D.C. CURRENT DENSITY CONTROL AT STEEL COUPONS AGAINST A.C. CORROSION RISKS

Adrián Gomila. Director GULDAGER ELECTRÓLISIS, C/ Legalitat, nº 13, 08024 Barcelona agomila@guldager.es

1. Introduction

In presence of a.c. corrosion risks, the best preventive method is to eliminate or decrease their influence to obtain an a.c. current density less than 30 A/m^2 in a $1cm^2$ steel coupon.

When this is not possible, the over cathodic protection shall be avoided to prevent an important corrosion rate when it combines with the a.c. current effect. An interesting control method for some cathodic protection installations has been verifying at the steel coupons installed in an a.c. interference area that the d.c. current density is not larger than an average of 1 A/m^2.

Along many years the cathodic protection effectiveness in pipelines, in severe stray currents areas, has been controlled by measuring the OFF potential and d.c. current that flows at the coupon using an external potential test probe. The common measuring technique used by Guldager to verify the accomplishment of the cathodic protection criteria has been measuring the pipe-to-soil potential between 0,5 and 1 seconds after the OFF disconnection.

In presence of a.c. interferences it's advisable to verify if this measuring technique should be reviewed or adjusted due to the fact that in many cases the average d.c. current density has been larger than 1 A/m^2 at the coupons. It's important that the cathodic protection criteria is accomplished without over protect the pipeline maintaining by this way a desirable d.c. current density at the coupons.

In this paper we analyze the results by measuring the cathodic protection level before 0,1 seconds since the OFF disconnection without waiting for an excessive pipeline depolarization like the common used technique.

The scope of this work is to verify if, thus, we can obtain enough electronegative potential values which allow decreasing the required current density to obtain the cathodic protection criteria and diminishing therefore the corrosion risk in presence of a.c. interferences.

2. Reduction of the a.c. interference

Where there is significant a.c. interference in a cathodic protected buried pipeline the most logical thing to do is trying to reduce it installing a proper drainage system.

For this solution it´s necessary to installed a device between the pipe and a lower resistance grounding element which allow to drain de a.c. current of the pipeline but blocking the d.c. current from the grounding element to the pipeline preventing by this way a negative effect in the cathodic protection system.

The average a.c. interference limit value over which is considered that could exist corrosion risks is 30 A/m2 and to verify the real situation and also be able to measure the a.c. current density, 1 cm2 steel coupons shall be installed in those locations considered dangerous.

In many cases this method or solution doesn´t allow to reduce sufficiently the a.c. interference therefore any cathodic overprotection that could provoke an important corrosion process in presence of the a.c. interference should be avoided.

3. Control of the cathodic protection

When is not possible to reduce the a.c. interference, the control of the cathodic protection could be performed to avoid a dangerous overprotection according to the

European standard project prEN 15280 avoiding ON pipe-to-soil potentials more negative than -1,2V, against a cooper-cooper sulfate reference electrode, or current densities over than 1 A/m2.

In pipelines affected by stray currents in which had been installed external potential test probes the best method is controlling the cathodic protection current density because in most cases it´s not possible to work with ON pipe-to-soil potentials more positive than -1,2V.

Spit of the fact that the prEN 15280 indicate that the cathodic protection current densities shall be measured in $1cm^2$ steel coupons, in this study all the measurements has been made using external potential test probes already installed, with superior surfaces.

4. Classic measurements at external potential test probes

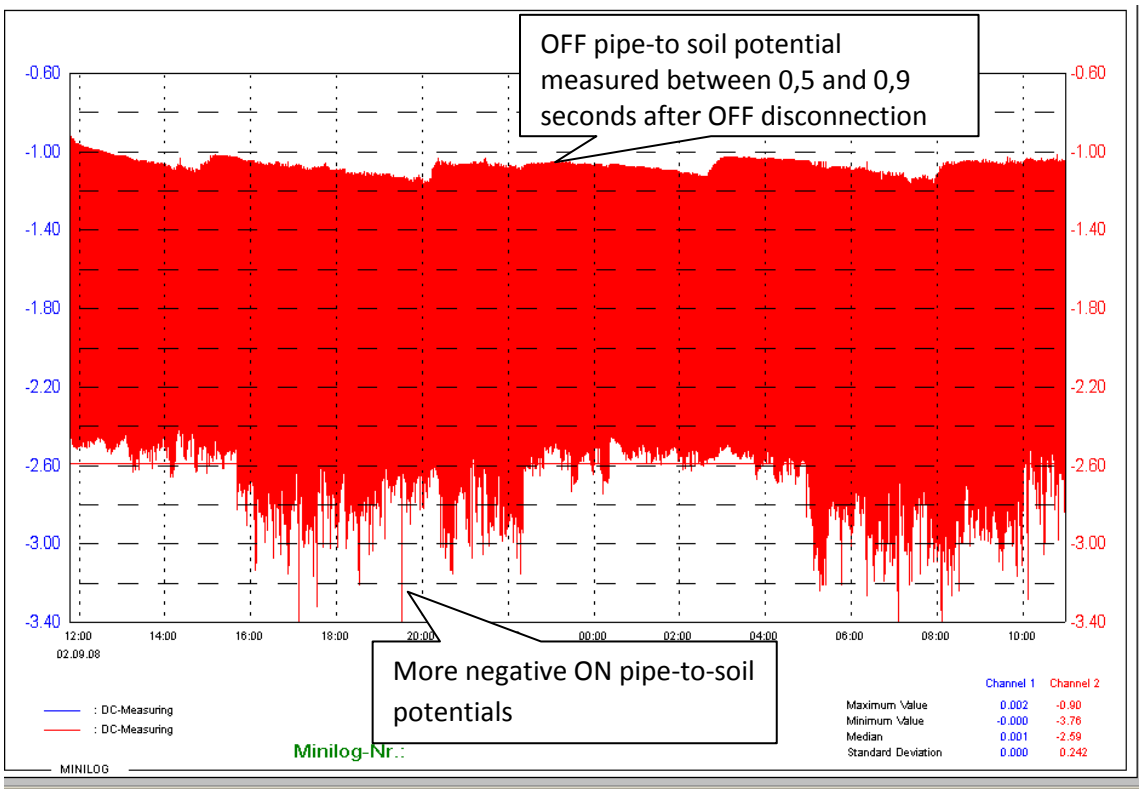
In 1993 Guldager installed the first external potential test probes for controlling the cathodic protection of GAS NATURAL pipelines and during almost 20 years measurements and recordings of the ON pipe-to-soil potentials, d.c. currents and OFF pipe-to-soil potentials of the steel coupons have been performed.

For more than 10 years these measurements has been performed using MiniLog Dataloggers to obtain simultaneously the pipe-to-soil potential and the d.c. current values every 0,5 seconds during a 24 hours recording period.

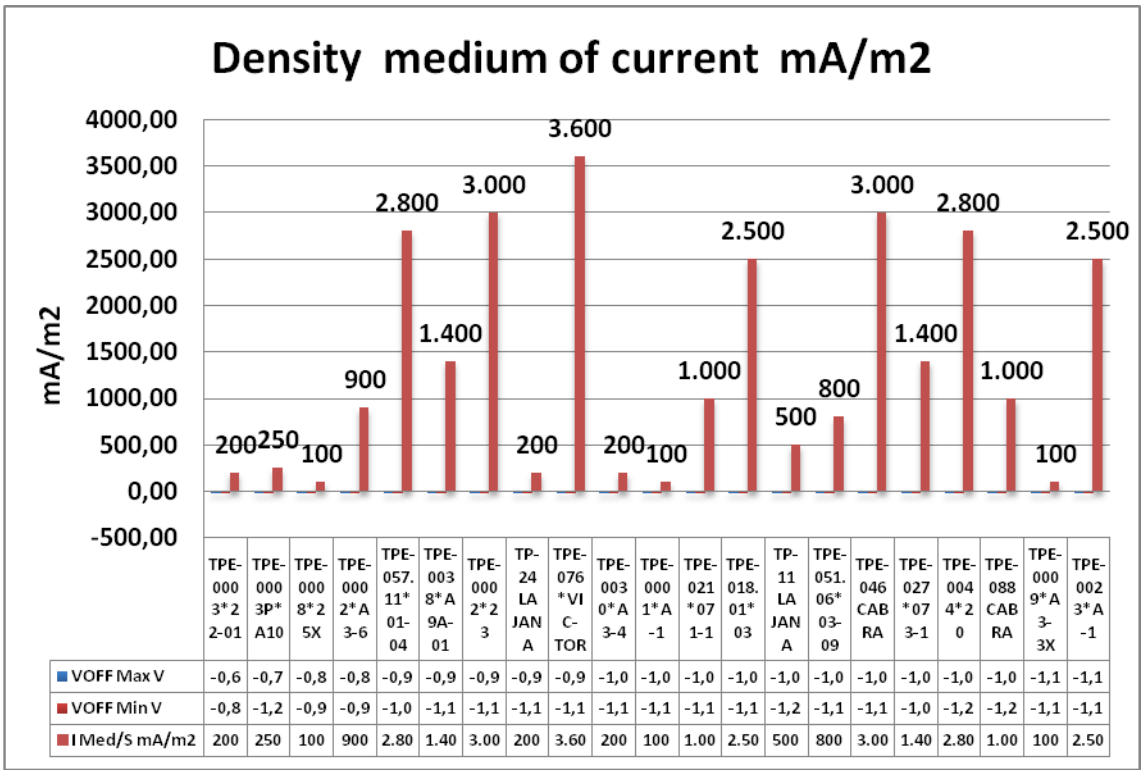
In the CEOCOR that was celebrated in Vienna in 2009 we present a summary of these works and it was possible to observe that by the used measuring and analysis system the OFF pipe-to-soil potential of the steel coupon was recorded between 0,5 and 0,9 seconds after the OFF disconnection.

It´s important to stand out that when long term recordings are performed it´s necessary a simple analysis method because it´s not practical a detail exam of each

depolarization curve obtained in each OFF disconnection between the pipe and the steel coupon during the entire recording period.



In this work was indicated that with this method possibly exists an important depolarization of the steel coupon and was showed that the average value of the d.c. current in some of the steel coupons was larger than 1 A/m^2. Due to the number of insulating joints, the distance between rectifiers and the important presence of stray currents, this situation allows to correctly protect pipeline sections very far away from the rectifier. When a.c. interferences do not exist this possible steel coupon overprotection doesn´t represent a problem, but in presence of a.c. should be avoided.



To know if there are a.c. interferences in the past 5 years we have been systematically performed instant measurements and data recordings of the a.c. voltage of the pipelines founding few cases with remarkable a.c. interferences. In those cases the adopted method was the installation of 1 cm^2 external potential test probes and draining systems to reduce the a.c. interference.

5. New measurements

To know the real depolarization level that takes place with the classic OFF pipe-to-soil potential measurements between 0,5 and 0,9 second after the OFF disconnection, and the possibilities to reduce the d.c. current density of the steel coupons against possible important a.c. interferences it was decided to performed a series of new measurements after 0,1 seconds in well known and perfectly controlled pipelines.

For this purpose it was used the new Weilekes MiniLog2 Data Logger which allows us to perform the following measurements.

Firstly we performed a pipe-to-soil potential recording every millisecond in which was possible to observe the depolarization curve in full detail. It can be appreciated that between the OFF potential measured at 10 milliseconds and the potential measured between 0,5 and 0,9 seconds, after certain depolarization, the differences are in the habit of being important, which confirms that in case of a.c. interference the level of the d.c. current density of the steel coupon could be lowered.

The second type of measurements were made by using the MiniLog2 “Mini-Coup” application which allows to obtain separated and independent d.c. and a.c. potential and current curves selecting the more likable reading frequency.

With this application is possible to obtain interesting comparatives and observe the possibilities to reduce the cathodic protection level when it´s necessary.

6. Results

There have been performed a series of measurements that are not already finished from which their results will be showed in the presentation of next May 30th by some graphs.

The main results obtained until this day are the following ones:

It´s confirmed that measuring with the Mini-Coup application at 10ms after the OFF disconnection is possible in many cases to decrease the rectifier´s current output maintaining an OFF pipe-to-soil potential at the steel coupon that accomplish the EN 12954 cathodic protection criteria.

In effect, for example, measuring at a steel coupon with the classic technique we obtain an OFF pipe-to-soil potential of -1280 mV and measuring with the Mini-Coup application at 10 milliseconds after the OFF disconnection the result is an OFF

potential of -1330 mV. Between both measurements the result is a 50 mV depolarization which confirm that is possible to decrease the rectifier current output. In this case the d.c. current density in the steel coupon is larger than 1 A/m^2 therefore is evident the interest to work with a more positive potential and lowering the cathodic protection current density at the coupon.

After decreasing the rectifier current output and waiting a brief period for the coupon depolarization, the Mini-Coup measurements were then repeated being still observed a OFF pipe-to-soil potential of -1190 mV and an important decrease in the d.c. current density but nevertheless it was still over 1 A/m^2.

The aim is to obtain a d.c. current density lower than 1 A/m^2 at the steel coupon which could allow to avoid corrosion risks in presence of important a.c. interferences.

Decreasing even more the rectifier current output to adjust the OFF pipe-to-soil potential to values nearby -850 or 900 mV and therefore to achieve that the d.c. current density at the steel coupon continues decreasing to a lower value than 1 A/m^2 it´s only possible in those cases were this adjustment doesn't provoke that other steel coupons nearby reached an IR free potential that not accomplish the cathodic protection criteria.

7. Conclusions

In areas with stray currents when it´s not possible to decrease or reduce the a.c. interferences. the control criteria to be applied for the cathodic protection for avoiding any corrosion risks shall be to obtain a d.c. current density less than 1 A/m^2 in the steel coupon, accomplishing always the cathodic protection criteria.

In areas where the use of external potential test probes is a wide confirmed technique, the OFF pipe-to-soil potential at 10 milliseconds after the disconnection allow to confirm that the cathodic protection criteria is accomplished and avoid excessive polarizations which involves high d.c. current densities.

The Mini-Coup application allows these types of measurements at 10 milliseconds after the OFF disconnection and also a fast and easy way for data analysis with a large amount of information.

Not always will be possible to obtain average values of current densities less than 1 A/m^2 in all the steel coupons in a same buried pipeline due to possible polarization differences between them.

8. Gratefulnesses

We are deeply grateful for the collaboration of the Company GAS NATURAL FENOSA to allow us to perform the measurements exposed in this work as well as the presentation of the results.