Gefran NaK pressure transmitters for Concentrating Solar Power Applications (CSP)

杰佛伦NaK压力变送器
CSP专用

Gefran's major customers in CSP field
杰佛伦在CSP领域的主要客户

- 摩洛哥努奥三期 Morocco Noor 3

- 意大利国家电力公司 Italy ENEL

- 西班牙Abengoa太阳能公司 Spain Abengoa

- 意大利阿基米德太阳能公司 Italy Archimede Solar Energy

- 中控太阳能德令哈50MW项目 Supcon Delingha 50MW Tower CSP project

- 中电建西北电力设计院哈密50MW项目 NWEPDI HaMi 50MW Tower CSP project

- 山东电建三公司鲁能海西50MW项目 SEPCO3 LUNENG HaiXi 50MW Tower CSP project

- 青海共和50MW项目 QingHai GongHe 50MW Tower CSP project

- 兰州大成敦煌50MW项目 LanZhou DaCheng DunHuang 50MW Fresnel Project

- 浙江大学-山东电建三公司 ZheJiang University test Loop

- 滨海阿克塞试验回路 BinHai AkeSai 800m Trough test loop

Gefran's state-of-the-art
杰佛伦的领先技术

E   **Sodium Potassium alloy** (NaK) **filled-in pressure sensor** → Designed for pressure measurements at high temperature media applications (up to 600 °C)

E   钠钾合金（**NaK**）填充压力变送器 → 特殊设计，用于测量高温介质的压力 （可达600 °C ）

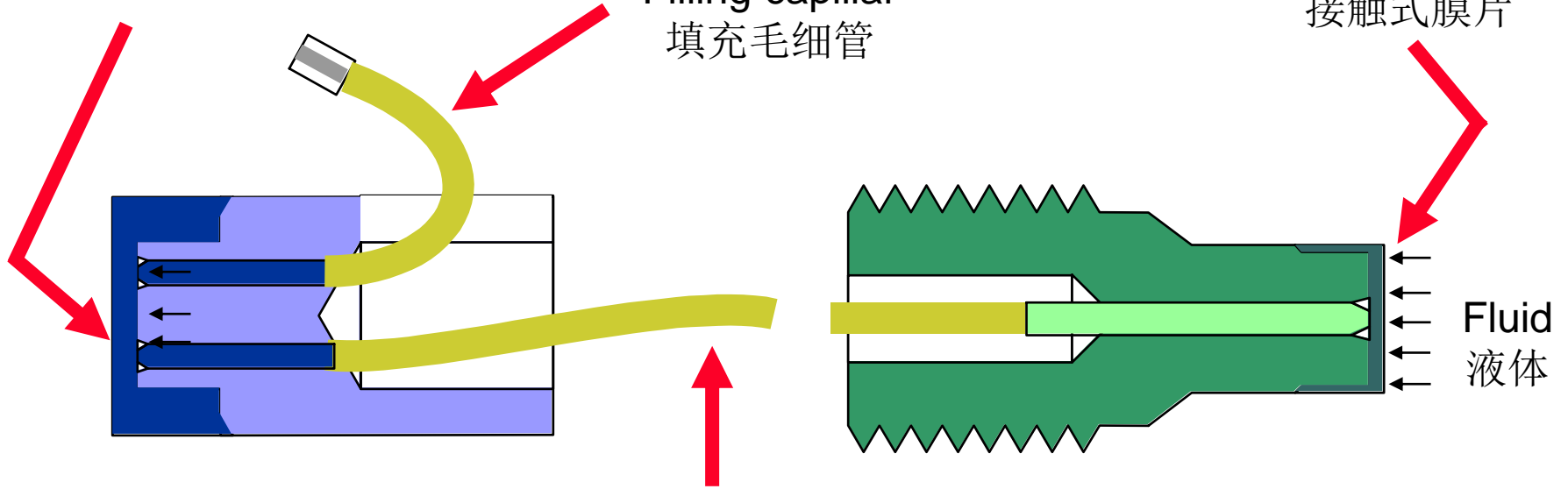# The functioning principle
工作原理

Measuring diaphragm 测量膜片
(strain gauge 应变仪）

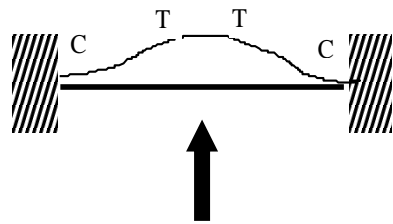Filling capillar
填充毛细管

In-contact
Diaphragm
接触式膜片

Fluid
液体

Pressure trasmission capillar压力传输毛细管
(filled-in with NaK 填充液体NaK）
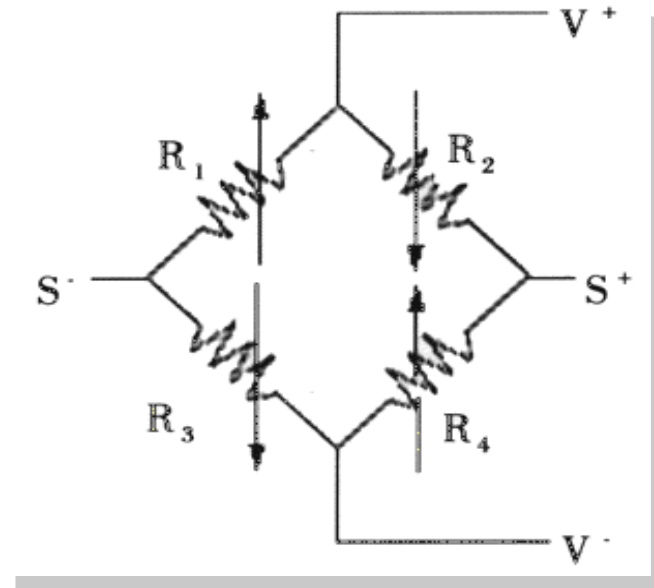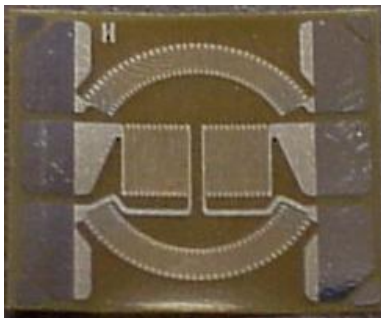
Cold Side

冷端

Hot Side

热端

The measuring diaphragm 测量膜片

C T T C

Applied pressure
施加的压力

T = traction牵引力
C = compression压缩

By applying a pressure a bridge resistance variation is obtained. The consequence is an output signal variation proportional to the applied pressure.

施加压力使电桥的电阻发生变化。此时，输出信号的变化与施加的压力成比例。

Gefran's added value
杰佛伦的附加值

E **Minimizing the offset drift** in order to achieve a **very high accuracy**, also for differential pressure measurements using two different sensors

E **将漂移降到最低**，以实现**超高精度**，也可以使用两个不同的变送器用于压差测量

Temperature Drift 温漂

E **Temperature offset drift** → Due to temperature variations (temperature produces expansion of the NaK inside the sensor):

E 温度漂移 → 源于温度变化（温度会引起传感器内填充的NaK膨胀）：

- **Related to the environment**
- 与环境有关

- **Related to the process**
- 与过程有关

The thermal drift
热漂移

E   The sensor is **intrinsically** subject to a **zero signal drift** due to the natural **thermal expansion of the transmission fluid** (i.e. NaK)

E   由于传输流体（即NaK）的自然热膨胀，变送器本质上会经受零信号漂移

E   **The customization** of the sensor designed for such an application tends to **minimize this effect**

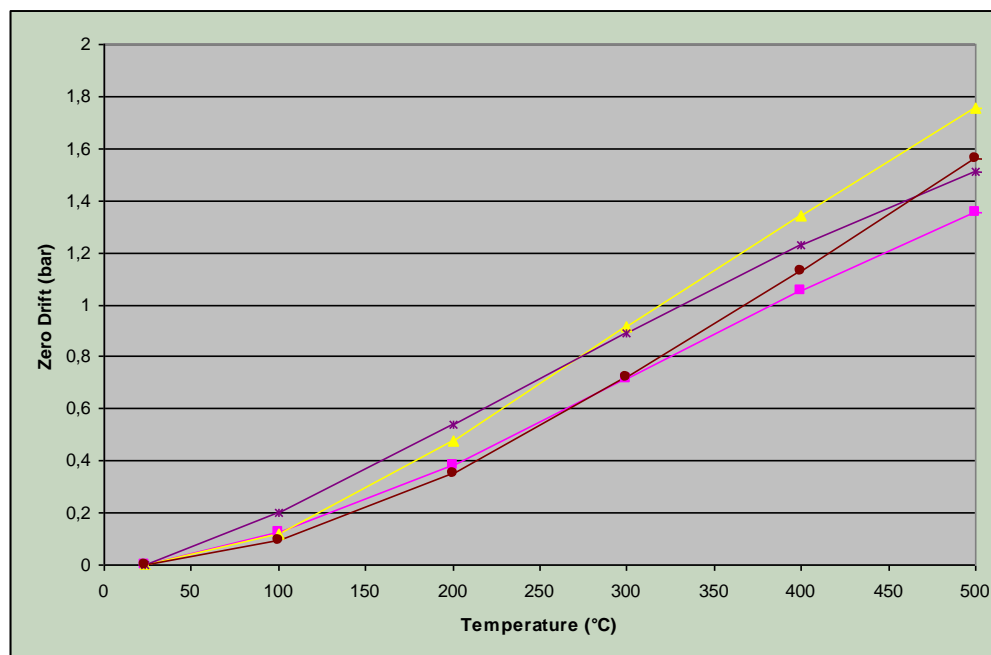E   专为该领域设计和**定制**的变送器将把此类**影响降到最低**

E   Following a **correct installation**, the zero signal drift **highest value** is equal to **0.5 bar /100°C**

E   正确安装后，零信号漂移的**最大值**为0.5 bar / 100°C

Influence of process temperature
过程温度的影响

E The graph below shows the **typical zero thermal drift** in a group of four sensors:

E 下图显示了四个传感器的**典型零点热漂移**情况：

The **zero drift** vs temperature can be considered "**linear**" in the range **above 200°C**.

高于**200°C**时，**零点漂移**与温度的比例基本是"**线性**"的。

Influence of environmental temperature (Day - Night cycle)
环境温度的影响（昼夜循环）

E A contribution to the zero drift is also due to the **influence of the temperature on the "cold side"** of the sensor → This effect has been **minimized too**

E 变送器**"冷端"的温度变化**也会影响零点漂移 → 此类影响已被**降至最低**

E Typically, the **Day-Night cycle** can be responsible for a **zero drift of ±100 mbar**

E 通常，**昼夜循环**会产生**±100 mbar**的零点漂移

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Influence of environmental temperature
(Day - Night cycle)
环境温度的影响（昼夜循环）

E   Suggestions in order to **minimize the influence of the external temperature** on the offset drift:

E   用于**减少外部温度对偏移影响**的几点建议：

- Do not expose the sensor to the direct radiation of the sun – keep it shaded
- 请勿将变送器暴露在阳光直射下 – 放置于阴凉处

- Possibly mount the sensor with slope, so that there are not heated parts below it
- 尽可能以一定仰角安装变送器，避免在其下方出现热源

Mounting Instructions安装指南

E The sensor must be mounted into a **proper and clean seat**:

E 传感器必须安装在清洁合适的底座上**:**

- A proper seat can be obtained **using the KF18 drilling kit**
- 可以使用**KF18**钻孔套件加工底座。

- Use the **CT18 Cleaning Tool** to remove salt residuals from the seat until it can turn freely. If the CT18 tool cannot turn freely this means that the seat is not clean or that the seat is not correctly machined
- 请使用杰佛伦**CT18**清洁工装去除底座上的残留盐渣，直至清洁工装可自由转动为止。

E It is mandatory to put **high temperature grease** on the threads
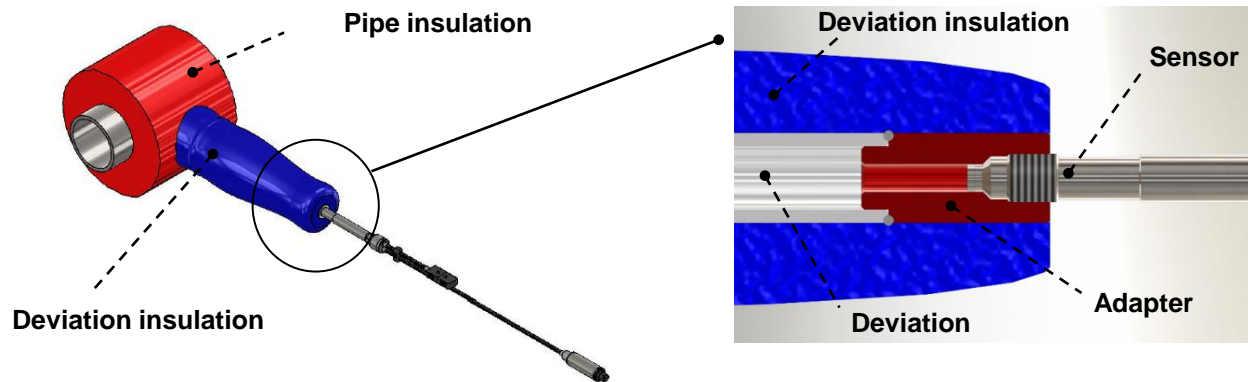
E 必须在螺纹上涂上**高温润滑脂**。

E **In case the sensor has to be removed**, this must be done when the **temperature of the seat is > 250°C** so that the salt is liquid.

E 拆卸传感器时，必须将底座加热至**> 250**℃，使盐融为液体。

Installation suggestions安装指南

E Do not put the tip of the sensor directly on the main pipe inside the salt flow → **Use a piezometric deviation**:

E 不要将传感器顶端直接装在熔盐主管道上 → 请采用压力支管

Pipe insulation

Deviation insulation

Deviation insulation

Sensor

Adapter

Deviation

E The piezometric deviation **insulation** should **not embrace the sensor**

E 支管**隔热材料不应覆盖整个传感器**。

Installation suggestions安装指南

E Keep the **deviation heated** at a temperature **> 250°C** (e.g. 300°C). This can help in installing/calibrating the sensor

E 保持支管温度**> 250°C** （如300℃）。这有利于变送器的安装/校准。

E The **longer** is the **deviation**, the **lower** will be the **working temperature of the sensor**

E 支管越长，变送器的工作温度越低

E An **interception valve** across the deviation should be **useful** to **isolate the sensor from the pressured pipe**

E 在支管上安装**截止阀有助于实现变送器与加压管道间的隔离**

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Calibration procedure 校准指南

- Put the sensor inside the seat without screwing it (so that it measures ambient pressure).
- 将传感器放入底座内，切勿拧紧（以便测量环境压力）。

- Heat the seat up to 250°C.
- 将底座加热至250℃。

- Let the sensor warm up for 30 minutes after a stable temperature is reached.
- 让传感器预热30分钟，直至温度稳定。

- Note the temperature indicated by the sensor thermocouple (To) and the signal output of the sensor (mAo).
- 记录此时热电偶感测的起始温度（To）和此时压力变送器的输出信号（mAo）。

Calibration procedure 校准指南

These values can be used (if necessary) for the compensation of the Zero drift Vs process temperature according to the following algorithm:
可以使用这些数值（如有必要）来补偿过程温度作用下的零点漂移，具体算法如下：

$$\text{Pressure} = (mA - mAo) \times FS/16 - k\,(T-To)/1000$$
$$压力 = （mA\text{-}mAo）\times FS / 16\text{-}k（T\text{-}To）/ 1000$$

Where:
其中：

"k" is the coefficient of pressure drift (mbar/°C) – Typical 3÷5 mbar/°C – this coefficient will be provided for every single sensor
"k"是压力漂移系数（mbar /℃）- 通常3.5 mbar /℃ - 我们会为每个传感器提供对应的系数

"FS" is the Pressure Range of the sensor (Full Scale)
· "FS"是传感器的压力范围（即满量程）

NaK sensor with thermocouple KE2 XMD05
➔ *The State of the Art* **Gefran solution for "CSP"**

带热电偶的NaK变送器 KE2 XMD05
➔**杰佛伦在"CSP"领域的前沿技术**

KE2 XMD05 ➔ Main features meeting CSP requirements

KE2 XMD05➔主要功能满足CSP要求

E **Hot-diaphragm and sensor tip** made of **Inconel 718** ➔ Usable up to **600°C**

E 热-膜片和变送器头部由**Inconel 718**制成 ➔ 可承受**600°C**高温

E **Very accurate** ➔ At typical CSP process temperatures the transmitter works @ $\pm$**1%FS (i.e. 20bar FSO = $\pm$0.2bar)**

E 非常精确 ➔ 在典型的CSP过程温度下，变送器的工作精度为**±1％FS**（即 **20bar FSO =±0.2bar**）

E **M18 x 1,5 thread** ➔ A very **reliable sealing (flange version available)**

E **M18 x 1,5 螺纹** ➔ 非常可靠的密封（也可用法兰连接）

HART
COMMUNICATION PROTOCOL

KE2 XMD05 ➔ Main features
meeting CSP requirements

KE2 XMD05➔主要功能满足CSP要求

E **Different pressure ranges** (from 0-20bar up to 0-100bar) ➔ The right range for the right need

E 不同的压力范围（从0-20bar到0-100bar） ➔ 不同需求选择不同的压力范围

E Many **flexible stem length options** available ➔ Several stem lengths **for diverse installation needs**

E 可选用**不同长度的柔性杆**➔ 针对**不同的安装需求**选用不同长度的杆子

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CSP Achievements
CSP领域的主要客户