armfield

CORROSION STUDIES KIT

CEQ
issue 10

Corrosion represents a significant factor in determining durability and safety of industrial processes. Student engineers need to understand fully the effects of corrosion and how these can be anticipated and prevented. The Armfield Corrosion Studies Kit is designed to provide an introduction to this topic and allows students to recognise potentially corrosive situations and develop information to permit the selection of adequate materials.

EXPERIMENTAL CAPABILITIES

- *effect on corrosion rate of pH level*
- *effect of dissolved oxygen concentration*
- *galvanic action*
- *electrolytic corrosion*
- *cathodic protection*
- *chemical inhibition*
- *prevention of scaling*
- *effect of internal stress.*

Basic Process Principles

CE

DESCRIPTION

The Armfield corrosion studies kit uses a number of simple items of equipment in a series of tests, designed to demonstrate to the student how potentially corrosive situations may be recognised and avoided. Although the experiments refer principally to steel water systems, the apparatus may be used as a test bench for other chemical systems.

The equipment allows for the simultaneous study of up to eight corrosion cells of whatever type is selected according to the teaching syllabus being followed. Each test cell allows for the immersion of three similar test specimens in the test liquid at any one time, to eliminate 'rogue' results from untypical metal samples. Each sample is mounted in a manner that minimises secondary effects and the metal surface of known area is exposed to the test liquid.

Corrosion rates are measured by both visual observation and direct weighing after a known period of immersion. Stirring is by air or inert gas agitation.

All connecting glass and plastic tubing is provided, as are the appropriate supports for the specimens and glass test cells. A digital pH meter and microsensor is supplied to ensure the correct strength of initial test solutions. For the study of electrochemical corrosion effects, a low voltage supply is included together with all necessary electrical connections. Initial buffer powders of pH 4, 7 and 9 are supplied.

The apparatus requires approximately 2m^2 of laboratory bench space for experimentation by two students. A full instruction manual is provided explaining how each corrosion cell situation is set up and the results assessed.

TYPICAL EXPERIMENTS

The influence of pH on corrosion

Iron and steel corrode in acid environments but much less so in alkaline situations. Students carry out corrosion tests at values of pH 4, 7 and 9. The results are explained with reference to the electrode potential series.

Stress corrosion

Metal samples are stressed in a variety of simple ways, including bending, scratching, filing or drilling. The alteration of the metal crystal structure may explain the observed results.

Brine and oxygen environments

Oxygen may be artificially removed from water by nitrogen purging. Comparison of corrosion rates of metal samples in oxygenated and de-oxygenated water may be related to localised ionic corrosion cells. The effects of sodium chloride solutions on the cells may also be deduced.

Galvanic action

Dissimilar metal pairs of steel/copper, and steel/zinc, are connected to form an electric circuit. The subsequent corrosion may be explained by reference to the electrode potential series.

Cathodic protection by impressed voltage

If platinum and steel are electrically connected, steel becomes the anode and corrodes in water. An external voltage may be applied to reverse the effect, thus protecting the steel.

Electrolytic corrosion

This demonstration shows that stray voltages between connected, dissimilar metals can greatly affect the corrosion rates. The low voltage D.C. supply is connected to various combinations of steel samples with platinum, zinc or copper samples.

Corrosion inhibition

The passivating influence of certain phosphates and silicates in solution on corrosion rates of steel may be demonstrated.

Water treatment projects

The following demonstrations may be conducted with the apparatus:

- *Calcium carbonate stabilisation*
- *Oxidation of iron and manganese in ground waters*
- *Disinfection of waste water with chlorine solutions*
- *Water softening by chemical precipitation.*

TECHNICAL DETAILS

Power supply unit:
Outputs: 0 - 15V at 2A
0 - 30V at 1A

Air pump: *diaphragm type*

Air flow rate:	*6 litres/min*
Max. head:	*0.8kg/cm²*
Max. power of motor:	*0.05kW*

Digital pH Microsensor and pH meter:

Range of pH meter:	*0 - 14pH*
Resolution:	*0.01pH*
Accuracy:	*±0.01pH*
Dimensions:	*195 x 29 x15mm*

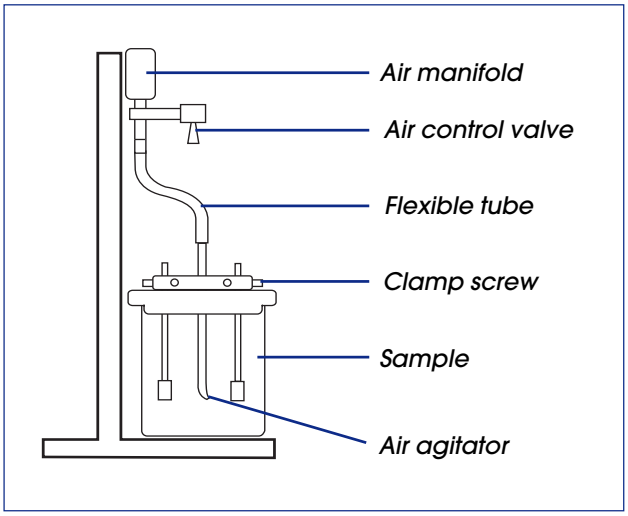
Beaker (x8): *borosilicate glass (Pyrex)*

Capacity:	*1000ml*

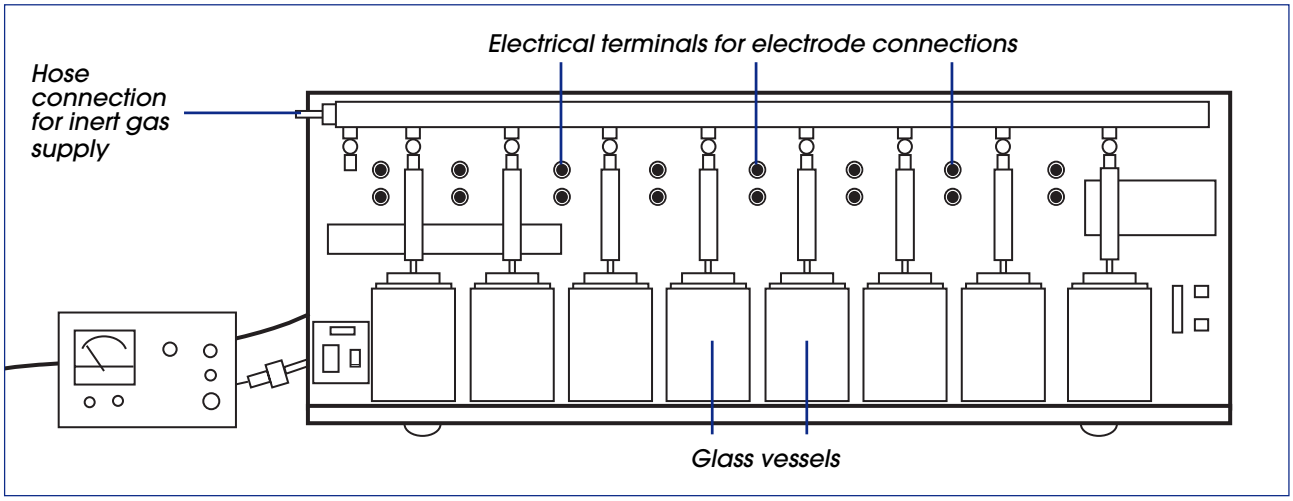
Electrodes: *platinum*

Test piece samples:	*zinc, mild steel, copper, brass*

Detail of a single corrosion cell



Side view of equipment



Front view of equipment

ORDERING SPECIFICATION

- ***The corrosion studies kit allows simultaneous study of up to eight corrosion cells each containing three test specimens.***
- ***Sample mounting in a manner to minimise secondary effects.***
- ***Corrosion rates measured visually and by weighing.***
- ***Stirring by air or inert gas.***
- ***Comprising:***
  - ***A service panel***
  - ***Air pump***
  - ***Eight test cells of glass construction, with specially machined lids enabling samples to be mounted***
  - ***Test cell supports***
  - ***Digital pH meter***
  - ***Specimen pieces of steel, zinc, brass and copper***
  - ***Platinum electrodes***
  - ***Low voltage supply***
  - ***Associated glassware, tubing and wiring***

ESSENTIAL ACCESSORIES TO BE SUPPLIED BY THE USER

- *Electronic top loading balance*
- *Cartridge de-ioniser*
- *Oven*
- *Laboratory glassware*
- *Inert gas cylinder e.g. nitrogen. Smallest available size. Pressure regulator needed.*

SERVICES REQUIRED

Electrical supply:

CEQ-A: 220/240V, 1ph, 50Hz
CEQ-B: 120V, 1ph, 60Hz

OVERALL DIMENSIONS

Height: 0.43m
Width: 1.19m
Depth: 0.28m

SHIPPING SPECIFICATIONS

Volume: 0.5m^3
Gross weight: 80kg

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