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APPLICATION OF ER PROBE IN CATHODIC PROTECTION, TECHART SOLUTIONS

ZASTOSOWANIE SONDY ER W OCHRONIE KATODOWEJ, ROZWIĄZANIE TECHART

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Abstract

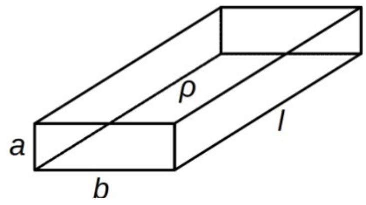
The criterion of corrosion protection for buried and submerged structures is based on indirect parameters, such as the polarization potential and density of AC currents on the isolation defect, and a direct indicator – the corrosion rate. Since the value of the required protective potential depends on multiple factors, along with the risk of residual currents or stray currents interfering with OFF measurements, the use of ER probes is justified. The main deficiencies of many ER probes are insufficiently precise measurement resolution and inability to apply the same material as the structure. Likewise, many ER probes only enable corrosion rate measurement, not other data, such as potential, alternating voltage, magnitude and density of current. The TECHART ER probe (TE-ERC) has characteristics that overcome the above deficiencies.

Streszczenie

Kryterium ochrony przeciwkorozyjnej zakopanych i zanurzonych konstrukcji metalowych bazuje na parametrach pośrednich, takich jak potencjał polaryzacji i gęstość prądu przemiennego w defekcie izolacji, i na bezpośrednim wskaźniku – szybkości korozji. Ponieważ wartość wymaganego potencjału ochronnego zależy od wielu czynników, łącznie z ryzykiem wystąpienia prądów szczątkowych lub prądów błądzących wpływających na pomiary wyłączeniowe, korzystanie z czujników korozymetrii rezystancyjnej (ER probe) jest uzasadnione. Główne braki wielu czujników ER to niewystarczająco precyzyjna rozdzielczość pomiarowa oraz niemożność zastosowania takiego samego materiału jak konstrukcja. Podobnie, wiele sond ER tylko umożliwia pomiar szybkości korozji, a nie innych wielkości, takich jak potencjał, napięcie przemienne, wielkość i gęstość prądu. Sonda TECHART ER (TE-ERC) posiada cechy, które przezwyciężają powyższe braki.

1. Requirements for Cathodic Protection

The criteria for cathodic protection according to standard EN12954 [1] are based on the values of the IR-FREE potential, the density of alternating currents on coating failure, and the corrosion rate. The protection potential value ranges from – 850 mVcse to -1200 mVcse (T = 25°C). In case the temperature exceeds 25°C and in the presence of SRB (anaerobic bacteria) the value of the protection potential should be more negative than – 850 mVcse. Furthermore, if the density of the AC current over a coating failure of 1 cm^2 is greater than 30 A/m^2, the structure is being compromised by corrosion despite cathodic protection. Due to the above, measuring the corrosion rate is highly recommended as the final indicator, as a proof that the structure is protected from corrosion. The maximum allowed corrosion rate is 10 μm per year [1], or 0.027 μm per day. The corrosion rate measurement is based on measuring changes to the coupon resistance [3]. In case the coupon corrodes, its thickness (a) decreases and therefore the longitudinal resistance (R) of the coupon as a conductor increases. (Fig. 1).



$$R = \rho \times \frac{l}{a \times b} \qquad \text{(Eq. 1)}$$

Fig. 1.

where:

ρ – resistivity of steel coupon (Ωm)

l – length of steel coupon (m)

b – width of steel coupon (m)

a – thickness of steel coupon (m)

2. Deficiencies of Existing Methods

The application of corrosion coupons is not practical because the measurement of metal loss is read manually and cannot detect corrosion in a short interval of time. Furthermore, the reading includes excavation and/or procedure that demands time.

The problems of existing ER probes on the market are:

- The coupon cannot always be made from the same quality of steel as the structure, which is otherwise necessary for results to be comparable. It would be ideal if a coupon could be made from the exact same construction material.
- The cable length from the ER probe to the RMU or data logger is up to 30 m, which may be insufficient, particularly in the case of hazardous area. The location of the ER probe should be at the most endangered point of the structure, which may not be practical for an above-ground test point;
- The minimum measurable rate of corrosion is greater than 0.027 μm per day and the structure could be exposed to corrosion for days, without being observed;

- The number of ER probes that can be connected to a data logger and RMU is 1-2 pieces, which can be an expensive solution for corrosion analyses on dozens of pipelines, as is the case with gathering stations for crude oil;
- Most ER probes measure only the corrosion rate, but not other parameters, such as: ON/OFF potential, natural potential, the magnitude and density of AC and DC current and AC voltage. However, all these parameters are useful in the analysis of corrosion;

3. TECHART Solutions

Referring to the above problems in practice, TECHART has applied 30 years of experience and developed its own ER PROBE (TE-ERC), without these disadvantages, with the following characteristics:

- The coupon can be of the same metal as the structure. For example, TECHART can produce coupons from pipe API 5L grade B or any other metal pipe. Steel plates or sheets can also be used in coupon production.

Fig. 2. TECHART ER probe with 1 cm^2 coupon

- Cable length from the ER PROBE (TE-ERC) to the TECHART RMU (TE-RMU) can be over 50 m. (Fig. 3, 4). The TECHART PROBE (TE-ERC) can be located below the aboveground storage tank (AST), and connected to the aboveground test point equipped with a remote monitoring unit (TE-RMU) outside the hazardous area. The length of the ER PROBE (TE-ERC) cable to the TE-RMU can be more than 50 m. An alternative approach would be the installation of EX proved test points with the RMU near the AST, which is an expensive solution.

  Furthermore, test points and ER probes should be placed at all characteristic points along a pipeline, such as: crossings with other pipelines, vicinity or crossing with High Voltage Transmission Lines (HVAC) etc. Due to property-legal relations or other circumstances it is not unusual that a test point (with RMU) cannot be installed along the pipeline, instead having to move it to a zone where it does not get in the way, e.g. next to a public road. In such cases, the length of the cable from the ER probe set next to the pipeline to the test point equipped with RMU can be several tens of meters. Since the TECHART ER PROBE (TE-ERC) can be connected with CP rectifier station, a distance to ER probe can be also more than 50 m. Data from TE-ERC are important for regulation of CP rectifier.

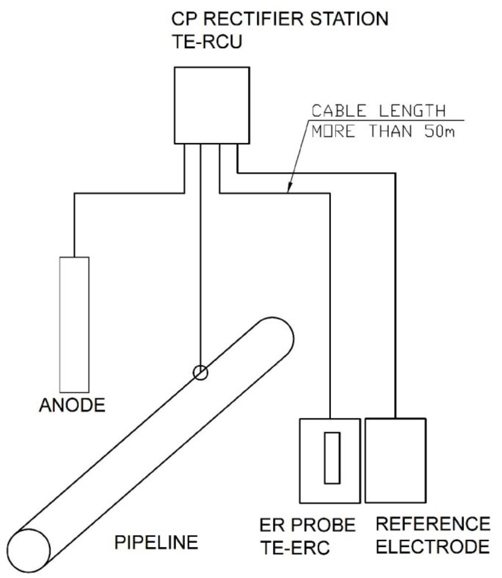


Fig. 3. ER probe connected to CP Rectifier Station

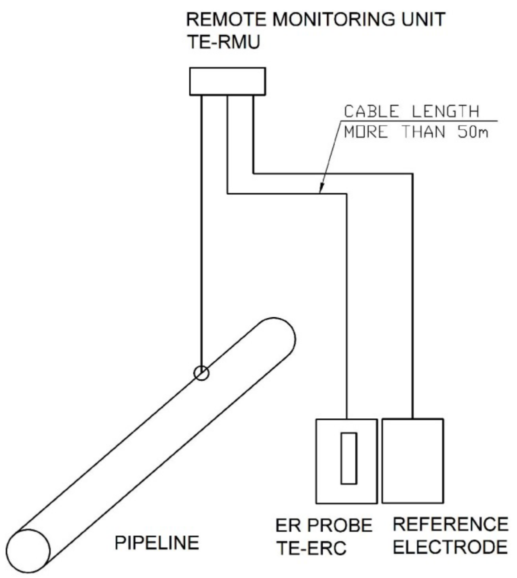


Fig. 4. ER probe connected to RMU

- The minimum corrosion rate which can be measured is less than 1 μm per year.

By applying a special measurement technique TECHART ER PROBE (TE-ERC) can detect changes of 0.0027 μm per day, corresponding to a corrosion rate of 1 μm per year. Standard EN 12954 permits corrosion rates of 0.01mm [1], i.e. 10 μm, thus the precision of the TECHART ER PROBE (TE-ERC) is satisfactory.

- The number of ER PROBES (TE-ERC) that can be connected to one TECHART Remote Monitoring Unit (TE-RMU) is 6 pieces, which is cost effective. In cases of multiple pipelines in parallel or at the gathering oil station, ER probes should be installed next to each pipeline. The use of TE.-RMU with 6 channels for 6 ER probes represents significant savings.
- The TECHART ER PROBE (TE-RMU) measures the following values:
  - Intensity of DC current across a coupon /soil surface – Idc
  - Intensity of AC current across a coupon/soil surface – Iac
  - ON/OFF potential – E_{on}, E_{off},
  - Value of the alternate voltage on the pipeline – U_{ac}
  - Corrosion rate – V_{corr}
  - Metal loss – M_{loss}
  - Density of DC current across a coupon /soil surface – J_{dc}
  - Density of AC current across a coupon/soil surface – J_{ac}

  This provides all the necessary data for corrosion analysis. The coupon is connected to the pipeline and is receiving all negative and positive influences. If the pipeline is exposed to corrosion or cathodic protection, so will the coupon be.
- The TECHART ER PROBE (TE-ERC) is connected to a CP station – transformer rectifier type TE –RCU (Fig. 5) or to a remote monitoring unit TE-RMU (Fig. 6). Available communication is: GSM/GPRS, MODBUS and USB port for PC/laptop.

Fig. 5. CP Rectifier Station (TE-RCU)

- The TECHART ER PROBE (TE-ERC) can be used for:
  - corrosion analysis of the outside surface of a structure (e.g. buried pipelines);
  - analysis of internal corrosion of pipelines and tanks;
  - analysis of corrosion of reinforcement in concrete;

Depending of application: soil, concrete or internal corrosion analyses, enclosure and coupon are adjusted.

Fig. 6. TECHART Remote Monitoring Unit (TE-RMU) for buried pipelines

References

[1] [EN 12954 – Cathodic protection of buried or immersed metallic structures -General principles and application for pipelines].

[2] [ANSI/NACE Standard RP0104-2004 The Use of Coupons for Cathodic Protection Monitoring Applications].

[3] [Lowrie. Fundamentals of Geophysics. Cambridge University Press. pp. 254. ISBN 978-1-139-46595-3].