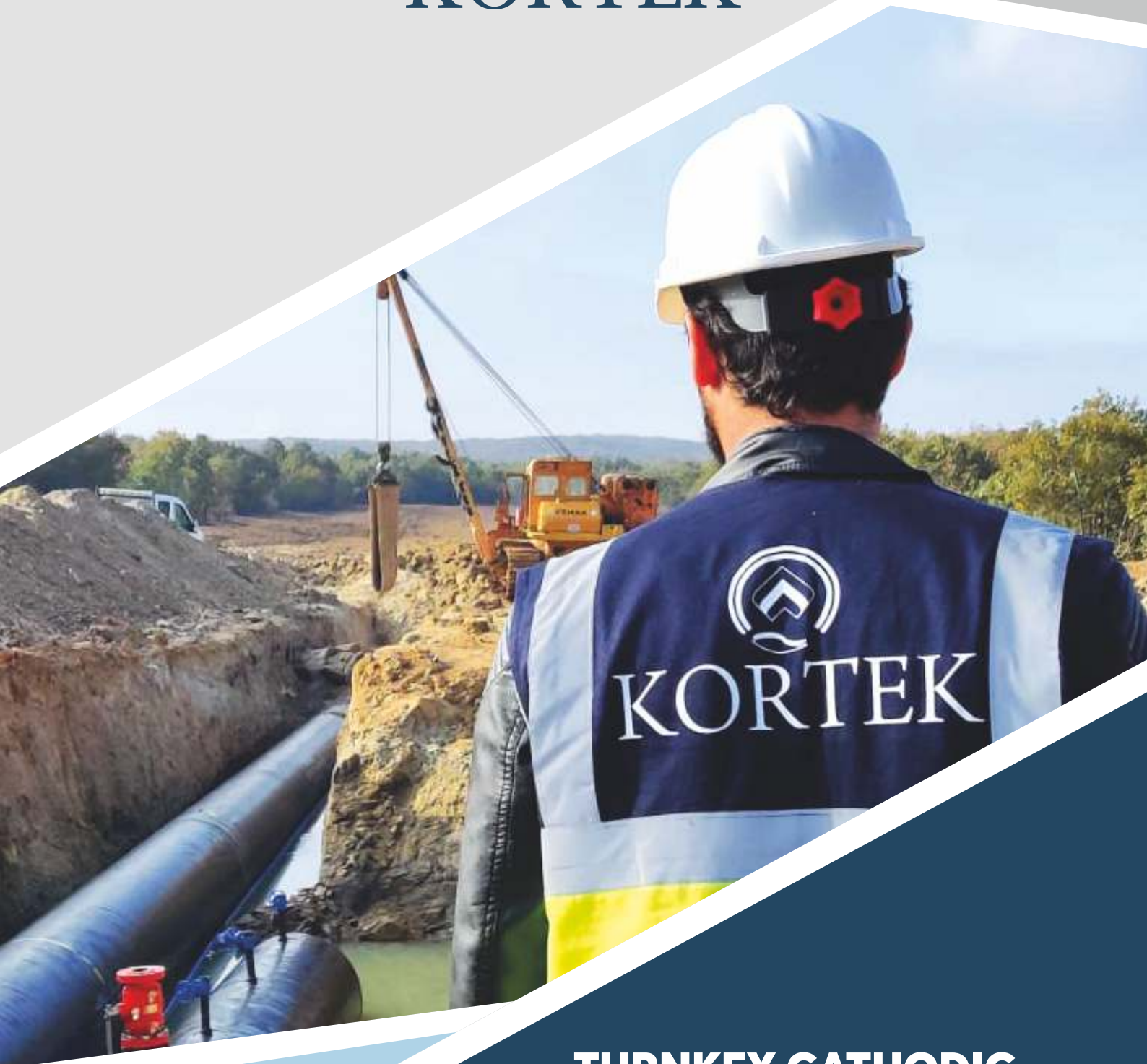
KORTEK




# TURNKEY CATHODIC PROTECTION SYSTEMS

CORROSION CONTROL TECHNOLOGIES

DON'T LET YOUR
INVESTMENT
TURN TO RUST

KORTEK

# CONTENTS

# COMPANY

KORTEK Corrosion Technologies Co. Ltd. was established in June 1992, in Ankara, Turkey. Our main fields of interest are corrosion technologies and corrosion protection. Specialized in corrosion protection, we deliver quality engineering, consultancy and on-site application services throughout the world, providing periodic care and inspection services in the area.

Our company owns a workshop and foundry manufacturing a great number of materials related to our field of interest, alongside outsourcing hi-tech products overseas.

We also represent several world renowned suppliers and producers. With our highly skilled professionals, we have undertaken several local and international projects safely and cost-effectively since 1992.


**1992** — KORTEK was first established in Ankara, Turkey exclusively for cathodic protection services.

**1997** — In the first 5 years, more than 40 local cathodic protection projects had been successfully completed and put into operation.

**2004** — First international project was undertaken and successfully carried out.

**2011** — KORTEK implemented the Integrated Quality Management System.

**2014** — Relocated in our own premises due to our steady growth with more than 50 employees.

**2015 2016** — KORTEK secured CP contracts of all Lots and Aboveground Stations of TANAP project (1800 km natural gas pipeline).

**2018** — KORTEK R&D started out as a sister company to develop high-tech CP specialized devices.

**2020** — KORTEK set up new branch as workshop and foundry in Ankara Industrial Zone. Main idea is to manufacture all type of galvanic anodes satisfying company general quality approach and CP material experience for 30 years and international standards. Another aim is to manufacture KORTEK R&D developed units and devices.

# CATHODIC PROTECTION BASICS

## WHAT IS CATHODIC PROTECTION - GENERAL DEFINITION

Cathodic protection is directly related with the polarization of metal surfaces. Cathodic protection is achieved by polarization of all cathode (noble) areas potential to the most anode (active) parts on the metal surface. Normally corroding structures have both cathodic and anodic areas that corrosion occurs. If all cathodic areas can reach the potential of most active anodic area, the entire structure will become a cathode and corrosion will be eliminated.

## CATHODIC PROTECTION POTENTIAL CRITERIA

A potential criteria is based on assumption of most anodic area potential on metal surface is likely to exist on the structure. Criteria depends on type of metal and environmental conditions.

Cathodic protection potential criteria from the literature for;

Iron or Steel in aerobic conditions at 25 $^{o}$C with respect to Copper Copper Sulphate is "-850 mVDC"

The potential criteria shall not be used without regard to environmental circumstances and operators requirements upon previous experience may differ.

In the application of potential criteria, regardless of structure material, the potential shall be considered as a polarized value (free of IR error) as indicated in current international standards.

## TYPES OF CATHODIC PROTECTION ANODES AND FIELD OF APPLICATIONS

**Magnesium Anodes:**

As a galvanic anodes, magnesium anodes are available in two general alloys, high potential (-1.75 VDC w.r.t Cu/CuSO4) and standard (-1.55 VDC w.r.t Cu/CuSO4). The magnesium alloys have an efficiency of %50 at maximum. This means that half of the metal alloy is consumed in self-corrosion during its life. They may be produced in wide variety of shapes as ribbons or blocks and available packaged with special backfill for maximum possible efficiency in underground use. These anodes are most useful in applications where the soil resistivity is moderately high includes fresh water and most soils.

**Zinc Anodes:**

The zinc alloy anodes have a nominal potential of -1.10 VDC with respect to copper copper sulfate reference. Its efficiency is relatively high ranging from %90 to %95. Zinc galvanic anodes can be casted and fabricated in wide variety of physical shapes and suitable for different methods of mounting. Zinc anodes with a backfill is used in soils having low resistivity commonly less than 2000 ohm.cm. These anodes is also commonly used as a galvanic anode for marine application on steel ship hulls and to mitigate induced AC on coated pipelines.

**Aluminum Anodes:**

Aluminum are mainly used in seawater environments. Different alloys are specified in international standards for diffent marine and off shore applications. The potential of aluminium anodes as galnvaic anode is between -1.10 VDC to -1.15 VDC w.r.t Cu/CuSO4 depends on alloy composition and efficiency between %85 and %95.

## TYPES OF CATHODIC PROTECTION SITE SURVEYS

Potential Measurement: Structure to electrolyte measurements by using a high input impedance (ideally more than 10 Mohm) DC voltmeter, test lead from structure and reference electrode. This type of measurement is main cathodic protection data collection. It is important to consider IR errors and other resistive elements in measurement circuit to collect usable data.

**Current Measurement:** While it is not a cathodic protection critera, measuring current in the CP circuit is necessary to evaluate system performance. DC cathodic protection current measurements can be applied for galvanic anode, impressed current system output, bond current and current flowing through the structure.

**Close Interval Potential Survey (CIP Survey):** Basic potential measurements can be conducted on test post locations mainly for pipeline applications. To determine the potential over the entire pipeline requires that the reference electrode to be moved along the pipe route and placed at regular intervals. By using data logger, coper conductor wires and wearable equipment sets, such measurement can be done for pipelines to record complete cathodic protection potential profile of pipeline.

**Coating Condition Surveys:** Cathodic protection systems are directly related with the coating conditions and holidays should be evaluated with the potential measurement results in many cases. The type of coating surveys are, holiday detection for reachable parts, coating conductance method, Direct Current Voltage Gradient survey (DCVG), Alternative Current Voltage Gradient Survey (ACVG).

## AC CORROSION AND MITIGATION METHODS

AC interference from overhead lines to a pipeline ca be transferred by three possible way, 1- conductive coupling, capacitivie coupling and inductive coupling. Estimating the AC interference effects on structure requires complex calculations or special softwares. Discharge of steady state AC currents from pipeline results with corrosion failures. Corrosion rate on such structures is related with the AC current density discharged from pipeline. Current international standards mention that more than 20 A/m2 AC current density may cause corrosion and corrosion is expected for more than 100 A/m2 AC current density. AC voltage on pipeline may also caused electrical shock hazards and standards have set the maximum allowable induced AC voltage that a person should be exposed as 15 VAC.

Basic type of induced AC voltage mitigation to safe levels of human safety and AC corrosion is grounding. Commonly used grounding electrodes for this purpose are packaged sacrificial anodes and anode ribbons installed in special backfill. Grounding materials that are not directly anodic to the pipeline would affect the cathodic protection system performance therefore such materials.

## OUR SCOPE

- Pipelines
  - Oil and Gas
  - Energy
  - Construction
  - Water and Wastewater
- Well Casings
- Vessels
- Storage Facilities / Reservoirs / Tanks
- Production Rigs
- Piers / Harbors / Docks /Wharfs

## OUR SERVICES

- CP Consultancy
- CP Design and Design Review
- FEED Studies
- Data Analysis
- Research and Development
- Customer Training
- Material Supply
- Installation / Installation Supervision
- AC Mitigation
- System Commisioning
- Resistivity Profile
- Interference
- Site / Field Surveys
- Close Interval Potential Surveys (CIPS)
- Direct Current Voltage Gradient Survey (DCVG)
- Maintenance & Monitoring

## ACCREDITATIONS

KORTEK is a corporate member of the following organizations.

# MATERIALS SUPPLY

KORTEK holds an extensive range of cathodic protection products covering every area of CP projects including:

- Anodes
  - Magnesium
  - Magnesium Tank
  - Aluminium
  - Iron Silicon
  - Cast Iron
  - Zinc Ribbon
- MMO
  - Rod
  - Tubular
  - Wire
  - Piggyback Wire Sock
- Junction Boxes
- Corrosion Coupons
- Shunts
- Remote Monitors
- Transformer Rectifier Units
- Switch Mode Power Supply
- Galvanic Anode Backfill
- Thermite Welding
- Spark Gaps
- Splice Kits
- End Caps
- CP Cables
- Repair Patches
- Solid State Decouplers
- Polarization Cells
- Reference Electrodes
  - Permanent
  - Portable
- Zinc Earthing Electrodes
- Casing Fillers
- Carbonecous Backfill
- Digital Multimeters
- Data Loggers
- Soil Resistance
- Isolation Testers
- Steel Test Posts
- BigFink Test Posts
- Survey Equipment

## HEALTH, SAFETY, SECURITY AND ENVIRONMENT (HSSE) POLICY

In relation to HSSE, we will;

• Comply with the applicable statutory HSSE legislation and other requirements of the organizations we are a member of.

• Conduct training and awareness-raising studies to ensure all employees are aware of their individual HSSE responsibilities.

• Provide every kind of protection to prevent damage to the property and life of our employees and other people.

• Comply with both local and international arrangements and regulations related to environment, health and safety during the studies.

• Assess the environmental impact of our studies and take all kinds of precautions to minimize negative effects.

• Take necessary precautions to prevent waste by using energy and natural resources necessary for our studies effectively.

• Keep under control our waste occurring as a result of our studies, take necessary precautions to prevent air, water and soil pollution and develop our performance continuously.

SOCOTEC CERTIFICATION INTERNATIONAL
ISO 9001
ISO 14001
ISO 45001
UKAS MANAGEMENT SYSTEMS
0063

## QUALITY MANAGEMENT POLICY

• Fulfilling the requirements of our Quality Management System and improving its efficiency.

• Providing the product that meet the requirements of both the customers and the legal regulations in operation.

• Increasing customer satisfaction by assuring customers that we always produce products of equal quality that meet the demands of them and legal regulations.

• Constantly revising our quality policy to maintain its convenience for our company/

• Getting into international markets and increasing our firm's competitive power without compromising quality.

• Performing each job undertaken with equal quality using the most advanced technological means, and trying to outperform ourselves.

• Creating an efficient monitoring and surveillance system using modern information management systems.

• Supporting training programs and increasing the qualifications of our workers with training.

• Establishing a young, hardworking, open-minded executive board with individuals who understand modern business relations.

# CATHODIC PROTECTION PRODUCTS

Designed and Manufactured through over 30 Years of Experience

KORTEK provides production services for a wide range of cathodic protection projects on local and international basis.

Our company utilizes safe and speed production tools to improve and keep a solid and reliable place in the cathodic protection production industry.

Our standards are based on internationally acknowledged procedures. Factory production is certified as

- Environmental Management System ISO 14001
- Occupational Health and Safety System ISO 45001
- Quality Management System ISO 9001:2015

Galvanic Anode Foundry is one of main activity in Kortek Sincan Factory. Production of Magnesium, Aluminum and Zinc Anodes is certified by Turkish Standards Institution in accordance with below standards;

EN 12496:2013 - Galvanic Anodes for Cathodic Protection in Sea Water and Saline Mud

TS 9234 - Cathodic Protection - Galvanic Anodes


# MAGNESIUM ANODES

Magnesium has got a very electronegative potential compared to other sacrificial anodes and self-corrosion rate is too much, if not alloyed. Other impurities particularly iron and other heavy metals can significantly affect the efficiency of the Mg anodes. The addition of zinc causes the Mg anode to corrode homogenously, at the same time, reduces the sensitivity of the anode to other impurities that is just described above.

The most common type of Mg anodes is high-potential and standard type (AZ-63). The high-potential Mg anode has an advantage of relatively high electronegative potential by adding small percentage of manganese to the alloy.

As Mg anode has the highest driving potential compared to other galvanic anodes, makes it better to use in high soil resistivity environments and fresh water. In addition to this, Mg anodes are not polluting and does not contaminate the electrolyte as it is also used in potable water tanks internal galvanic cathodic protection.

The Mg anodes are also useful in combination of usage with other (low potential) galvanic anodes. Because it has high driving potential than, for example, aluminium, which supports and speeds up the initial polarization of the structure.

Type of applications with magnesium anodes are:
- Temporary protection of buried pipelines
- Protection of well-coated buried pipelines
- Internal protection of water tanks
- Protection of small marine structures
- "Hot spot" locations for buried & submerged steel structures
- Magnesium anode is suitable to be used in soil, mud, fresh water, brackish water, and sea water.

For buried applications, the bare Mg anode is assembled with cable, sealed with epoxy resin, and packaged in a cotton bag.

Composition of Backfill
- Gypsum 75%
- Bentonite 20%
- Sodium Sulphate 5%

# ALUMINUM ANODES

Aluminium anodes working performance could be sorted as well for the salty environment and decent for the fresh water and lower levels of brackish water. The reason why the aluminium works better in the salty environment is due to it requires chloride ions in the electrolyte to function properly. As the chloride ions decrease as the capacity of the anode decreases. Aluminium anodes last longer than zinc anodes and provides more protection. Because of their relatively high current capacity and light weight, aluminium anodes have virtually replaced zinc in seawater applications. In addition, the aluminium anodes are not polluting and does not contaminate the electrolyte.

All type of aluminium anodes is offered in our production line; bracelet anodes for offshore pipelines, standoff anodes for platforms, eyebolt and threaded stud anodes for pier, piling, and heater-treater applications, and flush-mount anodes for hulls and special applications.

KORTEK supplies series of aluminium anodes for defend the corrosion of steel structures in seawater. The performance of anode is affected by the chemical composition of the alloy. We adopt high purity of aluminium ingot for the anodes. The anodes are casted automatically, thus the anode alloy is uniform, free of dust and oxides.

Production is carried our according to the international standards and as specified in Client specifications as DNVGL B401 and EN 12496.

# ZINC ANODES

Zinc anodes are the oldest sacrificial anodes and first used by Sir Humphrey Davy about 1824. Zinc anodes (zinc alloys) are for two general applications: freshwater/soil and seawater/brackish water. Although zinc anode current capacity is low, the capacity is independent of current density compared to other galvanic anodes. Furthermore, its efficiency is relatively high (between 90-95%). Even at a current density as low as 50 mA/m$^2$ (5 mA/ft$^2$) an efficiency of 90% or more is expected. Zinc anode with a gypsum and bentonite backfill may make it more cost effective than Magnesium anodes due to its high efficiency.

However, the high temperature and chemistry of the environment (presence of bicarbonates, carbonates, or nitrates) could result more noble potentials of the anode.

## APPLICATION

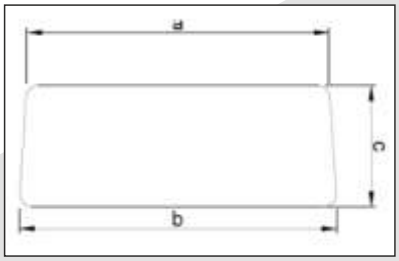
- To avoid bi-metallic corrosion of associated structures.
- To mitigate voltages introduced in pipelines by adjacent overhead AC power lines.
- Corrosion control of underground metallic structures.

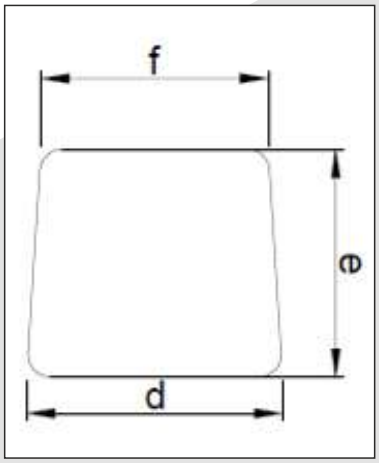
In grounding earthing application of zinc anodes, packaged anode where the anode has a high length to weight ratio in order to minimise its ohmic resistance to ground.

# CONCRETE ANODE

Zinc anodes are widely adopted for cathodic protection of steel in concrete in corrosive environment. The chemical composition and electrochemical properties of the anode are covered by the ASTM-B418 Type-I. The anode is covered by a specially formulated high alkaline porous cementitious mortar.

KORTEK galvanic concrete anode series CP-X with fully in-house designed, developed, manufactured, and first introduced with 160 gr/nett model.




| CP-X Anode Dimensions | | | | | |
|---|---|---|---|---|---|
| a, mm | b, mm | c, mm | d, mm | e, mm | f, mm |
| 100 | 105 | 40 | 50 | 40 | 40 |
| Zinc Anode Weight | | | 160 gr | | |
| Galvanised connection wires total length is 50 cm. (18 ~ 20 cm each side of anodes) | | | | | |


## Application

•The anode is tied to the surrounding reinforcement bars through its galvanized wires.
•The anodes are uniformly distributed based on the steel surface area.
•The anode performance and service life depends on many factors which are concrete conductivity, steel density, spacing of the anodes, concrete cover thickness, humidity, whether the anodes are used for corrosion prevention (existing structure repair) or corrosion control (new structure), pH of the concrete, temperature etc.

# REMOTE MONITORING

Our compact and accurate Cathodic Protection remote monitoring Sentinel series are designed to be used in any type of CP application. It may fit inside several types of test posts including steel test posts and by using GSM connection, all type of CP regular measurement data could be collected remotely. Measurement interval and parameters are easily set via internet on our in-house built server interface.

• Rugged and durable with aluminium enclosure•
• Easy to fit inside 4" steel test post
• AndroidTM application to first start up and data control on site
• AC/DC Voltage and AC/DC Current Measurements from pipe, coupon and anode
• Long battery life without any replacement (up to 5 years by weekly data collection.)

**Areas of Use:**
• Regular Cathodic Protection Potential Survey
• Pipe Polarized Potential Survey
• Polarization Tests
• AC / DC Interference Tests
• Coupon Tests
• Current Requirement Tests

**DC / AC Voltmeter / Ammeter**
• Measurement Waveform: DC & AC
• Voltage Measuring Range: ± 8 Volts DC, AC (RMS)
• Current Measuring Range: ± 100mA DC, AC
• Voltage Resolution: 1 mV DC/AC
• Current Resolution: 0.1mA DC/AC
• Accuracy: + / – %1
• High Voltage Protection
• 50Hz AC Filter

**Remote Data Transfer via GSM**
• Device locations on web-based interface
• Data collection settings including data interval, parameters, and alarms

**Android Application via Bluetooth**
• Supports Android TM 4.4 to Android TM 9
• Real Time Voltage Measurements and Graphs
• Remote Monitoring Settings

**Physical Properties**
• Dimensions – 125x80x57mm excluding terminals

# MMO ANODES

Impressed current anodes corrode at a very low rate and one of the most common impressed current cathodic protection (ICCP) dimensionally stable anode is Mixed Metal Oxide Anodes (MMO). Mixed metal oxide anodes are first introduced to cathodic protection in 1980s. Anode inactive substrate metal is titanium and active surface consists rare metal oxide such as iridium, tantalum, and titanium oxides.

Active surface thickness of anode shall be designed according to recommended environment, current density, and design life. The breakdown voltage of MMO anodes depend on the environment, in fresh water with low chloride concentration breakdown voltage may be greater than 60 V however in high chloride environments such as sea water maximum applied voltage to MMO anode shall not be more than 8 V.

MMO anodes are suitable to use in carbonaceous or calcined petroleum backfill to minimise its ohmic resistance to ground and extend the anode surface area. They are available in a number of different sizes and shapes including tubes, wires, rods, meshes and strips.

General applications with MMO anodes are:
- Marine Structures,
- Seawater Intakes,
- Deep well Ground beds,
- Horizontal Ground beds,
- Distributed Anodes,
- Tank Internals& Tank Bottoms

Different shapes and types are available in KORTEK standard stock as below:
MMO Tubular Anode:
- 16mm dia. X 500mm
- 16mm dia. X 1000mm
- 25mm dia. X 500mm
- 25mm dia. X 1000mm

MMO Ribbon Anode:
- Width: 6.35mm
- Thickness: 0.635mm
- Standard coil Length: 152 meters
- Shipping coil weight: 2.8kgs

Titanium Conductor Bar:
- Width: 12.7mm
- Thickness: 0.90mm
- Standard coil Length: 152 meters
- Shipping coil weight: 7.8kgs

Tubular anodes are supplied with the specified cable connected to anode mid-length by in-house developed internal connection to minimise anode to cable resistance and not to lower anode surface area.

KORTEK also supply MMO anodes pre-backfilled with coke breeze or carbonaceous backfill in a canister according to client requirements.

# JUNCTION BOXES

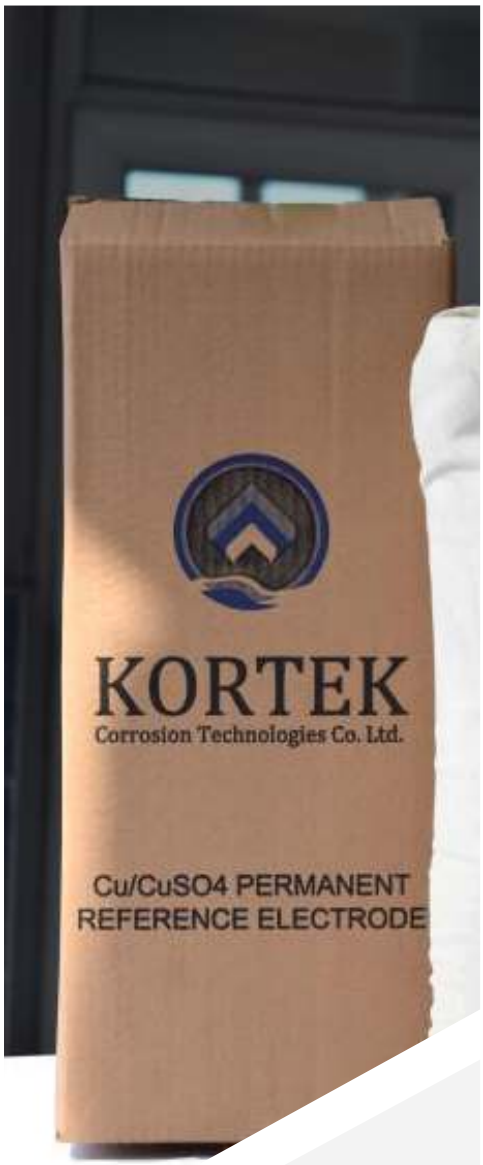
Cathodic protection junction boxes are used in impressed current system for positive and negative distribution, control and resistance bonding are available to be manufactured specifically to meet client specifications. Junction boxes panels are selected suitable for onshore and marine environment in safe and hazardous areas.

Junction box assembly shall be specified with the enclosure types and components listed as;

**Enclosures:**
- Stainless Steel 316L or 304
- Painted Mild Steel
- Galvanised Steel
- Aluminium
- GRP

**Accessories:**
- Resistors
- Shunts
- Supper Frames
- Copper Links
- Diodes
- Metering
- Monitoring
- Transducers
- Switches
- Security and Locking

# REFERENCE ELECTRODES




**Cu/CuSO4 Reference Electrodes – Permanent**
This type of permanent reference electrode is used to measure CP potentials on buried pipelines, storage tanks and other buried metallic structures to which CP has been applied.

**Specifications are as below:**
Cell Type: Permanent Buried Cu/CuSO4
Casing: Porous Ceramic Pot
Electrolyte: Saturated Copper Sulphate Crystals
Packaging: Cotton Bag
Backfill: 75% Gypsum / 20% Bentonite / 5% Sodium Sulphate (or to suit client specification)
Weight (Gross): Approx. 25 kgs.
Bare Dimensions: ~120 mm x 300 mm
Packaged Dimensions: ~200 mm x 410 mm

**Ag/AgCl Reference Electrodes – Permanent**
Ag/AgCl reference electrode is designed to use in seawater and water tanks internal applications.
Can be purchased with either standard cable tails, your choice of cable or a self-assembly version for your convenience.

**Materials Specification:**
Electrode Element: 99.9 % pure silver
Body: Polyethylene
Operating Life: 25 years minimum, with correct handling prior to installation
Shelf Life: Indefinite
Temperature Range: 0 – 75 °C

# TEST POST

Each cathodic protection system requires a testing to check the cathodic protection criteria and system health. From long-range pipelines to offshore structures, facilities with cathodic protection system consist of test stations.

A permanent durable steel test stations are used for the measurement of pipe to soil potentials, current flow, testing of insulated flanges, resistance bonds, and anode outputs.

Vandal proof and high durability posts are achieved by steel selection and suitable coating with hot dip galvanizing as base coat.

Test stations may be designed and manufactured according to project specific requirements and environmental conditions.

KORTEK

# SERVICES

- Cathodic Protection Design
- Cathodic Protection Site Survey
- Cathodic Protection Installation
- AC Mitigation
- Cathodic Protection Periodic Control
- Cathodic Protection Tender Preperation

# CATHODIC PROTECTION DESIGN

Cathodic protection system design requires a complex calculations and interpretations to meet the principal objectives while taking care of many factors that are influencing the design. Our experienced team is here to fulfill your demands in any design of CP system.

Our principal objectives for cathodic protection system design are as follows:

• Provide a system design life proportional to the planned structure life time or Client's requirements.
• Ensure that the safety of the personnel and public, apply all related standards and codes.
• Ensure that a system has flexibility to operate smoothly through its entire design life.
• Minimize or completely remove any interference to other structures.
• Provide sufficient current density to all parts of the structure to achieve polarization criteria.
• Make sure that the system has got enough test points and monitoring systems to be controlled and
checked periodically.
• Ensure that the system overlaps the construction specifications.

To achieve above points, there are many factors that could affect the cathodic protection system in both ways as an advantage or disadvantage, which means our consideration covers most of the points below:

• Environmental factors
• Moisture
• pH
• Soil Type
• Oxygen Content
• Temperature
• Any Movement
• Microbiological Activity
• Structure
• Construction Materials
• Geometry
• Voltage Gradients From Current Sources
• Coatings; Organic and Inorganic
• Electrical Isolations
• Groundings
• Stray Current
• Surrounding Structures
• Accessability
• AC Power Availability
• Attenuation etc.

# SITE SURVEY

Our team with NACE certified engineers and technicians specializes in cathodic protection site survey and inspection works.

**What we offer?**

• Cathodic protection transformer rectifier adjustment, inspection and basic troubleshooting.
• Structure to electrolyte potential measurements to confirm CP criteria and check electrical isolation, continuity, shielding, stray current, coating evaluation, railroad crossing, road crossing etc.
• Direct current measurements to evaluate CP current direction and magnitude, pipeline longitudinal resistances, anode groundbed efficiency, continuity bond current, interference bond current and various other measurements.
• Diagnostic testing to test for deficiencies in CP system and identify possible causes of the problems to determine the requirements to enhance the CP system.
• Adjustive survey to ensure that the CP system meets the criteria, if not, adjust the system to achieve CP criteria. If the criteria cannot be achieved within the capacity of the system then diagnostic testing may be required to enhance.
• Commissioning survey is to confirm the new CP system can meet the design specifications.
• Close Interval Potential Survey (CIPS) is to outline process that will show clear picture of representative series of potentials throughout the structure (a pipeline) to evaluate the criteria for CP, to identify local deficiencies, to assist in identifying possible causes of such deficiencies and aid in determining the requirements to enhance the level of cathodic protection to the structure.
• DC stray current interference survey is to investigate the possibility of DC stray current on underground or submerged structures. There could be complex dynamic interference problems each should deeply be inspected and taken into account.
• Electrical isolation survey is to determine the effectiveness of aboveground or underground structures insulation features to check the electrical continuity between structures. So that the CP system could be inspected individually for each structure.
• Road and railroad cased crossing surveys to identify the insulation between the structure (usually a pipeline) and casing. So that the interference between two structures could be determined.
• Purpose of the soil resistivity measurement is to assess the corrosiveness of the soil. Soil resistivity values identify general environmental conditions that effects corrosion on buried metallic structures. These data have an import role as CP design parameter to assess appropriate protection along the structure.
• Direct Current Voltage Gradient (DCVG) survey is to determine the coating defects on the structure. DC source is produced along the structure and the current is interrupted. Current leakages occur on where the coating damage presents. Those current leakages produce voltage gradient as the DCVG surveyor walks towards them. The advantage of this survey is the possible location and the size of the defect could be estimated.



# SITE INSTALLATION

## OFFSHORE AND MARINE INSTALLATION WORKS

Offshore and Marine works involve unique conditions and problems that can greatly influence execution of work, but such conditions and problems vary considerably depending on the location of the jobsite and types of activities. Our company can overcome many of those problems with different types of installation technics and designs.

In this area, the most important design issues are determining the protection zone, electrical connection of the CP elements and mechanical forces to the CP system. There are quite a few ways to overcome every single issue based on Client's requirements and related specifications, that has an advantage one on another.

Main offshore and marine installation technics for Impressed Current Cathodic Protection (ICCP) system;

• The anodes are evenly distributed along and very close to the structure. There is less risk of a completely shut down of the CP system due to cable damages. However, there are much more work to keep the system alive in a manner of maintenance and repair of the CP elements.

• The anodes are installed remotely to the structure. There is a less risk that cables are being cut or damaged by external forces. But, if the cable is broken, some part of the structure CP system is cut off until the main anode cable is repaired.

Main offshore and marine installation technics for Galvanic Cathodic Protection (with sacrificial anode) system;

• The anodes are homogeneously distributed and installed to the structure. The main difference from an ICCP system is the maintenance cost. Because, the system starts working as soon as the anodes are electrically connected to the structure (cathode) and the anodes are working throughout the design life unless there is a mechanical force that causes the separation of the anode from the structure (cathode).

• The anodes can also be installed remotely to the structure. Again the maintenance cost is much lower than an ICCP system but an advantage of less labour brings a disadvantage of the possibility of anode cable damage.

## *STEEL REINFORCEMENT BARS IN CONCRETE CATHODIC PROTECTION*

Steel reinforcement bars are compatible with concrete because they provide strong tension capacity to the structure and concrete usually provides the steel excellent corrosion protection. The corrosion protection is the result of the formation of a passive oxidized film on the surface of the metal by highly alkaline Portland cement contained in concrete. The passive film can be compromised by excessive amounts of chloride or other corrosive ions and gases or the metal inside concrete is not sufficiently encased by concrete.

The cathodic protection can be applied for both new structures before pouring the concrete and corroded structures to stop corrosion or completely repair the concrete.

Our company offers both galvanic (with sacrificial anodes) and impressed current cathodic protection system for all type of concrete structures. Our experienced team can design, procure, install and commission the system all the way through.

Galvanic anode manufactured by our company is called CP-X, it is zinc cored anode surrounded by highly alkali cementitious porous mortar which inhibits the passivation of the zinc through its design life.


## *AC/DC INTERFERENCE MITIGATION*

Electrical energy from a power transmission line can affect the pipeline by conductive coupling (during fault conditions), electrostatic or capacitive coupling and electromagnetic or inductive coupling. How those couplings affect the pipeline and the magnitude of the affect could be predicted by using AC modelling.

Once the magnitude and the reason of the AC interference are solved, then mitigation technics implemented to the system. There are many ways to mitigate; the main one is grounding the pipeline and a few other methods are used to overcome this problem. For example;

- Grounding the Pipeline by Means of Buried Horizontal
- Wires, Galvanic Anodes etc.
- Discrete Anode Groundbed
- Distributed Anode Groundbed
- Parallel Copper Cables Connected to a DC De-Coupler
- Bonding the Pipeline; Making the Pipeline Electrically
  Long or Lossy Pipeline
- Combination of the Above Points

We offer all kind of mitigation installations indicated above with our experienced CP certified engineers and technicians.


## *TANK EXTERNAL INSTALLATION WORKS*

Cathodic protection system for the tank bottom is based on an impressed current grid anode system placed directly underneath the tank bottom. System is designed to ensure a relatively uniform current distribution that maintains all points on the tank bottom within the required protection criteria limit. This shall be achieved using mixed metal oxide (MMO) coated titanium ribbon anode, installed as a series of parallel anode 'runs' over (and perpendicular to) a series of parallel titanium conductor bar lengths, such that the resultant configuration is a 'grid' network. At each crossing point between the ribbon anode and conductor bar, spot welding shall be applied to make the mechanical/electrical connection.

All cables shall be installed and clearly identified in the junction boxes before termination according to drawings. The location of the junction boxes shall be in accordance with layout drawings. They shall be installed in such a manner that easy access to the junction boxes is maintained. Number of terminals and gland quantities shall be in accordance with detail drawings.

Before completion of tank bottom foundation works, permanent reference electrodes are installed and lead wires are terminated at test box. Electrodes shall be placed as close as possible to the tank floor to minimize the IR drop in the soil path. Before installation, permanent reference electrodes shall be visually checked whether there exists any damage or not. If damage or any other defect is found, electrodes shall be replaced with appropriate one.

All related drawings shall be considered for TR Unit installation works. TR unit shall be inspected to ensure that internal connections are mechanically secure and that no damage exists. Cable tagging inside the TR unit shall be done according to the project specifications.

DC output cables shall be terminated securely in the cable gland plate of the Transformer Rectifier but not terminated. DC positive cables shall not be terminated inside of the TR until pre-commissioning and the final cable termination shall be done at the time of pre-commissioning.

## *TANK INTERNAL INSTALLATION WORKS*

**Tank Internal ICCP System:**

Storage tanks shall be protected by internal lining in accordance with Project Specification and impressed current cathodic protection (ICCP) with mixed metal oxide (MMO) coated titanium tubes.

All required installation works are completed before internal coating application. For ICCP system, generally suspended MMO tubular anodes are selected. Anode wires are suspended inside of the tank by using stranded rope and tethering lugs are welded to tank bottom. MMO anode ropes are fastened tight through welded lugs to prevent short circuit between Anode/Cathode systems and to stabilize anodes against water movement inside of the tank.

Anode tubes will be mounted on a cable tail and anode strings will be suspended through the tank roof. Anode strings will be terminated in Anode Splice Boxes where they will be cabled to a Positive Junction box (PJB) and TR Unit.

All cables shall be installed and clearly identified in the junction boxes before termination according to drawings. The location of the junction boxes shall be in accordance with layout drawings. They shall be installed in such a manner that easy access to the junction boxes is maintained. Number of terminals and gland quantities shall be in accordance with detail drawings

All related drawings shall be considered for TR Unit installation works. TR unit shall be inspected to ensure that internal connections are mechanically secure and that no damage exists. Cable tagging inside the TR unit shall be done according to the project specifications

DC output cables shall be terminated securely in the cable gland plate of the Transformer Rectifier but not terminated. DC positive cables shall not be terminated inside of the TR until pre-commissioning and the final cable termination shall be done at the time of pre-commissioning.

**Tank Internal Galvanic System:**

Main concept of cathodic protection system is to provide homogenous cathodic protection current distributed to cathode surface area. Within that scope, all necessary cathodic protection calculations are performed to ensure that amount of CP current and to ensure linear CP potentials everywhere, anodes are distributed to structure surface area homogenously. Location of the anodes and different anode types/sizes shall be checked in such a way that they are in accordance with for construction projects

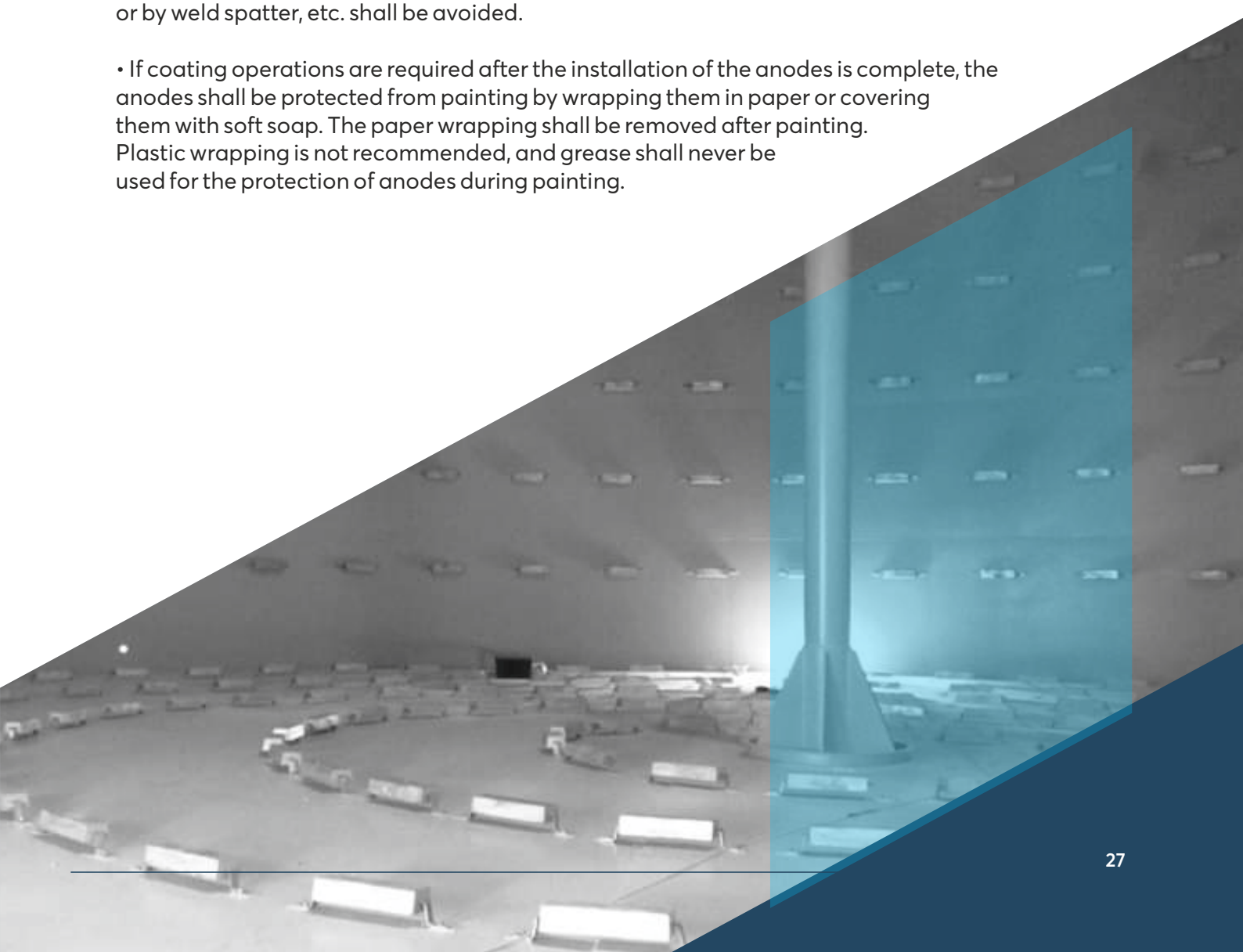
To provide linear cathodic protection current, providing low resistance has significant role for easy ion transfer via electrolyte. Within that scope, anodes will be fully welded, or bolted to a support, to the steel structure.

Installation on coated surfaces may require special precautions, such as:

• Anode cores and supports may need to be coated to the same standards as the structure coating.

• During installation of anodes on coated areas, coating damage by dragging or dropping anodes or by weld spatter, etc. shall be avoided.

• If coating operations are required after the installation of the anodes is complete, the anodes shall be protected from painting by wrapping them in paper or covering them with soft soap. The paper wrapping shall be removed after painting. Plastic wrapping is not recommended, and grease shall never be used for the protection of anodes during painting.



## ONSHORE PIPELINE INSTALLATION WORKS

**Onshore Pipeline ICCP System:**

**For deep-well anode groundbed installations, steps to be followed on site are as follows:**

• Exact location of borehole is determined, surveyed and controlled prior to installation works by surveyor and experienced CP engineer.
• All excavation and earth work necessary to prepare the drilling is completed.
• Casings are installed in accordance with project drawings.
• While adjusting casing string to final level, it is gripped with an appropriate clamp. A string may be released from the rig and kept in place.
• Bore hole is flushed / cleaned upon casing installation by using water lifting method until no mud or otherwise contaminated water occur at the surface.
• Ensure that all anodes and anode cables are free from damage prior to installation.
• Pre-assembled anode strings are lowered to the designed level and temporarily secured from the top end to flexible holding device.
• Ensure that the weight of the all equipments are pulled by the rope so that there is no high tension occurs on the cables.

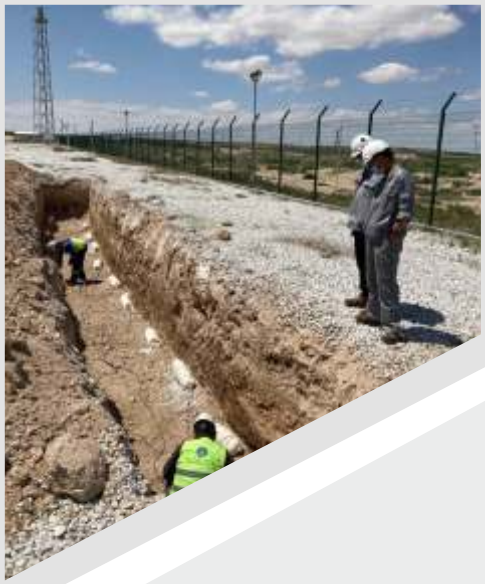
**For horizontal anode groundbed installations, steps to be followed on site are as follows:**

• Ensure that all relevant site conditions and working practices are observed. If necessary,
• Excavate to the required depth of anode bed as shown in project specific drawings.
• Before placing the MMO anodes, backfill material is poured according to amount indicated in material list.
Place the anodes in the required position. Distance between anodes are provided according to construction projects
• All related drawings are considered for TR Unit installation works. TR unit are inspected to ensure that internal connections are mechanically secure and that no damage exists. Cable tagging inside the TR unit is done according to the project specifications.
• DC output cables are terminated securely in the cable gland plate of the Transformer Rectifier. DC positive cables are not terminated inside of the TR until pre-commissioning and the final cable termination is done at the time of pre-commissioning.

**Onshore Pipeline Galvanic System:**

**During galvanic anode installation, following steps are done:**

• Number of anodes are in accordance with TP schedule.
• Electrical continuity of anode cable connections are checked against broken cables. All cable connections are done in such a way that all of them are in serial circuit.
Itis ensured that there exists no other structure (foreign pipeline etc.) at excavation zone.
• To ensure that full soil contact, plastic cover is removed from the anode.
• Min. 20 lt. of water is added to ensure sufficient water sorption before backfilling works.
• Minimum anode to pipe distance (according to project drawings) needs to be ensured
• Depends on site conditions and anode distribution along pipeline, anodes shall be placed at either both sides or one side of pipeline.
• Test posts are placed as per Drawings and Concrete foundation of test post is aligned to ensure stability during backfill.



# AC MITIGATION

As it's known that the cathodic protection of the steel structures are provided through "DC sources". However, a steel structure could also be corroded by alternative current, which is known as AC induction to the structure via close by AC sources. There are two different measurements to be considered in AC induction; firstly, an AC current density on a structure and secondly AC potential of a structure versus a reference electrode. There are different standards that stand up for many common points but the main idea is to lower both; current density and AC potential. High current density causes a structure to be corroded and high AC potential is a potential risk for health and safety.


Both of the measurements must be done to evaluate the level of risk for corrosion and health-and-safety manner.

Because, low AC potential may sometimes cause high current density which means the structure is safe to touch at steady-state, however, is risky in corrosive manner.

There are many factors influence the magnitude of the AC induction which are; soil resistivity along the pipeline/structure, electrically long pipeline, short pipeline, lossy pipeline, a pipeline with groundings/without groundings, depth of the structure, insulation joints along the pipeline, complex structures on the way etc... A high-purity zinc anode is commonly used in grounding cells or structure grounding applications. A zinc ribbon anode is installed parallel to a pipeline or localized zinc anodes are installed on a pipeline. The product properties are described detailly in Zinc Anodes products page.

An AC mitigation requires complex calculation so, we use AC induction modelling softwares to mitigate an AC corrosion. Many solutions are provided for Client's review and with our experienced and expert team, our company is capable of doing a high-quality installation and commissioning of AC mitigation system.

# PERIODIC CONTROL

The cathodic protection system should periodically be checked regardless of the type of the CP system. Because, the system can be affected by many factors which may result in over or under protection. That is the reason why, even if the system is galvanic (sacrificial anode) cathodic protection system, the system potential against proper reference electrode should be checked and the potential is ensured that its inside the criteria.

**In this scope our Company offers but not limited to below services:**

- P1AC/DC measurements from test posts
- Datalogger measurements from coupons
- TR Unit performance check
- Anode groundbed effectiveness check
- Reference Electrode check
- Cathode connection check
- Interference measurements
- Mechanical checks of all CP elements
- Visual checks of all CP elements

So that the CP system can be kept upgraded all the time to provide effective cathodic protection to your structure.

# TENDER PREPARATION

Detailed tender preparation phase has significant role on project life cycle as a first part and to acquire contract award. KORTEK has qualified engineers with remarkable experience in cathodic protection sector to follow-up global tenders. Following points are the KORTEK' s approach in detailed tender preparation to provide technically qualified and commercially accurate proposal:

- Detailed review of FEED documents.
- Providing all technical qualification requirements (Integrated quality certificates, reference turn-key projects, organization charts etc.) as a part of technical proposal.
- Evaluating cathodic protection requirements according to project specific requirements.
- Material Take-Off Study.
- Detailed market price research.
- Cost analysis of both direct and indirect cost items.
- Clarification requests from CLIENT where necessary

In addition to Turkey, KORTEK supported Contractors and Investors in global by providing tender consultancy services, assisting their international business development and aiding them in signing new contracts in cathodic protection.

# REFERENCE PROJECTS

## Trans Anatolian Natural Gas Pipeline Project (LOT1, LOT2, LOT3, LOT4, Compressor and Metering Stations)

**Brief Project Description:**

The TANAP Natural Gas Pipeline Project covers high-pressurized pipeline and associated structures for transmission of natural gas 31 billion $m^3$/y, scheduled for supply from Azerbaijan to Turkey and Europe for 50 years.

**Pipeline:**

Length: 1850 km

Pipeline Diameter Onshore : 56" (1340 km) and 48" (460 km) respectively

**Station facilities:**

Compressor Station: 7 Nos.

Block Valve Stations: 49 Nos block valve stations.

PIG Stations: 11 Nos.

**Brief CP Scope:**

TANAP Cathodic protection system covers 56" main line (which is approximately 1850 km, starting at the border of Georgia-Turkey, leading to Turkey-Greece Border of Turkey.), water tanks and in-plant underground pipings inside of metering and compressor stations. Kortek is selected to provide material supply and workmanship for all CP equipment including 50 Transformer Rectifier Units, 105 Distribution Box, 35 horizontal anode groundbed accessories (including MMO anodes, coke breeze, splice kit etc.) and other related equipment such as reference electrodes, cables, test posts etc. All material supply, site installation and CP system commissioning for entire project was finalized in 2020.

# ARCTIC LNG 2 PROJECT

**Brief Project Description:**

As part of the Arctic LNG 2 Project, it is planned to construct the PLANT – a fixed nearshore terminal for the production, storage and offloading of liquefied natural gas (LNG) and stabilized gas condensate (SGC). Each of the three trains will be supported on a gravity-based structure (GBS) and located within a sea port to harbour the PLANT and facilitate the offloading of the LNG and SGC (stored inside the GBSs) to LNG carriers and condensate tankers.

The Arctic LNG 2 Project consists of three trains, each with a capacity of 6.5- 6.6 MTPA of LNG. Total LNG storage volume is 687,000 m3 (229,000 m3 per GBS) and approximately 1.4 MTPA of stabilized marketable condensate with 75,000m3 of condensate storage per GBS.

The GBSs are to be fabricated in two (2) dry docks in the NOVATEK MURMANSK PLANT, which is located in the vicinity of the Belokamenka village (Murmansk Region).

The topside modules will be fabricated in local (including NOVATEK MURMANSK PLANT), or international module yards, then installed and integrated on the GBS and pre-commissioned at NOVATEK MURMANSK PLANT.

**Brief CP Scope:**

Galvanic system is used for cathodic protection for the steel in concrete of the internal ballast compartments, exposed to ballasted water for 3 Gravity Base Structures (GBS). According to seawater resistivity, zinc alloy-based anodes are selected to be used for CP system and Kortek is selected to provide 1200 tons of Zinc Alloyed Galvanic anodes for 3 GBS (400 tons of Anode per each GBS). Anodes have been produced and shipped successfully for 2 GBS, and production of anodes for last GBS unit are still in the progress.

# TURKSTREAM PROJECT ONSHORE SECTION-2

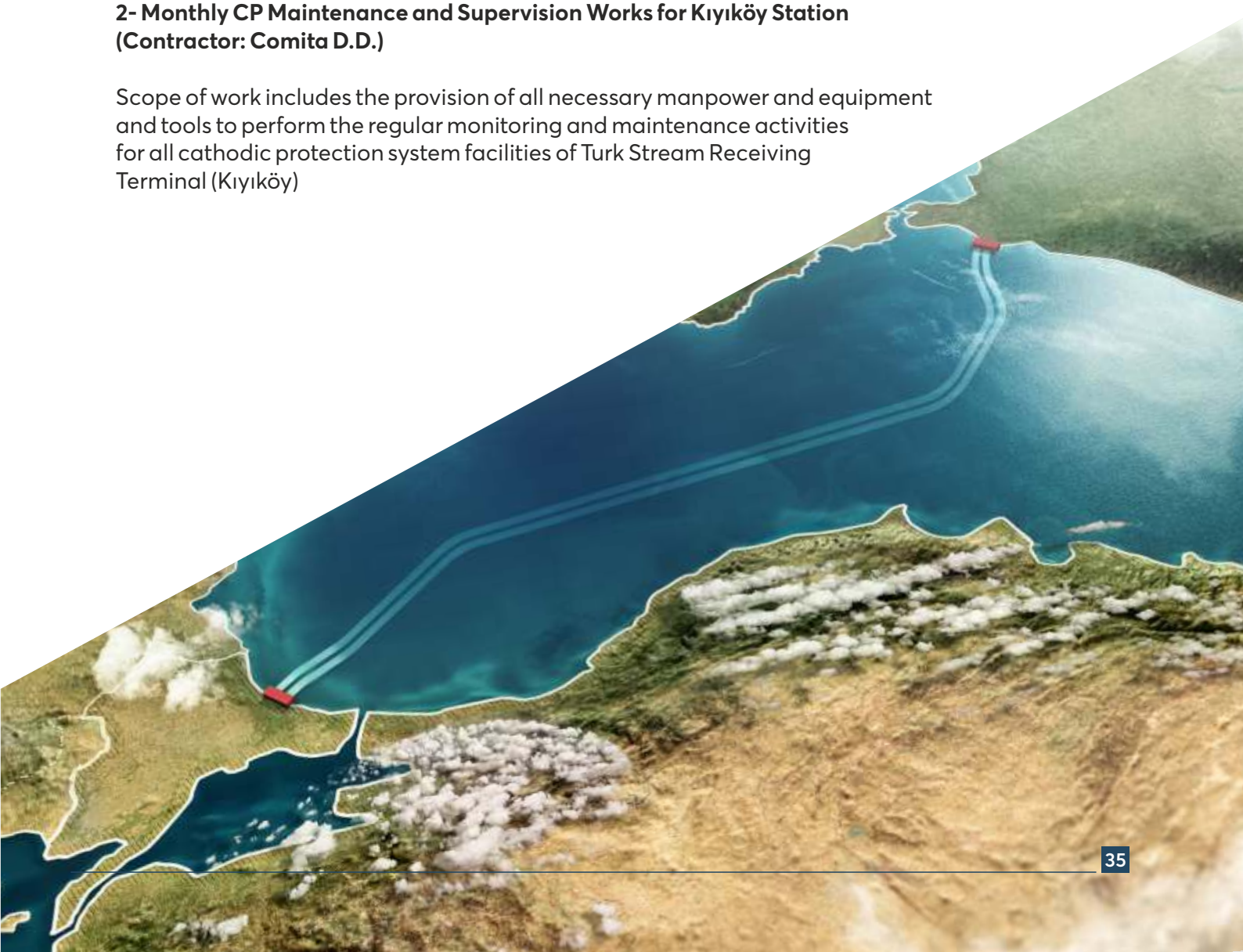
**1- Brief Project Description:**

TurkStream gas pipeline is 142 km in length, with a diameter of 48 inches. The modern Telecommunication system along the pipeline is provided via a Fiber Optic Cable System running parallel to the Pipeline, with a back-up system to ensure an uninterrupted transmission of SCADA signals. The SCADA system monitor and control the 5(five) mainline block valve stations and 1 (one) PIG launcher station.The landing point in Turkey is Kıyıköy, a village in the district of Vize in Kırklareli Province at northwestern Turkey. From there, the 70 km section (Onshore Section-1) of the first line towards to national transmission connection at Misinli village in Lüleburgaz. The second line which is called as Türk Akım Gas Pipeline (Onshore Section-2) continues from Kıyıköy to Malkoçlar on Turkey–Bulgaria border, where it is connected to the existing Trans-Balkan pipeline system.Brief CP Scope:Kortek has been awarded for 3 different contracts as follows:1 – CP Works for Turkstream Gas Pipeline (142 km length) (Contractor: ACD İnşaat)

Material supply, installation and commissioning works have been completed in 2020 within the scope of this project that includes 4 TR Unit, 4 horizontal anode groundbed (with equipment such as MMO anodes, coke breeze, cables etc.) and 145 Test Post along the route.

**2- Monthly CP Maintenance and Supervision Works for Kıyıköy Station (Contractor: Comita D.D.)**

Scope of work includes the provision of all necessary manpower and equipment and tools to perform the regular monitoring and maintenance activities for all cathodic protection system facilities of Turk Stream Receiving Terminal (Kıyıköy)



# *TUZ GOLU UNDERGROUND GAS STORAGE PROJECT-2*

**Brief Project Description:**
In Tuz Gölü Underground Storage Facility Expansion Project, working gas capacity of the existing storage plant will be increased to 5.2 billion Nm3 with the help of new 40 caverns. 6 of 40 new caverns will be leached by SF 1 (existing plant). For leaching of 34 caverns a new plant will be built Surface Facility 2 (SF2), consisting of leaching and gas facilities located, a fresh water supply system, brine disposal system, blanket system and gas injection & withdraw field pipeline system.

At the first step, leaching process will be done in new caverns to obtain required storage volume. During leaching process, fresh water from Hirfanlı Dam and nitrogen (blanket) gas from nitrogen unit system will be used. Brine, that is generated in leaching operation phase, will be transferred firstly from caverns to settlement basin and then disposed to the Tuz Gölü via gravity by Brine GRP pipeline. After completion of leaching process, caverns will be ready to fill with Natural Gas from Kayseri-Konya-Seydisehir transmission line. The new plant (SF2) will be located in North direction of existing Tuz Gölü Sf1.

**Brief CP Scope:**
Cathodic protection is applied for the underground piping structures as per approved project design documents within the scope of "Tuz Golu Underground Gas Storage Project-2". Kortek is selected to supply the materials for related Impressed Current System including 4 Transformer Rectifier Units, 6 horizontal (4+2 replacement) anode groundbed accessories (including MMO anodes, groundbed casings, coke breeze etc.) and other related equipment such as reference electrodes, cables, test posts etc. All materials have been produced and shipped successfully to site except TR Units and CP system is planning to be commissioned by the end of August 2021.

# EPC FOR WELL PADS EXPANSION AND HOOK-UP OF HISTORICAL WELLS AT THE WEST QURNA (PHASE 2) CONTRACT AREA

**Brief Project Description:**
Lukoil Mid-East Limited (COMPANY) is planning to develop its upstream production facilities and infrastructure to meet a target of 800 BOPD of production in the West Qurna-2 oil field in Southern Iraq.

The West Qurna-2 field is located in the south-eastern part of Iraq, 64 km westwards from Basrah and 32 km to south-west from Zubair Oil Field.

The West Qurna-2 field occupies lower reaches of the Tigris and Euphrates rivers, which confluence constitutes the Shatt Al Arab River. The relief of the area is described as a plateau of low-lying coastal sand plain having an elevation 5 to 50 m. The contract area of the West Qurna-2 field lies in the northernmost part of the Rumaila Field.

Expansion of existing well pads by hook-up of 54 wells at 6 existing well pads # 2, 5, 7, 8, 10 and 12 and hook-up of two historical wells. Detailed information is as follows:

- Expansion of existing well pads by hook up of 52 wells at 6 existing well pads # 2, 5, 7, 8, IO and 12
- Hook-Up of 2 water injection wells, WQ#2 I 5 at WP#8 and WQ# 232 at WP#7
- Hook-up of historical well # WQ 08 to manifold of existing well pad# 2
- Hook-up of historical well# WQ 148 to manifold of existing well pad #7

**Brief CP Scope:**
Cathodic protection is applied for the Well casings, trunk lines and underground piping structures as per approved project design documents within the scope of "EPC for Well Pads Expansion and Hook-Up of Historical Wells at the West Qurna (Phase 2) Contract Area Project". Kortek is selected to supply the materials for related Impressed Current System including 11 Transformer Rectifier Units, 49 Distribution Box, 11 deep-well anode groundbed accessories (including MMO anodes, groundbed casings, coke breeze etc.) and other related equipment such as reference electrodes, cables, test posts etc. All materials have been produced and shipped successfully to site and CP system commissioning will be finalized by the end of March 2021.

KORTEK

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