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Development of a Measuring and Analysis System for Gas Pipelines Under Cathodic Protection

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ABSTRACT

The buried gas pipeline is protected from corrosion by cathodic protection and the management of corrosion protection condition is performed by measuring the pipe-to-soil potential.

There are many measuring points for the pipe-to-soil potential and the continuous measuring for 24 hours is required, so that it comes under the effect of stray current. The authors have developed and introduced a “measuring and analysis system” to record and analyze such a vast amount of measurement.

In this paper, the development of system and an example of demonstration on site are reported.

Keywords: buried pipeline, cathodic protection, small digital potential recording unit, corrosion protection management,

Paper

1 . INTRODUCTION

At Osaka Gas Co., Ltd., long routes of welded steel pipelines are protected by cathodic protection by the impressed current system. A medium-pressure line is generally protected with one rectifier for every 10 to 20 km depending on the degree of the grade of insulation of pipe coating and of the effect of the stray current from a railway.

The pipe-to-soil potential is measured with a Cu/CuSO4 reference electrode and an analog voltage recorder at each measuring point, where it is installed in a hand hole provided every 200 to 300 m on the ground surface along the gas pipeline and also in pressure regulating station.

The pipe-to-soil potential is measured continuously at each measuring point for fifteen minutes every year for simple measurement and for 24 h every 5 years for detail measurement. The detail measurement is performed to know the accurate corrosion protection condition of the buried pipeline under cathodic protection, because the pipe-to-soil potential comes under the effect of the stray current from railways around the urban area. Figure 1 shows an example of the pipe-to-soil potential under the effect of such stray current. If there is a point where the potential does not satisfy the corrosion protection potential, it is investigated in detail and evaluated on site.

Fig.1 An example of the pipe-by-soil potential which comes under the effect of stray current.

In 1988, small digital potential recording units and accompanying software were

introduced as substitutes for analog voltage recorders, which had many problems in recording time and accuracy of measurement.

In 2000, a new system substituting for the old system was introduced and a new system that was able continuously to measure it at most for six days. As a result, the problem at the record time of an old system was solved, and it came to be able to understand the influence of the straying current accurately. However, this system had the problem that it did not rain for the measurement period.

To understand such an influence accurately, the potential recorder that can be measured for a long term and system that can easily analyze huge recorded data is needed. Then, the author developed a “measuring and analysis system” that was able to measure and to analyze it accurately.

2. Content of development

2.1 Small digital potential recorder

This system is composed of a small digital potential recorder unit, analysis software and a calibrator. Figure 2 shows the photograph of the Small digital potential recorder. The record meter should be small and power saving design because The record meter should store in the protector set up on the road, and do the measuring the pipe-to-soil potential by uninhabited 30 days more continuously.

Fig.2 Small digital potential recorder

To achieve such a specification Small digital potential recorder enabled the chronic measurement by examining the composition of the thing

and the internal logic that selected the one of low power consumption to complete parts.

As a result, small digital potential recorder, sequential measurement is possible with a rechargeable battery available on the market by sampling once a second for 30 days. Moreover, a rechargeable battery on the market was used for the power supply, and the SD card was used for the record media. As a result, the small digital potential recorder did not have to be taken to the office because the battery and the SD card were able to be exchanged on the site, and the improvement of the working efficiency was achieved, too. The battery exchange on the site becomes possible because it uses a rechargeable battery on the market, and the improvement of the working efficiency can be expected. Moreover, a high-accuracy error margin ±1 mV was able to be achieved with a ±20000 mV measuring span. In addition, big reduction in costs was able to be achieved by constructing the small digital potential recorder by not using special parts, and using the marketed commodity compared with conventional product. The small digital potential recorder stores in a waterproof container on the market, and records potential in the protector set up on the road.

Table 1 Specifications of small digital potential recording unit

Items of measurement	Pipe-to-soil potential
Range of measurement	From plus or minus 20 volts
Accuracy	Plus or minus 0.005 % Fs
Power supply	rechargeable AA battery ×4
Sampling speed	One second
Temperature span	minus10□ from plus50□
Input resistance	Over 5 MΩ

Recording length	30 days
Waterproof property	Special waterproof container storage
Dimensions and weight	90^{W} 130^{H} 35^{D}, 0.35 kg

2.2 Analysis software

Software can have the analysis features of the display of the list of recorded data the electrical potential distribution etc. of the measurement point, and analyze the data easily and quickly. Moreover, it can be also possible to output recorded data by the text model, and analyze it by expressing it numerically. A specific cause and the state of cathodic protection condition when lower potential is generated by analyzing it like this can be confirmed, and it is possible to tie to the improvement of the state of cathodic protection condition.

An efficiency analysis can be achieved by assortment of these files. Figure 3 shows the flow chart of the analysis.

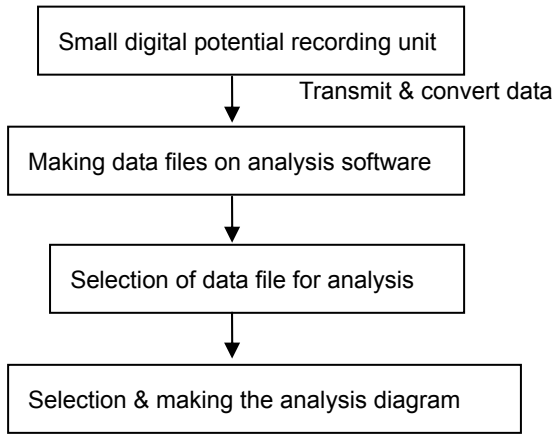

Fig.3 Flow chart of data analysis

2.2.1 Example of analysis software

An example of analysis menu with analysis results will follow.

2.2.1.1 Chart of the pipe-by-soil potential varying with time at a measuring point (Fig.4)

It is possible to survey the measurement of the pipe-to-soil potential, which is recorded once per second, in any span.

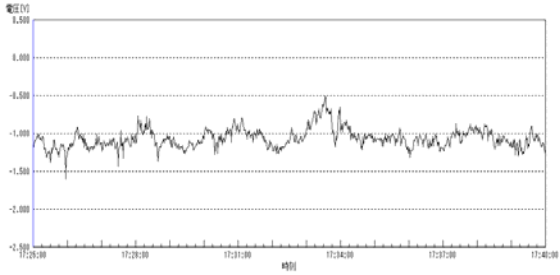

Fig.4 Chart of the pipe-to-soil potential at a measuring point.

2.2.1.2 Potential distribution along measuring points (Fig. 5)

This diagram shows the relationship between the distance of each measuring point from the rectifier and the measurement of the pipe-to-soil potential. The corrosion protection condition of every line can be known.

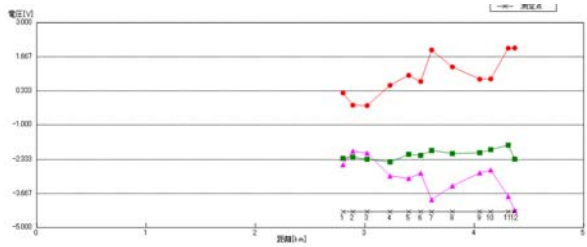

Fig.5 Example of the pipe-to-soil potential distribution along the

2.2.1.3 Chart of shift value (Fig. 6)

This diagram shows the estimation of the accurate potential by eliminating the IR-drop by the soil from the pipe-to-soil potential as an error by the current interrupt method.

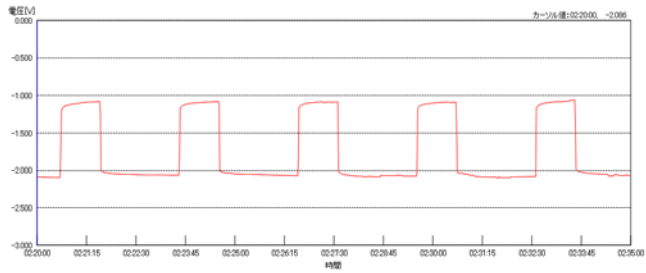

Fig.6 Example of the chart of shift value

2.3 Calibrator

To do the proofreading of the small digital potential recorder easily and quickly, the proofreading machine was developed. Because the proofreading of the small digital potential recorder is very important work because it understands the state of cathodic protection accurately, it is necessary to do. Calibrator can work only by connecting it with the small digital potential recorder in about 20 seconds per one like the time correction, 0 point adjustment, and the span adjustment, etc.

Osaka Gas used this system, and a more advanced operation and maintenance of the buried gas pipeline by cathodic protection was executed was achieved.

It wants to be going to use this system in the future, and to try to improve a further management level.

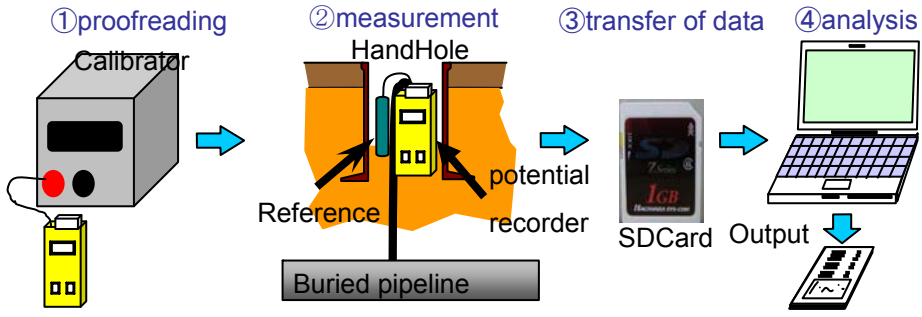

Fig.7 The configuration of the measuring and analysis system

3. CONCLUSIONS

At Osaka Gas Co., Ltd. used this system, and a more advanced operation and maintenance of the buried gas pipeline by cathodic protection was executed was achieved. This system has proved to be effective for its far greater accuracy of measurement and higher efficiency of analysis for the high- and medium- pressure lines with 500 small digital potential recording units.

It wants to be going to use this system in the future, and to try to improve a further management level.