The General Equation Of Pipe To Soil Potential During Humidity Change By The Use Of Both Soil Factor and Protection Current For Pipe – Soil – Earth System

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Abstract: For pipe-soil-earth system, the buried pipe line segment with soil surrounding medium could be simulated electrically by an electric circuit where the system is subjected to the law: charge = capacitance × voltage between the pipe surface and remote earth. This is where each of circuit electric parameter (electrolytic stray capacitor between pipe & earth, the stray potential across the stray capacitor, surface charge and the protection current of the cathodic protection system passed through the pipe segment) could be obtained by an equation which is function of the measured electrochemical properties of the soil (soil factor), 4th degree polynomial at room temperature but the A's constants are different for each electric quantity .These constants of each equation (A's) considered to be as a print of such pipe-soil-earth system . The useful of these prints is to obtain complete electrical data correlated with many cathodic protection levels**.** One of the most critical problems in CP systems is the effect of a sudden change of the soil humidity around the protected pipe line**.** The behavior of the protection current demand of the pipe-soil-earth system during the change of the electrochemical properties of the soil could be plotted as protection current print which will be always valid in all times as the pipe-soil-earth system is maintained and without any external interference. In other words, if the system is subjected to humidity change, there will be another new protection current demand with new print for this pipe-soil-earth system to keep the pipe cathodically protected. Of course, as a result of humidity change, the pipe to soil potential will be changed. This paper tries to calculate segmental pipe to soil potential along the pipe line without the need of both the test point and $Cu/CuSO_4$ half cell by a general equation of the pipe to soil potential which is function of both the segmental protection current and the soil factor around the pipe segment during such humidity change.

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1. Introduction:

The behavior of the electrical parameters (stray potential V_{P-PE}, stray capacitor C_{P-PE}, surface total charge Q and protection current I_P) of the pipe-soil-earth system, during the change of the electrochemical properties of the soil, with and without applying cathodic protection system, could be plotted as an electrical parameter PRINT which will be always valid in all times as the pipe-soil-earth system is maintained and without any external interference. Once the system is changed by replacement another pipe with different dimension and/or the replacement of the soil (of course, or by humidity change), there will be another new electrical parameter PRINT for the new pipe-soil-earth system. Also, the buried pipe line segment with soil surrounding medium could be simulated electrically by an electric circuit where the system is subjected to the law Q = C×V between the pipe surface and earth. This is where each of circuit electric parameter could be obtained by an equation which is function of the measured electrochemical properties of the soil (soil factor), 4th degree polynomial at room temperature but the A's constants are different for each electric quantity. The constants of each equation (A's) considered to be as a PRINT of such pipe-soil-earth system [10] [12]. The useful of these PRINTS are to obtain complete electrical data correlated with many cathodic protection levels which help, after complete erection of the pipeline, in defining the cathodic protection level of any pipe line segment through its length by measuring the protection current and calculating the soil factor at the pipe segment from direct field measurements. The average error of the electrical parameters equations reduced to be less than ± 5%. The most important advantage of such electrical analogue circuit of pipe-soil-earth system is the possibility to simulate a complete pipeline-soil-earth system by an electric circuit and to convert the corrosion problem and cathodic protection of the pipeline to an electric problem [11] [13]. In the near future after completing such electrical studies of the pipe-soil-earth systems, this will help in corrosion monitoring and the maintenance of c.p systems. Not only has that but also to define the most suitable route of the pipe line, before the erection process, which generates the minimum surface charge. The most important result is that: the pipe to soil potential of any buried pipeline could be obtained segmental along its route without the need of both the test point and $Cu/CuSO_4$ half cell. This is by the use of the new electric concept of pipe-soil-earth system. One of the most critical problems in CP systems is the effect of a sudden change of the soil humidity around the protected pipe line. Of course, the electrochemical properties of the soil will also be changed. As a result, the demand of the protection current will also be changed. The questions now are: what is the proper value of the protection current to keep the pipe cathodically protected during humidity change? What is the value of the protection current required during soil dryness process? By the use of the voltage canister, new idea, which will be equipped with the intelligent pig, this paper tries to calculate segmental pipe to soil potential along the pipe line without the need of both the test point and $Cu/CuSO_4$ half cell by the deduction of a general equation of the pipe to soil potential which is function of both the protection current and the soil factor around the pipe segment during such humidity change.

1. Literature Review

2.1 The Soil Factor

As the electrochemical properties of any soil are changed by the change of humidity but returns back to its initial conditions after some time required for soil dryness, we can define a new factor named the soil factor as: "The soil factor (S_f) is the instantaneous value of the electro-chemical properties of the soil based on the electrical properties at Humidity equal to 10% "[1] [2] and is equal to:

$S_f = (1 / K_S)\ pH\ H \log \rho$ at room temperature (1)

Dimension of $[S_f] = [1/K_S]\ [pH]\ [H]\ [\log \rho] = \Omega.m\ \%$

Where:
S_f = soil factor $\Omega.m$ %
K_S = dielectric constant of the soil at H = 10%
pH = power of Hydrogen of the soil
H = humidity of the soil %
ρ = soil resistivity in $\Omega.m$ at H = 10%

Figure 1 shows the range values of the soil factor due to humidity change for 10 soil samples under test.

The importance of the soil factor is that it is combining all parameters which can affect directly on the cathodic protection level or in corrosion process. Such factors which can be obtained by a direct measurements from the field. This means that if it is possible to study the relationship between the soil factor and the electrical parameters of the bare pipe segment, then the print curves and the print constants of the electrical parameters of the pipe-soil-earth system could be obtained at natural condition with and without applying cathodic protection system. The soil factor can be considered to be as the key of many studies based on the new proposed electrical concept of corrosion. For an example, the general equation of the natural stray capacitance between external surface area of bare pipe segment and earth is obtained in terms of the soil factor with an average error ± 30% and its print curves and constants are obtained for pipe-soil-earth system for 10 different soils [3]. Also, the general equation of both the natural stray potential and the natural created charge are obtained in terms of the soil factor with an average error ± 30% and their print curves and constants are obtained for pipe-soil system for 10 different soils [4] [5]. Finally, the error of the general equation of the electrical parameters reduced to ± 5% [6] [7] [8] [9].

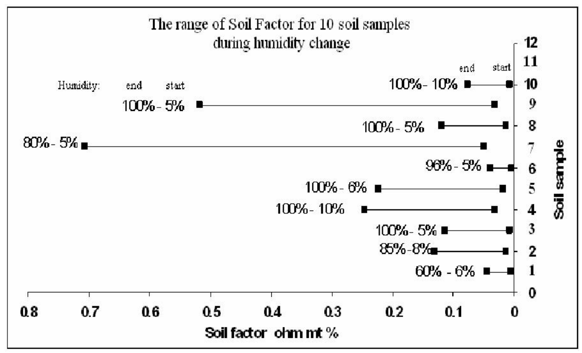

Figure 1: The range of the soil factor & humidity range for the soils under test

2.2 ONOIN Print Curves For Pipe-Soil – Earth System Under Test

The onion curves are the curves of the protection current I_P in terms of the soil factor S_f at different pipe to soil potential by the use of $Cu/CuSO_4$ half cell.

By considering the measured soil factor as x axis against the measured protection current as y axis at different cathodic protection levels, the next following print curves were obtained for the pipe-soil-earth systems under test. As an example, figures 2a & 2b show the ONION curves for boxes 10 & 19 respectively. From the print ONION curves and equations, it can easily observe that the general equation of the protection current of a cathodically protected bare pipe segment during humidity change under multi level of cathodic protection levels is a 4^{th} degree polynomial equation which is function of the soil factor, I_P = f (X = soil factor). The protection current general equation is equal to equation 2:

$I_P = A_{4I} X^4 + A_{3I} X^3 + A_{2I} X^2 + A_{1I} X + A_{0I}$ (2)

Where:
A's: = $A_{(\,)\,I}$ are the protection current print constants of the pipe soil under test
X = is the value of the soil factor at certain humidity

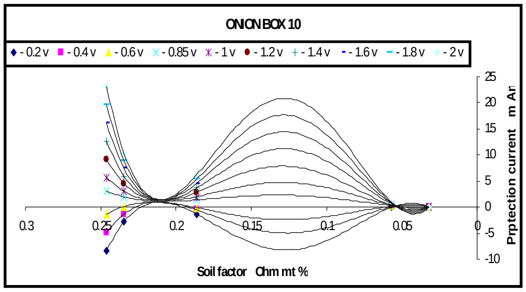

Figure 2a: The ONION curve for box 10

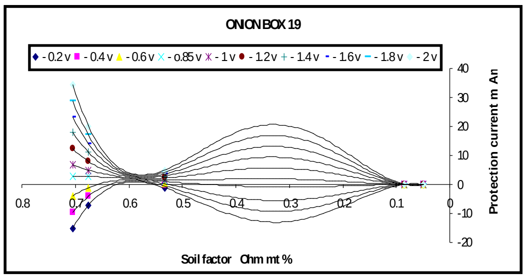

Figure2b: The ONION curve for box 10

2.3 Protection current Print Constants For Pipe-Soil Under Test

Now, the protection current print constants of the pipe-soil-earth systems under test are A_{4I}, A_{3I}, A_{2I}, A_{1I} and A_{0I} at a definite cathodic protection level. This means that these print values are valid for these CP levels for these pipe-soil-earth systems under test at any time at the correspondent electrochemical properties (the soil factor). Tables 1& 2 show result examples of the protection current print constants at CP levels equal to -0.6 & -0.85 volt respectively for all boxes under test.

2.4 Circular ΔV PIG Idea: [1][2]

This is a new idea of the voltage drop technique to measure the protection current I_P passed through the buried pipeline. By considering a pipe line with total length L m, if such length is divided into segments with length L m./segment Then:

Total length L = segment length L_{Seg} × number of segments n

Electrically, the pipe line could be considered as: total resistance = segment resistance × number of segments n as shown in Fig.3.

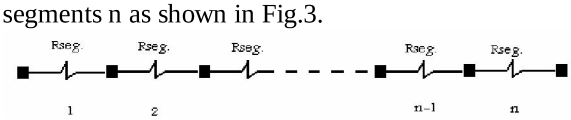

Figure 3: Electrical analogue resistance of the total pipe line length

Now if the voltage between points a & b of the segment is measured, as shown in figure 4, then the instantaneous measured protection current will equal to:

$$I_p = \frac{\Delta V}{R_{seg.}}$$

That means that an additional circular voltage drop canister could be added in the future with the available intelligent pig to measure the protection current I_P. Figure 4 shows such canister, and in the meantime by using GPS technology to determine the segment position. By the use of this voltage drop canister which pigged with the intelligent pig and by the use of GPS system, each segment flow current I_P could be measured.

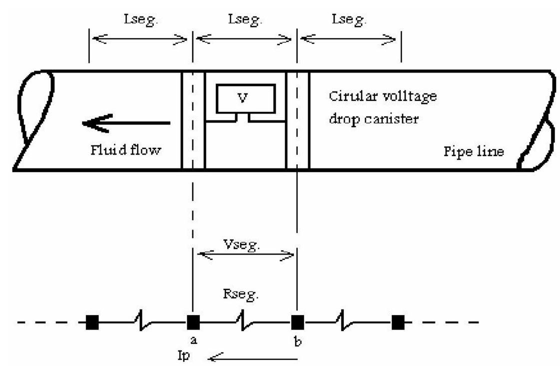

Figure 4: Idea of voltage drop canister to be pigged with the fluid through the pipeline

Then by measuring the humidity around this pipe segment, the soil factor could be determined. Finally, from the ONION curves obtained before [9] (which correlate I_P, S_F and $V_{H.C}$), the equivalent pipe to soil potential of this buried pipe segment could be determined without the need of test point and without the need of $Cu/CuSO_4$ half cell. The most important result is that: the pipe to soil potential of any buried pipeline could be obtained segmental along its route without the need of any test points. This target could be achieved by another technique which is a direct calculation of the pipe to soil potential from a general equation. This paper deduces this general equation of the pipe to soil potential for all boxes under test

3. Analysis

As we said before, the print A's of the protection current passed through the pipe segment could be obtained from the general equation of the protection current (2) and easily we can construct the print of the protection current A's table for all boxes under test at pipe to soil potential, by the use of $Cu/CuSO_4$ half cell, from -0.2V up to -2V as per tables 1 & 2 as an examples. The questions now are: is it possible to rearrange the table results such that to be as the protection current A's for each box against the pipe to soil potential? This is as per table 3 as an example for the protection current A's against pipe to soil potential for box 19. What would be the results for all boxes under test?

4. Results

4.1 A_{0I} print constant

The protection current A_{0I} print constant is linearly proportional to the pipe to soil potential V_{H-C} measured by $Cu/CuSO_4$ half cell. Figure 5 show box 19 as an example and the correlation between them is governed by equation 3 for all boxes under test as follow:

$$\mathbf{A}_{0I} = B_{1A0I}\,\mathbf{V}_{H-C} + B_{0A0I} \qquad (3)$$

4.2 A_{1I} print constant

The protection current A_{1I} print constant is linearly proportional to the pipe to soil potential V_{H-C} measured by $Cu/CuSO_4$ half cell. Figure 5 show box 19 as an example and the correlation between them is governed by equation 4 as follow:

$$\mathbf{A}_{1I} = B_{1A1I}\,\mathbf{V}_{H-C} + B_{0A1I} \qquad (4)$$

Table 1: The PRINT I_P constants of the pipe current at pipe to soil potential equal to -0.6 volt

	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}
	Box 1	Box 4	Box 9	Box 10	Box 13	Box 18	Box 19	Box 24	Box 27	Box 28
A_{4I}	2.00E+06	0	-212996	-58661	-1.00E+06	-4.00E+07	-1249.7	-64520	-1997.6	-1.00E+06
A_{3I}	-144117	-4412.5	48599	30400	655922	3.00E+06	1653.4	15344	1804.1	133859
A_{2I}	3880.2	640.72	-3607.7	-5064.1	-94674	-55418	-642.13	-1283.8	-485.31	-43141
A_{1I}	-28.355	-14.944	97.032	294.94	3510.5	466.03	65.66	48.437	38.626	69.402
A_{0I}	0.0623	0.108	-0.5228	-5.1853	-36.066	-0.9527	-1.8728	-0.4347	-0.7779	-0.3237
Equation Error	0	70%	0	0	0	0	0	0	0	0

Table 2: The PRINT I_P constants of the pipe current at pipe to soil potential equal to -0.85 volt

	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}
	Box 1	Box 4	Box 9	Box 10	Box 13	Box 18	Box 19	Box 24	Box 27	Box 28
A_{4I}	7.00E+06	0	14928	32198	-452755	-1.00E+07	-206.05	23296	4596.1	4.00E+06
A_{3I}	-636953	-6222.8	9230.9	-16158	216364	906336	296.05	1329.2	-4408.8	-617139
A_{2I}	17742	1138.7	-1749.1	2569.4	-30555	-25814	-117.82	-596.87	1202.1	26816
A_{1I}	-148.86	-25.216	99.925	-129.41	1138.9	371.13	12.562	47.276	-66.944	-345.35
A_{0I}	0.3781	0.1582	-0.6199	2.0098	-11.767	-0.8843	-0.366	-0.5009	1.054	1.3383
Equation Error	0	30%	0	0	0	0	0	0	0	0

Table 3: Protection current print constants of box 19 at pipe to soil potential equal to -0.2 volt to -2 volt

	Box 19 ρ_7									
$V_{H.C}$ Volt	-0.2	-0.4	-0.6	-0.85	-1	-1.2	-1.4	-1.6	-1.8	-2
A_{4I}	-2919.6	-2084.6	-1249.7	-206.05	420.24	1255.3	2.09E+03	2925.2	3760.1	4595.1
A_{3I}	3825.4	2739.4	1653.4	296.05	-518.53	-1604.6	-2.69E+03	-3776.5	-4862.5	-5948.5
A_{2I}	-1481.1	-1061.6	-642.13	-117.82	196.83	616.33	1.04E+03	1455.3	1874.8	2294.3
A_{1I}	150.62	108.14	65.66	12.562	-19.303	-61.787	-1.04E+02	-146.75	-189.23	-231.71
A_{0I}	-4.2838	-3.0782	-1.8728	-0.366	0.5383	1.7439	2.95E+00	4.1549	5.3604	6.5659
% error	0	0	0	0	0	0	0	0	0	0

4.3 A_{2I} print constant

The protection current A_{2I} print constant is linearly proportional to the pipe to soil potential V_{H-C} measured by $Cu/CuSO_4$ half cell. Figure 5 show box 19 as an example and the correlation between them is governed by equation 5 as follow:

$$\mathbf{A}_{2I} = B_{1A2I}\,\mathbf{V}_{H-C} + B_{0A2I} \qquad (5)$$

4.4 A_{3I} print constant

The protection current A_{3I} print constant is linearly proportional to the pipe to soil potential V_{H-C} measured by $Cu/CuSO_4$ half cell. Figure 5 show box 19 as an example and the correlation between them is governed by equation 6 as follow:

$$\mathbf{A}_{3I} = B_{1A3I}\,\mathbf{V}_{H-C} + B_{0A3I} \qquad (6)$$

4.5 A_{4I} print constant

The protection current A_{4I} print constant is linearly proportional to the pipe to soil potential V_{H-C} measured by $Cu/CuSO_4$ half cell. Figures 5 and 6 show boxes 4 & 19 as an example and the correlation between them is governed by equation 7 as follow:

$$\mathbf{A}_{4I} = B_{1A4I}\,\mathbf{V}_{H-C} + B_{0A4I} \qquad (7)$$

Table 4 shows the result table of protection current print constants (A's) in terms of pipe to soil potential for all boxes under test

Table 4: The protection current print constants (A's) in terms of pipe to soil potential for all boxes under test

		ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}
		Box 1	**Box 4**	**Box 9**	**Box 10**	**Box 13**	**Box 18**	**Box 19**	**Box 24**	**Box 27**	**Box 28**
A_{4I}	B_{1A4I}	-2.00E+07	0.00E+00	-7.23E+04	-3.34E+04	-1.00E+06	-1.00E+08	-4.17E+03	-3.52E+04	-2.64E+04	-2.00E+07
	B_{0A4I}	-1.00E+07	0.00E+00	-4.79E+04	-2.53E+04	-2.00E+06	-1.00E+08	-3.75E+03	-2.76E+04	-1.78E+04	-1.00E+07
	error	H	H	H	0%	H	0%	0%	0%	0%	H
A_{3I}	B_{1A3I}	2.00E+06	7.24E+03	1.57E+04	1.70E+04	6.59E+04	7.00E+06	5.43E+03	5.63E+04	2.49E+04	3.00E+06
	B_{0A3I}	1.00E+06	-6.99E+01	1.43E+04	1.29E+04	1.00E+06	8.00E+06	4.91E+03	4.92E+04	1.67E+04	2.00E+06
	error	H	0%	0%	0%	H	H	0%	0%	0%	H
A_{2I}	B_{1A2I}	-5.53E+04	-1.99E+03	-7.41E+03	-2.75E+04	-9.94E+04	-1.22E+04	-2.10E+03	-2.77E+03	-6.75E+03	-1.21E+04
	B_{0A2I}	-2.97E+04	-5.54E+02	-8.04E+03	-2.09E+04	-1.48E+04	-1.33E+04	-1.90E+03	-2.95E+03	-4.54E+03	-8.30E+04
	error	0%	0%	0%	0%	H	H	0%	0%	0%	H
A_{1I}	B_{1I}	4.81E+02	4.11E+01	-1.23E+01	1.52E+03	3.70E+03	4.01E+02	2.12E+02	5.25E+00	4.22E+02	1.53E+03
	B_{0I}	2.63E+02	9.69E+00	8.94E+01	1.17E+03	5.49E+03	7.27E+02	1.93E+02	5.17E+01	2.92E+02	9.79E+02
	error	0%	0%	0%	0%	H	0%	0%	0%	0%	0%
A_{0I}	B_{1A0I}	-1.26E+00	-2.00E-01	3.93E-01	-2.57E+01	-3.79E+01	-3.07E-01	-6.03E+00	2.59E-01	-7.33E+00	-6.15E+00
	B_{0A0I}	-7.00E-01	-1.20E-02	-2.85E-01	-1.99E+01	-5.63E+01	-1.17E+00	-5.49E+00	-2.80E-01	-5.17E+00	-3.97E+00
	error	5%	0%	0%	0%	30%	5%	0%	0%	0%	0%

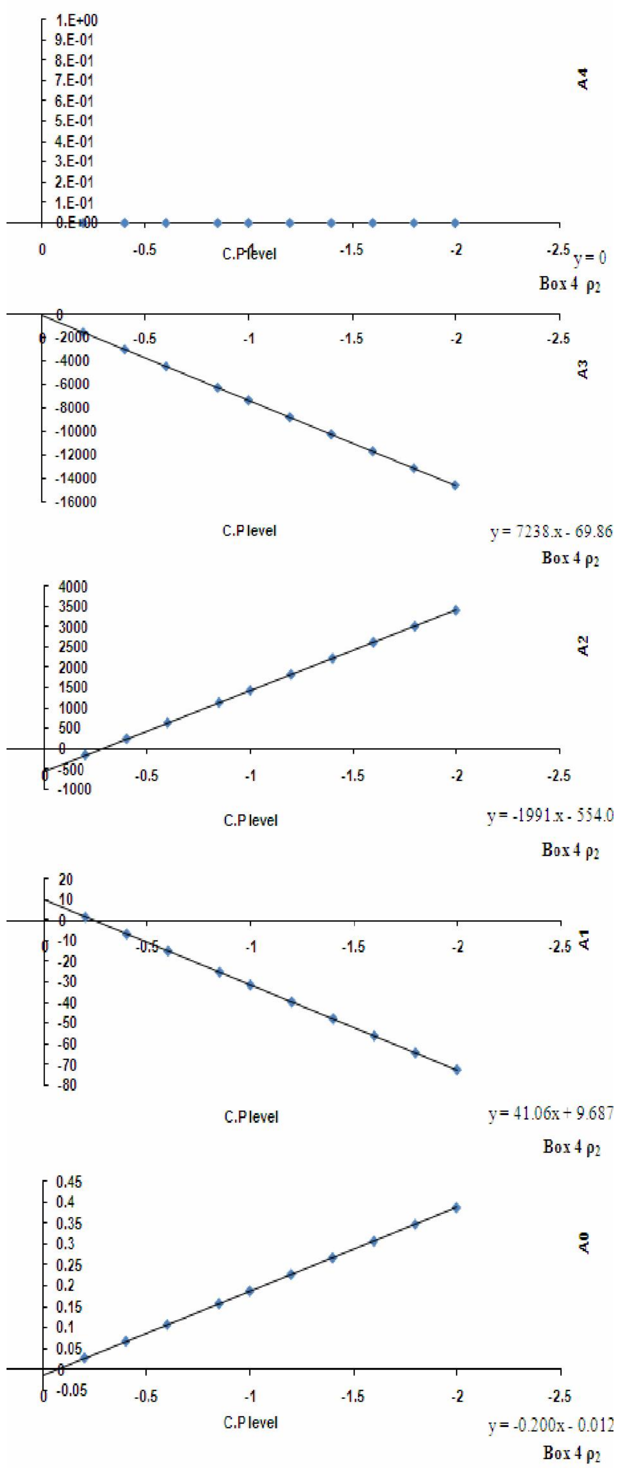

Figure 5: The protection current print constants against pipe to soil potential for box 4

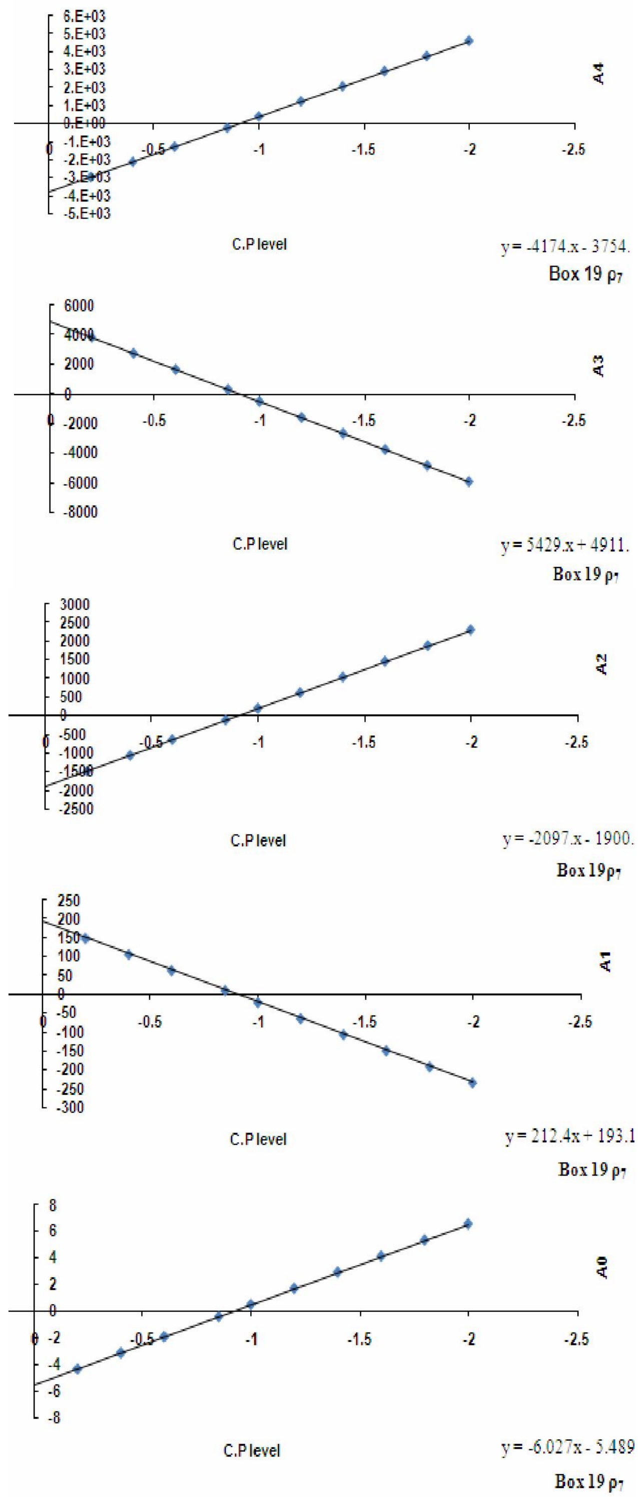

Figure 6: The protection current print constants against pipe to soil potential for box 4

4.6 The deduction of the general equation of the pipe to soil potential

We have the protection current general equation from equation 2 as follow:

$I_P = A_{4I} X^4 + A_{3I} X^3 + A_{2I} X^2 + A_{1I} X + A_{0I}$ (2)

Where:

A's: = $A_{(\,)\,I}$ are the protection current print constants of the pipe soil under test

X = is the value of the soil factor at certain humidity

By substituting the values of A's from equations 3, 4, 5, 6 and 7 in equation 2 , the general equation of the pipe to soil potential will equal to equation 8 as follow:

$$V_{H.C} = \frac{I_P - [B_{0A4I} X^4 + B_{0A3I} X^3 + B_{0A2I} X^2 + B_{0A1I} X + B_{0A0I}]}{[B_{1A4I} X^4 + B_{1A3I} X^3 + B_{1A2I} X^2 + B_{1A1I} X + B_{1A0I}]} \quad (8)$$

Where:

$\mathbf{V_{H.C}}$: The equivalent value of the pipe to soil potential in volt measured by $Cu/CuSO_4$ half cell.

$\mathbf{I_P}$: Segmental protection current in m Amp measured by the voltage drop canister of the intelligent pig.

X: Segmental soil factor in Ω.m%.

B's: New print constants of pipe-soil-earth system

Table 5 shows the error for all boxes under test while tables 6 & 7 are showing the detailed comparison between the pipe to soil potential obtained by equation 8 and the pipe to soil potential obtained by direct measurement by the use of $Cu/CuSO_4$ half cell for boxes 4 & 19 respectively during humidity change..

Table 5: Error table between theoretical and experimental values of pipe to soil potential for all boxes under test during humidity change

Resistivity	ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	ρ_7	ρ_8	ρ_9	ρ_{10}
Box No.	1	4	9	10	13	18	19	24	27	28
Av. Error	H	± 10 %	± 15 %	± 35 %	H	± 35 %	± 5 %	H	± 10 %	H

Table 6: Comparison between theoretical and experimental values of pipe to soil potential of box 4 during humidity change

	Electrical Parameters					Pipe to Soil Potential		
Box	V_{P-PE} Volt	C_{P-PE} nF	I mA	PH	H %	Theoretical V_{HC} - Volt	Experimental V_{HC} - Volt	Error %
4	0.1480	-0.570	0.0002	7.0	45%	-0.476829528	-0.4910	2.8860432
4	-0.2710	-0.570	0.4000	7.0	45%	-0.557774389	-0.5640	1.103831794
4	-3.7100	-0.570	5.1000	7.0	45%	-1.509352292	-1.3700	-10.17170015
4	-6.3900	-0.570	8.6000	7.0	45%	-2.217974135	-2.1110	-5.067462573
4	-9.3800	-0.570	11.1000	7.0	45%	-2.724132594	-2.6400	-3.186840686
4	-11.4400	-0.570	13.0000	7.0	45%	-3.108813023	-3.0000	-3.627100771
4	0.1000	45.600	0.0010	6.9	80%	-0.663867462	-0.5190	-27.91280574
4	-0.2050	45.600	0.3300	6.9	80%	-0.690445272	-0.5520	-25.08066515
4	-4.2800	45.600	7.9000	6.9	80%	-1.301977249	-1.3400	2.837518756
4	-6.3700	45.600	11.2200	6.9	80%	-1.570178856	-1.7000	7.636537911
4	-10.1500	45.600	15.9000	6.9	80%	-1.948246181	-2.2600	13.79441678
4	0.1930	70.000	0.0033	6.5	85%	-0.664663193	-0.6020	-10.40916827
4	-0.2140	70.000	0.1530	6.5	85%	-0.676743878	-0.8800	23.09728664
4	-2.9500	70.000	16.0000	6.5	85%	-1.955585621	-1.7800	-9.864360757
4	-4.9000	70.000	29.6000	6.5	85%	-3.053096047	-2.5500	-19.72925675
4	-6.8000	70.000	40.0000	6.5	85%	-3.892368726	-3.2300	-20.5067717
4	-8.5500	70.000	47.8000	6.5	85%	-4.521823235	-3.7700	-19.94226087

Table 7: Comparison between theoretical and experimental values of pipe to soil potential of box 19 during humidity change

Box	Electrical Parameters			PH	H	Pipe to Soil Potential		Error
	V_{P-PE}	C_{P-PE}	I		H	Theoretical	Experimental	Error
	Volt	nF	mA		%	V_{HC} - Volt	V_{HC} - Volt	%
19	0.1276	8.000	-0.0002	7.0	55%	-0.591185741	-0.5520	-7.098866132
19	-0.2490	8.000	0.3000	7.0	55%	-0.6986547	-0.6230	-12.14361155
19	-3.6500	8.000	3.0000	7.0	55%	-1.665230946	-1.4060	-18.43747837
19	-6.3200	8.000	5.2000	7.0	55%	-2.452811591	-2.0600	-19.06852382
19	-9.3000	8.000	7.7000	7.0	55%	-3.347789596	-2.8400	-17.87991536
19	0.0340	13.900	-0.0008	6.5	75%	-0.68121396	-0.6650	-2.438189508
19	-0.1920	13.900	0.1900	6.5	75%	-0.694328432	-0.6950	0.096628523
19	-4.0000	13.900	9.1000	6.5	75%	-1.306749508	-1.2500	-4.539960668
19	-6.6300	13.900	15.7000	6.5	75%	-1.76039475	-1.7300	-1.756921981
19	-9.8300	13.900	24.5000	6.5	75%	-2.365255073	-2.2800	-3.73925758
19	0.2700	72.000	0.0062	5.3	96%	-0.75561634	-0.7070	-6.876427114
19	-0.4400	72.000	0.1506	5.3	96%	-0.761007335	-0.7370	-3.25744026
19	-3.1300	72.000	14.0000	5.3	96%	-1.278057518	-1.2900	0.925773821
19	-4.7500	72.000	24.7000	5.3	96%	-1.677528755	-1.7000	1.321837922
19	-6.6900	72.000	35.8000	5.3	96%	-2.091933497	-2.0800	-0.573725824
19	-8.2000	72.000	46.2000	5.3	96%	-2.480204607	-2.4400	-1.647729778
19	-1.0700	72.000	57.4000	5.3	96%	-2.898342724	-2.8000	-3.512240159

5. Conclusion

One of the most critical problems in CP systems is the sudden humidity change in the soil around the protected pipe line. Electrochemistry helps to determine the integrity of buried pipe from corrosion by measuring pipe to soil potential by the use of $Cu/CuSO_4$ half cell. In electrical study of pipe-soil-earth system we are now able to calculate the value of the pipe to soil potential from the protection current flow through the pipe segment as an electrical parameter, the electrochemical properties of the soil around this pipe segment as the soil factor and finally by the use of B's print constants of the pipe –soil-earth system. By the use of voltage drop canister which will be equipped with the intelligent pig to measure the segmental protection current through the pipeline, this will help to calculate the correspondent value of the pipe to soil potential for each segment of the pipe however long it is. This will help in pipeline both monitoring and maintenance, not only that but also to define the most proper current values during humidity change.

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