partial pressures of O_2 on either side of the cup, and **mV is the potential difference across the cup wall in millivolts.**

If the cell voltage is expressed in milivolts then, $E = 0.0469T(\log p_1 - \log p_2)$
Above function takes place at about 750°C, which requires quite a bit of energy to reach and maintain. In case of the high temperature, O_2 moves at blazing speed through the ceramic, so the response time of zirconia-cell analyzers is extremely fast. In addition, as the O_2 potential pressure difference across the cup wall climbs, the signal from the cup gets larger and larger (rather than smaller and smaller), making the zirconia analyzers effective at measuring very low O_2 concentrations if ambient air is used as the reference gas, which is usually the case.
Fast response times and excellent low-range performance are the zirconia analyzer's two strong points. The latter is unimportant in respirometry, however, and unless you need to do breath-by-breath analysis, so are very fast response times. this is because the limitation on the response times in most respirometry systems is set primarily by the flow rate divided by the volume of the chamber and tubing, which is typically anything from several seconds to a minute or more. In the vast majority of respirometry setups, all three major types of O_2 analyzers will produce results that are difficult or impossible to distinguish on the ground of response speed, even though the native response speeds of the analyzers themselves may be very different.

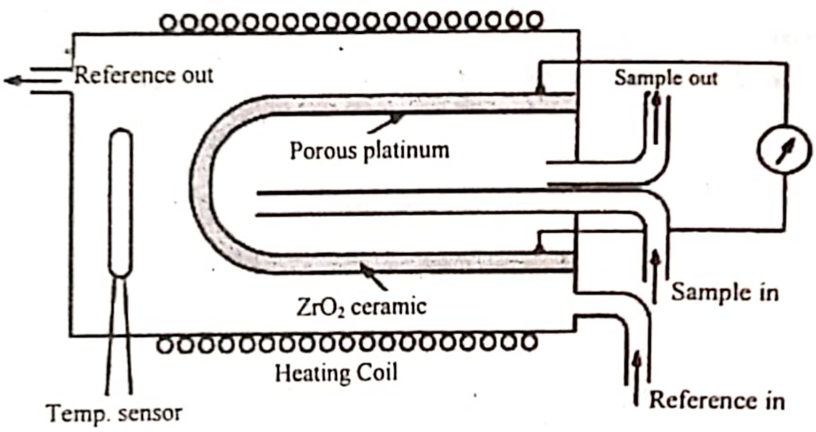

Fig: Zirconia fuel cell oxygen analyser

The primary disadvantages of the zirconia-cell O_2 analyzer are:
1. It is bulky, requires high power (not for field use), and requires a long warm-up period, typically 4 h or more.
2. It is more prone to drift and noise than the other two types analyzers.
3. It is very sensitive to changes in flow rate.
4. If liquid water enters its zirconia cell, the water will explosively change phase into steam, and the pressure front will crack the cell.

5. If volatile organic compounds or gases such as methane enter the cell, they will combust with atmospheric O_2, causing an artificial increase in O_2, depletion. With some organism this can result in massive measurement errors.
6. Over time the sensor may (depending on the manufacturer) degrade and have to be "rebuilt" periodically at considerable cost.

Now these days differential zirconia-cell O_2 analyzers are available that are capable of better noise and drift performance, but they are very expensive.

5. a) What do you mean by conductivity of a solution and state the factors on which it depends? [WBUT 2010, 2012, 2018]
Describe the working of the conductivity cell. [WBUT 2010]
What is cell constant? [WBUT 2010, 2012]
Why pulse dc or ac excitation is more appropriate than dc excitation?
b) Describe the operation of the molecular selective gas sensor to monitor dissolve carbon dioxide. [WBUT 2010]

Answer:

a) The conductivity (or specific conductance) of an electrolyte solution is measure of its ability to conduct electricity. The SI unit of conductivity is Siemens per meter (S/m).

Conductivity measurements are used routine in many industrial an environmental applications as fast, inexpensive and reliable way of measuring the ionic content in a solution. For example, the measurement of product conductivity is a typical way to monitor and continuously trend the performance of the water purification systems.

By applying a rapidly oscillating field (>1 kHz) in an electrochemical cell, the mobility of ions in solution, or conductivity can be measured (see Fig. below). No oxidation or reduction takes place in conductivity detection, but charging and discharging of cell electrodes do occur. The fundamental measurement used to study conductivity is resistance, R, of the solution. Under the precautions required the earlier experimental description should follow Ohm's law in which $R = \frac{\rho l}{A}$ ... (1)