Polarized forced inverter drainage with controlled reverse-current release

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Abstract. To solve the problem of limiting the potential displacement of the protected structures to a very negative side, it was proposed to use a controlled release enabling passing the reverse current by direct connection of electric transport rail running on direct current.

1 Introduction

In the past decade, the production of converters for cathodic protection of underground steel structures from stray current corrosion made a significant breakthrough in efficiency improvement and reduction of materials/output ratio due to the widespread use of inverters[1].

Inverters for cathodic protection have a 10-15% higher conversion efficiency and make for significant reduction of material expenses for production of converters (especially copper). Mass indicators of inverters are 3-4 times better than that of transformers.

Further development of converters for cathodic protection is mostly coming from further improvement of inverters. The most technically challenging is to create polarized forced inverter drainage since, as a rule, high powered converters of 3-5 kW with high output current of 200-300 A are needed.

Out of all types of corrosion, galvanic corrosion caused by stray currents is the most destructive. The main source of stray currents is direct current electric railway. Underground metal structures (pipelines) often pass near or cut the electrical transport lines; for this reason, it is highly likely that stray currents get on these structures. To drain stray currents to their source, drainages are used [2].

The currently existing automatic forced polarized drainages allow displacing the potential of the protected structure towards the negative side to a certain value to be automatically maintained by the converter. When the own protective potential is displaced to the negative side, the converter current decreases proportionally, however, if the potential of the protected structure is displaced negatively way over the set-point, the converter current goes down to zero and further control over the potential of the protected structure is impossible. In most cases, the potential displacement over -2.5 V, is not advisable.

To solve the problem of limiting the potential displacement of the protected structures to a very negative side, it was proposed to use a controlled release enabling passing the reverse current by direct connection of electric transport rail running on direct current to the

protected structure. As a result, the potential from the negative side returns to the set-point.

The best way to consider the work of cathodic polarization devices providing a solution to this problem is to use a specific object as an example.

2 Process

For instance, at Savchenko Street, Dnipro, with no cathode polarization devices, the potential on the moderate pressure gas pipeline with mastic and bitumen insulation located in close vicinity of the tram rail varies between +0.04 and -4.50 V (scatter of potential is 4.5 V), the average value is -1.10 V against the copper-sulfate reference electrode (CSRE). The potential shift for a day is shown in Fig. 1.

Fig. 1. Potential on a moderate pressure gas pipeline (against CSRE) with no external polarization

When using a simple forced drainage with output voltage of 6 V as a device for external polarization, the potential on the pipeline can be displaced to the negative side and it varies between -0.61 and -4.00 V, the average value is -1.28 V against CSRE. The potential shift during operation of an ordinary forced drainage with output voltage of 6 V within a day is shown in Fig. 2.

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Fig. 2. Potential on a moderate pressure gas pipeline (against CSRE) when forced drainage operates with output voltage of 6 V.

As a whole, using an ordinary forced drainage enables solving the problem of providing the protective potential on gas pipeline, however there is a great scatter of potential values (3,4 V) and polarization less than -2,5 V.

Use of drainages with automatic pre-set potential maintenance on a protected steel structure allows ensuring the level of potential that cannot be surpassed. Thus, Fig. 3 shows the operation of a forced inverter drainage with automatic potential maintenance that provides maintenance of the potential below -2,20 V. The potential varies between -2,12 and - 6.81 V, the average value is -2,54 V against CSRE. Scatter of potential is 4,7 V.

Fig. 3. Potential on a moderate pressure gas pipeline (against CSRE) when inverter drainage with automatic pre-set potential maintenance

By using the drainage with automatic potential maintenance one can also save on electricity, as compared with an ordinary drainage, since when gas pipeline has a negative (protective) potential, the drainage reduces output current or turns it off.

Use of polarized forced drainage with automatic protective potential maintenance makes it possible to solve the problem of provision of a desired protective potential on a protected structure, however it cannot help with a significant potential displacement to the negative side.

We have proposed to use automatic inverter drainage

with direct automatic closure of a protected structure on electric transport rail in cases when there is a significant positive potential on the rails of electric transport running on direct current and the potential of nearby steel structures has a significant displacement to the negative side. Therefore, significant stability of a pre-set protective potential of a protected structure can be achieved (see Fig. 4).

As Fig. 4 shows, the potential on moderate pressure gas pipeline varied between -2,13 and -3,26 V during a day. The average value is -2,43 V against CSRE. Scatter of potential is 1,1 V.

Thus, use of polarized forced drainage with automatic protective potential maintenance and reverse-current release enabled to stabilize the potential value on a protected structure (scatter of 1,1 V compared with 3,4 - 4,7 V for other drainage types). Protective potential displacement to the negative side has been significantly reduced.

Fig. 4. Potential on a moderate pressure gas pipeline (against CSRE) when inverter drainage with automatic protective potential maintenance and reverse-current release operates.

Polarized forced inverter drainage with automatic protective potential maintenance and controlled reverse-current release of 5 kW capacity has been successfully operating over 5 years at the site mentioned above. The outside appearance of the equipment is shown in Fig. 5.

Fig. 5. Outside appearance of inverter drainage and power unit with automatic protective potential maintenance and reverse-current release

3 Conclusions

The use of polarized forced automatic inverter drainages with controlled reverse-current release enables to stabilize the potential on a protected underground metal structure and therefore extend the working life of such structures.

References

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