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ITALY

INSULATION IN WATER PIPES WITH CATHODIC PROTECTION

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OBJECTIVES OF SET UP

In 1982 it was found that a flange insulator, in a water pipe, four inches in diameter, was well insulated with a system of cathodic protection with a difference of 500 mV potential. The steel internal surface of the pipe was bare because according to documentation avialable, these state that the resistence in these cases is calculated taking into account the water as a conductor in the resistance of **R = ρ.l/s**

Water had a high resistivity (14.000 Ω x cm) however the calculation, according to the above formula was:

R = 14.000 x 0.32 Ω x cm^2 / $300cm^2$ = **4.37 Ω**

Therefore this resitance would be considered as the REAL resistance level and the current 114 mA.

Nevertheless it is understood that the pipe in the insulated side, without Cathodic Protection would have problems with internal corrossion and losing 1 Kg of steel per year. Nowadays there is no internal corrossion problem.

Then why are we investigating the real resistance in a water pipe with insulaters?

THE SET UP

The instalation consists of two 4” and 2” (inches) pipes with a flange insulator between them.

A pump and hosing enables water to flow through the pipes from left to right and alternatively from right to left. In addition there are three Ag/AgCl electrode placed in each pipe.The thickness of the gasket issolator is 3,2 mm.

The resistivity of water was started at 7.500 Ω x cm temp of 20º C and then was continued at 13.900 Ω x cm temp of 20º(Water “Real”of Madrid) .

The test has been made with still water and then with flowing water at a speed of 1 m/seg.This was flowing through and taking the air.

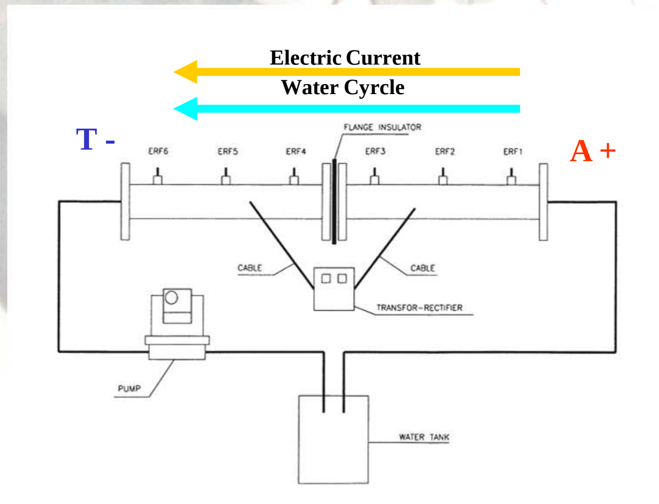
The reference electrode was Ag/AgCl saturated and they were tested against other patrons, assuring a differents of potencial at least at ±5 mV

There is a regulable power supply connected to each pipe so as to simulate a varying potential

The measure of intensity (strength) was carried out with a shunt with properties of 150 mV and 1 A

As well we were carried out further testing adding salt into the water and reducing its intensity.

<u>Figure:</u> Anexo 1



Still Water (7500 Ω x cm) resistivity

TIME	Va-Vt	I	R (Ohns)	ER6	ER5	ER4	ER3	ER2	ER1
					-			+	
26-2-03 11h13’	**2.42 mV**	**In this case Rectification off.**	**In this case Rectification off.**	**-729.1**	**-765.2**	**-728.5**	**-728.2**	**-716.2**	**-714.4**
11h19’	**730.5 mV**	**6.5 mA**	**112 Ω**	**-729.5**	**-760.4**	**- 821.7**	**-680.0**	**-720.1**	**-713.9**
11h47’	**730.5 mV**	**4 mA**	**182 Ω**	**-730.3**	**-757.1**	**- 873.1**	**-669.8**	**-730.7**	**-713.2**
12h18’	**729.5 mV**	**4 mA**	**182 Ω**	**-731.8**	**-755.9**	**- 898.9**	**-667.0**	**-742.6**	**-712.4**
12h52’	**729.0 mV**	**3.5 mA**	**208 Ω**	**-734.3**	**-756.1**	**- 909.1**	**-665.3**	**-750.6**	**-713.1**
13h42’	**728.3 mV**	**2.5 mA**	**291 Ω**	**-735.9**	**-759.3**	**- 918.0**	**-664.4**	**-755.0**	**-712.2**
16h17’	**727.6 mV**	**3.5 mA**	**207 Ω**	**-744.2**	**-775.9**	**- 930.2**	**-664.8**	**-755.1**	**-714.8**
17h13’	**727.6 mV**	**2.5 mA**	**290 Ω**	**-747.4**	**-780.0**	**- 927.0**	**-665.3**	**-755.4**	**-712.9**
18h12’	**727.4 mV**	**2.5 mA**	**291 Ω**	**-750.3**	**-783.8**	**- 929.5**	**-665.6**	**-755.8**	**-710.0**
27-2-03 9h15’	**726.6 mV**	**4 mA**	**181 Ω**	**-786.2**	**-810.8**	**- 958.3**	**-671.7**	**-755.5**	**-780**
28-2-03 8h50’	**724.3 mV**	**4.5 mA**	**161 Ω**	**-853.2**	**-901.7**	**- 961.5**	**-677.8**	**-754.2**	**-785.0**

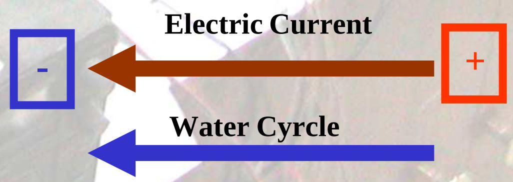
Electric Current

- ← +

Flowing Water (7500 🌢 x cm) resistivity

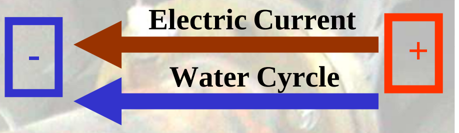
Polorasation in test pipe

TIME	Va-Vt	I	R (Ohns)	ER6	ER5	ER4	ER3	ER2	ER1
				-			+		
28-2-03 9h01'	**723.2 mV**	**7.5 mA**	**96 🌢**	**-854.3**	**-794.5**	**-948.7**	**-676.9**	**-744.5**	**-770.8**
10h19'	**724.3 mV**	**6.5 mA**	**111 🌢**	**-855.9**	**-779.4**	**-1002.1**	**-681.9**	**-748.4**	**-777.1**
12h08'	**724.2 mV**	**7.5 mA**	**96 🌢**	**-859.9**	**-771.9**	**-1030.6**	**-685.8**	**-754.1**	**-800.6**
13h07'	**723.6 mV**	**6 mA**	**120 🌢**	**-860.6**	**-769.8**	**-1036.7**	**-687.2**	**-756.3**	**-816.3**
14h00'	**723.5 mV**	**6.5 mA**	**111 🌢**	**-861.6**	**-768.4**	**-1041.4**	**-689.9**	**-758.4**	**-834.8**
15h01'	**723.5 mV**	**6.5 mA**	**111 🌢**	**-861.1**	**-767.2**	**-1048.0**	**-690.6**	**-757.4**	**-849.7**



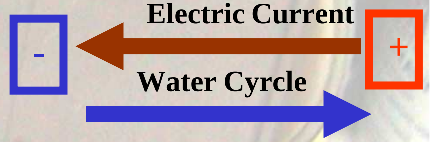
Flowing Water (13.900 💧 x cm) resistivity

TIME	Va-Vt	I	R (Ohns)	ER6	ER5	ER4	ER3	ER2	ER1
11-3-03 18h25’	**716 mV Switch on**	**3 mA**	**238 💧**	**-1210**	**-1115**	**-1130**	**-669**	**-446**	**-642**
12-3-03 9h15’	**711 mV**	**2.5 a 3 mA**	**284 💧**	**-787**	**-713**	**-773**	**-686**	**-700**	**-710**
11h20’	**710.5 mV**	**3 mA**	**237 💧**	**-828**	**-726**	**-788**	**-693**	**-600**	**-726**



Reversed Flowing Water

TIME	Va-Vt	I	R (Ohns)	ER6	ER5	ER4	ER3	ER2	ER1
12-03-03 12h37’	**-26 mV**	**In this case Rectification off.**	**In this case Rectification off.**	**-585**	**-569**	**-592**	**-573**	**-563**	**-600**
12h41’	**710 mV**	**1.5 mA**	**473 💧**	**-731**	**-660**	**-631**	**-592**	**-620**	**-713**
13h09’	**712.7 mV**	**1.5 mA**	**473 💧**	**-713**	**-716**	**-655**	**-622**	**-616**	**-625**
16h09’	**711.3 mV**	**1.5 mA**	**473 💧**	**-722**	**-603**	**-512**	**-595**	**-596**	**-678**



Argument

The REAL resistence is by no means similar to Ohm´s Law and a distance bewteen the pipes, being superior to that calculated by Ohm´s Law. With water of a high resitivity the area proximate to the joint issolator is clearly affected at both sides with still water; This is to say, the biggest influence is nearest the joint insulator.

With the water resistivity at 7.500 🌢 x cm:

The resistivity with still water starts at 112 🌢 and reaches 291 🌢.

The resistivity flowing water in the same direction of electric current starts at 96 🌢 and reaches 120 🌢 stabilising and the end of 111 🌢.

With the water resistivity at 13.900 🌢 x cm:

The resistivity flowing water in the same direction of electric current maintains constant at 238 🌢 and with water flowing in reverse to the electric current at 473 🌢.

All testing was ended after measurements were repeated several times till they were stabilised and maintained for several hours.

Conclusions

As this investigation is still ongoing, results are not complete and if anything, they should be considered as an approximation.

Hopefully I will be able to give a completed conclusions as we continue to develop our investigations.

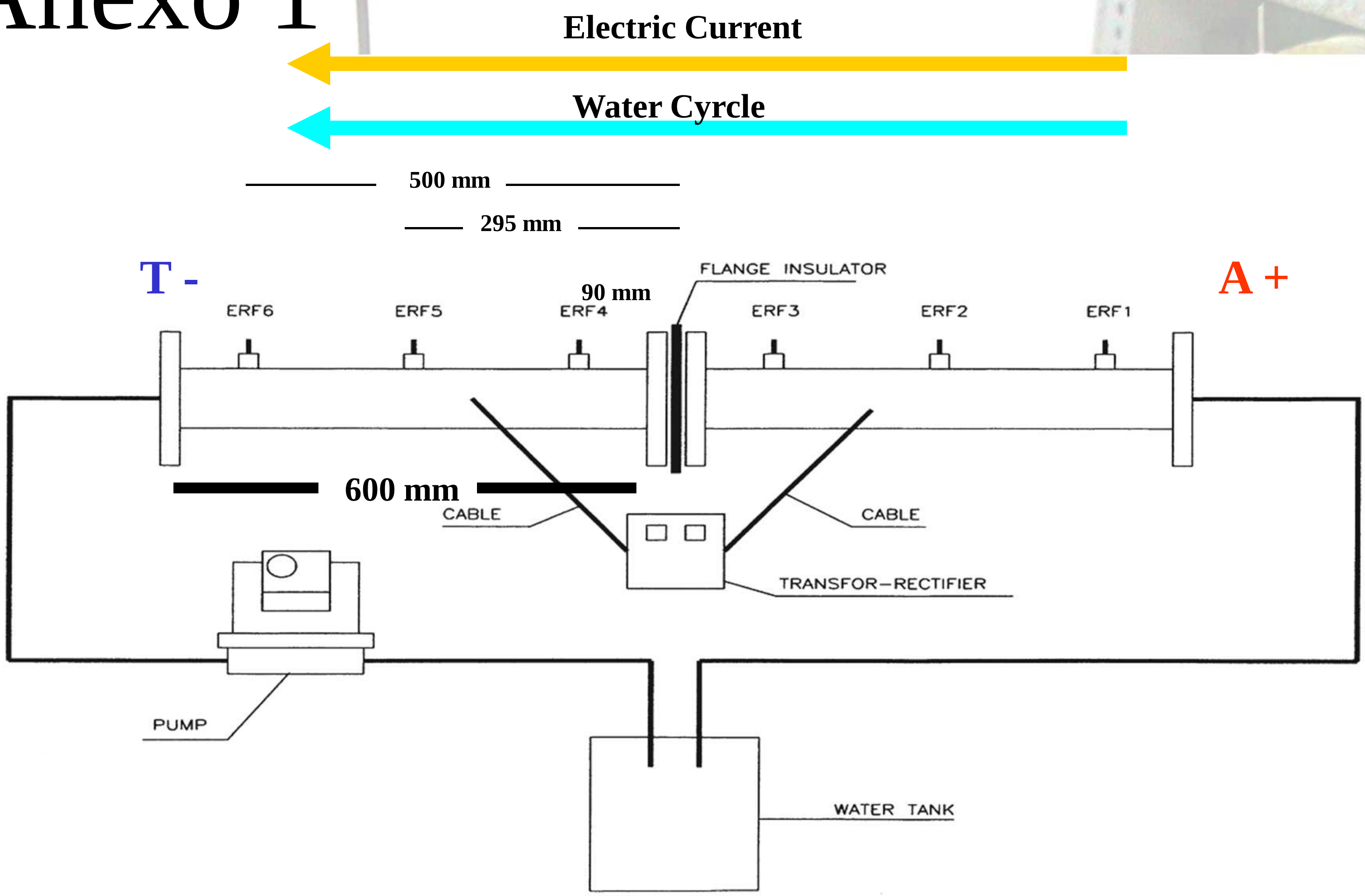
With this resistivity of 13.900 Ω x cm the REAL resistance level between two pipes wasn´t the result (4,37 Ω as calculated) but much higher (238 Ω) with water flowing in the same direction as the running current and change With flowing water in a diferent direction to that of the running current (473 Ω) .

When the resistivity is reduced to 7.500 Ω x cm, with flowing water the same direction as running the resistance decreases to aprox. 120 Ω and with still water to aprox. 291 Ω.

Continuation of Set Up

- **Repeat Set Up inserting one piece of PVC of large ....**
- **Repeat all the proofs changing the electrodes for test tube**
- **Repeat Set Up with other resistivity 5000 Ω x cm ; 1000 Ω x cm ...**
- **Repeat all the proofs changing the electrodes for test tube**
- **Repeating as already specified ,preceding with 2’’ of pipe with the same conditions what 4” pipes**
- **At the end analysis of all the results and seeing if it´s suitable Low resistivity and testing with pieces of PVC large or short.**

Anexo 1



Electric Current
Water Cyrcle
500 mm
295 mm
T -
A +
90 mm
FLANGE INSULATOR
ERF6
ERF5
ERF4
ERF3
ERF2
ERF1
600 mm
CABLE
CABLE
TRANSFOR–RECTIFIER
PUMP
WATER TANK