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Control of the cathodic protection of a buried and well insulated pipeline in presence of stray currents

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"Control of the cathodic protection of a buried and well insulated pipeline in presence of stray currents"

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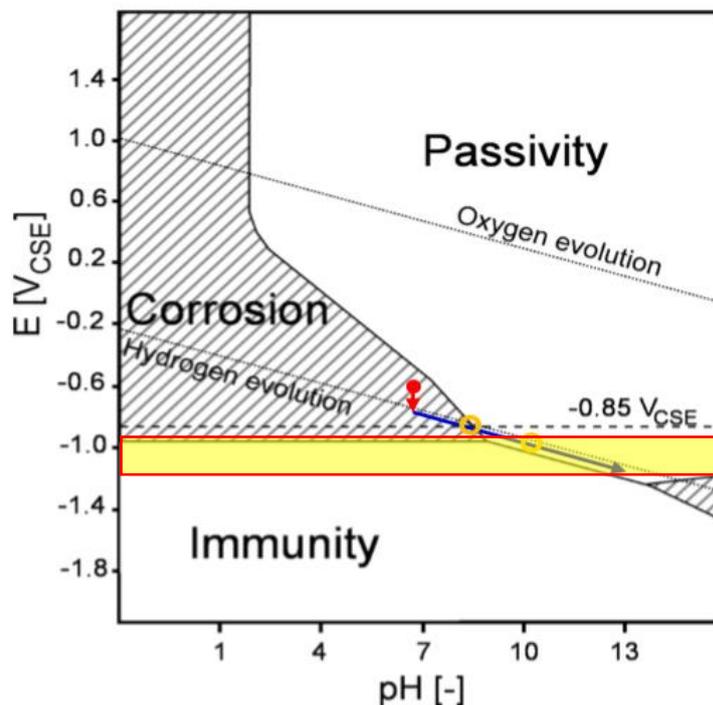
A buried pipeline is perfectly protected against external corrosion when the conditions for effective cathodic protection are met in all coating failures.

The effectiveness of the cathodic protection of a buried steel pipe, as indicated in the regulations, can only be verified by making measurements of the potential to verify that the applicable cathodic protection criterion is met in each case.

- Cathodic protection criterion

In the case of a buried pipe, isolated from other buried metal structures and equipped with a good coating, the standards indicate that when the corresponding cathodic protection criterion is met, the corrosion rate is less than 10 microns / year.

At all points where the IR free potential, measured relative to a correct copper /copper sulphate reference electrode, is between -0.95V and -1.2V, the corrosion rate is less than 10 microns / year and, in addition, with this the risks of overprotection are avoided.

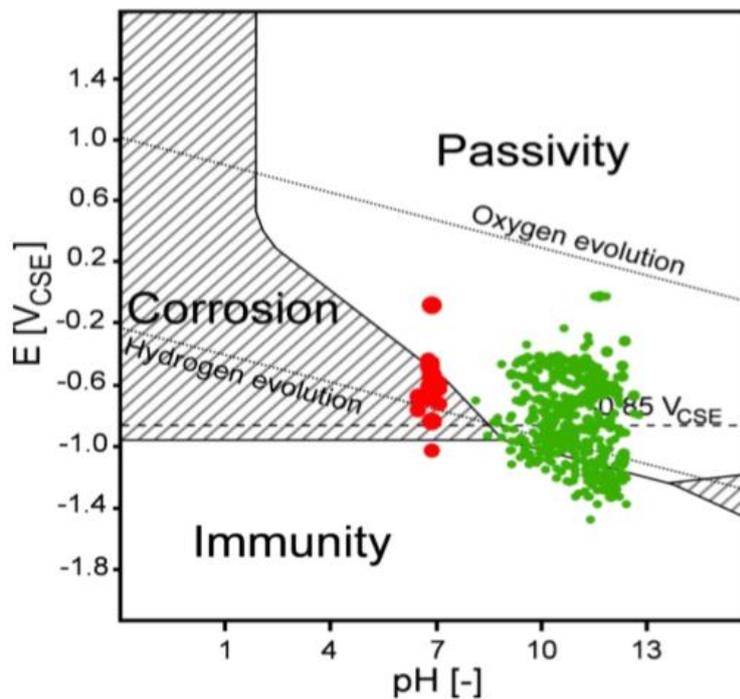


In recent years, in the CEOCOR working group that analyses the Protection Criterion, two major issues have been debated.

The first of the topics, which refers specifically to the criterion, contemplates that, under certain conditions, for potentials more positive than -0.95V there are no corrosion problems. This is possible, in addition to whether high soil resistivities can be guaranteed, if due to the pH reached, we are in the passivity zone of the Pourbaix diagram.

The ISO 15589.1 standard indicates that, if in aerobic conditions it can be guaranteed that the resistivity is greater than $100\ \Omega\cdot\text{m}$, the protection potential can be $-0.75\ \text{V}$ and if it is greater than $1000\ \Omega\cdot\text{m}$ it can be $-0.65\ \text{V}$

On the other hand, if the pH is high enough, we can be in the passivity zone without reaching the protection criterion as shown in the following figure



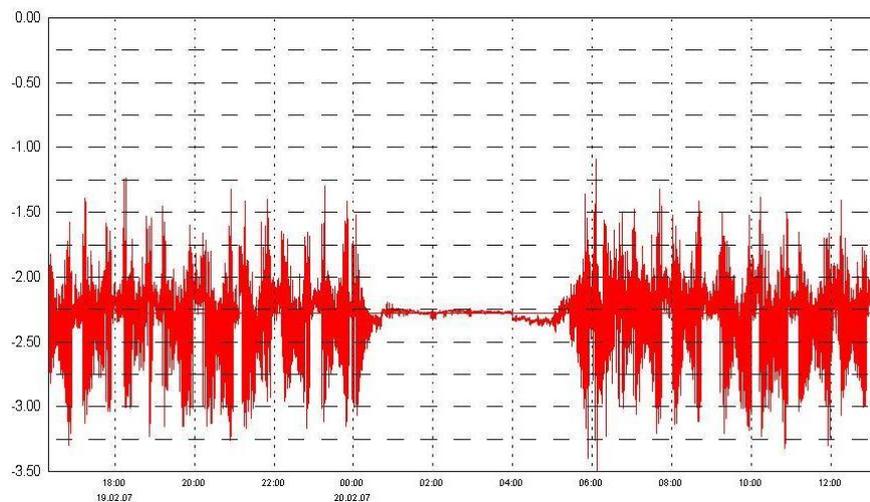
- Potential measurements on the pipe

The second topic that is debated in CEOCOR, and that is also of great importance, refers to the possibilities and / or difficulties to measure the IR-free potential.

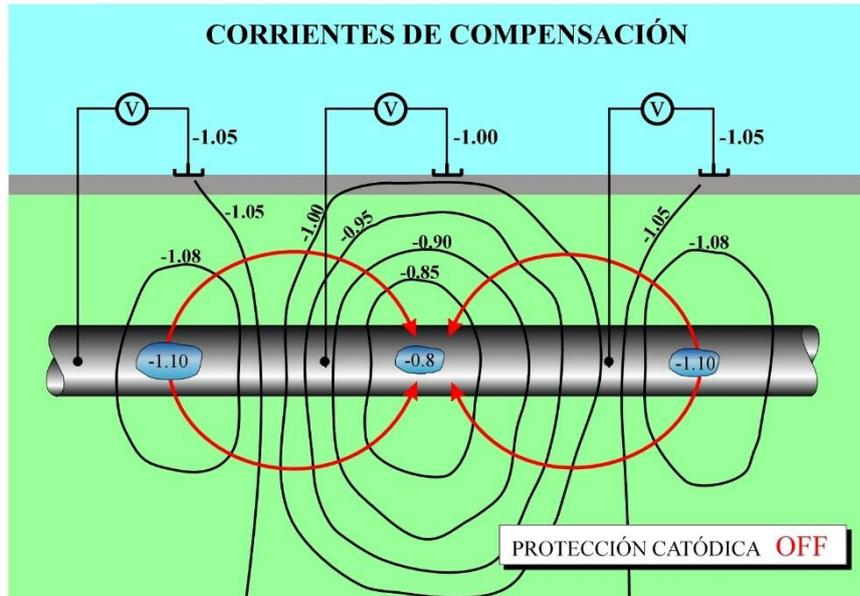
The potential measurements that can be carried out on the pipe are ON measurements, ON OFF measurements and Intensive Measurements.

In the case that we are analysing in this paper, of a pipe isolated from other structures, with a good coating and in presence of stray currents caused by traction systems, none of the three types of measurements in the previous paragraph is valid.

Measurements of ON potential cannot be accepted as criteria for cathodic protection according to current standards and, furthermore, in the case of stray currents caused by traction systems, large variations in ON potentials prevent the use of this method.

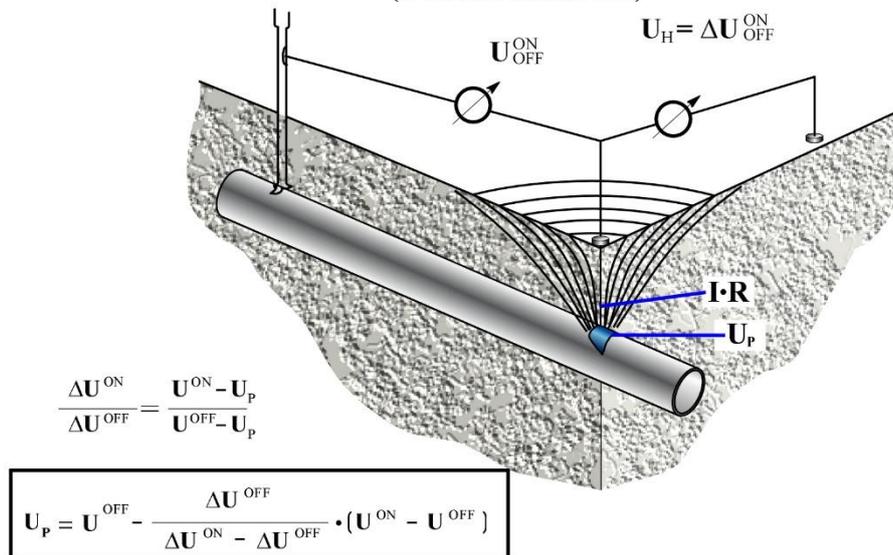


Constant or variable stray currents and compensation currents make it impossible to use measurements of the ON OFF potential on the pipe to verify the criterion.



Finally, in the case of high-quality coatings, the small gradients that occur when the current passes through the soil prevent the use of the “Intensive Measures” method.

**MEDIDAS INTENSIVAS Y GRADIENTE TRANSVERSAL
(2 ELECTRODOS)**



- Potential measurements on coupons

In the case of a buried coupon permanently connected to the pipe, if the reference electrode is close enough to it, the ON OFF measurements obtained by

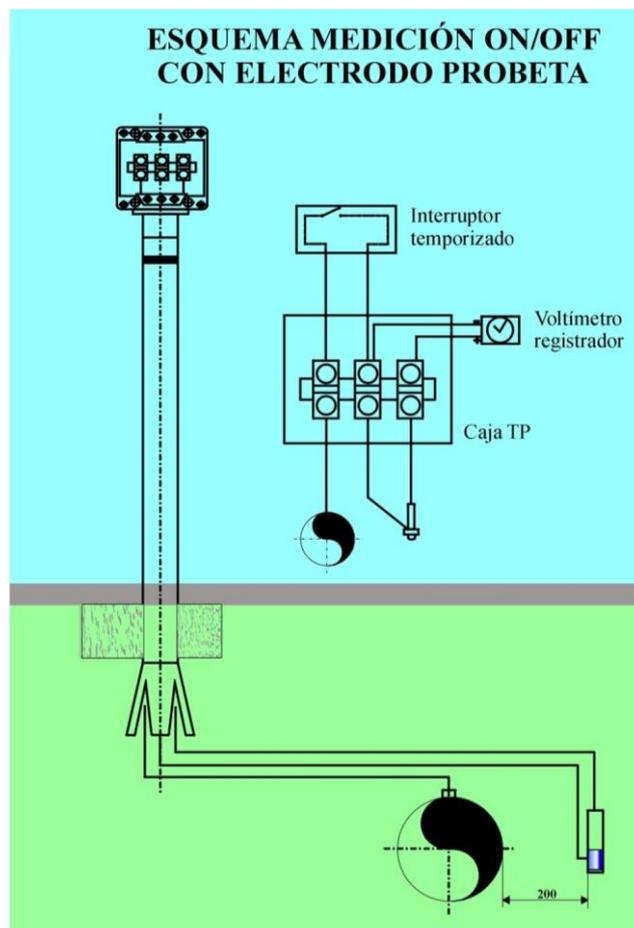
opening the switch located on the cable that connects the coupon to the pipe, allow to measure an OFF potential which can be quite similar to the IR free potential of the coupon.

Indeed, when the switch between the coupon and the pipe is opened, the current that circulates between the coupon and the soil is zero. In addition, the small distance between the coupon and the reference electrode minimizes the IR error due to the currents that continue to flow through the soil.

In addition to the proximity between the coupon and the reference electrode, and the verification of the proper functioning of the reference electrode, it is convenient to properly select the time elapsed between the instant OFF and the measurement of the potential, to avoid an excessive depolarization.

After an excessive depolarization, the measured potential moves away from the free IR potential that is the one that really interests us, and can mask the existence of overprotection potentials of the coupon, which can be dangerous in the case of the existence of a.c. interference.

In presence of stray currents due to traction systems, 24-hour recordings of the ON OFF potential of the coupons should be made to see the different existing conditions.



In the case of permanently buried coupon electrodes, it must be regularly verified that the reference electrode remains in good condition and allows us to measure correctly. To do this, when necessary, certain checks can be carried out using the appropriate equipment and techniques.

- Coupons representativity

In addition to being near the reference electrode, the coupons should be representative of nearby coating failures by:

- The bare surface of the coupon shall be less than that of the faults of the coating to be protected, therefore the surface of the coupons to be installed depends on the quality of the coating.
- The coupon shall be close to the pipe and in very similar soil, so that permanently buried coupons should be used at the same depth of the pipe and close to it.
- Sufficient coupons must be installed, particularly in doubtful or conflictive areas.
- It is important to carefully install the coupons and carry out the appropriate checks to confirm its correct condition to perform the measurements properly.

- Limitations

Obviously, getting all the coupons to have an IR-free potential that meets the cathodic protection criteria does not guarantee that all pipe coating defects will also meet it.

One method to minimize this problem is to install many coupons along the pipeline, carefully analysing not only the most suitable surface of the coupon and its correct installation and verification, but also the most suitable places in the pipe path to cover the maximum possible of special circumstances.

- Complementary measurements

In general, measurements of the ON OFF potential in the coupons should be complemented with measurements of the ON potential and the ON OFF potential on the pipe.

In presence of stray currents, ON OFF measurements on the pipe, with the switch located on the rectifier dc cables, should be carried out at moments without influence of stray currents.

It would be interesting to obtain a correlation between the IR free potentials measured in the coupons and the ON and OFF potentials measured on the pipe.

- Conclusions
 - IR-free cathodic protection potentials with values between -0.95 V and -1.2 V prevent corrosion
 - It is difficult to measure IR free potentials directly in the pipe, mainly in the presence of stray currents
 - It is relatively easy to measure a potential very similar to the IR free potential in a coupon.
 - Buried coupons shall be representative of coating failures and shall be installed and verified correctly.
 - Measure the potential after excessive depolarization of the coupon should be avoided, especially with a.c. interferences
 - Periodic verification of permanent reference electrodes is important
 - As a complement to the measurements on the coupons, it is important to carry out measurements on the pipe, mainly in periods without influences by stray currents, and obtain a correlation