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## Case Studies

- Transmission filter manufacturer continues to optimize technology
- Filtration at new water treatment plant in Egypt
- Preventing Legionnaires' disease by filtration
- Effluent improvements in India
- Ceramic membranes provide solution for automotive parts wastewater treatment
- PTFE membranes introduced to the U.S.
- Development in forward osmosis and zero liquid discharge
- New sludge dewaterers

## Technical Paper Abstracts

### FILTER MEDIA DESIGN AND ITS INFLUENCE ON FILTRATION RESULTS – POSSIBILITIES TO ENHANCE VACUUM AND PRESSURE FILTRATION

A. Seitz and C. Maurer (pages 44-51)

The design and characteristics of filter media, such as weave pattern, number of pores, pore shape, pore size, pore size distribution and permeability influence cake formation, cake filtration, particle retention, filter media lifetime as well as the resulting machine efficiency and productivity. In the end, the overall cost of ownership is affected.

By carrying out intensive laboratory analysis, filtration trials and scale-up testing, the influence of filter media design on the final filtration result during vacuum and pressure filtration is investigated and described in this paper. If everything is calculated and implemented thoroughly there can be a substantial contribution to achieving a higher production yield, while obtaining, or even improving, the final product quality. The paper compares the variables and performance criteria that require definition in order to select the most efficient filter media for a given application. An actual example of the guidelines used to judge filter media performance and some of the properties of enhanced future filter media is presented to conclude the paper.

Scalable Double Layer Weave (DLW) filter fabrics for different applications and requirements are presented. Laboratory and field tests illustrate how filtration results are dependent on the selection of appropriate filter media and their specific properties. Improved cake dryness and purity, better cake release, higher production capacity and, in the end, lower process costs result from new filter media design and careful selection.

### DEVELOPMENTS IN FILTER MEDIA: INCORPORATING ADDITIONAL VALUE-ADDED FEATURES

I. Chisem, D. Fogg and R.P. Lydon (pages 51-56)

As industry strives for increased levels of efficiency through rigorous process optimisation programmes, filter media suppliers must seek to add value to their products by improving product performance, lifetime, ease-of-use and maximising process up-time. Clear Edge has developed a comprehensive body of practical knowledge in solid-liquid separation together with a strong scientific understanding, using its state-of-the-art laboratories to understand the chemical and structural properties required to maximise performance. By way of illustration, two innovative filter media technologies are described herein.

It has been demonstrated that microporous coated media can improve blinding resistance, enhance throughput and improve filtrate clarity; these properties are mainly attributed to the surface filtration mechanism afforded by the microporous coating which is impregnated both onto and into the base filter media. Additional productivity gains result from increased retention efficiencies. To further enhance the value proposition, this technology can be used in combination with the elastomeric welded barrel neck product line, Coreflo™, which affords ease of cloth fitting with a leak free seal. Combining innovative solutions such as these results in tangible benefits for the customer: to demonstrate this the findings from a number of case studies are presented to prove the measurable added value of these technologies, either alone or used in combination.

## INSIGHT INTO THE STICKY PHASE OF ACTIVATED SLUDGE AND ITS IMPLICATION TO SLUDGE DEWATERING/DRYING OPERATIONS

B. Peeters and L. Vernimmen (pages 57-60)

The sticky phase of wastewater sludge poses a persistent challenge when the sludge volume is reduced in industrial dewatering-drying installations. At some intermediate dryness content, during its passage through mechanical dewatering and consecutive thermal drying, the sludge transforms into a rubbery material. This either adheres to the equipment surfaces or further agglomerates into large lumps by cohesion, thereby impeding the proper working of these unit operations. Although insight in the sticky phase of sludge is essential for smooth operations in industry, most literature pertains to research conducted in the context of sludge dewatering and drying as such, rather than to the concomitantly appearing sticky behaviour.

In this paper, we discuss the sticky phase: how it can be mapped, how its existence can be explained and how industry copes with it during daily operations. One strategy to deal with the stickiness, rigorously tested by the authors at lab- and full-scale over the past six years, is the conditioning of the sludge with polyaluminium chloride (PACl) which will be specifically highlighted.

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## Case Studies

- Porometric mesh: The pore is the key
- Improvements at water reclamation facility
- Power plant installs integrated membrane system to reduce costs and decrease energy use
- Fertiliser production: Reduced penetration increases productivity

## Technical Paper Abstracts

### CHALLENGE TESTING: PART 1 - WET TESTING - INVESTIGATING THE MEASUREMENT UNCERTAINTIES ASSOCIATED WITH DIFFERENT DEFINITIONS OF MAXIMUM PORE SIZE

G. Rideal and A. Stewart (pages 100-102)

The ‘maximum’ pore size in a sand screen, when challenged by glass microspheres, can be defined as the 97$^{th}$ percentile (the Cut Point), the 99$^{th}$ percentile or the single largest sphere passing the mesh. When analysing the microspheres by Image Analysis, this paper shows that, provided at least 1000 spherical beads (maximum size/minimum size <1.2) are analysed, the measurement uncertainty is approximately 3% for both d97 and d99. However, the uncertainty for the Maximum Penetrating Particle (MPP) went up to 17% and so cannot be recommended as a reliable parameter. Excellent agreement was found between the Ultrasonic wet test method and the Sonic dry test method.

### CHALLENGE TESTING: PART 2 - DRY TESTING - INVESTIGATING THE MEASUREMENT UNCERTAINTIES ASSOCIATED WITH DIFFERENT DEFINITIONS OF MAXIMUM PORE SIZE

G. Rideal and A. Stewart (pages 102-107)

Pre-calibrated, narrow size distribution glass microspheres were used to investigate the most appropriate measure of the ‘maximum’ pore sizes of sand screens. Using a calibration graph of weight passing versus cut point, the measurement uncertainty in a dry challenge test was only 3-4% (this compared with the inherent measurement uncertainty of 1% when the same mesh was analysed 10 times). Analysis of the beads passing three different sand screens by microscopy and image analysis confirmed that the cut point corresponded to the D97 and the measurement uncertainty remained at 3-4% up to D99, herein defined as the ‘maximum’ pore size. The uncertainty for the single largest sphere passing the mesh (D100) was too high (+/-15%) to be of any practical value and could cause confusion in the industry.

### FILTERABILITY AND CAKE COMPRESSIBILITY IN DEADEND MEMBRANE FILTRATION CONTROLLED BY CAKE FORMATION

E. Iritani and N. Katagiri (pages 108-120)

The cake properties presented as specific cake resistance and cake porosity provide essential information about the flux decline behaviour in deadend membrane filtration such as microfiltration and ultrafiltration controlled by the cake filtration mechanism. Initially, various types of constitutive equations are shown to represent local specific cake resistance and local cake porosity as functions of the solid compressive pressure. It is also shown that their average values can be analytically derived from such local values based upon the compressible cake filtration theory and vice versa.

In the filtration testing methods, the pressure dependence of the average specific cake resistance was available over wide ranges of pressure drop across the filter cake by carrying out a single constant pressure deadend filtration using a membrane with an extremely high flow resistance. Step-up pressure filtration using a filtration cell with a single stage reduction in the effective filtration area allowed us to obtain the pressure dependence not only of the average specific cake resistance but also of the average cake porosity from only one run by making use of the decrease in the cake thickness caused by the cake compression arising from stepped-pressure operation. In sedimentation testing methods such as analytical ultracentrifugation, permeability data were evaluated by measuring sedimentation velocities at various solid concentrations, and the compression data were estimated by measuring the thicknesses of sediments obtained under various rotor speeds of the test cell. These data successfully described the flux decline behaviour observed in the deadend ultrafiltration of nanocolloids.

## VOLUME 17(3)

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## Case Studies

- Conductive 2D nanosheets of boron nitride provide promising new membrane material
- Environmental monitoring stations installed in Baden-Wuerttemberg, Germany
- Membrane contactors can improve water quality

## Technical Paper Abstracts

### IMPROVEMENT IN THE MEASUREMENT OF BUBBLE POINT FOR WIRE MESH USING NUMERICAL MODELS

D. Herper (pages 164-168)

The bubble point test is a widely used measurement method in filter media quality control. The basic principle is that pores filled with liquid only become permeable for gas from a certain pressure level upwards. This pressure level is measured and then used to deduce the pore size. The problem is that the underlying correlation between pressure and pore size is only valid for cylindrical pores. To determine the size of pores with other shapes, correction factors are applied. Up to now, these have been determined empirically or simply estimated.

This paper describes a method using CFD simulations that makes it possible to determine a more accurate correction factor and thus a more precise pore size.

### INFLUENCE OF FIBRE FINENESS AND PORE SIZE OF FILTER MEDIA AND THEIR COMPARATIVE ANALYSIS ON A FLAT MEDIA TEST RIG AND INDUSTRIAL PULSE-JET FILTRATION

A.K. Choudhary and S. Dutta (pages 169-180)

The environmental issue has become a major subject in the last few decades, affecting the science and technology throughout the world due to the serious environmental impact caused by air pollution. In a study related to this area the effect of dust concentration on the performance of different filter media in terms of emissions, filtration efficiency, pressure drop and other factors was performed. The experimental programme consisted of testing filter media performance at 1000 Pa differential pressure ($\Delta P$) on a flat media test rig and also on an industrial pulse-jet filter, and their comparative performance with selecting a filter medium for real time requirements in the process industries. In the experimental work two types of polyester needle punched, water repellent finished, filter media of different deniers (i.e. 2 and 2.5) and different pore sizes (36 µm and 51 µm) were used. The filter fabrics were tested for filtration performance based on cleaning at a fixed peak pressure drop with an equal number of test cycles for the first three phases (i.e. conditioning, ageing and stabilizing) and for the measurement of filtration performance.

The results from a light scattering aerosol spectrometer system particle size analyser were also evaluated for various emission parameters. The $PM_{2.5}$ emission, efficiency, $PM_{10}$ emission, number concentration and mass concentration of particles in the downstream were found to be lower for a fine denier, smaller pore size filter fabric. The test results at a higher feed dust concentration showed greater emissions for the coarser denier and larger pore size fabric. It was found that in the case of the industrial pulse-jet filtration, the emissions and pressure drop values were higher compared to the flat media test rig.

The pressure drop behaviour, i.e. peak and residual pressure at $\Delta P$'s of 1000 Pa and 500 Pa during the filtration, were also investigated. There was less variation in the residual pressure of the smaller pore size, fine denier fabric on the test rigs.

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## Case Studies

- New closed circuit reverse osmosis module for design software
- New water treatment solution for the beverage industry
- Innovative method to remove phosphorus from wastewater
- Safety first: High-tech production of EGR filters
- Contracts announced and innovative filtration technology launched

## Technical Paper Abstracts

### ORGANIC SOLVENT NANOFILTRATION TECHNOLOGY IN FUEL PROCESSING

E.S. Tarleton and J.P. Robinson (pages 222-233)

Traditionally, membrane nanofiltration has been largely confined to aqueous applications such as the treatment of drinking water and the removal of contaminants from effluent streams. In recent years a new generation of polymeric membrane materials has been developed which can process organic streams, in particular those similar in nature to common gasoline and diesel fuels.
By utilising a system of representative model compounds, this study explores the effectiveness of organic solvent nanofiltration (OSN) for fuel treatment, and highlights the prevalent permeation and separation mechanisms when poly(dimethylsiloxane) (PDMS) membranes are used to process non-polar and polar feed streams (including the alcohols found in biofuels). It is shown that membrane performance, e.g. solvent flux and solute rejection, is governed by both molecular size and polarity. Potential methods to tailor a membrane material to a specific application via crosslinking are also discussed.

### FILTER CAKE FORMATION WITH SIMULTANEOUS FILTRATION AND SEDIMENTATION

E.S. Tarleton (pages 234-240)

Data for near incompressible cake formations with simultaneous settling are presented. Aqueous calcite suspensions exhibiting similar median particle size, but different size distributions, were filtered over a range of constant pressures. For each experiment the time dependent history of filtrate removal and the particle size distributions of cake samples at different spatial positions were measured. These data were compared with predictions from a mathematical model that divides cake formation into a range of discrete time steps. Cake growth due to filtration and sedimentation were considered to proceed simultaneously, but separately, with the additive results predicting the change in cake thickness during a time step. Account was taken of the changing effects of suspension concentration on settling rate and the transient influence of size distribution on specific cake resistance.

The model is shown to quantitatively predict the influence of feed particle size distribution on cake formation and filtrate removal rates and favourable comparisons are made with values recorded in experiments. For the experimental conditions investigated, sedimentation is shown to contribute up to one third of the cake resistance in a filtration test. At lower pressures and with wider size distributions, larger particles from the feed tended to accumulate near the filter medium and in some cases a minimum cake resistance was observed toward a mean cake height. For higher pressures, however, the effect of particle sedimentation in filtration was reduced and cakes formed with near uniform median size through the cake height.