

8.2 Evaluation of the cleaning process reveal the mechanism For research purposes, the measurements do not need to be quick, easy to handle and non-invasive. Visual inspection is an off-line method and can range from ordinary photos to follow the course of cleaning, but also together with dyes for specific elements and microscopic techniques to enhance the details and resolution. Using Scanning electron microscopy (SEM) structural changes of the fouling, such as the swelling of the protein deposit, can be revealed. By monitoring and analyzing the effluent during cleaning over time, important information is obtained; such as when the protein and mineral content is released in comparison to each other and to the current parameters used for the cleaning process. UV-absorbance can be used in cleaning studies to investigate the effluent concentration of proteins [84]. The content of the mineral deposit could be obtained in using a SEM-EDX, giving the elemental composition in a certain area of the sample [111]. Following the fouling removal (and buildup) with a direct online measurement with time on a surface inside a process plant is difficult to do on an industrial scale. It is also possible to measure the protein content by measuring the chemical oxygen demand (COD) [5, 56] or the Kjeldahl method [31, 49-51]. Downsizing the equipment to a smaller pilot plant is many times used for research purposes, but still has not given the obvious methods to online and on site follow the changes of the fouling. From effluent analysis, the original composition of the fouling can be determined, but without any spatial information. Since it's common to foul the surfaces in a closed system, it is difficult to a priori visualize and determine the microstructure. The noninvasive effluent analysis are common in pilot scale cleaning studies [107]. The equipment can be dismantled and prepared at different stages and for different type of analyses. An analysis of the effluent can only tell when there is nothing left leaving the equipment, but cannot validate that the surface is clean. The above mentioned methods are the same as discussed in chapter 4 under fouling characterization.