The Rank Brothers Oxygen Electrode

Operating Manual

Manufactured by:
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1. The Rank Brothers Oxygen Electrode

This electrode is designed for following the uptake or production of oxygen by cell suspensions, subcellular particles or enzyme systems. The principle of operation is that first described by Clark.

Oxygen diffuses through a thin (0.0005 in thick) PTFE membrane and is reduced at a platinum surface immediately in contact with the membrane.

$$O_2 + 2e^- + 2H^+ = H_2O_2$$

$$H_2O_2 + 2e^- + 2H^+ = 2H_2O$$

The other half cell is also incorporated in the base of the incubation vessel and is composed of a silver/silver chloride electrode.

1.1 Setting up the Electrode

1. Detach the base of the incubation chamber vessel by unscrewing the Perspex locking ring.
2. Add sufficient 3M KCl or saturated KCl to wet the silver and platinum electrodes.
3. Cut a 1 cm square of lens tissue and make a 1 mm diameter hole in it with scissors. Place the tissue over the platinum electrode so that the hole is over the electrode.
4. Cut a 1 cm square piece of PTFE membrane and place over the lens tissue.
5. Gently push the silicone rubber 'O' ring over the platinum electrode so as to hold the PTFE membrane in place when the plastic base and the incubation chamber are clamped together (you can use the incubation chamber to gently push the 'O' ring into place).
6. Lock this in place by putting the incubation chamber in place and screwing down the locking ring. Take care that no air bubbles are trapped under the membrane and that it is not twisted. The oxygen electrode is now ready for operation and should be placed on the magnetic stirrer (Rank Bros.).
7. The sample needs to be stirred by a suitable magnetised stirring bar. We can supply glass coated versions for the various different incubation chamber volumes.

1.2 Electrical Connections and Recording

The platinum electrode is polarised at −0.6 V with respect to the silver/silver chloride electrode. The current that flows under these conditions is about 1 µA in stirred air-saturated water at 30 °C. The current flowing is proportional to the activity (partial pressure) of oxygen in solution over a wide range.

The electrode is wired to a 3-pin DIN plug as follows:

Pin 1	Silver electrode (red wire)
Pin 2	Not connected

Pin 3	Platinum electrode (blue wire)

1.3 Suitable Chart Recorders

Most modern chart recorders are suitable providing they have a sensitivity of 10 mV full scale or better. Both the Polarising Circuit & the Read-out Meter are connected by a 3-pin DIN plug that should be wired as follows:

Pin 1	To Red 4 mm Plug
Pin 2	Screen to Black 4 mm Plug
Pin 3	Not connected

1.4 Method of Use

Connect the silver/silver chloride electrode to the positive side of the potential divider and the platinum electrode to the negative. Add air saturated medium to the incubation vessel; place the Perspex plunger in position and after ensuring that no air bubbles are trapped, switch on the magnetic stirrer. Adjust the sensitivity control to give a suitable deflection on the recorder. When steady state has been achieved proceed with the experiment. All additions should be made through the small hole in the Perspex plunger, being careful not to introduce air bubbles. The experiment is concluded when the suspension becomes anaerobic (if respiration is being followed), that is when the current falls to zero or very nearly so. To start the next experiment, remove the Perspex plunger and wash the vessel out by sucking out the contents with a vacuum water pump.

1.5 Do Not

- Do not over tighten the locking ring.
- Do not switch off the electrode between experiments. The electrode may be left on all day without harm.

1.6 Testing for residual current

Add a few crystals of sodium dithionite. The electrode current should fall within 5 seconds to zero or nearly so. If it does not, change the membrane and check the electrical connections. A ‘leaky’ membrane often leads to noise – change the membrane.

1.7 Oxygen content of solutions

Suitable data values are to be found in the International Critical Tables and the Handbook of Physics and Chemistry.

1.8 Cleaning and Storing the Oxygen Electrode

When the electrode is not in use for a few hours (e.g. overnight) it is best dismantled and the electrodes left to soak in distilled water, we can supply a storage cell for this purpose. If the electrode assembly must be left intact, but non-operational for a few

hours, it is best if the electrode is left on, but with the stirrer switched off. The platinum electrode needs to have a 'mirror' finish, any surface damage will affect the response of the electrode, and it will thus need to be cleaned approximately once every 5–7 days of use or when it has lost its shine. A suitable polish can be made by mixing a thick slurry of 0.3 µm polishing alumina (obtainable from BDH Chemicals & Merck for instance) in distilled water. A piece of cotton wool can then be used to polish the platinum electrode until it is smooth, bright and clean (this should only take a few minutes). The silver electrode will need to have the layer of silver chloride removed and the surface polished every 2–3 months of use. A 10% ammonia solution on cotton wool can be used to remove the silver chloride layer. (Ensure that the appropriate handling precautions are observed.) The silver electrode can then be made smooth, bright and clean by polishing with the alumina slurry as described above for the platinum electrode.

2. Instructions for the Readout Meter

1. Switch control to *Read*.
2. Set the polarising voltage to 0.6 V, or as required, using a small screwdriver.
3. Set the *Oxygen Read Out* meter to zero with the appropriate control.
4. Plug in the electrode with a reference solution in it, and adjust the *Sensitivity* control to give a suitable deflection on the meter.
5. Refill the electrode with the sample to be tested.

2.1 To use with a Recorder

1. Switch control to *Record*.
2. Set polarising voltage as described above.
3. Plug in the electrode with a reference solution in it, and adjust the *Sensitivity* control to give a suitable deflection on the recorder.
4. Refill the electrode with the sample to be tested.

3. Instructions for the Polarising Circuit

1. Switch the *Coarse* control to the first position from *Off*.
2. Set the polarising voltage to 0.6 V, or as required, using a small screwdriver.
3. Plug in the electrode with a reference solution in it, and adjust both the *Coarse* control and the *Fine* control to give a suitable deflection on the recorder.
4. Refill the electrode with the sample to be tested.

4. General Notes

- The Readout Meter contains one 'C' size and two PP3 batteries and thus the instrument should always be turned off when not in use to conserve battery life.
- The Polarising Circuit contains one 'C' size battery and should also be switched off when not in use.
- The screen of the lead to the recorder should be earthed to reduce unwanted noise.