COMPUTER SOFTWARE

Close interval potential survey (CIPS)

German Cathodic Protection

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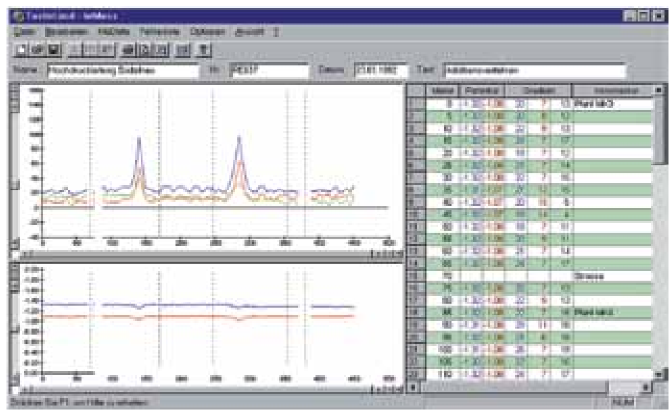
Analysis of the external corrosion of buried pipelines is made using pipe-to-soil potential measurements. Pipe-to-soil potentials are usually measured at fixed test points spaced between 1-5 km along a pipeline. However, since such measurements are only valid at the location of the reference electrodes, there is a lack of reliable information about the CP status elsewhere along the pipeline.
Considerable deviation in soil resistivity, interference and other factors can cause corrosion at intermediate locations even though the test points indicate favourable data. If the distance between the test points is decreased, the survey will provide more accurate data about CP conditions along the pipeline. This is why we have developed the Close Interval Potential Survey (CIPS), an intensive survey which allows potential measurements to be taken at intervals of 5 metres or less.

Reasons to use close interval potential survey - CIPS

It is obvious that a manual survey of pipe-to-soil potentials at such close intervals can be neither practical nor economic, especially if a long distance transmission pipeline is to be inspected. Even if stripchart recorders are available, such a survey woud be extremely time consuming. Thus a faster and more reliable method is a better alternative.
CIPS overcomes such problems by automatically recording, storing, calculating and displaying measurement data. This can be presented in a table or a graphic.



Required hardware

- MoData2 including handheld PC Itronix fex21
- MoData2 scope of delivery package

Required software

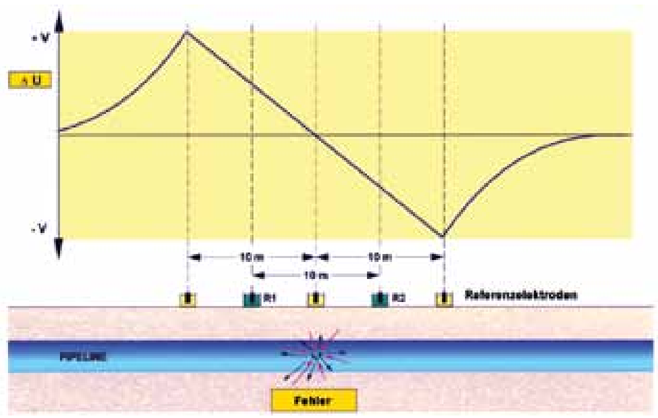
- NaMobil 3.0
- IntMobil 3.0
- WinTrans 1.0
- IntMess 3.0

The MoData2 Multifunction Instrument is used for field recording and display of pipe-to-soil potentials and voltage drops in a cathodic protection system. These are also stored in the MoData2`s internal memory.
4 measuring methods are directly integrated into the mobile software package:

- 2-electrode method
- 3-electrode method
- Additions method
- IFO method

IFO method

IFO (Intensive Fault Location) is the preferred choice for use with new pipelines with intact coatings and a relatively small number of defects.
IFO detects faults only and does not allow measuring of potentials. For checking the potential at a test point during IFO measuring, it is necessary to switch to either the 2 or 3-electrode method.
In order to optimise the measurement of even the smallest voltage differences, it is common to increase the feeding current of the rectifier during measuring with the IFO method, as this produces a higher potential gradient at fault locations.



Description of the measuring method

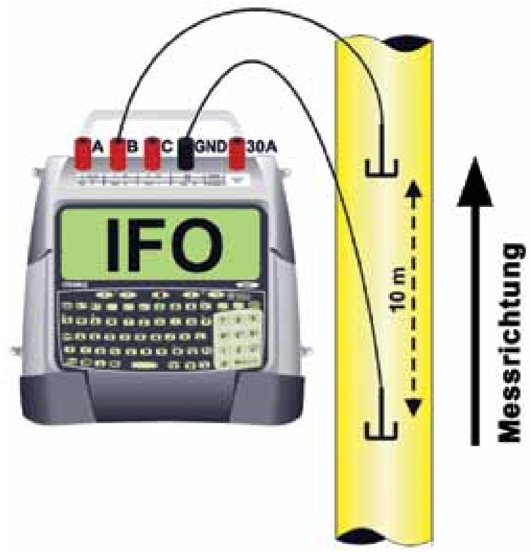
The IFO method measures the ON and OFF voltage drops along pipelines. For this, two electrodes are placed at ground level along the line at distances of 5 or 10 m. The standard step size is 5 m, meaning that both electrodes will be shifted by another step (of 5 m) in the measuring direction after each reading has been completed.
For an evaluation of the values of the IFO measurement, the difference between the measured ON and OFF voltages is compared. An increment of the voltage differences followed by a reversed polarity indicates a possible defect location.

Note regarding the electrode placing

Using a distance of 10 m between the two moving electrodes offers advantages when measuring small voltage drops. Using a distance of 5 metres allows determination of absolute voltage gradient by simply adding up the voltage drops measured.

Measuring array: IFO

The measuring array for the IFO measurement is very simple to implement: Just connect terminal channel B and the ground to the 2 electrodes to be used.



2-electrodes method

This is the most frequently applied method for intensive measurements.
The ON and OFF potentials and the respective voltage gradients are measured at each individual measuring point.
Measurement of the ON and OFF potentials is performed by means of a direct connection of the measuring contacts, while measurement of the ON and OFF voltage gradients takes place perpendicular to the pipeline axis at a distance of about 5 to 10 m. To ensure a reliable comparison of the voltage gradient values, measurements must be taken at a constant perpendicular distance to the pipeline.

Advantages of the 2-electrode method

Since this direct way of collecting measuring values does not require any adding up, it is very easy to perform.

Disadvantages of the 2-electrode method

As this method requires a direct connection to the test point, it may require rather large cable lengths, i.e. at least half of the distance between the two test points.
Moreover, taking the perpendicular measurements of the voltage gradients requires a constant and relatively large distance to the pipeline axis (about 10 m), which means that difficulties may arise in uneven terrain, residential or industrial areas.

Measuring array: 2-electrode method

Applying this method requires a proper connection to the test point. For measuring potentials, channel A of the MoData2 multi task converter (MTC) is connected to the test point.
The lateral measuring electrode connected to channel B of the MoData2.
The reference electrode on top of the pipe axis is connected to the black ground terminal of the MTC.

3-electrodes method

The 3-electrode method is an extension of the 2-electrode method. In contrast to the latter, the 3-electrode method allows measurement of two voltage gradients symmetrically along both sides of the pipe axis.
The MoData2 system thus allows the calculation of IR-free potentials according to the so-called extrapolation method by simultaneously measuring the potential and the two voltage gradients on the left and right sides of the pipe.

Advantages of the 3-electrode method

This method offers considerable advantages when evaluating intensive measurement data of parallel pipelines. Interfering external voltage gradients on one side of the pipe axis can be suppressed during the evaluation of the measurement data thus allowing a more accurate data evaluation.
The 3-electrode method is often used for remeasurement of pipe locations where a previous IFO method indicated a flow. In most cases measurement of the left and right side voltage gradients combined with a calculation of the IR-free potential allows a more precise assessment of the cathodic protection at the flawed pipe spots than would be possible with other measurement methods.

Disadvantages of the 3-electrode method

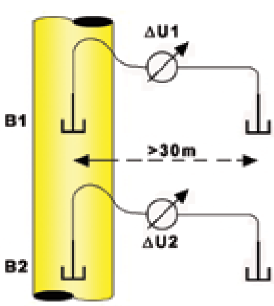
The extensive measuring array requires a relatively large number of staff to operate the system. The double-sided measurement of the voltage gradients at the largest possible and constant electrode distance (e.g. 20 m between the left and the right electrode) may result in slow daily progress over areas of difficult terrain.

Measuring array: 3-electrode method

Applying this method requires a proper connection to the test point. For measuring potentials, channel A of the multi task converter (MTC) is to be connected to the test point.
The lateral measuring electrodes are to be connected to channels B and C of the MTC. The reference electrode on top of the pipe axis is connected to the black ground terminal of the MTC. Compensation of electrode differences will be needed to ensure reliable calculation of IR-free potentials.

Addition method

The addition method uses simple longitudinal voltage measurements and a subsequent calculation of potentials and voltage gradients. The addition method is based on the assumption that the voltage between two reference electrodes being installed on remote ground is more or less 0 mV. This means that, for instance, during a voltage gradient measurement the position of the laterally mounted reference electrode is irrelevant so long as it is installed on remote ground.



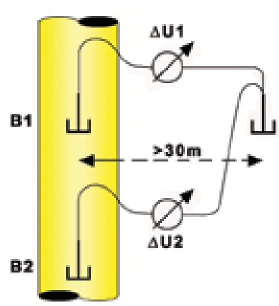
Mathematically expressed:

[1] UA1 - UA2 = 0
[2] UA1 = UA2
(considering remote ground)

Thus:

[3] UB1 - UA1 = UB1 - UA2
[4] UB2 - UA2 = UB2 - UA1

The laterally positioned reference electrode may be installed on remote ground.



Assumption:

[5] ΔU1 = UB1 - UA1
[6] ΔU2 = UB2 - UA1

resulting in equation (for UA1):

[7] ΔU1 - UB1 = ΔU2 - UB2
[8] 0 = ΔU1 + (UB2 - UB1) - ΔU2

Thus:

ΔU2 = UB2 - UB1 + ΔU1

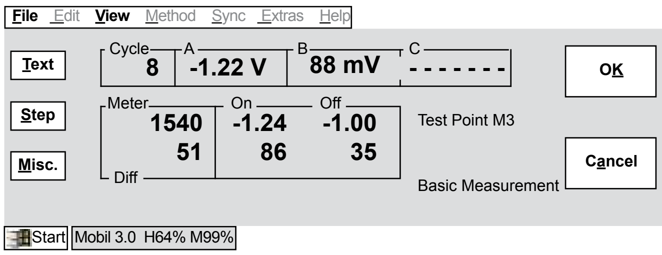
This means that the voltage gradient ΔU2 can be calculated by taking the differential voltage UB2 - UB1 (voltage drop alongside the pipeline) and adding ΔU1 (basic voltage).

The procedure for calculating the potential is similar.

Basic value collection

Prerequisites for any calculation are the so-called basic values that are to be collected when commencing the measuring and again whenever further measuring contacts are being reached.

Each time basic values are measured, IntMobil shows „Basic Measurement" beneath the line for the text entry on the display of the current measuring mode.



Basic values are taken using the 2-electrode method. Please refer to for the measuring array.

Basic values may be taken and calculated at any test point. This results in a higher accuracy of the calculation of further potentials and voltage gradients.

Notes regarding the addition method:

When taking basic values at stray current-influenced pipes, problems may arise during the adding-up procedure. The basic values may drift during the intensive measurement thus leading to incorrect values.

Furthermore, it must be noted that upon each electrode shifting larger electrode differences may lead to significant step changes of the voltage gradient and/or potential values. Therefore, keep the number of electrode shifts as small as possible.

Measuring array: Addition method

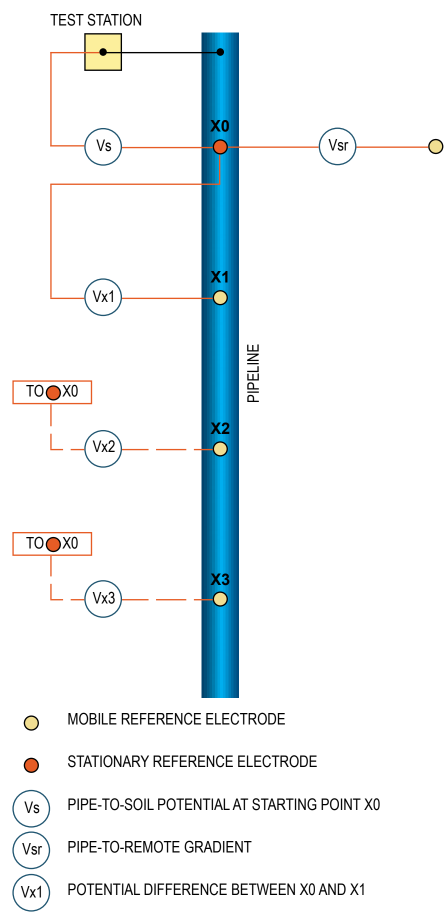
After the measurement of basic values has been completed, the so-called „fixed electrode" has to be placed exactly where the reference electrode was positioned during the basic measurement of voltage gradients and potentials. The so-called „moving-electrode" has to be placed according to the step size along the pipeline.

After a measurement has been completed, the moving electrode will be repositioned by one step size in the measuring direction along the pipeline. The fixed electrode remains at its location and will only be moved and repositioned after an electrode shift or in the course of a new basic measurement.

Shifting electrodes

The fixed electrode remains positioned during the basic measuring value collection. During the progress of the measuring procedure increasingly larger cable lengths will be required between the fixed electrode and the multi task converter (MTC). If an extension cable is unavailable, the fixed electrode has to be shifted to make further intensive measurements possible.

BASIC METHOD FOR MEASUREMENT OF POTENTIAL



IntMobil stores the latest voltage gradient and potential values measured during the electrode shift and uses these values as new basic values for the addition of measured longitudinal voltages between the fixed and the moving electrode.

Note regarding the shifting of electrodes

Shifting electrodes is not only helpful after the available cable length has been fully used, but also when crossing railway lines or roads.

Collect the measuring values beyond the railway line. Afterwards, shift the electrodes as described above with the fixed electrode being positioned beyond the railway line.

Cabling across the obstacle will then be necessary for the period of one measurement only.