



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

MATERIAL STANDARD
FOR
CATHODIC PROTECTION

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1 SCOPE

This standard covers the minimum requirements for material, equipment and facilities used for cathodic protection systems.

Also this standard is intended to include pertinent guidance on the selection of materials and equipment for used with impressed current and sacrificial anodes (galvanic anodes) systems.

2 STANDARDS AND CODES

2.1 Anode materials and insulations shall be in accordance with the latest NACE standards.

2.2 Transformation-rectifier; cable and connections shall be in accordance with the latest IEC or NEC codes.

2.3 Coating materials shall be in accordance with the latest ASTM standards.

3 GENERAL

3.1 All materials and equipment shall be performed in strict accordance with this standard.

3.2 No substitution or modification to materials and equipment detailed in this standard is permissible, unless prior approval of client has been obtained.

3.3 Prior to the commencement of work, contractor shall submit for the approval of client, fully detailed proposal as to how he intends to carry out the work within the frame work of this standard.

3.4 All equipment, including the anodes, power source, cable, etc., shall be adequate efficient for the life of the pipeline or 25 years, whichever is less.



1 MATERIALS AND EQUIPMENT FOR IMPRESSED CURRENT SYSTEMS

1.1 ANODES

Anode is an electrode at which oxidation of its surface or some component of the solution is occurring. Materials currently popular for use as anode material include graphite, high silicon cast Iron and Steel.

1.1.1 Graphite Anodes

The first permanent anodes were made from graphite and Carbon. These material were very brittle and porous. Improved forms are available with inert resins and waxes. Graphite is usually made as rods of between 2 1/2" and 6" diameter and in lengths that vary from 3 ft to 7 ft.

Buried directly in the ground graphite should not be run at current densities in excess of one third ampere per ft² on any part of its surface which usually imposes a restriction of a mean current density of a quarter ampere per ft². At these outputs, its consumption will be less than 1 lb per ampere year.

Graphite anode should be handled accordingly. The connection between insulated anode Lead and the anode Proper is mechanical in nature with insulating material used to protect it from moisture penetration.

In soil when graphite anode are backfilled with carbonaceous backfill material, they are rated, typically, at a current output up to one ampere per ft². A 3" by 60" anode are most commonly used for pipeline ground bed, would have a maximum output of 4 ampere.

In fresh water, graphite anode can be used at low current densities approximately 1/4 ampere per ft².

In seawater, graphite anode also can be used below 1 ampere per ft².

1.1.2 High Silicon Iron

High silicon cast Iron anodes contain between 14 and 15% silicon plus lesser quantities of other alloying elements. One proprietary product includes Chromiums, between 4 and 5%.

A common size used in carbonaceous backfill is 2" diameter by 60". Rate of consumption of high silicon cast Iron is less than 407 per ampere year at current densities below 2 ampere per ft² while the rate of attach increases to 2 lb per ampere year at 10 ampere per ft². A modified alloy which includes Molybdenum is superior. This type common used in seawater and/or fresh water at elevated temperatures up to boiling water temperature.

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High silicon cast Iron anodes also are provided with insulated Leads as was the case with graphite. The material is brittle and must be handled with care.

4.1.3

Steel Anode

Steel anode may be used in some instances in deep-well ground beds.

Although formerly used more extensively for conventional ground bed construction, either graphite or high silicon cast Iron is considered better because of their greater life expectancy.

4.1.4

Other suitable material for anodes are as follow:

For anode in contact with salt water, inert anodes of platonizeed Titanium, Tantalum or Niobium or Lead/silver are commonly used.

Polymeric anodes are used for cathodic protection of reinforcing steel in salt contaminated concrete.

Magnetite (Fe_3O_4 plus additives) is to be considered a suitable anode in contact with soil.

Ceramic anodes are the newest materials available for cathodic protection of reinforcing steel in concrete, chlor-alkali industry and seawater electrolysis. These anodes are produced in sheet, mesh and wire from.

4.2

BACKFILL AND ANODE BED

A low resistance moisture holding material immediately surrounding buried anode for the purpose of increasing the effective area of contact with soil and to minimized the anode to earth resistance. In impressed current anode bed this refers to coke breeze.

4.2.1

Graphite, magnetite, Platinum and high silicon Iron anodes may be surrounded by a mixture of coke breeze and graphites particles. This mixture can have resistivity as low as 2 or 3 Ohm-cm. Petroleum coke can be specifically manufactured to provide much lower resistivity as low as 1 Ohm-cm.

Consumption rate of this backfill should not exceed 2 lb per ampere per year. Maximum particle size shall not exceed $3/8$ "; not more than 10% dust shall be included.



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4.2.2 A second type of backfill can be made by mixing chemicals with clean clays. Usually common salt or gypsum is mixed with bentonite and this is either poured as a slurry around the anode or is packed around the anode by placing both in a cotton bag. Resistivities below 100 ohm-cm can be obtained with Sodium Chloride additions, while 300 ohm-cm is the minimum usually obtainable with mixtures of gypsum and clays. This backfill common used for high silicon and steel anodes.

4.3 CABLES AND CONNECTIONS

4.3.1 Electric cable shall be made of the conventional electrical metals, Copper or Aluminium and these would suffer rapid corrosion if they were exposed to the electrolyte.

4.3.2 Cable conductors shall be sized such that the conductor be capable of carrying maximum designed current for the circuit without excessive voltage drops except that bonding cables shall be 16 mm² minimum. The conductor shall be No. 8 AWG or larger.

4.3.3 The conductor shall be extremely well insulated and this insulation shall be compatible with the anode environment which including generated chlorine gas. Suitable common cable insulation materials are plastic and synthetic rubbers. The best results are obtained with polyethylene and cross linked polyethylene cable insulation sheathed with PVC synthetic rubber.

4.3.4 Anode Leads shall be connected to the header cable by a method that will have permanently low resistance. The connection shall be insulated, so that it will be absolutely waterproof to eliminate the possibility of current leakage and wire corrosion.

4.3.5 Connection methods for Copper wire include soft soldering (65% tin alloy + 35% Lead), powder welding (30% Zn + 70% Cu), hard soldering (Silver alloy), phosphor-Copper brazing, compression (crimp type) couplings and split-bolt couplings. For Aluminium wire, aluminothermic welding (cadweld) can be used.

4.3.6 Joints should be insulated by material such as, cast epoxy resin insulation, polyester resin, PVC and/or polyethylene tapes and glass reinforced resin.

2.4 COATINGS MATERIALS

The function of a coating is to reduce the area of metal exposed to the electrolyte (soil, water, concrete,.....) and reduce greatly the current density required for cathodic protection.