

### Characteristic and usage

The conductivity cell CD-210 is a system of 2 ring shaped platinum electrodes placed on glass core inside glass cell. It is designed for measurements of electric conductivity of water solutions (electrolytes). The conductivity is an ability of conducting electric current, transporting the charges by ions present in the solution. The main unit of conductivity is Siemens/meter (S/m). But the most often used are (mS/cm) and ( $\mu$ S/cm). By changing the units a following dependence may be used:

$$1 \text{ (S/m)} = 1000 \text{ (mS/m)} = 10 \text{ (mS/cm)}$$

$$1 \text{ (mS/cm)} = 100 \text{ mS/m}$$

$$1 \text{ (mS/cm)} = 1000 \text{ (}\mu\text{S/cm)}$$

The construction of the cell and used materials enable using it in measurements of samples with wide range of conductivity, also chemically aggressive samples. The cell is designed for measurements in range 1,0 mS/cm – 800 mS/cm. This cell can't be used for measurements in distilled water, concentrated salt solutions, strong alkaline, and solutions of mineral acids. The CD-210 cell was designed as immersing cell and is constructed for measurements in samples which are not moving. It is not prepared for measurements in streams of solution. In case of observing changes of conductivity during measurement in a vessel or container it is necessary to use a magnetic stirrer. The cell can't be used for measurements which are strongly contaminated with deposits fats or oils.

The CD-210 cell is prepared for work with conductivity meter equipped with BNC-50 connector. The usage of the cell is closely related with the technical abilities of the meter. Modern microcontroller based conductivity meters enable realisation of many features like:

- wide conductivity measuring range,
- work with cells with different constant K,
- automatic calibration of the cell in solutions with known conductivity, or by introducing the constant K of the cell
- using automatic or manual temperature compensation with possibility of introducing individual temperature coefficients for the measured solutions
- storing in the memory the results of measurements

The actions during calibration, measurements and way of temperature compensation should be compliant with the meter's producer instructions.

Beside this some universal principles of using conductivity cell should be taken into consideration. The conductivity measurements have a wide range of advantages as: easy calibration, reliability, repeatability and possibility of measurements in wide range of temperature and pressure. The main disadvantage of conductivity measurements is: high influence of the temperature on the measurement. The conductivity cells are used in many places like: power industry, chemical and pharmaceutical industry, environment protection, science, etc.

### The cell construction

The construction of the conductivity cell type CD-210 is showed on the picture 1. The main part of the cell are the platinum rings placed on glass core and covered with platinum black to increase their active surface. The platinum black coating reduces the appearing of unfavourable phenomenon of electrodes polarisation and decreases the influence of capacity on the cell impedance. The electrodes are connected with cable by platinum wires. On the end of the cable there is a BNC plug. It enables applying from the meter a sine wave voltage to the electrodes. The core with electrodes is placed in glass cell which limits the influence of the vessel walls on the measurement result. Small holes in upper part of the cell enable removing air from the cell. The CD conductivity cell hasn't built in temperature probe. This enables cooperation of the cell with different systems of temperature compensation.

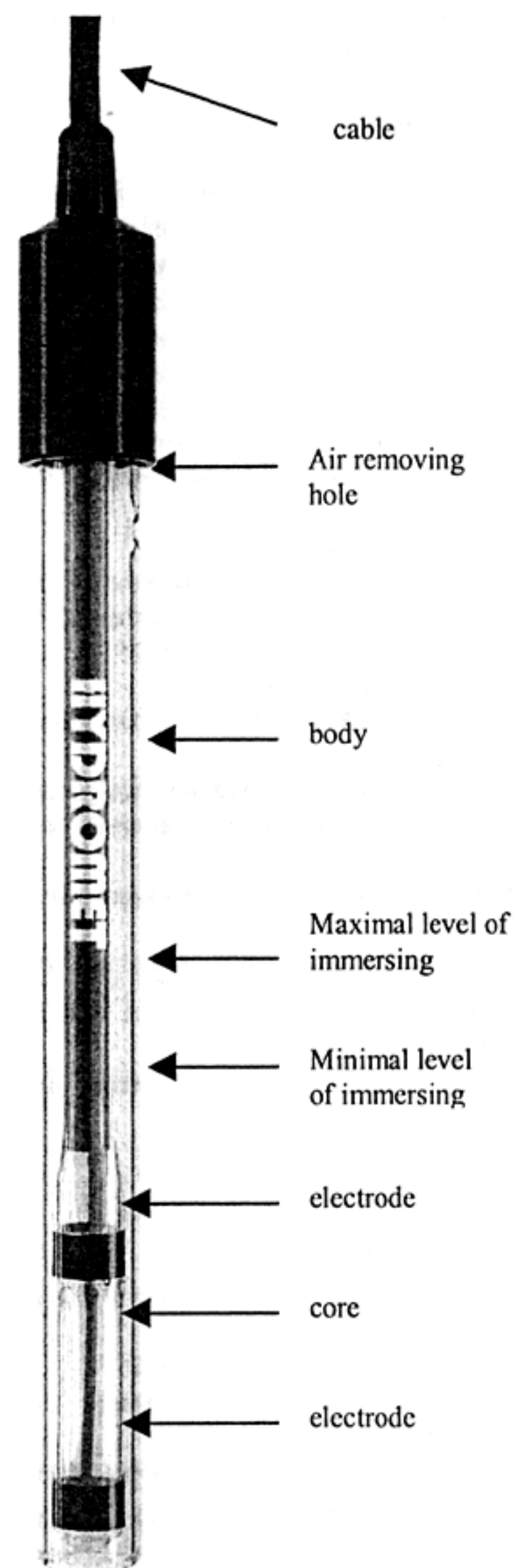
### Preparation for the measurement

Before starting the measurements it is necessary to wet the electrodes by immersing the cell in distilled water for few minutes. If on the electrode's surface an air bubbles are staying, what disables even moistening the electrodes it is advised to add to the water few drops of detergent (ex. washing up liquid) and next wash the cell in distilled water.

### Cell calibration

The characteristic feature of conductivity cell is it's constant K. It's value is determined in ( $\text{m}^{-1}$ ) and usually given by the producer. Very often this value is given in ( $\text{cm}^{-1}$ ) where:

$$K = 1 \text{ (cm}^{-1}\text{)} = 100 \text{ (m}^{-1}\text{)}$$



Pic. 1 Conductivity cell CD-210

As a result of longer using of the probe or it's contamination the effective surface of the electrodes is decreasing. This can cause changing of the constant k of the cell. That's why from time to time this constant should be checked with use of solution with known value in given

temperature. The constant K may be determined using the conductivity meter.

### Influence of the temperature

Together with growth of the solution temperature it's conductivity is growing. The influence of temperature is determined as temperature coefficient  $\alpha$ . This coefficient is changing together with the temperature and concentration. In practice the  $\alpha$  coefficient may be determined with simplification that on the value of this coefficient greater influence has the temperature change than changes in the composition of the salts and their concentration

To determine the coefficient one should:

1. Take the solution, which conductivity will be measured in temperatures different than 25 °C
2. Bring the solution in the lab to 25 °C and measure it's conductivity ( $G_{25}$ ).
3. Change the temperature to other determined value ex. 20 °C.
4. Turn the meter to manual temperature compensation by disconnecting the temperature probe from the meter.
5. Enter with the keyboard temperature value 25 °C.
6. Again measure the conductivity of the solution (ex. in 20 °C) This value will be different than in 25 °C ( $G_{Tx}$ ).
7. Determine the  $\alpha$  coefficient using the formula:

$$\alpha = \frac{G_{25} - G_{Tx}}{G_{25} (25 - T_x)} \times 100 (\%/^{\circ}\text{C})$$

where:  $T_x$  - value of the changed temperature in °C

$G_{25}$  - conductivity measured in 25 °C.

$G_{Tx}$  - conductivity measured in temperature  $T_x$

This same should be done reducing the temperature to ex. 15, 10 and 5 °C, taking down the counted values of  $\alpha$  coefficient. This same may be done raising the temperature of the sample.

During measurements in temperatures different than 25 °C, before starting measurement, it is necessary to introduce the received  $\alpha$  coefficient for the existing temperature.

Because of large influence of temperature to the conductivity in most cases it is necessary to use

automatic or manual temperature compensation. It is based on automatic counting of the conductivity measured in the given temperature to the conductivity in the reference temperature and next correcting the result. Manual temperature compensation may be used when the measurements are done in constant temperatures or when there is no temperature probe for the meter.

### Conductivity measurement

Before starting the measurement it is necessary to decide weather the measurements will be done in liquids with 25 °C what enables receiving the most accurate results or with use of manual or automatic temperature compensation.

The measurement should be done as follows:

1. Connect the conductivity meter to the power source or use the batteries. Connect the temperature sensor (if ATC is planned) and conductivity cell to the right connectors in the meter.
2. According to the user's manual of the meter introduce the constant K of the cell and the  $\alpha$  coefficient for the measured solution.
3. Immerse the cell and temperature probe in the measured solution. Keep the cell away from the bottom and walls of the vessel. The best way is to use a stand. When immersing the cell it is important to remove the air bubbles from it. It should be done by shaking the cell. The air bubbles may significantly change the result.
4. After the stabilisation of the result note it or introduce it to the meter's memory.

To receive high accuracy and avoid damaging the cell it is advised to act respecting below given points:

- The measurement should be done quite fast to limit influence of gases from the air.
- The samples taken for the measurements should be stored in filled to top plastic containers. They should be stored in dark place, to minimise the biologic activity.
- When registering conductivity changes it is necessary to stir the solution, to ensure liquid change inside the cell.
- Samples with fats, oils, suspensions or lubricants may block the surface of the electrodes what causes changing the constant K. In case of this kind of contamination it is necessary very often to check the constant K.

Samples which include non soluble contamination should be filtered before measurement. The sediments may cause damaging the surface of the electrodes.

The electrodes of the CD-210 cell should be kept clean. In case of contamination the electrodes can't be cleaned manually. The best way to clean them is washing in solvent right for the kind of contamination. Every substance which is not destroying glass or platinum may be used. On the beginning one may try to use water with detergent (washing up liquid) Contamination with oil, lubricants, fats, paints and resins may be removed with use of following solvents: acetone, chloroform, fourhydrofurane, etc. Mineral contamination such as: fur, plaster etc. should be removed with acid solutions like hydrochloric acid, phosphorus acid, sulphuric acid, or use alkalis like: sodium hydroxide. After cleaning the electrodes the whole cell should be washed carefully in distilled water.

### Storing

During short breaks between the measurements the conductivity cell type CD-210 may be stored in distilled water. During longer breaks or for storing the cell may be placed in the package delivered by the producer. The connector should be protected against contamination and influence of factors which may cause corrosion. Poor contact between the meter and cell may cause errors occur. The glass body of the cell should be protected against mechanical damages.

### Technical Data

|                            |                             |
|----------------------------|-----------------------------|
| Measuring Range            | 1,0 mS/cm – 800 mS/cm       |
| Constant K rang            | $10 \pm 1 \text{ cm}^{-1}$  |
| Temperature range          | $0 \div 70^{\circ}\text{C}$ |
| Minimal level of immersing | 50 mm                       |
| Maximal level of immersing | 60 mm                       |
| Cell diameter              | $12,0 \pm 0,5 \text{ mm}$   |
| Body diameter              | $12,0 \pm 0,5 \text{ mm}$   |
| Electrodes                 | Platinum                    |
| Body                       | Glass                       |
| Cable length               | 1 m                         |
| Connector                  | BNC                         |