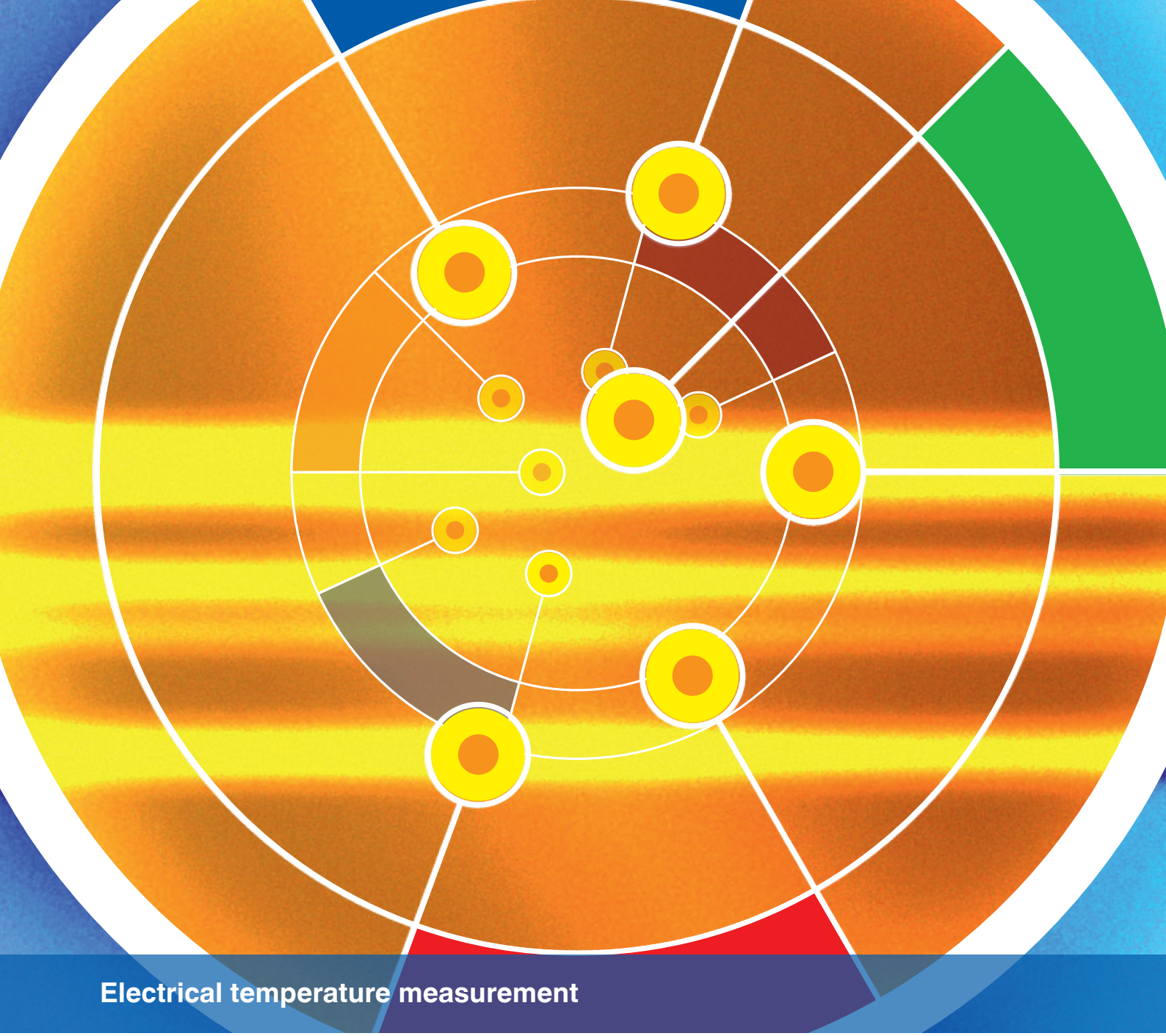


Electrical temperature measurement

Multipoint temperature measurements

WIKA

Smart in sensing

GAYESCO®

Temperature Specialists

About us

Alexander Wiegand,
Chairman and CEO WIKA

As a family-run business acting globally, with over 7,900 highly qualified employees, the WIKA group of companies is a worldwide leader in pressure and temperature measurement. The company also sets the standard in the measurement of level and flow, and in calibration technology. Founded in 1946, WIKA is today a strong and reliable partner for all the requirements of industrial measurement technology, thanks to a broad portfolio of high-precision instruments and comprehensive services.

With manufacturing locations around the globe, WIKA ensures flexibility and the highest delivery performance. Every year, over 50 million quality products, both standard and customer-specific solutions, are delivered in batches of 1 to over 10,000 units. With numerous wholly-owned subsidiaries and partners, WIKA competently and reliably supports its customers worldwide. Our experienced engineers and sales experts are your competent and dependable contacts locally.

Contents

Your partner for multipoint temperature measurements

WIKA and Gayesco have ranked for more than 50 years among the world-leading suppliers of measurement technology for the petrochemical industry. The acquisition of Gayesco International Inc. has further strengthened the WIKA Group. This expands its market position in the field of electrical temperature measurement and on-site services.

Worldwide, WIKA and Gayesco have together supplied over 4,000 multipoints to pressure vessels with 130,000 measuring points. Gayesco has been a pioneer in the development of flexible multipoints, which are today established as an industry standard in the petrochemical industry.

We are more than simply a reliable supplier of high-quality measuring instruments: As a competent partner we develop products and solutions with you that are specifically tailored to your requirements. WIKA's high level of performance is based essentially on three factors: A wide and innovative product range, comprehensive and competent service and a reliable global presence.

The wide selection of customer-specific multipoint assembly designs outside the refining and petrochemical industry ensures that we can offer the right multipoint designs for all your applications. Customer-specific process connections, the installation in existing pipewells or special designs to meet approval requirements (e.g. requirements for explosion protection) are part of the multipoint portfolio from WIKA.

Introduction

In the petrochemical industry, there is an increasing need to determine temperature profiles accurately in demanding applications. This sector of industry is more and more confronted with higher legal regulations, increased competition and the need to operate older plants more efficiently. A profitable operation often needs to maximise production and extend the time between planned maintenance activities. An increasing flexibility with respect to new process methods and catalysts is becoming more and more important, as this often gives significant differences in:

- Operating conditions
- Reactor designs
- Process parameters
- Mechanical loading
- Reactivity of the catalyst

There is a high relevance that the temperature measurement with multipoints is professionally designed and implemented. Careful selection and design of multipoints, satisfying the specific requirements, enables an

- Optimisation of the productivity
- Extension of the catalyst´s service life
- Enhancement of operational safety
- Decrease in maintenance costs
- Increase in production
- Improvement of product quality

Depending on the application, there are various designs of modern multipoints to choose from. WIKA/Gayesco offers comprehensive professional support. This ranges from the specification and design of multipoints, through their production to installation and commissioning, and includes the following maintenance services:

Flex-R® (temperature measurement with flexible multipoint assemblies)

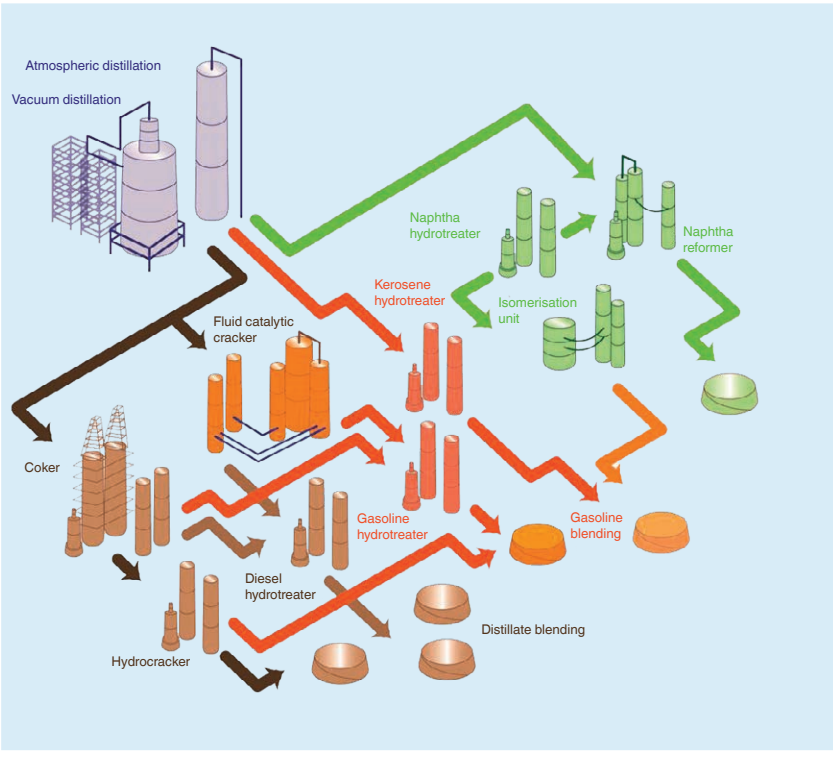
- Standard flange assemblies
- Special connections including Radial Tap and Radial Tap Next Gen
- Hybrid solutions

Linear multipoint assemblies

- Flexible multipoint assemblies
- Drawn and stuffed multipoint assemblies

Multipoints for/with pipewell

- Flex-O™ with bimetal spring loading, optional with purging
- Thermowell design with heat transfer block
- Freely suspended or with spring loading



Applications

Hydrocracker/Hydrotreater

Some reactions in the presence of hydrogen can be strongly exothermic, as sulphur, nitrogen and metals become separated from the process. These processes utilise advanced and expensive catalysts and internal fixtures to process the hydrocarbon feed. Monitoring the process is essential for safe, efficient and profitable operation. Hydroprocessing, specifically “hydrocracking”, is what initiated the development of the flexible reactor multipoint (Flex-R®) in 1987. New, highly active catalysts were developed to give refineries greater processing capacity. The danger of these new catalysts was that a chain reaction could be triggered (thermal “runaway”) which could result in damage to the catalyst and eventually to a failure of the reactor.

The advantages of the Flex-R® in comparison to conventional pipewell designs are:

- Greater number of measuring points
- Radial distribution of the measuring points within the reactor
- Significant reduction in the response time

These days, the majority of hydrocrackers/hydrotreaters that are found in operation worldwide, for reasons of safety and efficient operation, are using a system with Flex-R® multipoint thermocouples.

Crude oil distillation

The breakdown of crude oil into its constituent elements is essential to the entire refining process. Distillation is always temperature dependent, since the process is based around the different boiling points of the various hydrocarbons, in order to achieve the differentiation and separation. While many processes are operated with simply designed temperature measurement points (thermometer + thermowell), many refineries are seeing the need to use sophisticated, flexible thermocouples to perform temperature measurements in distillation columns. This enables the detailed collection of the temperature profile of the distillation trays and the packing materials. One of the most common retrofits is the installation of flexible thermocouples in the area of the flash zone and the packing materials of the vacuum column. The Gayesco Flex-R® enables the refinery to detect coking and channeling in the (condensation) packing materials.

Catalytic reforming processes

The catalytic reforming process increases the octane content of gasoline while supplying a significant amount of the hydrogen needed for hydroprocessing. This process uses a sophisticated platinum catalyst, where a reliable control of the continuous regeneration is important for safe and profitable operation. Over time, the platinum catalyst sinters or compacts, and thus, while there may be the same quantity of catalyst present, however, it presents a lower surface area and is thus less active. During catalyst regeneration, heat and chlorides are used to burn off impurities and break down the platinum back to smaller crystal structures. Both flexible and straight multipoints can be found in operation with the regeneration of the platinum catalysts in order to ensure optimal monitoring of the process.

Fluid catalytic cracking unit

The fluid catalytic cracking unit (FCC) is one of the most complex units in a modern refinery and essential for profitable operations in upgrading gas oil into gasoline. The fast moving, dusty catalysts and the high temperatures make for very high loads on the equipment. WIKA/Gayesco has developed a range of solutions which are perfectly matched to the harsh operating conditions of fluid catalytic cracking units.

These include:

- Dip-leg temperature measurement
- Catalyst cooling temperature measurement
- Special thermowell and cyclone temperature measurement

The start-up of a fluid catalytic cracking unit can represent a major challenge. To ensure a smooth process, many licensors require the installation of temperature sensors to monitor the dip-leg temperature. Thus the plant operator is given the possibility of ensuring that the equipment has been heated above the dew point, before steam is introduced. This helps to avoid any condensation, which on start-up can lead to bridging effects (clumping) and the loss of catalyst circulation. WIKA/Gayesco was the first company to develop special retrofittable temperature measurement technology for this application, which enables simple installation and replacement without welding.

Radial multipoints

Flex-R®

- By measuring the temperature profiles, the plant operator receives valuable data that will give him a better idea of exactly what processes are occurring in the reactor. With these profiles, hotspots, channeling and distribution problems can be better recognised.
- Short response times (4 ... 8 seconds) deliver fast information about changes in the process.
- The solutions specifically developed by experienced engineers, installation technicians and industry experts ensure that the installation and routing of the radial elements has the lowest possible influence on the function of the catalyst.
- Safety features: Secondary containment, safety transitions and repairability to ensure that, when a thermometer is damaged, no significant downtime or process loss occurs.
- Minimising the installation costs by matching to the existing nozzles during retrofitting.

Routing of the thermocouples within the reactor

Radial Tap™

- Thermometers of the Radial TapTM range consist of Flex-R® thermocouples, which can be fixed to reactors without flange connections through specially developed couplings.
- WIKA/Gayesco offers both the conventional Radial TapTM and also the Radial TapTM Nex Gen designs.
- Radial TapTM Nex Gen allows for less installation welding in the field.

WIKA/Gayesco service team employee installing a Radial Tap™

Design considerations

- In the event that a thermocouple is damaged during corrective maintenance of the plant, WIKA/Gayesco is in a position to offer a quick and cost-effective solution so that stocking of complete systems is avoided.
- Calibration of the thermocouples within the process corresponds to common engineering practice. WIKA/Gayesco offers you on-site calibration of the actual measuring points of the installed thermocouples, and not just a sample.
- As standard, we perform hydrostatic pressure tests on the wetted and pressurised components. In addition to these standard pressure tests, we also offer a pneumatic pressure test of the secondary containment as a safety test.
- The WIKA/Gayesco service can include turnkey installation by our own service team, or one of our installation supervisors can actively support you with your own installation every step of the way.
- All of our installation supervisors have an average of 10 years of professional experience and have at least 2,500 hours served in the installation of temperature measuring instruments.
- While some suppliers employ duplex thermocouples to ensure redundancy - however, without specifying these in greater detail - WIKA/Gayesco offer around 50 % higher redundancy. We ensure this for you through design optimised for your application and installation of the thermocouples in the reactor in accordance with best engineering practice.
- WIKA/Gayesco work closely with all major licensors and can help you to meet the requirements directly in the most cost-effective way possible, while ensuring the longest possible service life for your production units.

Multipoints for fitting in pipewells

High-temperature version with bimetal spring loading

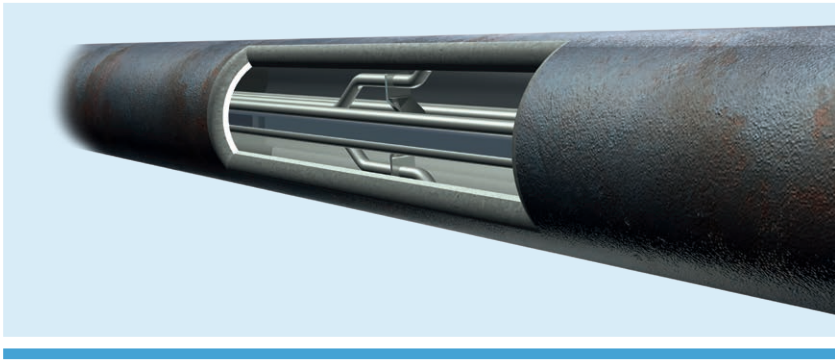
With this design, for each individual sensor a secure contact between the sensor tip and the inner wall of the pipewell is ensured through the bimetal spring loading. The bimetal spring loading is inserted into the pipewell in the unloaded position and the contact with the inner wall of the pipewell first occurs when heat is applied from the process. This multipoint assembly design for pipewells operates at temperatures up to 583 °C (1,081 °F). A special design with a high-temperature steel spring can be used up to a maximum temperature of 650 °C (1,202 °F).

Thermowells with heat transfer block

This design allows for individual removal and replacement of the sensors during operation if required. Furthermore, there is the advantage of a dual protection against the process pressure. The heat transfer block is welded into the wall of the pipewell and to an inner guide tube. The sensor is located inside the inner guide tube and rests against the heat transfer block in order to ensure short response times.

High-temperature band design

The support strip holds the sensors over the entire length of the pipewell. The spring loading provides a secure contact with the pipewell, increasing the accuracy and reducing the response time on temperature changes in the process.

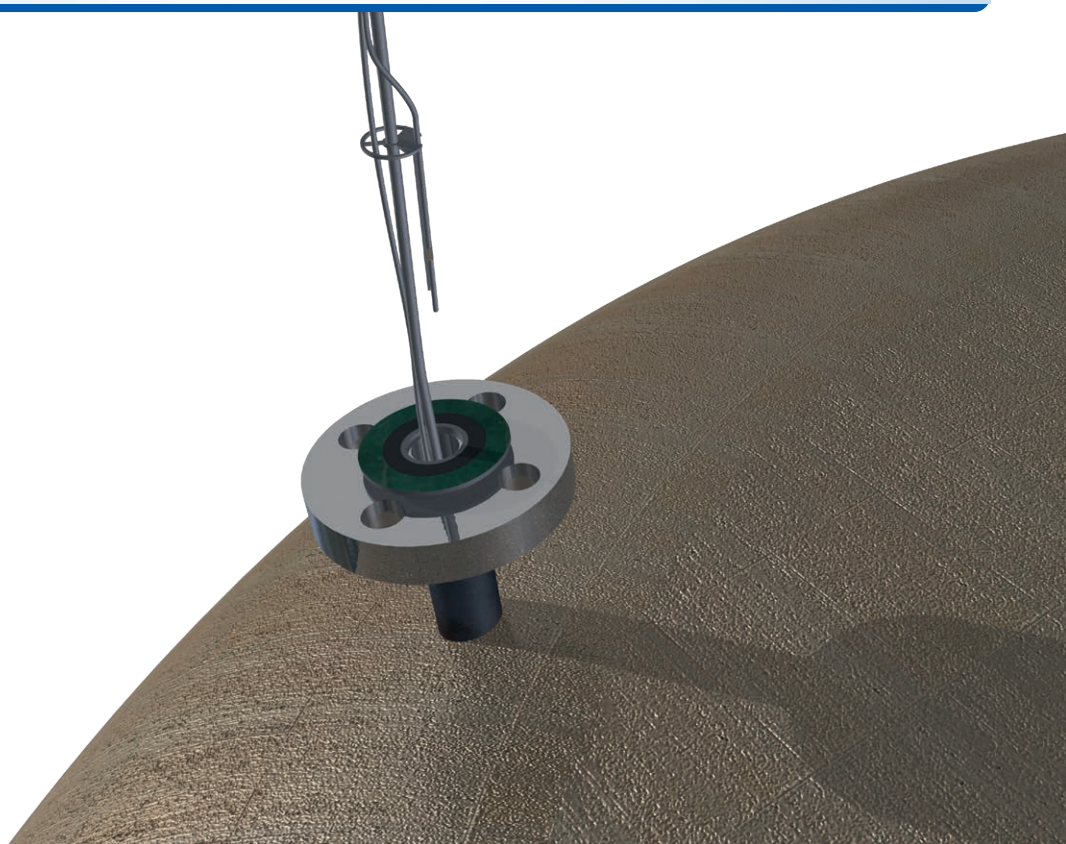


Flex-O™ with bimetal spring loading, optional with purging

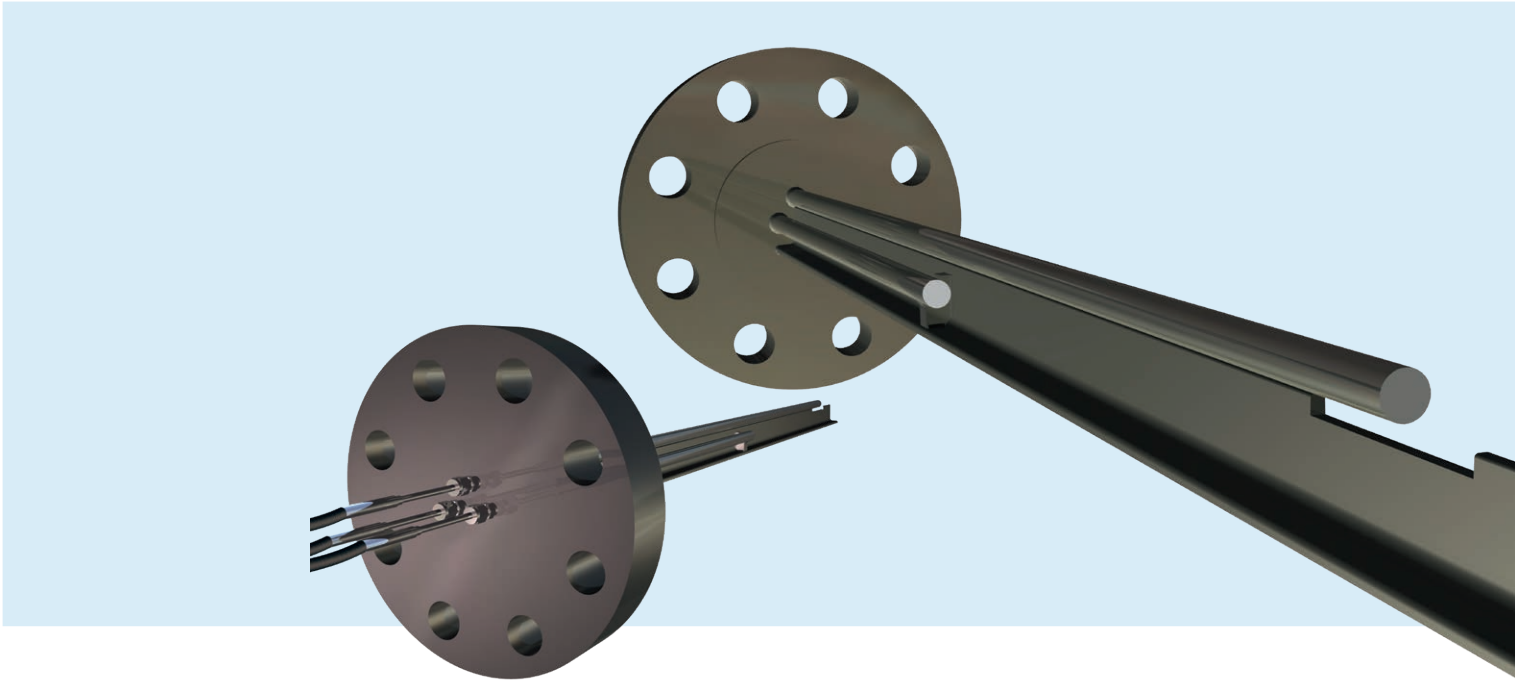
- The flexible design enables much easier and cost-effective transport.
- Due to the flexible construction, for installation, there is no need for cranes at double the reactor height and also the insertion into bent pipewells is simplified.
- Patented purge tube design can purge water and other contamination from the pipewell.
- The Flex-O™ design features special bimetal spring loading that contacts the inside of the pipewell on heating, ensuring the direct contact of the measuring point with the pipewell. This contact and the lower mass of metal in this design ensures a short response time.
- Installation in third-party pipewells is easily possible. Because of the design of the Flex-O™, special pipewells with internal guide tubes are not required.
- Special spacers reduce friction and thus make the insertion and removal of the multipoint easier.

Purge system benefits

- The enhancement of the Flex-O™ multipoint has been complemented by a purge tube to prevent failure of the thermocouple sheath through chloride-induced stress corrosion cracking.
- The purge tube enables the flushing of contaminants, such as chloride-laden vapour in cooling towers, from the pipewell, thus preventing problems such as chloride-induced stress corrosion cracking and corrosion from deposits (contact corrosion).
- The purge can either be carried out once on start-up or continuously, should there be a risk of hydrogen diffusion that could lead to a pressure build-up in the pipewell.



Application-specific multipoints



T-beam

- This is a traditional pipewell/multipoint assembly with a T-beam which is additionally anchored to the opposing wall of the reactor for support.
- The basic design is with three thermowells holding small-diameter thermocouples. This construction enables their replacement during plant operation.
- The multipoint assemblies must be removed and then reinstalled with each catalyst replacement.
- The enhanced WIKA/Gayesco design features a secondary containment and optimised thermocouples and can be fitted with up to 11 measuring points.

Miniature multipoints

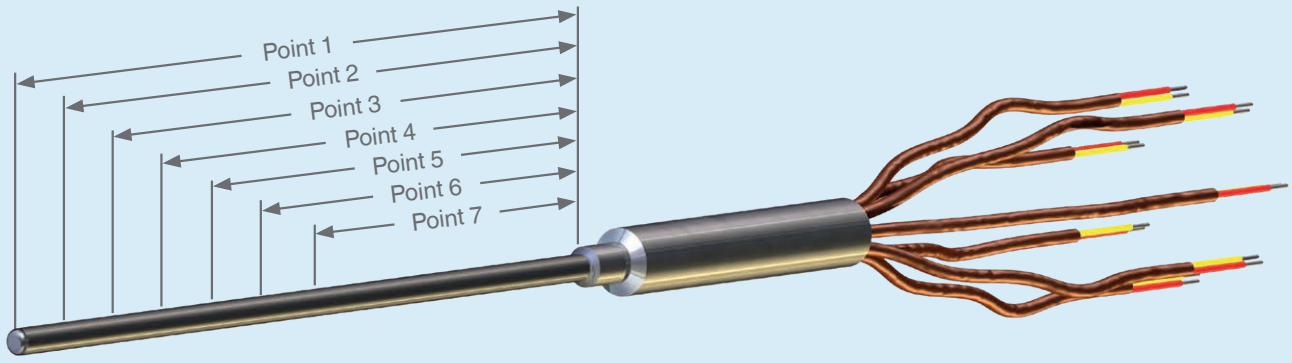
In principle, miniature multipoints are made from individual measuring probes with low diameters, which measure the temperature at different positions or heights. Each individual probe is protected with a sheath from either stainless steel or a special alloy. The individual thermocouples can be combined within a single thermowell. This design is used where the generation of a temperature profile is required, but the weight or size of the multipoint is limited. These designs are available in a number of variants.

Tubesheet reactors:
These vertically orientated reactors consist of one or more tubes filled with catalyst, through which the process gases pass. During the flow, a temperature profile exists in the tubes. This temperature gradient data is important information with respect to the process that is occurring. This information represents the basis for the optimisation of the process and the product quality.

Design features:
- Reduction of problems with the catalyst filling in the reactor
- Maintenance problems can be minimised by using designs which permit an exchange of the sensor during operation
- Low mass designed to avoid influencing process conversion and temperatures
- Axial centring in the catalyst tube for accurate process temperatures

Temperature measurement in pilot plants:
For research and development, processes are often built in pilot plants. Since the measurement of temperature data for the understanding of a new or modified process is of utmost importance, the multipoints must be designed and manufactured carefully. Since the operation of pilot plants is on a smaller scale, the sensors must be scaled down, so as not to influence the reactions taking place. At the same time it is important that the measured temperatures are correct. These factors are of utmost relevance and must be taken into account during design.

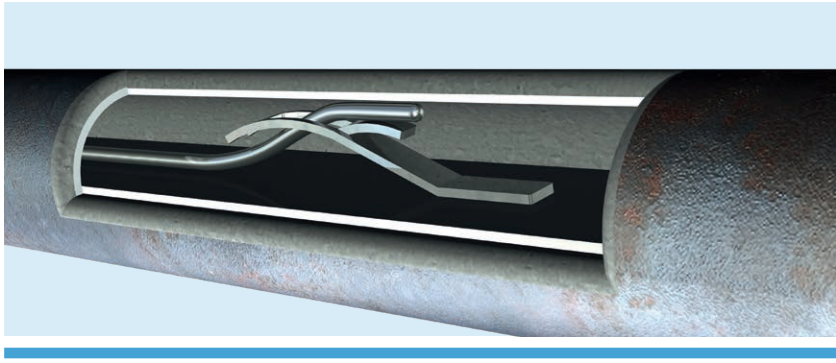
Design features:
- Low mass designed to avoid influencing process conversion and temperatures
- Accurate temperature measurements – the sensors can be calibrated in accordance with NIST requirements (National Institute of Standards and Technology)
- Highly cost-effective
- Axial centring in the catalyst tube for accurate process temperatures



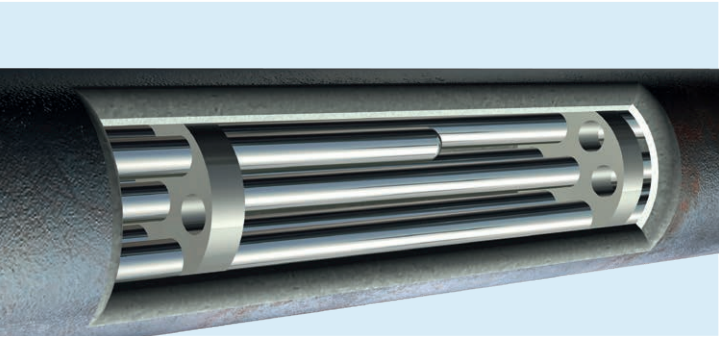
Multipoints for fitting in pipewells

Spring-loaded band design

This design allows the use of different resistance thermometers (RTD) and thermocouples (TC), which, through the contact to the inside of the pipewell, offer a short response time. The exchange of each individual sensor element is possible after the removal of the multipoint from the pipewell. Shipping coiled reduces shipping costs and simplifies the mounting in an existing pipewell. As an option, the use of a flexible purge hose is possible.



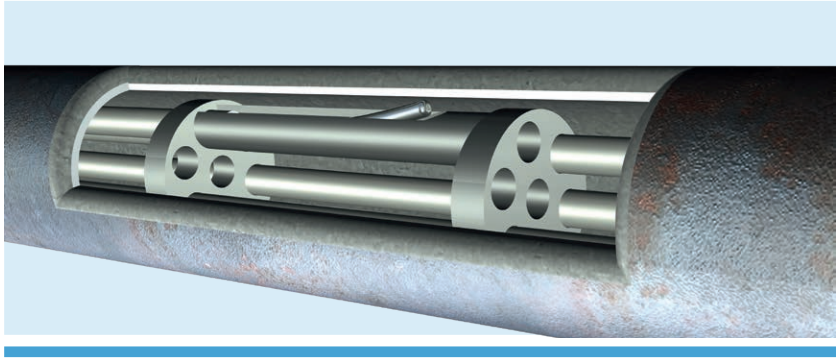
Washer disc design



This design allows the use of different resistance thermometers (RTD) and thermocouples (TC). An advantage of this design is the possibility to exchange each individual sensor element while the process is running. This is enabled through a separate thermowell for each individual sensor. A further advantage of this design is the very fast response time in applications with low to medium loads, such as occurs in tanks. If this multipoint is used in a separate external pipewell, an optional purge tube can be used.

Spring-loaded slide design

This design allows the use of different resistance thermometers (RTD) and thermocouples (TC), which, through the contact to the inside of the pipewell, offer a good response time and are available with a variety of Ex-approvals, e.g. Ex-d. The replacement of each single sensor is possible during the running process. As an option, the use of a purge tube is possible.



Installation services

Fitting by a WIKA/Gayesco service team ensures that the design features of your multipoint are implemented exactly as the engineers intended. All service technicians can look back on many years of professional experience. With the average professional experience of our installation supervisors being over 10 years, you can entrust them with your installation. With installation services from WIKA/Gayesco, you can be sure to receive a solution specially tailored for you - starting with the first on-site consultation through to the completion of the installation. The following list provides a brief overview of the services we offer.

WIKA/Gayesco service team member on an on-site calibration in a reactor

Installation

Our offering includes all the manpower, training and equipment required for the installation of our temperature measuring instruments. All members of our service team are trained in the handling of these instruments and have completed extensive training programmes for work in refining and petrochemical plant environments. The general services in our installation portfolio are:

- On-site or internet “kick off” meeting
- Supervising or performing welding
- Supervising the assembly of support elements
- Supervising or carrying out (routing) the installation of thermocouple measuring assemblies
- Calibration of thermocouples in the field
- Problem-solving through our experienced service technicians during plant repair

Installation supervision

To ensure that the handling and installation of the temperature measuring instruments is carried out correctly, on-site supervision of the works can be arranged. Many clients have asked for our customer services involvement from the planning phase of the first shutdown through to the final inspection at the restart of operation.

Field repair

Our customer services support you on site with the repair or upgrade of temperature measuring instruments.
Typical installation works are:

- Soldering
- Welding
- Splicing
- Bending

On-site calibration

A check/calibration of the thermocouples already installed in the reactor or column – including the Flex-R® product line – can be made at any time by the WIKA/Gayesco customer service. The calibration can be carried out in the reactor while it is shut down, when the thermocouples are fully accessible, as is the case, for example, during a change of the catalyst. The calibration will be carried out by trained technicians at as close to the process temperature as possible.

The following variants of the check/calibration are possible:

- A functional check to ensure the correct wiring and positioning of each individual thermocouple.
- An accurate check/calibration of the thermocouples at 372 °C/700 °F (standard), which enables a complete diagnosis of the thermocouple. This encompasses the wiring, including the transmitter.
- An accurate check/calibration of the thermocouples at a specified temperature, including a calibration report.

Welding services

All welding technicians in the WIKA/Gayesco customer service have welding certification in accordance with ASME Section IX.
The installation of our products such as multipoints or tubeskin thermometers is one of our strengths. Since the lifetime of these products depends essentially on the professional installation, many customers take up the offer of our installation.

Non-destructive testing requirements

Our multipoints can be tested in accordance with globally accepted standards and norms through a wide range of non-destructive testing. The following tests are examples of this. Customised testing for compliance with specific regulatory requirements can be requested as part of an individualised inspection and test plan.

NDE or NDT

NDE/NDT are abbreviations for “Non-Destructive Examination”/“Non-Destructive Testing”. The abbreviations NDE or NDT stand for “Non-Destructive Examination” or “Non-Destructive Testing”, respectively. This is generally used to refer to non-destructive inspections or tests on components.

Liquid penetrant inspection

With the penetrant inspection in accordance with SNT-TC-1A or DIN EN 571-1, fine surface cracks and porosities in weld seams can be made visible. After cleaning the surface to be inspected, a contrast agent (red or fluorescent) is sprayed on. Through the capillary effect, this agent penetrates any surface defects there might be. After re-cleaning the surface, a developer (white) is then sprayed on, which extracts the contrast agent (from any hairline cracks, etc.) and through colour contrast, enables an easy evaluation of the defects.

X-ray testing

Through an X-ray test to EN 1435 or ASME Section V, Article 2, Edition 2004, for example, full penetration welds on thermowells can be investigated with respect to irregularities (cracks, voids, insufficient bonding). Here, depending on the dimensions of the thermowell, up to five X-ray images may be necessary to determine irregularities with sizes < 0.5 mm in the full-penetration weld. An X-ray examination can also be used to record the bore centrality in solid body material thermowells. For this purpose, two images of the thermowell tip at 90° to each other are required. X-ray testing specific to Gayesco Flex-R® multipoint assemblies will also include the X-ray of each individual measuring point (hot junction). The films generated are kept and can be requested as required. On all pressure-loaded weld seams whose geometry enables an X-ray test this will be carried out as standard testing.

Pressure and stability tests

The hydrostatic pressure test is a pressure and stability test of the components of, for example, a thermowell to ASME Section XIII Division 1 Section UG-99 or AD 2000 code of practice HP30. For the test, the product to be tested is clamped into a testing device and subjected to a defined test pressure at room temperature for a certain period of time (e.g. 3 min.). In general, a distinction is made between the outside and inside pressure test. A typical pressure is 1.5 times the nominal pressure of the flange as outside pressure or 500 bar as inside pressure.

Pressure tests for Gayesco Flex-R® multipoint assemblies include a hydrostatic pressure test of all wetted parts, which is carried out in compliance with the requirements of the relevant standard. To carry out this test, the multipoint is inserted into a test chamber and the entire length of the thermocouples, including the primary seal, is tested. The secondary containment of the Gayesco Flex-R® multipoint assembly is subjected to an additional pneumatic test in order to ensure the functional safety.

Helium leak test

For leak testing in accordance with DIN EN 1779 (1999)/ EN 13185, helium 4.6 is used as a test gas. The test is able to detect minimal leakage rates and is considered the most sensitive test method for leak testing. In general, one should distinguish between an integral and local test method. In the integral test, leak rates (e.g. 1x10-7 mbar * l/s) can be determined, while the local testing enables the location of the leak to be determined using a spray probe. After passing a helium leak test, the thermowell is marked with a corresponding sticker.

Ultrasonic test

Through an ultrasonic test in accordance with DIN EN ISO 17640, for example, full penetration weld seams on thermowells can be investigated with respect to irregularities (cracks, voids, insufficient bonding). For this, the reflections of a radiated ultrasound signal are measured at the interfaces of irregularities. To determine the position of the irregularities, the ultrasonic device is adjusted beforehand by means of a reference body. The ultrasonic test can also be used to measure the wall thicknesses of a thermowell from solid body material to determine the bore centrality.

Positive material identification test (PMI)

The PMI (positive material identification) test proves which alloy constituents exist in the material. There are various common test procedures. With optical emission spectroscopy (OES) in accordance with DIN 51008-1 and -2, an arc is generated between the thermowell surface and the test equipment, and the spectrum of this arc enables the alloy's elements to be identified – both qualitatively and quantitatively. This process does leave a characteristic burn mark on the workpiece. A test procedure which doesn't damage the surface is the X-ray analysis in accordance with DIN 51001; during the X-ray the atoms of the thermowell material are energised until they radiate themselves. The wavelength and intensity of the emitted radiation is in turn a measure of the alloy's constituent elements and their concentration. After passing a positive material identification test (PMI), the thermowell is marked with "PMI".

3.1 material inspection certificate

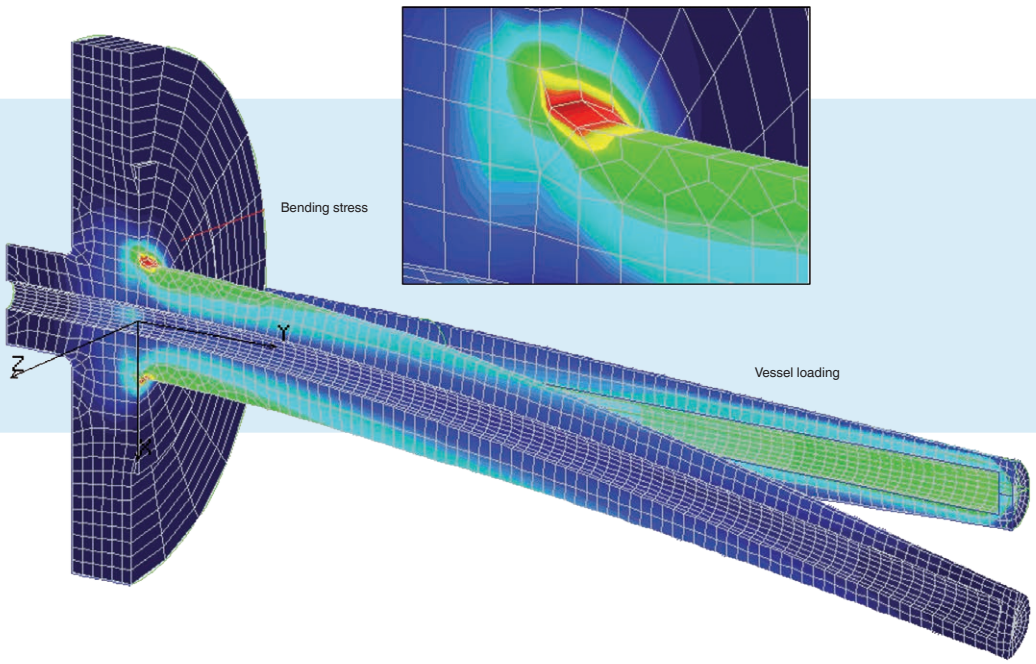
Confirmation of the materials used for the manufacturing. The project documentation can have the 3.1 inspection certificates in accordance with DIN EN 10204 added, which declare the chemical composition and the status of the semifinished products which have been used in the manufacture of the multipoint assemblies. These certificates can be used in conjunction with the PMI test reports to verify the use of the correct materials.

Calibration

Confirmation of the compliance of the tolerance of the thermocouples of each individual sensor by comparing with a known temperature. The MI cable of the multipoint is calibrated by random-sample calibration in accordance with the industry standards of the MI cable manufacturers. The individual thermocouples of the WIKA/Gayesco Flex-R® multipoint assembly are calibrated after manufacturing at an exactly known temperature and the values are specified in the project documentation. Additionally, WIKA/Gayesco customer services can provide an "in situ" verification of Flex-R® thermocouples after installation or during subsequent maintenance outages when access to the thermocouples is available.

Magnetic particle inspection (MPI)

Confirmation that no surface defects are found in the weld seams for ferromagnetic materials (e.g. carbon steels such as A105).



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14096352 04/2023 EN

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