The making of a combined pH electrode – the inside story

Radiometer Analytical's experience in electrochemistry dates back nearly seventy years to when the company pioneered its very first pH meter in Copenhagen, Denmark.

Today, it develops and manufactures a comprehensive range of instruments, software, sensors and calibration standards, extending its expertise across the entire measuring chain.

The company is particularly proud of its range of more than 300 electrodes - combined pH, glass or reference electrodes, metal electrodes, ion-selective electrodes and conductivity cells - for every application and budget.

Electrodes are manufactured on its premises in Villeurbanne, France using a blend of traditional know-how and state-of-the-art technology.

It takes between 2 and 11 days to manufacture a combined pH electrode, depending on the type. The electrode described below features Red Rod technology - a unique concept developed by Radiometer Analytical which ensures fast response time across a wide temperature range.

First of all, 2 m long crystal tubes with diameters of between 2 mm and 12 mm are used to manufacture the internal and external bodies of a combined pH electrode.

These crystal tubes are subjected to cold working with a wet or dry saw then drilled. The blades and bit are diamond tipped for maximum cutting efficiency. The parts obtained are then subjected to heat treatment.

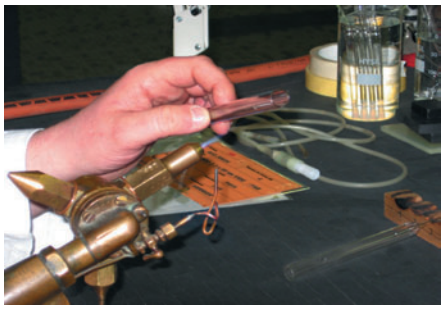


Photo 1: burning process

The cutting process leaves sharp edges that need to be smoothed off using fire polishing (photos 1 and 2).

Photo 2: filling hole before (left) and after burning (right)

The following stage, called annealing, allows any stresses introduced into the glassware to be removed. The electrode is then separated into two compartments by a double welding operation (photo 3)

Photo 3: right: before double welding left: after double welding

Next, the ceramic porous junction (Ø 1 mm) is fitted (photos 4 and 5).

This is an extremely delicate process as, if the temperature is too high, the ceramic porous junction becomes blocked and the ions will not be correctly exchanged and, if it is too low, there is a risk of leakage.

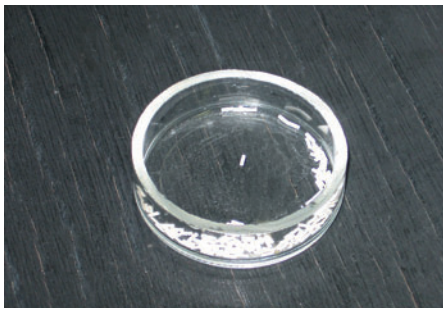


Photo 4: porous junctions

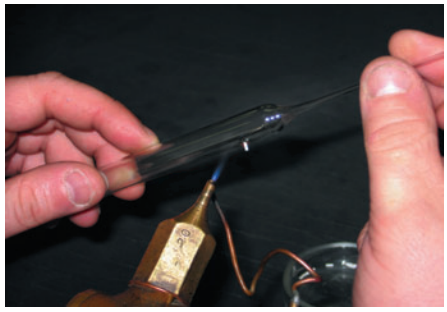


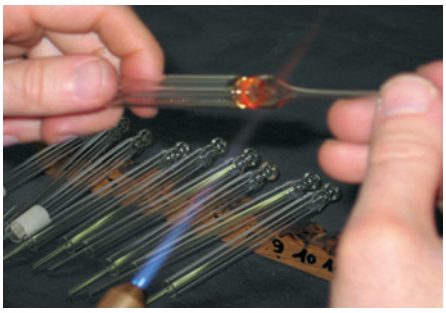
Photo 5: fitting the porous pin

Now comes the most spectacular and most skilful stage of the process - the blowing of the glass bulb. A steady hand and a trained eye are the essential tools here as the diameter of the glass bulb

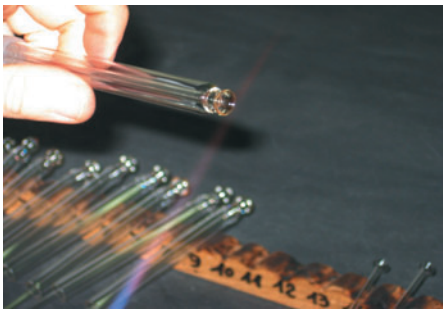
(sensitive membrane) must measure 10.5 mm with a tolerance of only 1 mm. It has to be right first time.

The glass used to form the pH-sensitive part of the electrode is made using a strictly confidential formula - and determines the performance of the electrode.

Firstly, the base of the electrode is prepared to form an adherent surface. This base is created using a blob of molten glass, which is blown into a bubble then broken off (photos 6 and 7).



Photos 6 and 7:
preparing the blank for dipping



The base of the electrode is dipped into an oven of molten glass at a temperature of 1200°C (see top photo overleaf).

At the next stage, the glass is blown (photo 8) to form the sensitive glass membrane. The glass parts are then carefully cleaned and checked before being sent to the assembly line.

On the assembly line the electrode is filled with KCl crystals and an inner filling solution. Next, the internal and external Red Rod reference elements containing AgCl powder are inserted (photo 9) and the electrode is glued to seal it.

Photo 8: blowing the glass bulb

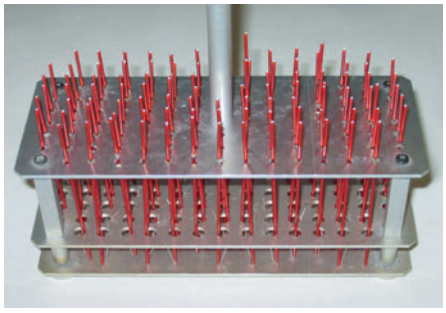


Photo 9: Red Rod reference elements

A copper shield is fitted to provide the electrical connection of the reference electrode and the shielding of the electrode head. The cable is attached.

Photo 10: electrodes during manufacturing

Each electrode is tagged to ensure complete traceability.

A second gluing phase takes place to insulate the electrode correctly. It is then left to dry for 24 hours.

The electrodes are virtually finished at this stage. All that remains is to glue on the head already attached to the cable, as can be seen from photo 10.

The assembled electrode is soaked in a hydrating solution for 12 hours to condition it. Once this is done, the specifications of each electrode are checked on an automated control bench (photo 11). A certificate is then issued stating the individual electrode specifications such as slope, response time etc.

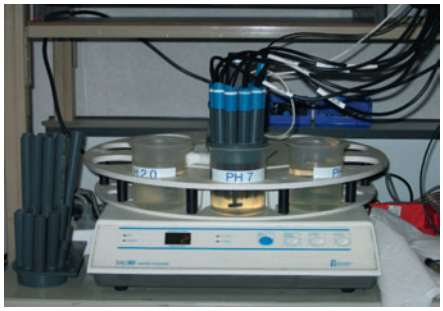


Photo 11: control bench

Now the electrodes can be boxed ready to be sent out to the customer (photo 12). Few people realise how many delicate operations are required to manufacture the electrodes they use every day.

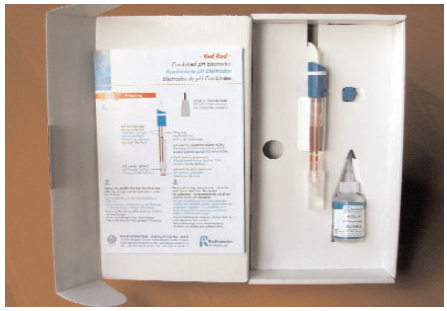


Photo 12: packed electrode with certificate of conformity

Thanks to our unparalleled experience in electrochemistry, you can be sure of obtaining accurate and reproducible results every time when you choose a Radiometer Analytical electrode.

Approved Quality System

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