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THERMO COMPENSATED CONDUCTIVITY MEASURING CELL

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Abstract: The water analytic methods, based on the conductivity measurements are in the field of the physico-chemistry, called conductometrie. Its main task is the defining the material quality, but also quantity via soluble materials. One important element in this hardware is the conductivity measuring device and especially the conductivity cell.

Keywords: conductivity measurements

1 INTRODUCTION

Modern analysis uses the solution specific conductivity measurements in a huge variety of element estimation, determination and also proving.

The measurement of the specific conductivity of a water solutions is an useful method by the estimation of the quality of a particular material, via a quantitative determination of the in the water soluted ions.

The so called - "Total Dissolved Solids" (TDS) - is an useful and convenient parameter in the process of estimation of the degree of the contamination of the water, e.g. the purity of the water. The general rule here is:

- The conductivity rises, as ion concentration increases!

This postulate is very useful one, but not only because the measurement does not differentiate between the contribution from specific ion, but it gives an indication of the total ion concentration. This technique is the base of certain process control devices, pointing the actual condition, in dynamic of the development of the process. The feedback brings than the process in the preliminary defined condition, if not.

At least, TDS measurement could estimate:

"…… how clean is clean ? "

A variety of examples, from the praxis - PCB quality, the fine mechanic parts production etc. are closely connected with the so-called "…wet processes ", where again conductivity measurements are of a huge importance.

The scope of the present paper is mainly connected with the measuring the conductivity of pure and mostly ultra pure water, in dynamic .The demands of ISO 3696, but also The US MIL - P - 28809 and similar are proven here, with the help of a certain

Hardware, produced from the firma, pointed above in the title.

2 CONDUCTIVITY MEASURING

Commonly, conductivity measuring methods are based on DC or AC excitation electronical circuitry. The first one showed a particular amount of inconvenience and uncomfortable way of action because of polarization events, so they found a limited popularity.

By the AC excitation methods, the voltage is applied between the electrodes, placed in the solution The two electrode conductivity measuring cell is the most commonly used, because of its simplicity, mainly .The electrical circuitry is shown bellow schematic.

A thermo compensation element, a simple thermo sensitive resistor serves to change the gain of the driver so, that the specific conductivity should be related at 25 degree Celsius .The driver is previously calibrated so, that the showings of the meter are at the already mentioned temperature.

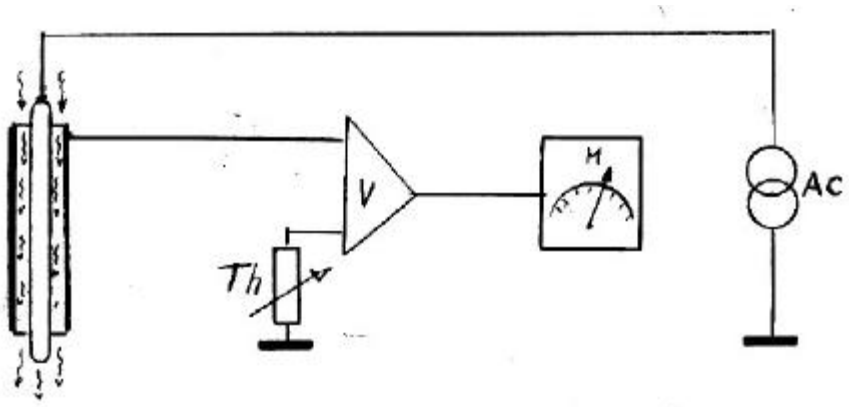

Figure 1. Electrical measuring circuit.

In the praxis, commonly used is the coax conductivity measuring cell. Here, two cylindrical electrodes also are placed one in other so that the are building the cell (Fig. 2).

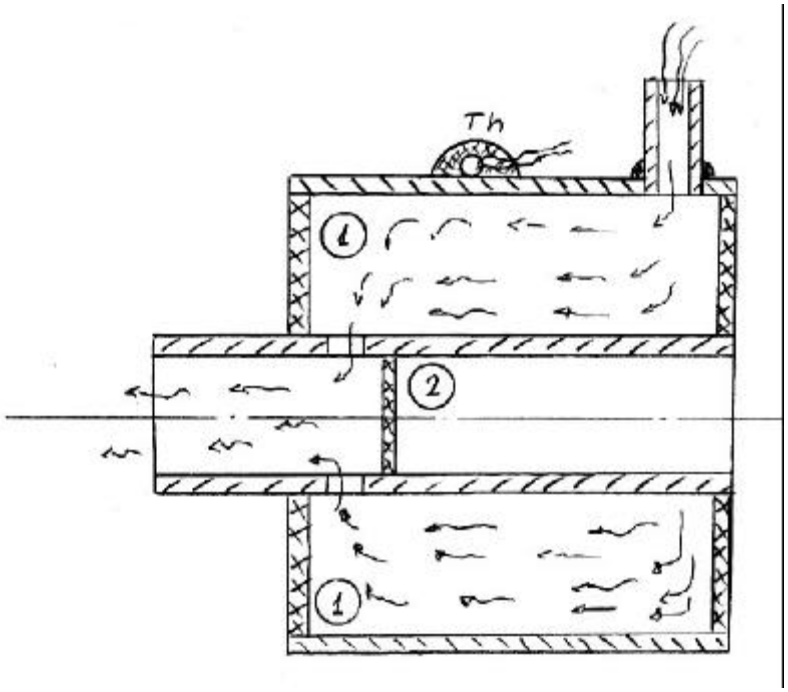

Figure 2. Construction of the coax conductivity measuring cell.

Suitable placed in- and outlets leads the water stream between the surfaces of the two electrodes so, that along the greater length the stream flows parallel to the axis of the cell - a very important demand for the precise measuring!

One can speculate, but also in previous patents described and written, the thermo sensor should be placed in the hole 2. Not, in contrary!! A huge volume of experimental work showed, that the ever most precision in the process of the measurement is reached when and if the thermo resistor is placed and molded by a special composition on the outstanding surface of the outer electrode!! And much more - hole 2 must exist and should be free!!

3 TECHNOLOGICAL ASPECTS

It is established, the two electrode cell is very suitable for precise conductivity measuring.

The surface of the electrodes is usually micro pore platinum, titanium gold plated nickel or even graphite. Electrodes must be replatinized, cleaned or even replaced if the become fouled or polarized (refer to the individual meter nature and the producer exploitation instructions).

Nowadays, a special alloyed stainless steel is used to form the coax designed conductivity measuring cell .The renewing in this case, falls out of scope for a very long period of time. This construction is used mainly for dynamic conductivity measuring in the process-controls, where bigger water streams should be measured.
But, one may mark, that:

- gold and platinum are very expensive! ;
- gold and platinum plating is not only a very expensive technological method, but a very complexive and hard process ;
- the special alloyed stainless steel is also an expensive material ;
- if stainless steel used - it is very hard-to-make the desired construction!;
- the encapsulation is also not so very simple task to be solved if stainless steel used.

4 SEMICONDUCTOR CONDUCTIVITY CELL

A specialized methods for delivering of the well known CuO, known from the very beginning of the radiotechnic, helped in delivering a very cheep and simple construction of a high precision conductivity measuring cell.
One of the important describing parameter of the conductivity cell is its constant, dependendend mostly , in practice of its geometry. Here, a segment of the hole 2 from figure 2, shown greater.

$$Kd = L/s \qquad (1)$$

where L is the distance between the electrodes, and s is the surface of the space between them.

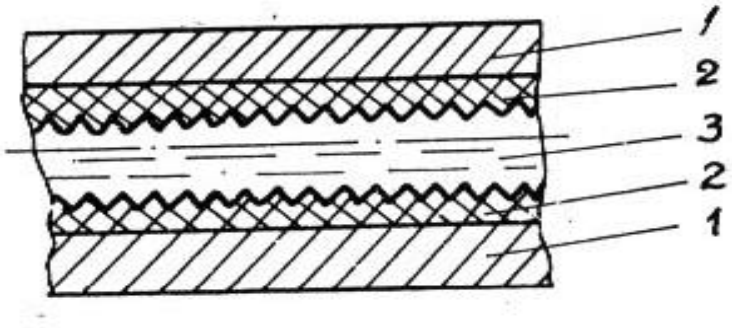

Figure 3. Scheme of the electrodes surfaces.

From the figure 3, one could see, that the kind and way of coating, of the both surfaces of the said cell brings to resent amount of largening of the working surfaces and certain deminishing of the distance between both electrodes, at the same time.
As result - the constant Kd reaches so little values in practice, impossible for the normal stainless steel or even for the platin conductivity measuring cell.
All this facts results in very high precision results in the process of the measurement of the speciphic conductivity of high purity water streams. The explanation ,reached experimentaly gives the knotion ,that the electromotive forces and the polarisation effects and especialy their disturbing action in the measurement process are mostly deminished.
The said conductivity mesuring cell has been proven in many high precision measuring devices and gave exellant results in the practice.

REFERENCES

Adjarov, T. & Co. BG Patent

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