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# The Field Test of a Mitigation Method from DC Subwaysystem for Underground Pipeline

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The owner of underground metallic structures (gas pipeline, oil pipeline, water pipeline, etc) has a burden of responsibility for the corrosion protection in order to prevent big accidents like gas explosion, soil pollution, leakage and so on. So far, Cathodic Protection(CP) technology have been implemented for protection of underground systems. The stray current from DC subway system in Korea has affected the cathodic protection (CP) design of the buried pipelines adjacent to the railroads. In this aspect, KERI has developed a various mitigation method, drainage system through steel bar under the rail, a stray current gathering mesh system, insulation method between yard and main line, distributed ICCP(Impressed Current Cathodic System), High speed response rectifier, restrictive drainage system, Boding ICCP system. We installed the mitigation system at the real field and test of its efficiency in Busan and Seoul, Korea. In this paper, the results of field test, especially, distributed ICCP are described.

***Keywords*** *: corrosion control, mitigation of stray current, underground pipeline*

## 1. Introduction

Generally, the metal structure is corroded inevitably by various factors as time passes. This corrosion can sometimes cause serious accidents. Therefore, in order to prevent those accidents, the owners of such structures have CP(Cathodic Protection) facilities which protect the metallic structures from corrosion and which can eventually extend the life of the structure.[1)-8)]

The owners of such cathodic protection facilities try to keep their system as stable as possible. Especially for the people in City Gas Co. LTD, it is their obligation to report their CP potential data regularly. Even though, they conducted a good manage their pipeline, stray current corrosion is can be occur.[9)]

Therefore, we have to protect a underground structures from DC stray current. In this aspect, most of case a drainage system is adopted. But when this system adopted, another problems are occur.[10)-19)]

In this paper, various mitigation method are developed and tested in the field. On the view point of source side, a drainage system through steel bar under the rail, a stray current gathering mesh system and insulation method between yard and main line are developed. On the view point of underground structures side, distributed ICCP(Impressed Current Cathodic System), High speed response rectifier, restrictive drainage system and Boding ICCP system are developed. We installed the mitigation system at the real field and test of its efficiency in Busan and Seoul, Korea. Especially, the test results of a distributed ICCP in the field are described in this paper.

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## 2. Background

A stray current results from DC current flow through paths other than the intended circuit, for example, by any extraneous current in the earth. This corrosion due to stray current is sometimes also called "electrolysis", because of its mechanism. Generally, stray current corrosion is caused by uncontrolled electrical DC currents from extraneous sources through unintended paths. These are mostly the result of bad earth return on electrical system, giving rise to leakage of currents through metal structures and other preferentially conductive paths.

Normally, common sources of stray currents include a DC electric transit system and other cathodic protection systems. We would like to focus on DC electric transit systems.

If current passes in and out the metal structure, an electrolysis cell is set up. As a result, the area where the positive current exits the metal structure is forced to react as an anodic site. This causes the local oxidation of the metal piece, which may lead to a rapid consumption of the metal(pitting corrosion) and, eventually, to a complete penetration of a metal wall.

So, we have to avoid the positive current exits the structure through the soil.

## 3. The mitigation of stray current

In general, the various mitigation method are there as follow. On the view point of source side, a drainage system through steel bar under the rail, a stray current gathering mesh system and insulation method between yard and main line are developed. On the view point of underground structures side, distributed ICCP(Impressed Current Cathodic System), High speed response rectifier, restrictive drainage system and Boding ICCP system are developed. In this section, I would like to explain to the distributed ICCP.

If we install a distributed ICCP as Fig. 1 on underground structures in the area of substation of DC transit system, the stray current which is entered to pipeline exit to soil through anodes of ICCP and return to negative feeder of DC converter at substation without the pipeline surface. In other words, the pipeline is not corrodes because of exit trough metallic path between anode and pipeline without the surface of pipeline. Even though the anode is corrodes but the corrosion rate is very low because the anode is insoluble anode type. In this case, it's prohibited for using a sacrificial anode, for instance, Magnesium anode because the corrosion rate is very high. It is cause pipeline to corrode. When multiple distributed ICCP of small output are adopted, the stray current is exit easily and the interference becomes also smaller. These are merits of distributed ICCP.

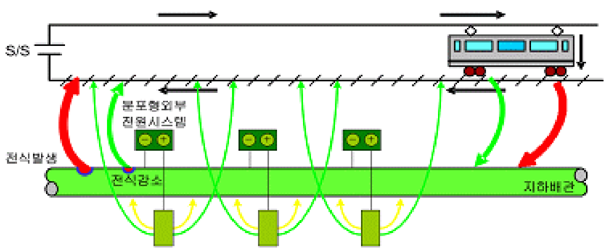


**Fig. 1.** A schematic diagram of distributed ICCP

## 4. The test result

We installed a distributed ICCP(output:10V/300mA) on a city gas pipeline in Seoul in order to evaluate the efficiency of mitigation of stray current. When the distributed ICCP is adopted, the P/S(pipe to soil) potentials are as following according to Fig. 2. The maximum potential is -640 mV/CSE. The minimum potential is -5,070 mV/CSE. The average potential is -1,720 mV/CSE. But when the distributed ICCP is not adopted, the P/S(pipe to soil) potentials are as following. The maximum potential is -620 mV/CSE. The minimum potential is -5,450 mV/CSE. The average potential is -1,620 mV/CSE. The 430 mV/CSE is shift to more negative direction.

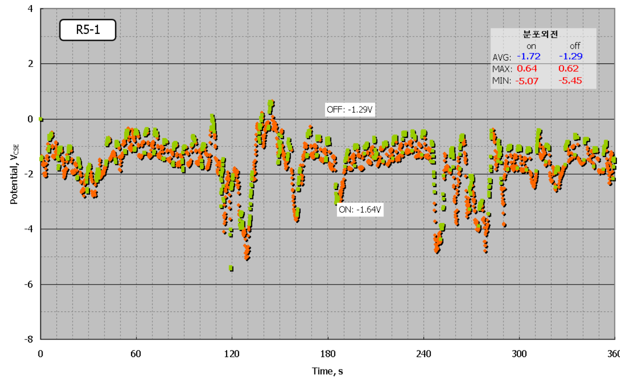


**Fig. 2.** The P/S(potential to soil) potential of gas pipeline in the field

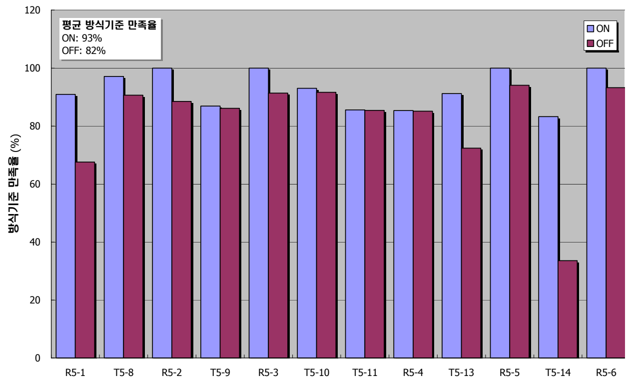


**Fig. 3.** The percentage of protection depend on adaptation of the proposed system


**Fig. 4.** A picture of distributed ICCP in the field

We also analyze the percentage of protection as Fig. 3. When the distributed ICCP is adopted, the percentage of protection is 93%. But when the distributed ICCP is not adopted, the percentage of protection is 82%. the distributed ICCP is adopted, the percentage of protection is getting high about 11%. These results are from 0.4A each 6 distributed ICCP. If we increase the output of ICCP in the permission range of interference, we can improve to 100% of protection rate.

The Fig. 4 is a picture of distributed ICCP in the field.

## 5. Conclusions

We developed the various mitigation methods of DC stray current and tested its method in the field. We installed a distributed ICCP(output:10V/300mA) on a city gas pipeline in Seoul in order to evaluate the efficiency of mitigation of stray current. When the distributed ICCP is adopted, the maximum P/S(pipe to soil) potentials is -640 mV/CSE and the minimum potential is -5,070 mV/CSE and the average potential is -1,720 mV/CSE respectively. But when the distributed ICCP is not adopted, the maximum P/S potentials is -620 mV/CSE and the minimum potential is -5,450 mV/CSE and the average potential is -1,620 mV/CSE respectively. The 430 mV/CSE is shift to more negative direction.

We also analyze the percentage of protection. When the distributed ICCP is adopted, the percentage of protection is 93%. Otherwise, the percentage of protection is 82%. The percentage of protection is getting higher about 11%. If we increase the output of ICCP in the permission range of interference, we can improve to 100% of protection rate.

In the future, we will report field test results of other mitigation method by DC stray current.

## Acknowledgments

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