



emtec FPO Fiber Potential Analyzer online

Online measurement of the surface charge of fibers, with instant availability of test results, which enables a permanent and reliable process control and allows a fast intervention in case it becomes necessary.

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Introduction

The FPO Fiber Zeta Potential Analyzer Online is an innovative measuring device for the fully automatic and accurate determination of the Zeta Potential of fibers in the paper and board production process. Until now, the Zeta Potential of fibers has been determined with the help of laboratory measuring devices (FPA – Fiber Potential Analyzer from emtec/ AFG). Because of the time difference between the sample-taking and the present measuring data, a reaction to changes in the process is only possible with a time delay. Furthermore, personnel efforts are needed for laboratory measurements, so a permanent process control is practically not possible in this manner. The new FPO Fiber Zeta Potential Analyzer Online uses the established measuring principle of the laboratory measuring device FPA and delivers accurate results fast and reliable. Especially the low-maintenance operation has to be pointed out. By the use of the innovative FPO the immediate intervention into the production process, which might be necessary because of unwanted measuring results, is possible. That is the reason why its application leads to obvious savings in material, time, and energy.

Theoretical principles of the Zeta Potential

The Zeta Potential is the charge, which develops on the surfaces of fibers, fillers and particles of liquids. The knowledge of these surface charges plays an essential role for the evaluation of reaction mechanisms in stock suspensions of fibers. The decisive criterion to identify the reaction behavior of fibers with the additives is the charge of a sample in original concentration, because the charge on the surfaces of fibers and fillers gives information about the manner of reaction of additives. Particles with different charge attract each other, and the reaction of retention- respectively wet strength agent on a fiber will be possible. The Zeta Potential predicates the power of the interaction of charged particles. The stronger this interaction between the charged particles, the higher is the Zeta Potential. If the Zeta Potential is negative (- mV), the analyzed fillers, fibers respectively solids have a negative charge; a positive Zeta Potential is a sign of a positive charge of fillers, fibers respectively solids. Certainly, the Zeta Potential cannot be calculated respectively determined directly, but only indirectly by factors such as the streaming potential and other parameters. The full Zeta Potential of a stock suspension is composed by the charge of colloidal dissolved particles and by the fiber charge. The FPO was developed for the computation of the Zeta Potential of fibers with the Helmholtz-Smoluchowski-equation by the simultaneous measurement of conductivity, pressure difference, and streaming potential. The direct operation at the paper machine is the specific of the FPO, because this enables the immediate intervention into the production, which might be necessary if there are deviations from the desired value. The knowledge of the surface charge of the fibers enables an accurate and effective dosage of additives. The adsorption of cationic starch, wet strength agent and many other additives on the fiber can be measured regularly and directly during the

production process to control and optimize the dosage of chemicals in the wet-end of the paper production.

Technical principle of the FPO

The surface charges of fibers, fillers, solid particles and colloidal dissolved material in suspensions are defined by the Zeta Potential of their surfaces. In stock suspensions the charge is separated into colloidal dissolved- and particle charges as well as in surface charges of fibers and fillers. Colloidal dissolved- and particle charges can be determined with the CAS Charge Analyzing System, the surface charges of fibers can be measured with the FPA Fiber Potential Analyzer respectively with the FPO directly at the paper machine. The knowledge about the fiber charges is the key for an optimal addition of chemical additives, which should be taken up by the fibers. The mostly negative (anionic) charged fibers adsorb the positive (cationic) charged additives during the paper production process. The adsorption of starch on the fibers, the effectiveness of wet strength agent and the adsorption behavior of many other chemical additives can be easily measured with the original sample. The measuring results make it possible to optimize the addition of chemicals in the wet-end area of the paper production process. The following example shows the measurement of Zeta Potential before and after a dosing point, in this case before and after the addition of cationic starch to the mixing chest:

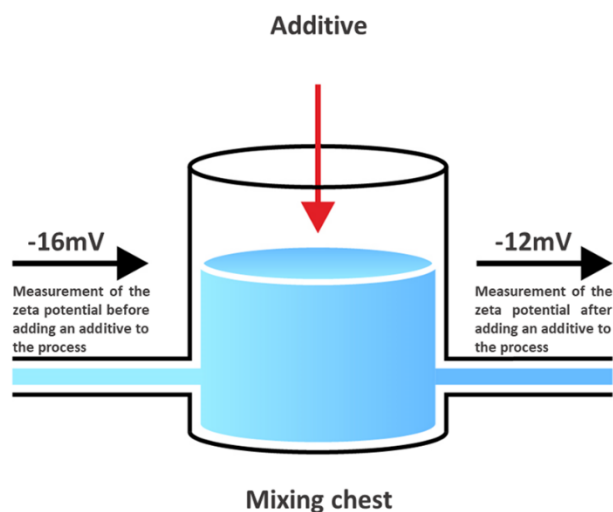


Figure 1: Example of the measurement of the Zeta Potential of fibers before and after the dosage of starch

At optimal size of the zeta potential of fibers, the cationic starch can stick to the fibers as desired. This effect is seen by the reduction of the zeta potential of -16 to -12 mV. If the zeta potential of the fibers is not optimal, there is no or only a slight difference before and after dosing, the starch could not stick on the fiber and is lost with the white water.

Measuring principle

The FPO (Online measuring device) or the FPA (laboratory measuring device) determine the Zeta Potential of fibers in suspensions in the wet-end area of paper and board machines, using the equation from Helmholtz and Smoluchowski. The sample is sucked into the suction tube by the vacuum in the measuring cell. A fiber plug develops in front of the screen electrode and is solidified during the stabilization period. For technical reasons, an oscillating electrolyte flow is generated through the fiber plug by means of a periodically changing underpressure. The counterions on the fiber surface within the plug are sheered away and generate a streaming potential, which is gathered by the electrodes. The Zeta Potential is calculated by the Helmholtz and Smoluchowski equation from the streaming potential, the conductivity, the pressure difference and a constant.

Benefits and advantages

- >> fully automatic operation: sample taking – measuring – cleaning
- >> low maintenance (maintenance interval: approx. 6 months)
- >> easy installation
- >> splash-proof because of the closed construction, stainless due to the use of highgrade steel
- >> high accuracy of measurement and reproducibility
- >> data transfer by standard interface to the process control system
- >> optional data storage on Internet server via modem:

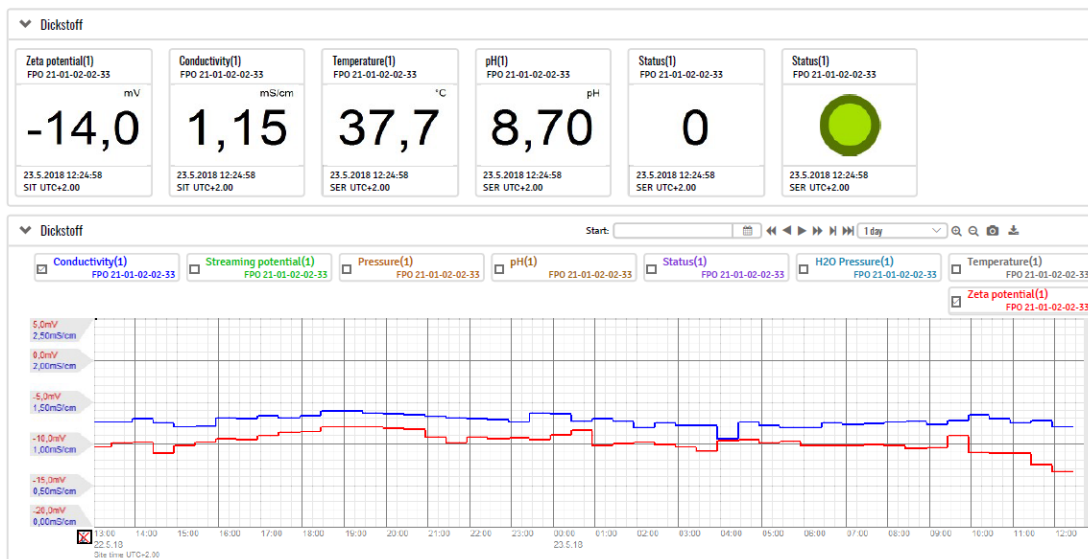


Figure 2: Online check of measuring results via Internet (Measuring point 1)

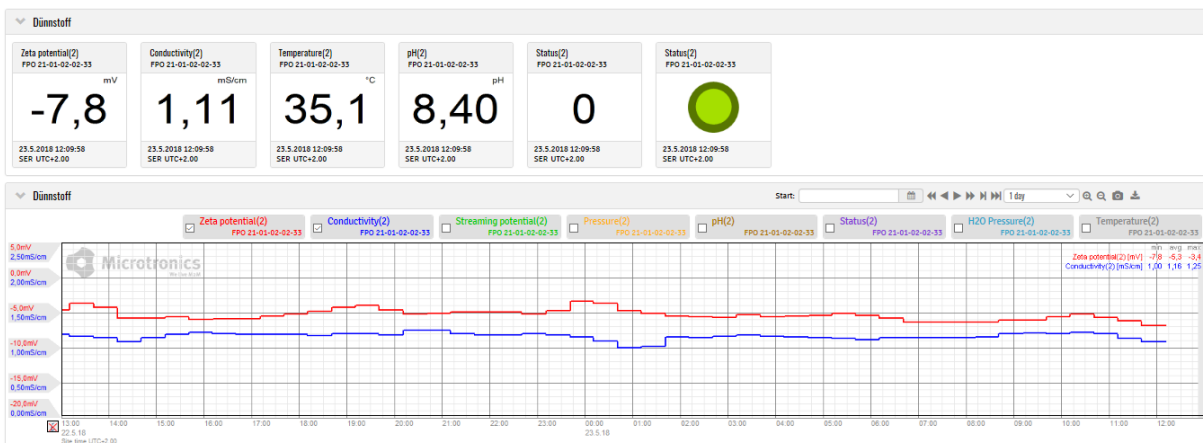


Figure 3: Online check of measuring results via Internet (Measuring point 2)

- >> device handling and display of measuring results by touch screen
- >> alert feature
- >> savings in material, time, and energy
- >> environment protection by the contribution to a better environmental balance
- >> enables process stabilization, reduction of process fluctuations by current dosage
- >> permanent control of the charge situation

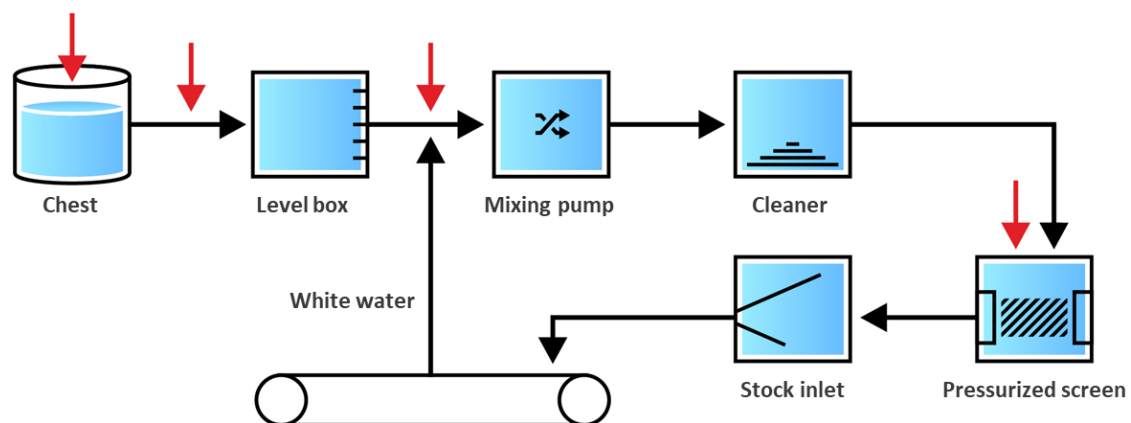
Application

The FPO gives the possibility of control and optimization of the dosage of additives during the paper production in the following (but also others):

- >> sizing agents
- >> wet strength agent / dry strength agent
- >> optical brighteners (OBA) and dyes
- >> fillers and pigments

Furthermore the control of the Zeta Potential is decisive for the assurance of:

- >> maximal retention of fines, fillers, dyes and resins
- >> optimal internal sizing for alkali and acid processes
- >> the efficient use of wet and dry strength agents
- >> the neutralization of negative effects of anionic trash, including pulp mill carryover, closure of the rear water system, recycling of coated production trash production of recycling paper and so on
- >> maximal efficiency of single process steps, including dosing of anionic trash catcher resp. fixing agents, and sludge dewatering



An example:

addition of cationic starch →

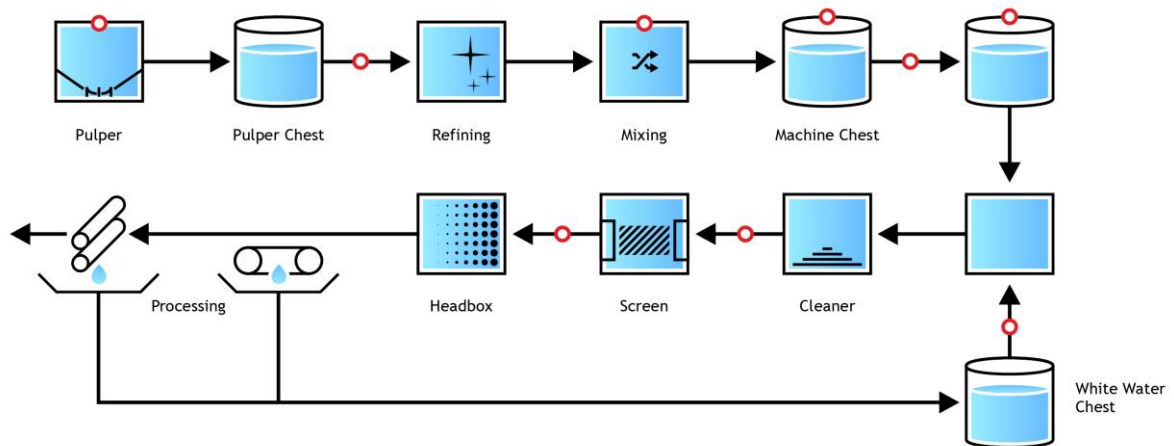
Dosing close to the chest:

- >> fixing of big amounts
- >> weaker retention effect

Dosing close to the stock inlet:

- >> fixing of only small amounts
- >> stronger retention effect

Figure 4: positions for dosing the cationic starch during the production process and its effects



Quelle: Dr. Stumm

Figure 5: application possibilities of the Fiber Zeta Potential Analyzer Online in the production process

Return on investment

Example 1

- >> 250,000 t/year board production in a paper mill
 - >> approx. 10 kg/t starch in the end-product
 - >> starch consumption 2,500 t/year = 2,500,000 kg/year
 - >> costs approx. 0.8 €/kg = 2,000,000 €/year overall costs for starch
- Saving potential approximately: 10 - 50% depending on the process conditions
= 200,000 to 1,000,000 €/year
- ROI for one FPO → approx. 1.5 – 7 months

Example 2

Consumption of wet strength agent (WSA)

- >> 250,000 t/year board production in a paper mill
- >> approx. 3 - 4 % WSA/t in the end-product
- >> WSA consumption at 3% respectively 7,500 t/year = 7,500,000 kg/year
- >> costs approx. 600 – 800 €/t WSA = 4,500,000 – 6,000,000 €/year costs for wet strength agent

Saving potential approximately: 10 – 50% depending on process conditions =
450,000 to 3,000,000 €/year

ROI for one FPO → approx. ½ month to 3 months, in the particular example.

Conclusion

If it is possible to optimize both, the dosage of starch and wet strength agent, the saving potential at 10% amounts to approx. 650,000 €, i.e., ROI after approx. 2 months!

Data output and evaluation

The display of the Fiber Zeta Potential Analyzer Online shows graphically the measuring data of the last 24 hours over the time (trend graph for zeta potential and conductivity).

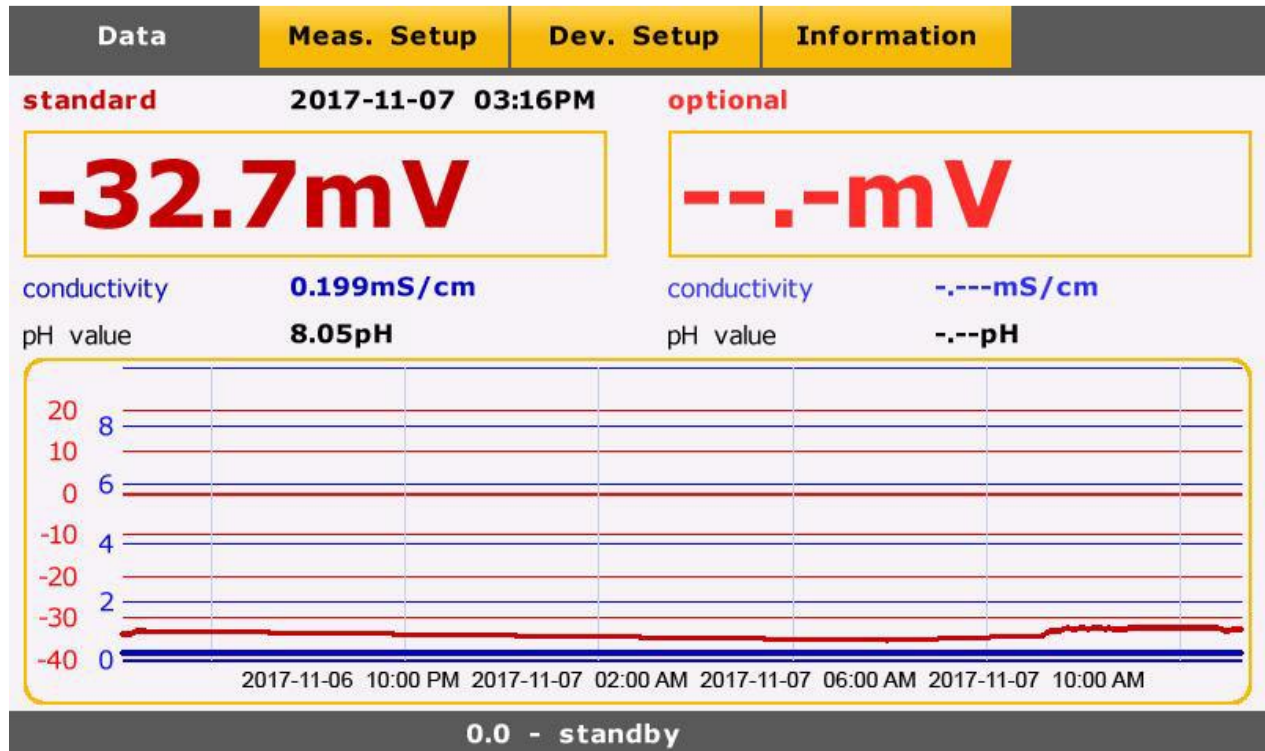


Figure 6: Display of the FPO with the measured data

Possible actual values, which can be shown on the display:

- >> conductivity
- >> streaming potential
- >> time of the last measurement
- >> pH value
- >> temperature

The export of the measuring data to an Excel-file is possible, if a PC is connected or the measuring data, which is saved on the USB flash drive, is further processed at the PC. With a modem, the data can be stored via Internet on a website and displayed. An export of the measuring data to Excel is also possible.

Technical data

Accuracy of measurement:	approx. $\pm 5\%$
Storage of measurement data:	for approx. 100.000 measurements (at least 3 years), possible to readout by USB connection with PC/Laptop also via USB flash drive, optional storage of data on Internet server (4GB)
Modem (optional):	for data transfer via Internet and display by website
Interval of measurement:	adjustable, depending on the automatic cleaning effort, maximum of 6 measurements per hour (3 per channel)
Volume of the sample:	approx. 4 liter per measurement
Consistency:	0.1% - 5 %
Required connections:	Pulp intake and outflow for each measuring point, rinse water, compressed air
Pulp:	Kamlock coupling 1 ¼ inch, plug diameter 32mm
Rinse water:	Kamlock coupling ½ inch, plug diameter 25mm
Compressed air:	coupling connector ¼ inch, nominal size 7.2mm
Rinsing water supply:	at least 2 bar, at least 5 bar for optimal cleaning
Compressed air supply:	at least 6 bar
Maintenance interval:	6 months (recommended)
Measures:	approx. 176 x 75 x 41 cm (height x width x depth) 50 cm free space (lefthand side) for connections
Weight:	approx. 160 kg
Power supply:	100 - 240 VAC (50/60 Hz) 120 W
Metrics:	Zeta Potential [mV] Streaming Potential [mV] Conductivity [mS/cm] Temperature [°C] pH value [pH]



Connections:	4-20mA for all available metrics adjustable by menu (maximum of two), CAN Interface, optional: other interfaces can be extended according to customer requirements
Optional:	Alert feature with 24V exit for relay to select external components, as a rotating light for example
Water consumption:	approx. 10 liter per cleaning process / adjustable

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