems. The special design of the measuring uni means that it can withstand pressure surges and overloads of up to 40bar. The electronic circuits are enclosed in a casing with a degree of protection Ip65 or 66.

Configuration & Comms

The settings of the following metrological parameters can be changed:
- the units of pressure in which the range is configured
- stat and end points of the range, time constant
- inverted characteristic (output signal 20 ÷ 4mA)

The transmitter is configured and calibrated using a KAP-03 communicator, other communicators (HART) or a PC using an RS-HART converter and Delta D-Soft configuration software.

The data interchange with the transmitter enables users transmitter identification, as well as readings of the currently measured differential pressure value, ouput current and range width percentage.

Measuring Ranges

Nominal measuring range (FSO)	Minimum set range	Vertical spacing of diaphragm seals	Maximum set range width, considering the actual vertical spacing of the diaphragm seals (m)	Static pressure limit
-160…160 mbar	0.1 m H_2O	Λ 1.7 m	[1.6 + (vertical spacing of seals × 0.94)] m H_2O	40 bar
-0.5…0.5 bar	0.5 m H_2O	Λ 6 m	[5 + (vertical spacing of seals × 1.04)] m H_2O	40 bar
-1.6…2 bar	1.5 m H_2O	Λ 15 m	[20 + (vertical spacing of seals × 1.04)] m H_2O	40 bar
-1.6…16 bar	1 bar	Λ 15 m	16 bar	40 bar

CAUTION: The maximum vertical diaphragm seal spacing shown in the table applies to level meas urement, ensuring that it is possible to set the zero point of the transmitter when the tank is empty. For measurements of density or phase bou ndaries (in the sugar, chemical or refinery industries) the vertical spacing of the diaphragm seals can be larger.

Metrological parameters

Accuracy   ≤±0.1% (FSO)
****See DPR-2000ALW Differential Pressure Transmitter datasheet for other parameters
DPR-2000ALW

Sealing Effect Errors - see Diaphragm Seal datasheet

NOTE: The additional absolute zero error due to ambient temperature can be compernsated by configuring the transmitter, seals and capillaries in accordance with the recommendations on the front page of this datasheet

Electrical parameters - see DPR-2000ALW Differential Pressure Transmitter datasheet

Operating conditions

Operating temperature range (ambient temperature)
- 25-85°C
DPR-2200ALW/EEx   - -25-80°C

Medium temperature ranage - see Diaphragm Seal datasheet ref. remote seal

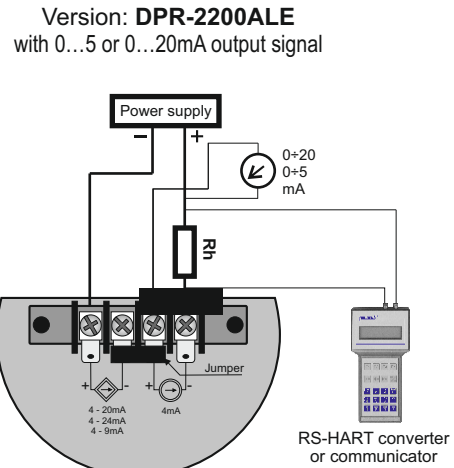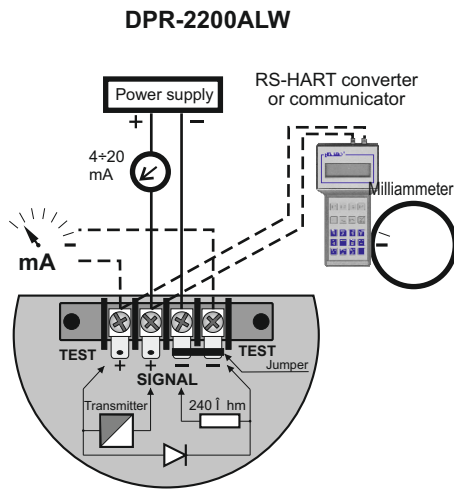**Special versions, certificates:**
EExia - ATEX Instrinsic safety
EExd - ATEX Explosion proof
100 bar, 160 bar - static pressure limit: 100bar or 160bar
Non-standard basic range
Others

Transmitters with HART protocol

DPR-2200ALW

Version: DPR-2200ALE
with 0…5 or 0…20mA output signal

How to Order

Model	Codes	Description		
DPR-2200		Smart differential pressure transmiter.		
Casing, Output signal →	ALW………………………………………...…..………	Aluminum housing, IP66/IP67, with display, output 4–20mA + Hart		
	ALE…………………………...………….......…………..	Aluminium housing, IP66/IP67, with display, output 4–20mA + Hart 0 – 20mA+ Hart, 0 – 5mA+ Hart,		
	ALW/SS……………………………………...….…….	Stainless steel housing, IP66/IP67, with display, output 4-20mA + Hart		
Versions, Certificates∗ ∗) more than one option is available	/EEx ia……………………...……..……………..	Ex I M1 Ex ia I Ma (steel enclosure only) Ex II 1/2G Ex ia IIC T4/T5 Ga/Gb Ex II 1/2G Ex ia IIB T4/T5 Ga/Gb (version with Teflon shielded cable) Ex II 1D Ex ia IIIC T105°C Da	(not available for ALE)	
	/EEx d……………………...………….………..	Ex I M2 Ex d ia I Mb (steel enclosure only) Ex II 1/2G Ex ia/d IIC T6/T5 Ga/Gb Ex II 1/2D Ex ia/t IIIC T85°C/T100°C Da/Db Packing gland available on request.	For pressures >250mbar (not available for ALE)	
	/100bar……………………...…..……………..	Static pressure limit – 100bar		
	/160bar……………………...…..……………..	Static pressure limit – 160bar		
Nominal measuring range → (∗ not standard ranges available on request)		Range		min set range
	-160÷160mbar……………..........…………..	-160÷160mbar (-16÷16kPa)		0,1 mH$_2$O
	-0.5÷0.5bar…………………..…..…………..	-0.5÷0.5bar (-50÷50kPa)		0,5mH$_2$O
	-1.6÷2bar……………..…………….………..	-1.6÷2bar (-160÷200kPa)		1,5mH$_2$O
	-1.6÷16bar………………......………..……..	-1.6÷16bar (-160÷1600kPa)		1bar
Measuring set range	/…÷... [required units]……...………...	Start and end of calibrated range in relation to 4mA and 20mA output		
Process connections	/(+)……………………………….....	Direct diaphragm seal or remote diaphragm seal mounted on the (+) side of the transmitter- code as given in the relevant diaphragm seal sheet		
	K=…………………………....	Capillary length on (+) side of transmitter		
	/(-)……………………....	Remote diaphragm seal mounted on the (-) side of the transmitter – code as given in the relevant diaphragm seal sheet (chapter III – seals)		
	K=………………....	Capillary length on (-) side of transmitter		
Electrical connection →	(without marking).....	Packing gland M20x1,5		
	/US………….……...	Thread 1/2NPT Female		
Accessories →	/FI25………….	Mounting bracket type FI25 for 2" pipe, material 304ss		
Other specification	/...............	Description of required parameters		

To simplify the mathematical operations, we introduce the density coefficient of the medium, X_ρ.

$$X_\rho = \frac{\rho_{medium}\ [g/cm]^3}{\rho_{water\ at\ 4\ °C}\ [g/cm^3]}$$

Since the density of water at 4°C is 1 g/cm^3 , the **density coefficient** X_ρ **is numerically equal to the density of the medium expressed in g/cm^3**. To determine the hydrostatic pressure of a column of liquid in mm H$_2$O, it is sufficient to multiply the height of the column h [mm] by the density coefficient of the liquid X_ρ. Since it is easy to determine the hydrostatic pressure in mm H$_2$O and the transmitter can be configured in those units, in the descriptions of measurement methods given below we will make use of pressures expressed in mm H$_2$O and the density coefficient X_ρ.

Configuration of the transmitter to measure the level of liquid in a tank

The measurement task:
To convert a variation in the level of a liquid with density $\rho = 0.87$ g/cm^3 between 0 and h $_{max}$ to a variation in the output signal from 4 to 20 mA.

H – vertical spacing of diaphragm seals
$0 \leq h \leq h_{max}$
$\rho = 0.87$ g/cm^3

4...20 mA
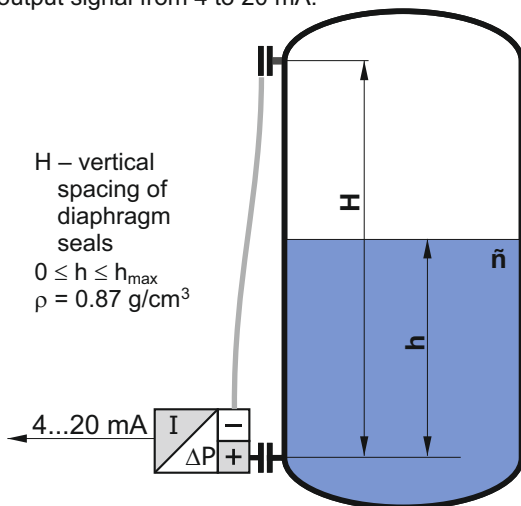
1. Install the transmitter in its working position on an empty tank.
2. Make the electrical connections of the transmitter, providing for the ability to use HART communication.
3. Connect the KAP-02 communicator, identify the transmitter and select the "configuration" function.

4. On the configuration menu select the "Reranging" procedure.
5. On the "Reranging" menu:
   a) change the units of measurement to mm H$_2$O at 4°C;
   b) enter the values for the start ($X_\rho \times h_{min}$ [mm]) and end ($X_\rho \times h_{max}$ [mm]) of the measurement range, namely 0 and (0.87 h$_{max}$ [mm]) respectively;
   c) to compensate for the hydrostatic pressure of the manometric fluid, the start of the measurement range should be set using regulated pressure; when subject to the action of only the manometric fluid (empty tank) the transmitter will shift the start and end-points of the range, compensating for the value of that pressure.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

If it is not possible to empty the tank to configure the transmitter, the hydrostatic pressure of the manometric fluid should be calculated by multiplying the vertical spacing of the diaphragm seals by the density coefficient of the oil in the capillaries. This pressure should be taken into account when entering the values for the start and end of the range:

Start [mm H$_2$O] = $-H$ [mm] $\times X_{\rho oil}$

End [mm H$_2$O] =
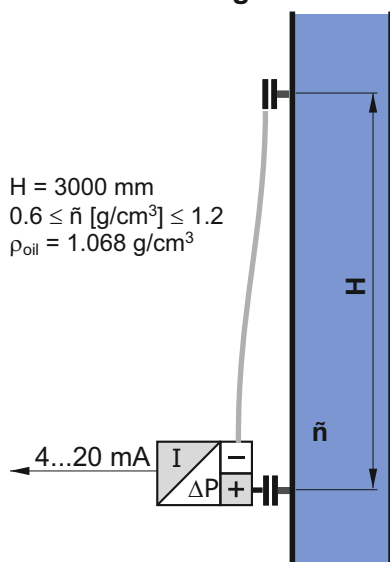$= h_{max}$[mm] $\times X_{\rho\ measured\ liquid} - H$ [mm] $\times X_{\rho oil}$

ρ_{oil} for DC-550 oil is equal to 1.068 g/cm^3
ρ_{oil} for AK-20 oil is equal to 0.945 g/cm^3

Configuration of the transmitter to measure density of liquids

H = 3000 mm
$0.6 \leq$ ñ [g/cm^3] ≤ 1.2
$\rho_{oil} = 1.068$ g/cm^3

4...20 mA

The measurement task:
To convert a variation in liquid density from $\rho_{min} = 0.6$ g/cm^3 to ñ $_{max} = 1.2$ g /cm^3 to a variation in the output signal from 4 to 20 mA, with the vertical spacing of the diaphragm seals equal to H = 3000 mm. The sealing system is filled with DC-550 oil with density $\rho_{oil} = 1.068$ g/cm^3.

1. Calculate the value o f the start of the range as follows:
   $H_{[mm]} \times (X_{\rho min} - X_{\rho oil}) =$
   $= 3000 \times (0.6 - 1.068) = -1404$ [mm H$_2$O]
2. Calculate the value of the end of the range as follows:
   $H_{[mm]} \times (X_{\rho max} - X_{\rho oil}) =$
   $= 3000 \times (1.2 - 1.068) = 396$ [mm H$_2$O]
3. Set the zero point of the transmitter with the diaphragm seals positioned at the same level.
4. Install the transmitter in its working position.
5. Make the electrical connections to the transmitter, providing for the possibility of using HART communication.

6. Connect the KAP-03 communicator, identify the transmitter and select the "configuration" function.
7. On the configuration menu select "Reranging" procedure.
8. On the "Reranging" menu:
   a) change the measurement units to mm H_2O at 4°C;
   b) enter the calculated values for the start (–1404) and end (396) of the range.

When the transmitter has been configured in this way it is ready to be used to carry out the given measurement task.

Note: If it is possible to fill the space between the seals with a liquid whose density corresponds to the start of the measurement range, the start of the range of the transmitter can be set using regulated pressure.

Measurement of phase boundary

The height of the phase boundary of liquids of different densities is determined by measuring the average density of the medium between the seals.

Example:
Calculate the measurement range start and end points for an DPR E-2200 transmitter configured to measure phase boundary height in the range 0–1000 mm between liquids of density $\rho_1 = 0.7$ g/cm^3 and $\rho_2 = 1.0$ g/cm^3, where the vertical spacing of the seals H = 1600 mm. The sealing system uses DC-550 oil with a density of 1.068 g/cm^3.

$H = 1600$ mm
$0 \le h \le 1000$ mm
$\rho_1 = 0.7$ g/cm^3
$\rho_2 = 1.0$ g/cm^3
$\rho_{oil} = 1.068$ g/cm^3

4...20 mA
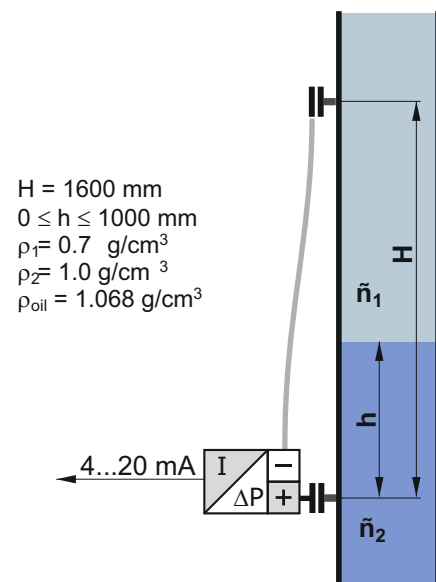
To determine the start of the measurement range, calculate the pressure difference at the transmitter when the tank is filled with the lighter liquid only:
$$1600 \text{ [mm]} \times (0.7 - 1.068) = -588.8 \text{ [mm } H_2O]$$

To determine the end-point of the range, add the increase in pressure resulting from the appearance of a 1 metre column of the heavier liquid:
$$-588.8 \text{ [mm } H_2O] + (1.0 - 0.7) \times 1000 \text{ [mm]} =$$
$$= -288.8 \text{ [mm } H_2O]$$

Additional remarks

The settings of the transmitter can be adjusted with reference to laboratory results from density measurements carried out on samples of the liquid being measured. This is most often necessary when the measurement takes place in a pipeline segment where the flow velocity of the measured liquid reaches several m/s.

Increasing the vertical spacing of the diaphragm seals widens the range and often improves measurement accuracy.

In planning the spacing of the diaphragm seals, ensure that the pressure difference at the transmitter lies within the basic range.

The maximum vertical spacing of the diaphragm seals (H) depends on the transmitter's basic range and the boundary values for the density of the measured liquid (ρ_{min}; ρ_{max}).

If $\rho_{min} < \rho_{oil} < \rho_{max}$, the seal spacing H should satisfy the following conditions:

$$H \text{[mm]} \le \frac{\text{lower boundary of range [mm } H_2O]}{X\rho_{min} - X\rho_{oil}}$$

$$H \text{[mm]} \le \frac{\text{upper boundary of range [mm } H_2O]}{X\rho_{max} - X\rho_{oil}}$$

Example:
Determine the maximum vertical spacing of the seals for the **DPRE-2200 / -10...10 kPa** transmitter when measuring the density of liquid between 0.6 and 1.2 g/cm^3. The sealing system uses AK-20 silicone oil with a density of 0.945 g/cm^3.

The lower boundary of the range of the transmitter is –10 kPa = –1020 mm H_2O

$$H \text{ [mm]} \le \frac{-1020}{0.6 - 0.945} \quad ? \qquad H \text{ [mm]} \le \frac{-1020}{-0.345} \quad ?$$
$$H \text{ [mm]} \le 2957$$

The upper boundary of the range of the transmitter is +10 kPa = 1020 mm H_2O

$$H \text{ [mm]} \le \frac{1020}{1.2 - 0.945} \quad ? \qquad H \text{ [mm]} \le \frac{1020}{0.255} \quad ?$$
$$H \text{ [mm]} \le 4000$$

In the example, both conditions are satisfied when the spacing of the seals is not more than 2957 mm.

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