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November/December 2009
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Antoinette DeWaal, Associate Publisher and Vice President
Ken Norberg, Editor in Chief

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Filtration News Welcomes Gregg Poppe to Editorial Advisory Board

Gregg Poppe is a global application development specialist for Dow Water and Process Solutions, a subsidiary of The Dow Chemical Company. In this role, he is responsible for identifying new or improved products and techniques to solve water treatment problems in the industrial water and power generation markets.

Mr. Poppe joined The Dow Chemical Company in 1991, and has spent most of his career in R&D or technical service, working with technologies, including reverse osmosis and nanofiltration, ion exchange, and ultrafiltration—all used in the purification of water or other aqueous streams. His experience has ranged from testing new applications for hollow-fiber microfiltration in various food processing waste streams to scaling up a new nanofiltration membrane with special rejection properties from the pilot plant to the manufacturing line. Mr. Poppe also served on special assignment to a sister-plant in Denmark in 1996, and spent more than five years providing technical service to users of ion exchange resins in sweetener plants.

Until recently, Mr. Poppe was the project manager for Dow's water treatment system design software tool, ROSA. During his six years with the program, Mr. Poppe upgraded the application making it more global to address the growing number of users in China and introduced new capabilities that allowed a designer to incorporate unique concepts such as permeate split stream and internally-staged design.

Mr. Poppe holds a degree in chemical engineering from the University of Nebraska-Lincoln, and was one of the very first Dow employees to achieve Six Sigma Black Belt certification. He is originally from Cook, Nebraska, but now resides in Prior Lake, Minnesota, with his family.

Dow Water & Process Solutions has a 50 year legacy of providing innovative water and process solutions to both communities and industries alike. A differentiated business unit of The Dow Chemical Company, Dow Water & Process Solutions offers a broad portfolio of ion exchange resins, reverse osmosis membranes, ultrafiltration membranes and electrodeionization products, with strong positions in a number of major application areas, including industrial and municipal water, industrial processes, pharmaceuticals, power, residential water and wastewater and water reuse. FN

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Lower Membrane Operating Costs by Keeping Membranes Clean

By Gregg Poppe, Application Development Specialist, Dow Water & Process Solutions

The push towards lower operating costs is ever-present and this has never been truer than in the current economic environment. One way to lower the operating cost of a reverse osmosis (RO) plant is to extend the feasible life of the membranes. When the membranes operate in an environment with potential to foul or scale, it is important to make wise and well-informed choices regarding membrane selection and maintenance.

SELECTING ADVANTAGED MEMBRANES

When it is finally time to replace the RO membrane elements, plant owners dealing with fouling waters can take advantage of the technology developments introduced by membrane manufacturers to help fight the battle. For example, there has been a growing acceptance that elements with 34-mil spacers foul less quickly and are easier to clean than those with thinner spacers.

Membrane manufacturers continue to develop new innovations around optimized spacer geometry intended to flush the membrane surface more effectively. Work is also advancing to improve the fouling-resistant properties of the spacer material or membrane surface.

All of these membrane development efforts are meant to extend the time between cleanings, the ease of cleaning and the overall lifetime of the membranes. The payoff comes back to the plant owner in the form of lower operating costs via: 1) consumption of less cleaning chemicals due to less frequent cleanings, 2) use of less electricity due to slower increases in feed pressure, and 3) lower membrane replacement costs due to longer life.

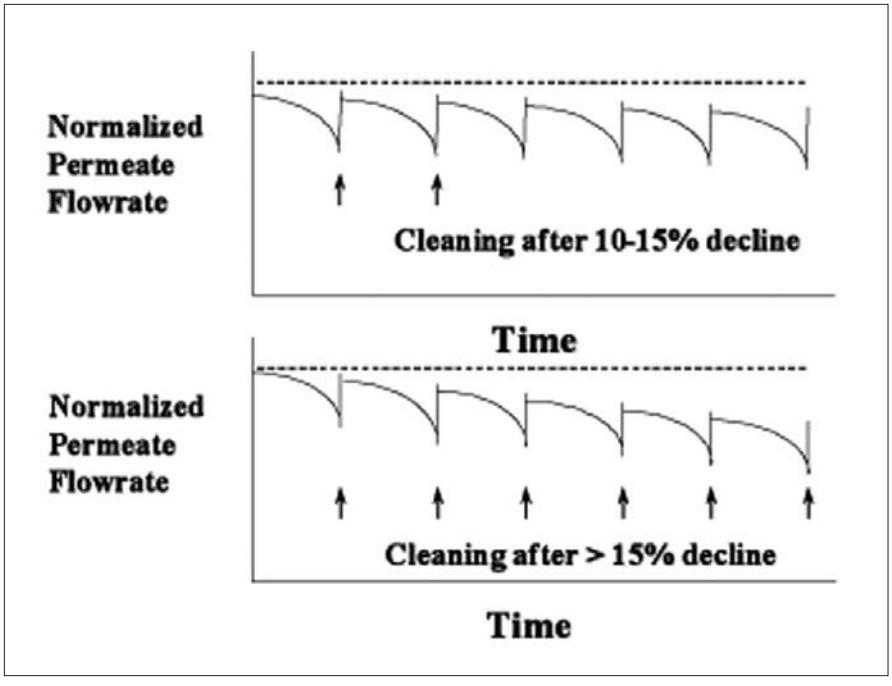

Figure 1. Comparison or RO performance resulting from waiting too long to clean.

MEMBRANES RUNNING OPTIMALLY

The technological developments being introduced by membrane manufacturers can help extend the time between cleanings, but it does not replace the need for good maintenance. There are some very helpful guidelines that can be applied to extend the productive life of the membranes and reduce overall operating costs of the RO plant:

The loss of permeate flow during operation is normal for a membrane system, so the first question is, "When to clean?" The frequency depends on the feed water source, operating parameters such as flux, and pretreatment. Commonly, systems are cleaned 2-3 times/year with well water, 3-4 times/year with city water, and 4-6 times/year with surface water. But it really depends on the specific situation, so it is important to be vigilant and look for signs of fouling. Any of the following observations should trigger a cleaning:

- Normalized permeate flow declines by 10-15%
- Normalized feed pressure increases by 10-15%
- Pressure drop increases by 10-15%
- Normalized salt passage increases by 5-10%

To make proper judgments, it is absolutely necessary to normalize the permeate flow, feed pressure, and salt passage to a standard reference point. Otherwise, fluctuations in feed temperature, salinity, or pressure will either mask or accentuate the trends, leading to inaccurate conclusions about when it is time to clean.

Figure 1 illustrates the consequence of waiting too long to clean. The

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A fouled membrane

foulants can usually be cleaned from the membrane surface with the right cleaning chemicals and good technique, but waiting too long can permanently reduce RO performance.

CLEANING CONDITIONS

Before cleaning, determine the type and location of the fouling. Organic and microbiological fouling can occur in either the first or second stage of the system. Colloidal fouling is specific to the first stage. Scaling appears in the second stage. Also identify the pH and temperature limits of the membranes being cleaned and make sure the cleaning chemicals are compatible.

Clean with alkaline cleaners first and then, if necessary, with acid. High pH cleaners are more likely to break down fouling layers. Acid may react with organics, silica, and biofouling, possibly leading to irreversible performance decline; therefore, it is recommended to remove these foulants first with an alkaline cleaner.

Clean at the appropriate pH and temperature to remove the foulants.

To remove biofouling, cleaning at pH 12 is much more effective than pH 11–about an order of magnitude better at restoring permeate flow. It is important to know the temperature range that is permissible for the membrane type at the high pH.

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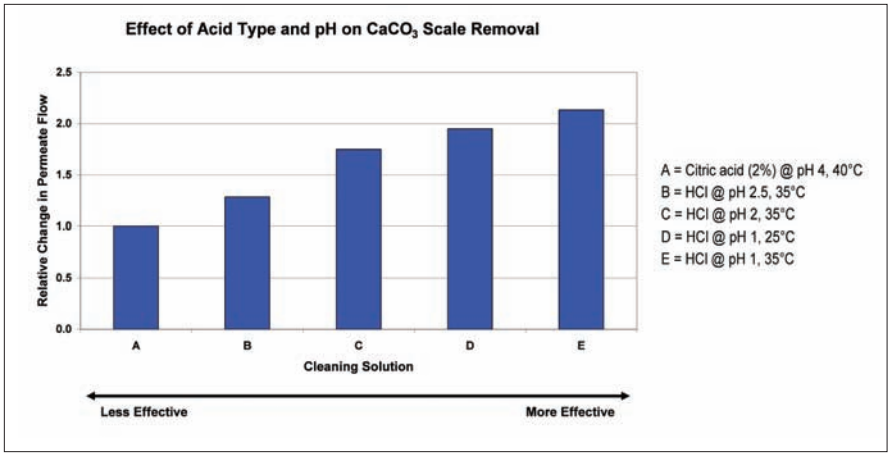

Figure 2. Relative performance of acid cleaners

permeate flow is restored more fully at lower pH and higher temperature, as shown in Figure 2. Some plants try to use citric acid (Cleaner A) to remove scale, but it is usually not very effective in comparison to HCl @ pH 1 (Cleaners D and E).

Higher/lower pH is more effective at removing foulants, but be cautious. Not all membrane manufacturers allow cleaning as high as pH 12 or as low as pH 1. It is important to determine the limits before cleaning.

Different foulants require different cleaning protocols to achieve effective results. As an aide, the following guidelines can be used. But first make sure that the pH and temperature limits are within the membrane manufacturer's allowance.

- Inorganic salts (such as $CaCO_3$): 0.2% (by wt.) HCl, 25-40°C, and pH 1-2
- Metal oxide (such as iron): 1.0% (by wt.) sodium hydrosulfite ($Na2S2O_4$), 25°C, and pH 5
- Inorganic colloids (silt), silica, biofilms, and organic compound: 0.1% (by wt.) NaOH, 35°C max, and pH 12 OR 0.1% (by wt.) NaOH and 0.025% (by wt.) Na-DSS, 35°C max, and pH 12

EFFECTIVE CLEANING PROTOCOL

The procedure used to clean is also important. When mixing the cleaning solution, ensure that all the chemicals are dissolved and well mixed before circulating it through the membrane elements. When the cleaning solution is

first introduced to the RO system, use a low flow rate while the water in the system is displaced. Also, use only enough pressure to compensate for the pressure drop to avoid driving foulants into the membrane surface. Dump the concentrate stream at first for as long as it is necessary to prevent diluting the cleaning solution upon recycle.

Once the cleaning chemicals have displaced the water, recycle the concentrate and permeate to the cleaning solution tank. Measure the pH and adjust as needed to maintain the desired pH. Monitor the color of the cleaning solution. A color change indicates that foulants are being removed. Then dispose of the heavily contaminated cleaning solution and mix fresh solution. Continue this for as long as it appears new foulants are being removed, but with an acid cleaning, recirculating for longer than 20-30 minutes increases the risk of any heavy metals falling out of suspension and becoming permanently embedded on the surface of the membrane, making it more difficult to clean.

Fresh cleaning solution should be prepared for the soaking step. The length of the soak is variable. While alkaline cleanings may require an overnight soak, acid cleanings typically only require a 30-minute soak. To maintain the desired elevated temperature during an extended soak, use a slow recirculation rate through the elements. As before, monitor the color of the cleaning solution and dispose or refresh the solution when a color change is observed.

After the soak, recirculate the cleaning solution at a high flow rate to flush out foulants removed from the membrane surface for 30-60 minutes. Finally, flush out the cleaning solution using RO permeate or de-ionized water. During the flush, the minimum temperature should be 20°C.

SUMMARY

Operating and maintenance budgets are under constant pressure, but timely and proper membrane maintenance is necessary to ultimately achieve the lowest operating costs.

Monitor the condition of the plant, normalize the data and clean according to the provided signals so that the performance of the membranes is not irreversibly reduced.

Do the required homework to determine the type of fouling and its location so the proper cleaning chemical can be used. Cleaning with higher and lower pH is much more effective, but always check first with the membrane manufacturer's literature to determine the allowable pH range for cleaning.

Waiting too long to clean will lead to shorter membrane life and even more money will be spent replacing the membranes than would have been required to keep them healthy.

Mr. Poppe is a global application development specialist at Dow Water & Process Solutions, focusing on the industrial water and power generation markets.

For more information contact:
Gregg Poppe
Tel: 1- 952- 897-4317
Email: poppeg@dow.com
Website: www.dow.com/liquidseps

Sonobond Ultrasonics Plays Vital Role Controlling Pollution, Improving Water Quality

By Melissa Alleman, Vice-President, Sonobond Ultrasonics, Inc.

JL Filtration of Nisku, Alberta, relies on Sonobond technology to produce the single-layered filters it uses for environmentally safe, in-field inspection of oil pipelines. Filtration quality is essential in assuring that the water used by JL Filtration for in-field testing is carefully cleaned before being returned to the environment.

JL Filtration, Nisku, Alberta, Canada, is a division of Clean Harbors, Inc., one of North America's leading providers of environmental, energy, and industrial services. The company has been a leading supplier of field-based effluent filtering and treating services for over 20 years. According to Ron Brown, Sales/Purchasing Manager at Clean Harbors/JL Filtration, the company relies on two Sonobond ultrasonic bonding units in the manufacture of single-layered filter bags it uses for filtration of oil, gas, amines, glycol and water. These units - the RingMaster™ Filter Bag Machine and the PlungeBonder™ - have been used by the company since 2005.

"Our in-field pipeline operation involves isolating a section of the line and then performing a pressure test to ensure no leaks. After the test, the water must be filtered back into the environment. This is done by passing it through a series of multi-layered filter bags and a carbon bed system. In most cases, the water is filtered down to a 1-micron level, so filtration quality and integrity are absolutely critical. On occasion, where high efficiency filtration is not required, the company JL Filtration is working for, will ask for single layer filter bags to be used in this process and the job will be performed using the filters we produce using Sonobond technology, said Mr. Brown.

"They have proven to be extremely reliable. Sonobond's equipment plays an important role in helping us provide

The innovative, award-winning RingMaster Filter Bag Machine is one of the two Sonobond units used by JL Filtration to manufacture its single-layered filters.

PlungeBonder welding the end of a filter bag.

JL Filtration uses Sonobond Ultrasonics' PlungeBonder to seal the ends of filter bags.

a responsible, environmentally safe operation. In addition to this application, we also provide filtration bags to other industries, such as hospitals and cooling plants. JL Filtration customers are very satisfied with the quality of the filters produced using Sonobond equipment, as demonstrated by our repeat sales," he added.

SONOBOND RINGMASTER FILTER BAG

The Sonobond RingMaster used by JL Filtration is a highly efficient ultrasonic bonder developed for manufacturers of bag filters used in a variety of chemical and industrial liquid applications. The International Association of the Nonwovens Fabrics Industry (INDA) presented the RingMaster - the first machine of its kind - with the IDEA Equipment Achievement Award in 2004.

This Sonobond technology bonds nonwoven filter media to rigid plastic collars in a two-step process that is completed in less than 10 seconds. Ultrasonic bonding channels high-frequency vibrations, via a welding head, at the interface of the plastic part and felted filter media. The vibrations create a rapid heat buildup, causing the synthetic materials to melt and fuse. This results in a strong, dependable ultrasonic bond that is achieved without consumables such as adhesives or thread. As a result, the need for drying time is eliminated, and there are no stitching perforations. Customized tooling is available to accommodate various bag sizes and ring diameters.

THREE WELDING HEADS

The RingMaster Filter Bag System is designed with three welding modules that are spaced 120º apart around a center fixture. The operator manually loads the plastic ring and filter bag onto the fixture and then activates the start buttons. The three welding heads close on the part, weld, and retract. In this first step, each head welds 1/6 of the circle. The center fixture then rotates 60º and the heads close in again, welding the remaining bag segments. This two-step process produces a complete 360º weld between the bag and the plastic ring. The system can produce up to 250 bags per hour.

ULTRASONIC PLUNGEBONDER™

The other ultrasonic bonding unit used by JL Filtration is the Sonobond 3,000-watt SureWeld 20 PlungeBonder. This versatile and powerful machine seals large, multi-layer and difficult-to-bond materials. It is ideal for sealing box-style filters and various plastic assemblies. JL Filtration uses this machine to seal its filter bag ends.

The PlungeBonder consists of a rugged welding press and a heavy-duty 1,000- to 3,000-watt power supply. The unit's high power output enables it to achieve superior repeatable performance. It also has a built-in leveling feature in the base with "T" slot and toe clamps for fixture holding. Shims are no longer needed to level the nest.

STRONG TECHNICAL BACKUP

Ron Brown added that JL Filtration has been pleased by Sonobond's willingness to customize its equipment to match the company's specific requirements.

"The Sonobond team worked with us before, during, and after installation of their units. We also found their equipment to be easy to operate with only minimal training. In addition, Sonobond provides strong technical support and solid customer service so our relationship has been very satisfactory in every respect," he said.

For more information contact:

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Adding Filtration Systems to Existing Coolant Reservoirs

By James J. Joseph, Joseph Marketing, Williamsburg, VA

Figure 1: Transporter Evacuating Large Sump Courtesy of Cecor, Verona, WI

This article is the third of three parts offering ideas adding filtration systems to existing coolant reservoirs, without investing large sums of money in order to save on the costs of coolant disposal. The three techniques are:

1. A sidearm coolant cleaning device to an existing reservoir with no filtration; published in the July/ August 2009 issue.
2. A coolant "polishing" device to improve the clarity of an existing filtration system; published in the September/October 2009 issue.
3. An off-line coolant recovery system for batches removed from individual machines.

As stated in the earlier articles, each of these techniques is possible with a minimum investment and the potential of "quicker" payback by reducing the number of coolant dumps and disposal. The first two scenarios discussed the addition of filtration directly to an existing online system. This third concept deals with the facility, which has a number of machine tools each with its own, small sump where no filtration (or a minimal filter) exists and revamping the layout is impractical. The reduction of disposal costs is the main factor in this program. The machines will still be "dumped" but the coolant is not discarded; it is recovered and reused. The technique to save the fluid must be economically justified where the volume of coolant lost is reduced so there is a net cost saving.

OFF-LINE RECOVERY FILTRATION MODULE

This is a form of sidearm filtration, but the cleaning function is accomplished off-line. It is a remove and repair maintenance mode.

Dirty coolant can be drawn from the sump with a dirty coolant transporter, similar to Figure 1. The sump is suctioned to be as clean as possible and recovered/clean coolant from a second, clean coolant transporter is pumped back in. A separate clean liquid transporter is desirable to keep the two liquids from intermingling in the same tank. Figure 2 shows a smaller unit evacuating a shallow sump. The suction of the dirty coolant transporter usually adequately cleans the sump for most batch cycles. However, there may be a need to thoroughly clean the sump manually at some frequency, depending upon the extent of accumulation of solids and sludge, which clings to the walls of the sump. A good detergent coolant will minimize the need. Of course, large chips for most machining operations are intercepted before the coolant drops into the sump. Most machines are built with chip conveyers so the large material does not reach the sump, otherwise, suction cleaning would be difficult. Some dirty liquid transport carts have a bag or screen basket to intercept the larger material before it is collected in the holding tank. Here, bag filters may not be practical because they would blind quickly. Since the liquid is going to be cleaned at the recovery unit, the only need to strain the chips is to prevent jamming the suction tank's piping or accumulating in the body of the tank.

DETERMINE THE BUDGET RANGE

The first step is to see if the money spent for disposing of dirty coolant can be used to install a remote recovery operation. The recovered fluid would be continually reused so the volume of disposed coolants would be much lower and the savings could be used for the equipment investment. There will be advantages in tool life, machine maintenance and lower scrap, but these items can only be estimated at the beginning. These rewards could be significant and will be measurable by studying trends after the recovery unit is operating.

When looking at the equipment needed to implement this option, such as purchasing two transporters and installing and operating the recovery module, it is obvious that the volumes of coolant must be such to justify the expenditure. This does

not mean the concept is only good for a large number of machines. A small number of machines may justify the use of a small recovery module. Or, small sumps may not need the more sophisticated transporter. Figure 3 reveals one of many designs of simple transporters. The key is to convert the volumes of coolant lost into potential dollars saved and then see what kind of equipment could be used to fit the need and show an acceptable economic justification. If the justification is not reachable, then routine dumping can continue because it is the least expensive.

Figure 2: Shallow Sump Evacuation
Courtesy of Cecor, Verona, WI

Since the majority of the costs are for disposing and replenishment, knowing their costs should yield a general idea of the money involved. The calculations can be simple for a given system: for example, a typical metalworking operation, using the same coolant on 20 machine tools, each with a 200-gallon sump and no filtration, dumps each sump every 6 weeks. The annual expenditure for legitimate disposal calculates to $42,240.00. The typical inputs include: coolant disposal cost of $1.00 per gallon, new coolant concentrate at $8.00 per gallon, and the mixed coolant concentration at 4 percent. Labor savings will not be a factor since time will be spent to remove and replace the fluids.

If a company can accept a two-year payback, then it has about $84,480.00 with which to work. If the return has to be in one year because of economic conditions, $42,240.00 is the budget. In either case, it is realistic to see if a remote recovery module can be installed with the funds saved.

REMOTE RECOVERY OPTIONS

Sizing a remote recovery unit depends upon the volume of coolant to be

Figure 3: Small Transporter
Courtsey of Cecor, Verona, WI

cleaned and the time needed for batch changing. The unit must provide clean batches in a reasonable time so the operators can maintain an effective exchange cycle. Also, it is important to pull batches before they are so dirty that recovery cycle would take longer. For example, the old 6-week dump cycle can have batch changes every 4 weeks. The machine is operating with cleaner liquid and the recovery unit is not shocked with an extremely dirty load at one time. If the plant, which has 20 machines each with 200 gallons and has scheduled a batch change of one machine a day – the 20 days would give about 4 weeks between changes. The module would need to clean at least 200 gallons per day. Over an eight hour period the module flow would be less than one gallon per minute. Over 24 hours the one GPM flow rate would clean 1,440 gallons. For the aggressive schedule of changing eight machines in one shift (an hour per machine) the module would have to produce 200 gallons in one hour or about 3.5 gallons per minute. These are not costly units. Also, the practical point for this is that it is better to operate the unit all the time to keep the coolant free of anaerobic bacteria. The tank volumes in the module would have to be sized to hold the capacity of the daily dumps and cover an emergency situation. It would be ideal for the 20 machines to have a module hold 4,000 gallons, which would be 2,000 clean and 2,000 dirty. However this may not be possible due to space and budget limits. Experience has shown that the volume can be altered to fit the space and needs of the system but should try to be at least half the total volume in the machines or 2,000 gallons. The variable would be the batch change frequency, which has a great deal of flexibility.

CLEANING DEVICES

The recovery units could be any cleaning mechanism, including filters and centrifuges. However, filters are used more often because they have a greater flexibility to cope with the variables and surges in contaminated fluids. Centrifuges can be added to keep

tramp oil in control. Selection and sizing of the device must consider the manufacturers guidelines for the application or benchmarks established with similar installations.

Figure 4 shows a typical schematic of the transfers between the machines' sumps and recovery module. The recovery unit is depicted as a full flow system with a clean and dirty tank. It should be capable of running all the time between batch-transfers to constantly turnover the volume and reap the benefits of polishing and aeration.

The transporters should be cleaned and free of coolant if they are going to be idle for an extended time. The coolant supplier can give some advice on the timing before problems develop with idle wet tanks, particularly, the dirty liquid unit.

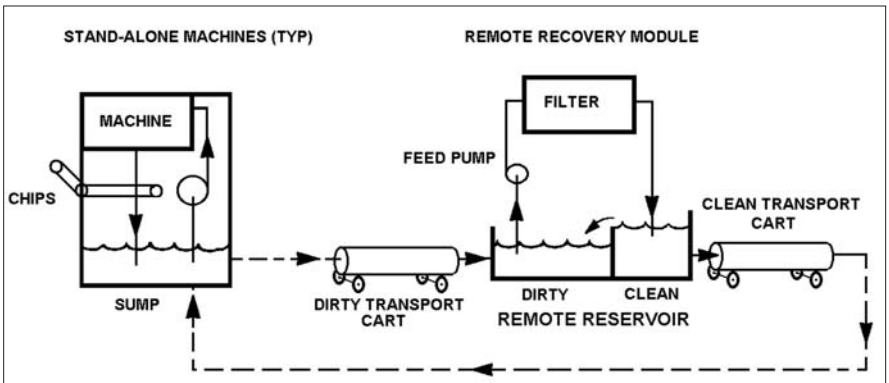

FIGURE 4: REMOTE RECOVERY MODULE SERVING A NUMBER OF MACHINES

FOLLOW THROUGH

This cursory review offers a general guide on using recovery modules. Once the range of economics is established, the concept should be reviewed by all involved and by outside resources if more know-how on filtration options is needed.

Here are just a few of the fundamental questions which should be asked for follow through.

What is the practical timing for pulling batches for the machines?

Will there be chemical dosing required for maintaining needed additives?

What is the best turnover rate through the recovery unit?

What volume should the recovery tanks hold for routine changes and the occasional emergency machine dump? FN

This article was submitted for publication courtesy and with permission of the author and liquid filtration consultant James J. Joseph who has also written a book "Coolant Filtration 2nd Edition, Additional Technologies." It is available from the company.

For more information contact:
Joseph Marketing, 120 Richmond Hill Court, Williamsburg, Virginia, 23185 USA
Tel/Fax: 1-757-565-1549
Email: josephmarketing@verizon.net
Mr. Joseph is a member of the Filtration News Editorial Board.

Submerged Membrane Bioreactor

The Advantage of MBR Technology

By Christophe Kullmann, Business Development Manager Submerged Membranes

Submerged membrane bioreactor (MBR) technology continues to experience rapid growth. During the past decade, MBR systems have been installed in thousands of municipal wastewater treatment plants (WWTP) of all sizes, and have serviced a wide variety of challenging industrial wastewater applications, including those found in paper mills, breweries, food processors, chemical plants and textile manufacturers.

MBR technology offers two main advantages over conventional biological wastewater treatment: significantly improved effluent quality, and a substantially smaller WWTP footprint. The difference is easy to visualize. As shown in Figure 1, conventional WWTP is a serial process consisting of three sequential steps. The pretreatment step involves screening out coarse materials. In the biological treatment step, bacteria are utilized to remove organic material in addition to nutrients such as nitrogen and phosphorus. The clarifier is used in the final step, where gravity sedimentation separates the treated liq-

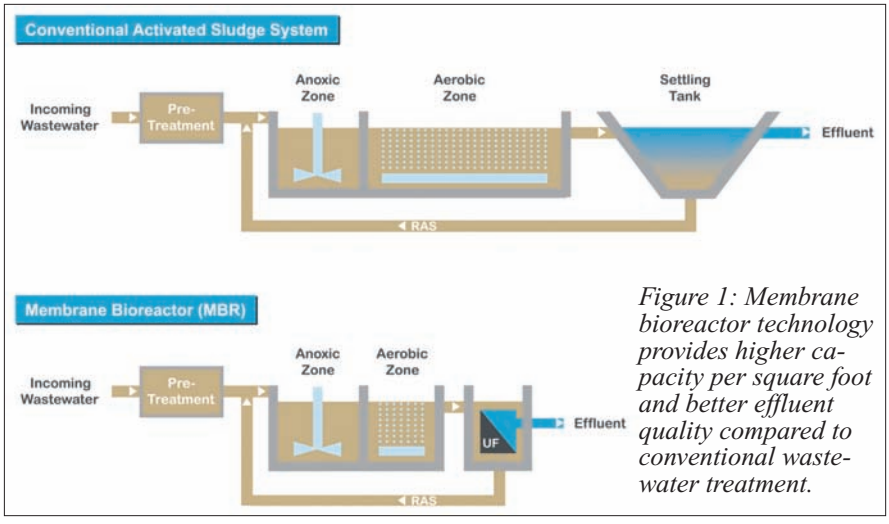

Figure 1: Membrane bioreactor technology provides higher capacity per square foot and better effluent quality compared to conventional wastewater treatment.

uid from the solids. Sedimentation often does not completely remove microorganisms and suspended solids. Typically, the discharge from a conventional plant will contain 10,000 to 100,000 microbes per milliliter even after the sedimentation process.

MBR technology improves on conventional wastewater treatment technology by using membranes to separate the biologically treated water from the solids. The membrane barrier eliminates the need for a secondary clarifier and allows the activated sludge to be more highly concentrated as the MBR is not dependent on gravity for liquid-solid separation. Unlike secondary clarifiers, which typically limit the mixed liquor suspended solids (MLSS) concentration to 2,000 - 3,000 mg/L, an MBR commonly utilizes a MLSS concentration of 10,000-12,000 mg/L. The higher MLSS concentration in the MBR allows for a reduced bioreactor volume that saves space and money. The plant footprint can be reduced by as much as 50 percent compared to a conventional WWTP. Alternatively, existing conventional plants can be retrofitted with MBR technology, thereby doubling capacity within the same plant footprint.

MBR systems significantly improve effluent quality because the membrane acts as a physical barrier to microorganisms. Membranes remove bacteria and suspended solids to produce a low turbidity treatment plant effluent with very low bacteria counts.

The higher quality effluent provides opportunities for water reuse. With MBR, treatment plant effluent can be used for a wide range of non-potable applications. When used in conjunction with reverse osmosis (RO), the MBR system also enables indirect potable reuse.

Parameter	MBR	Conventional
Solids mg/L	<1	10-15
COD mg/L	<30	40-50
P_{total} with precipitation mg/L	<0.1	0.8-1.0
MLSS content in aeration tank g/L	<20	<5

Table 1: Typical Municipal WWTP Effluent Quality

MBR TECHNOLOGY ADVANCES

The history of membrane bioreactors follows a typical pattern of technology evolution. The idea of coupling an activated sludge bioreactor with an external membrane separation system dates back to the mid-1960s. When the concept of submerging membranes into the bioreactor was first conceived in the late 1980s and early 1990s, independent teams in Japan and North America experimented with different membrane designs, notably hollow fibers and flat sheet panels. Since then, MBR products have evolved to a second generation. PURON™ submerged membrane technology from Koch Membrane Systems, Inc., (KMS) of Wilmington, MA, is a second-generation MBR system that employs hollow fiber membranes. Unlike the first

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The versatility of the technology means that labels can monitor time from just a few minutes to over a year and at different temperature ranges too: products are available for ambient, chilled and freezer environments. Timestrip's patented technology has produced a range of products that are inexpensive, versatile and present an excellent value proposition. In the filtration market, FilterChange™ will pay for itself many times over by providing even a small increase in filter replacement compliance (typically it will do much more).

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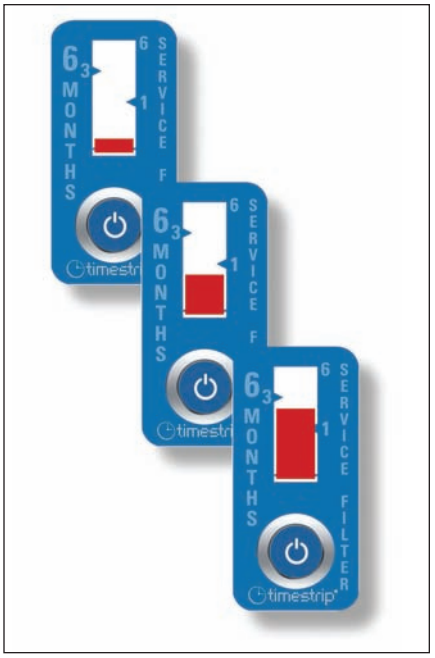

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generation "double header" design of hollow fiber MBR modules that encased the ends of the hollow fibers in epoxy at the top and the bottom, the PURON module has no top header that can trap hair and other debris and cause clogging of the hollow fibers. Instead, the tips of the PURON hollow fiber membranes are individually sealed and move freely in the water with a seaweed-like motion. Another advantage of the PURON design is the introduction of air at the center of the fiber bundle. This allows the air to reach all of the membrane fibers within the bundle, effectively scouring each fiber. Low-pressure compressed air creates coarse bubbles that shake the membrane fibers and effectively scours their entire length, removing accumulated debris.

The robust, reinforced second generation hollow fibers are cast on an internal reinforcing braid to overcome the fiber breakage problems typical of first generation systems that utilize non-reinforced fibers. The free-floating tips of the hollow fibers in the single-header design also reduce breakage by placing less mechanical stress on the fibers compared to double header designs.

Unlike flat sheet membranes and some non-reinforced hollow fibers that do not support a backflushing sequence, the PURON membranes resist fouling and maintain flux by introducing a small portion of the filtrate back through the fiber pores from the inside to the outside at timed intervals. PURON hollow fibers provide significantly higher membrane surface area, and therefore, higher filtration capacity within the same module footprint compared to flat sheet membrane designs.

PIONEERING WASTEWATER SYSTEM

The pioneering municipal water reuse system in the mountain community of Cloudcroft, NM, utilizes a second-generation MBR system. Faced with a drought that necessitated trucking in 20,000 gallons of water up the mountain each day during the peak summer tourism season, the new system helps 1,000 local residents overcome concerns about recycling wastewater for indirect potable reuse. The system employs a PURON membrane bioreactor and an RO system to treat wastewater, which is used to supplement the raw water source of spring and well water.

The project involved the conversion of the existing WWTP to a MBR process that utilized four PURON membrane modules. The MBR was designed for an average flow of 100,000 gallons per day (GPD), with room for expansion to an additional 100,000 GPD. MBR systems produce a high quality effluent with a turbidity typi-

Puron modules

Submerged modules

cally less than 0.2 NTU and less than 1.0 mg/L TSS.

Each day, 100,000 gallons typically flow downhill approximately 2.5 miles to the water treatment facility, which houses the RO desalination system. The force of gravity produces approximately 175 psi of residual pressure at the terminus of the 4-inch waterline – the pressure required to operate the RO system.

The RO system is a single train, three-stage, one-pass system with five pressure vessels set up in a 2:2:1 array, containing Magnum® 8822HR spiral wound membranes, also from KMS. The recycled water combines with well and spring water, constituting no more than 50 percent of the blended water

that is further treated at the water treatment plant using ultrafiltration membranes, granular activated carbon and sodium hypochlorite disinfection prior to entering the municipal water distribution system.

DIFFICULT-TO-TREAT WASTEWATER

Second generation MBR systems also service a wide variety of challenging industrial wastewater treatment applications. For example, the new water recycling plant at Joe White Maltings Pty. Ltd., Perth, Australia, turns plant wastewater into a stream of purified water that exceeds the quality of the municipal drinking water system. The compact, integrated system is the country's largest industrial MBR/RO water reuse facility.

Australia is currently suffering from critical water shortages. The Joe White Maltings recycling system serves as a model for industrial reuse, which is a critical component of Western Australia Water Corporation's "Security through Diversity" strategy – an integrated resource management program that also includes catchment management, usage restrictions, and a recently completed 40 MGD seawater desalination plant powered by wind turbines.

Malt is a critical ingredient in beer brewing, and Joe White Maltings has benefited from strong demand from domestic and international breweries. To capitalize on this demand, Joe White Maltings expanded its Perth plant last year, making it the largest malting facility in the Southern hemisphere. The plant needed to increase malt production by 120 percent without increasing the demand on the municipal water and sewer systems and to produce water for reuse of a quality equal to, or better than, Australian Drinking Water Guidelines.

The malting process is very water intensive. The high volume of liquor waste from the steeping process is difficult to treat because oxidizable chemicals and biological compounds are at significantly higher concentration than in domestic sewage. The total wastewater stream produced by the Perth plant contains COD of 3500 mg/L, BOD of 2000 mg/L and suspended solids of 350 mg/L.

The Joe White Maltings plant now incorporates a total of eight PURON membrane modules, each with 588 square meters of active membrane area (total area 4,704 square meters). The modules are arranged in groups of four and placed into two process streams.

For the RO system, the plant also turned to KMS, because its MegaMagnum® Ultra Low Pressure (ULP) spiral reverse osmosis elements are the largest available and help achieve a smaller footprint and a more simple skid arrangement. Each 18-inch diameter and 61-inch long element contains more than 2,800 square feet of membrane surface area, compared to 400 square feet in commonly deployed 8" x 40" products. The 15-element MegaMagnum system

occupies 50 percent of the footprint that would have been required by other RO systems with comparable capacity.

THE FUTURE

The adoption of MBR technology will continue to expand, driven by two main advantages – significantly improved effluent quality and a substantially higher capacity per square foot. These advantages will only become more critical over time, as the world responds to increasing demand for scarcer water resources and growing concerns about the environmental impact of wastewater discharge. FN

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Monitoring Granular Activated Carbon Drinking Water Filters

By Henry Nowicki, George Nowicki, Wayne Schuliger, Robert Roodman and Barbara Sherman

More likely than not, most drinking water has been filtered with activated carbon (AC). Municipal drinking water plants are mandated by the United States EPA to purify drinking water supplies in major cities with activated carbon filters. Domestic point-of-use (POU) and point-of-entry (POE) devices rely on activated carbon adsorption. The pour-thru-pitcher, in-line filter on your kitchen faucet or refrigerator cold water or ice cube maker are becoming standard applications for AC purification. Point-of-entry (POE) activated carbon units can protect the whole facility water supply, like restaurants or recreational vehicles. All of these applications use activated carbon, which is the best available technology (BAT) to purify drinking water. These activated carbon filters need to be periodically monitored to validate their performance. Activated carbon does not last forever. It needs to be changed out when it becomes used. Following is a low cost and easy monitoring tool dubbed the AC Tester.

WHAT IS ACTIVATED CARBON?

Activated carbon is a crude form of graphite, randomly oriented graphitic platelets (1). In the drinking water application coconut shells and bituminous coal are the major raw source materials to manufacture AC. These starting materials are carbonized (increase the materials percent carbon) and activated (develop a porous and microporous structure) to develop a surface area of 800-1200 m2/g. This exceptionally high surface area is responsible for its physical adsorption performance: toxic, taste, and odor removal from water supplies and air streams.

ADSORPTION SPACES IN GAC

The starting GAC in AC applications have nanometer sized adsorption spaces called micro-pores. These 1-3 nanome-

ter (nm) spaced graphitic platelets provide the strongest adsorptive forces to remove trace soluble contaminants from water. Classically activated carbon pores have been divided into micro-pores, meso-pores and macro-pores. Dr. Mick Greenbank has simplified the classical distribution of pores into adsorption and transport, which is functional, descriptive and easier to understand (2).

WATER TREATMENT WITH GAC

Water treatment with granular activated carbon (GAC) is done by passing the water to be purified through fixed-bed adsorbers containing GAC. In municipal plants these beds are typically 3 feet deep, but can go up to 7 feet. Historically, sand was used in these water filters to remove suspended solids. Today most have GAC, which provides trace dissolved organics adsorption in addition to filtration of dissolved solids and thus has replaced sand or anthracite in these filters. Many plants still leave a couple of inches of sand or anthracite to put the GAC on top. Under the adsorber bed media is the underdrain system, which takes the finished water to the distribution system. Typically after GAC treatment disinfectants are added. This is done to minimize the formation of disinfectant by-products and provide microbiological control to the consumers water tap.

Drinking water plants copiously wash the GAC before putting it into services (3) using the American Water Works Association (AWWA) guidelines. AWWA provides much of the leadership for drinking water plants operations (3). The GAC preliminary water washings remove fine dust and floaters and stratify the bed. This is done by backwashing the bed to suspend the GAC particles. When the backwash valve is slowly closed the larger particles sink the fastest and the smaller particles are located at the top of the stratified bed.

Backwashing is an important process parameter to remove GAC filtered particles from the influent. Since these GAC units flow on gravity, removing the accumulated fine particulate matter keeps them flowing and avoids development of head pressure. Many GAC filter systems have automatic backwashing. As the name implies, the GAC filter is raised by directing water up through the underdrain. The stratified bed is raised about 50% to float away the low-density fine particulates filtered out by GAC. This dislodged filtered material is taken away in a trough above the stationary filter bed, when the water is raised above the take away troughs.

It is important to let the backwashed GAC particles settle slowly. This allows the larger and heavier GAC particles to return to the bottom of the bed and the smallest lightest particles to remain at the top when the bed is put back into service. Returning the bed to its proper original stratification maintains the mass transfer zone (MTZ), the region in which the concentration of the adsorbate(s) in the water decreases from influent concentration to the lowest detectable concentration. Obviously if the operator closes the backwash valve too quickly, the smaller particles (which have the most adsorbate) will end up distributed in the bed. GAC particles equilibrate with the sur-

Table 1

AC Tester Heat-of-Immersion (HOI) and Apparent Densities As a Function of Bed Depth Composite Samples

Bed 1	Apparent Density (g/cc)		
	Received	Dry	HOI °C
Top 1-4 inch	0.621	0.493	3.5
5-8	0.619	0.491	3.5
9-12	0.615	0.496	3.6
13-16	0.625	0.495	3.6
17-20	0.630	0.493	3.8
21-24	0.636	0.489	3.9
25-28	0.629	0.480	4.1
29-32	0.626	0.478	4.1
Bottom, 33-36	0.625	0.471	4.1

Bed 2	Apparent Density (g/cc)		
	Received	Dry	HOI °C
Top 1-4 inch	0.637	0.499	3.6
5-8	0.639	0.498	3.6
9-12	0.630	0.490	3.7
13-16	0.625	0.481	3.8
17-20	0.623	0.475	3.9
21-24	0.621	0.480	4.0
25-28	0.620	0.471	4.1
29-32	0.620	0.469	4.1
Bottom, 33-36	0.629	0.462	4.1

rounding liquid. Thus, a dislocated GAC particle loaded with adsorbates can facilitate pre-mature contaminant breakthrough.

AC TESTER MECHANISM OF ACTION

The original idea for the AC Tester came to the lead author while attending a short course (4) by Dr. Milton Manes. He stated, "if you put a pound of activated carbon into a plastic bucket containing gasoline, the bucket would melt due to the exothermic adsorption heat." This idea was reduced to practice by the lead author and presented (5). The original idea was scaled down to a hand held device shown schematically in Figure 1. The reservoir has calibrated graduated volume marks on its straight edge side. Every test is started with fresh mineral oil. The 30 ml line is marked on the AC Tester. The thermometer has calibrated graduated marks from 10°C to 30°C with marked increments of 0.5°C. It is possible to estimate the AC heat-of-immersion (HOI) adsorption temperature rise to a tenth of a degree in this simple device.

This test method has been used continuously and finds new applications as well (5). This report deals with application for confirming incoming GAC quality and location of the mass transfer zones (MTZ) in drinking water activated carbon beds.

It is easy to put one of these AC Tester devices together. All that is needed is a reservoir to hold the solvent into which the AC specimen to be tested is immersed into and a thermometer to measure the HOI temperature rise. It is recommended to use mineral oil as the solvent because it is globally readily available. This solvent is inert, non-toxic, has relatively low competitive desorption capacity, and has a high boiling point so the adsorption heat will be maintained in the liquid and thus not boiled away, if a low boiling solvent is used.

HOW TO DO THE TEST

This test is designed to be easy to do with low cost equipment and operator skill. Typically a level tablespoon of GAC is sufficient to provide a good maximum temperature rise in about 2 minutes in the AC Tester. Thus it is easy to check incoming loads of activated carbon. Do not rely solely on this easy test. It needs to be complimented with official standard AWWA (2) and ASTM (5) test methods. Vendors provide these standard tests, which can be checked with experienced and qualified laboratories.

Ideally it is neccessary to compare the

unused GAC with the used GAC sampled from operational adsorbers. Unfortunately, experience has shown that most activated carbon users do not retain a representative sample of media installed into the adsorbers. This is easy to fix by collecting GAC samples and storing them in clean airtight containers similar to paint cans. For example, if the unused and used GAC both give a 4.0˚ centigrade rise, the carbon is like new, but if the used GAC has only a 1.0˚ rise the adsorption space is nearly filled and not likely to be working well.

AC TESTER MONITORING RESULTS

Results are presented in Table 1. Core GAC samples were taken from two settled GAC beds at a municipal drinking water plant. The core samples were placed on absorbent paper to remove bulk water. After air drying composite samples were taken every four inches from the top of the bed to the bottom. Heat of immersion (HOI) was determined in the AC Tester and densities according to ASTM (5) to decrease from influent concentration to the lowest detectable concentration obtained the GAC samples reported in Table 1.

When a large (20,000 pound AC municipal unit) or small (1 pound POU device containing AC) GAC adsorber is put in service the heterogeneous adsorption spaces are empty. As a water or air stream is passed through the AC, the adsorption spaces fill by taking materials out of the passing stream. Eventually the useful adsorption spaces fill and the influent and effluent are the same when total equilibrium is obtained with the stream being treated with AC. At equilibrium, the AC Tester will have its smallest increase in temperature compared to the unused starting AC for that application.

OTHER AC MONITORING TOOLS

In recent prior articles we have described other activated carbon monitoring methods (7-8). The method described with the AC Tester is a low cost approach, which anyone can do. The official ASTM and AWWA test methods (3, 6) are the cornerstones of the activated carbon industry and the advanced test methods (3; 7-8) are pushing the carbon envelope.

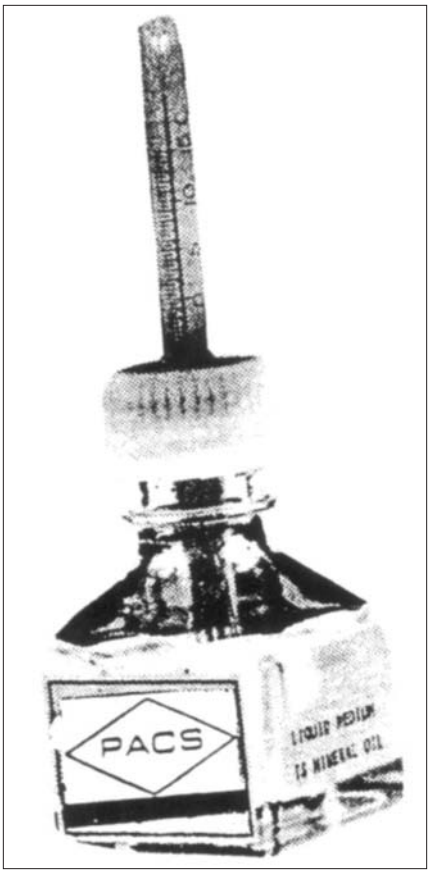

Figure 1. AC Tester

CONCLUSION

These sophisticated test methods are relatively expensive compared to the AC Tester. The AC Tester is a practical tool, but it needs to be used in conjunction with classical and advanced test methods to help make the best decisions about purchasing and monitoring real-world working activated carbon adsorption systems.

AWWA, WQA, ASTM, PACS and others provide educational programs to help explain these methods and what they provide users.

Gravimetric Rapid Pore Size Distribution (GRPD) method can be applied to the unused and used GAC to help reveal the pores, which are filled during a particular application (7). Knowing which pores are filled can help select the best AC for the application, by using a carbon, which supplies the needed pores. The GRPD sister method (8) helps to better understand the fine micropore, and the strongest adsorption pores.

OTHER AC TESTER APPLICATIONS

When the user is purchasing large amounts of GAC the AC Tester makes it possible to run many samples at the job site. This test is fast and easy to do. It requires no sample preparation. In its simplest form a level tablespoon is put into the AC Tester to determine the mineral oil temperature rise. You can do this in a few minutes.

Sending samples for ASTM and AWWA laboratory testing may take a few days to get the test results back. The AC Tester gets results in a few minutes. By running a lot of incoming samples provides a statistical analysis of a newly installed GAC.

Manufacturers can use the AC Tester at the production line. Getting product quality data in a few minutes after it comes out of the furnace. Tjis allows operators to have timely information. Instead of sending samples to the lab for iodine numbers to get results the next day, it makes sense to have a near on-line quality check on AC products as they come out of the furnace.

The AC Tester has been found useful for all forms of AC: powder, granular, pellets, fabric, felts, composites and nanomaterials. Pellets are often used in vapor-phase application because they provide the least resistance to drive air through the bed with pellets. To get samples of pellets for the AC Tester lining up 150-200 millimeters of length provides a reproducible sample to deliver to the AC Tester. Tablespoons of GAC are reproducible, but pellets do not pack in this small space reproducibly. Pelleted samples are reproducible on a linear (end-to-end) continuous segment.

These other applications for the AC Tester will be covered at upcoming conferences (9-10).

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About the authors:

Henry Nowicki, Ph.D. and M.B.A. provides the introductory course for the Activated Carbon School titled Activated Carbon Adsorption: Principles, Practices, Applications and Opportunities. Dr. Nowicki directs the day-to-day routine and advanced Testing, R&D, and Consulting services for PACS.
Tel: 1-724-457-6576
Email: Henry@pacslabs.com

Wayne Schuliger, P.E. provides the PACS short course titled, Design, Operation and Trouble Shooting Activated Carbon Adsorption Systems. He utilizes his 40 years of activated carbon adsorption engineering experiences to help solve client problems through on-site and Internet consulting services. Email: Wayne@pacslabs.com

Robert Roodman, P.E. has 21 years of experience in the manufacture and reactivation of used activated carbons and other process chemistries at plant scale.

H. George Nowicki, BS, BA, is the manager for PACS Laboratories and new business developer for PACS. Tel: 724-457- 6576 Email: George@pacslabs.com.

Barbara Sherman, BS, and M.B.A. is the operational manager for PACS Testing, Consulting, R&D, Training and Conferences. She directs the day-to-day short courses, conference and business for PACS. Email: Barb@pacslabs.com

Blücher Technologies: A Tradition of Innovation

Spherical adsorbers

Blücher GmbH, Erkrath, Germany, can look back over a history that spans forty years. Still in family hands, this traditional company has retained its very high ethical claim of always focusing activities on protecting life.

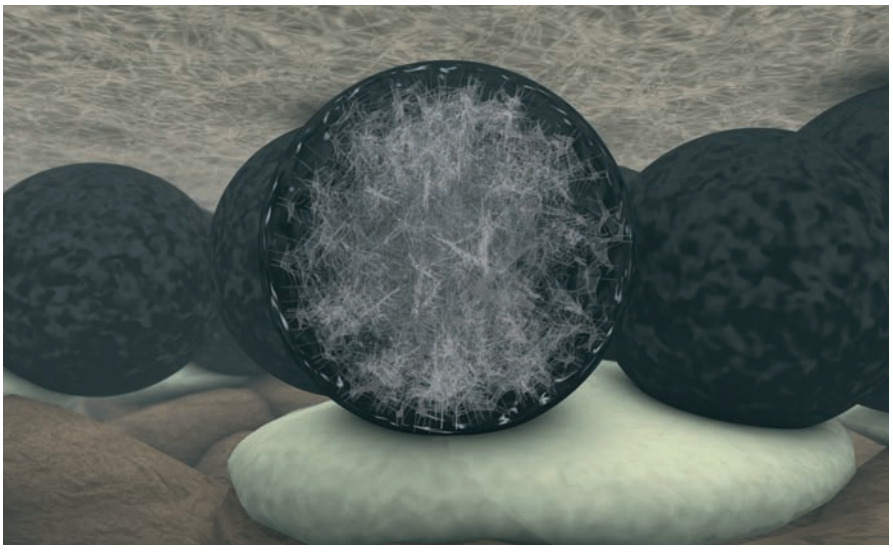
The core business of Blücher GmbH is the development and production of high-efficiency filter technologies. Based on spherical, high-performance adsorbers – in principle similar to activated carbon – pollutants, smells and other unwanted substances are reliably filtered out of gases and fluids and safely bonded for optimum protection and comfort in all circumstances, whether in action, at work or play.

HIGH-TECH AS A PRINCIPLE

Blücher has developed very special and unique production methods that allow product characteristics such as shape, mechanical and adsorptive capacities to be individually customised for optimum performance across a huge range of highly demanding applications. This combination of flexi-

bility and hyper-performance is one of the reasons for Blücher's global technological leadership in spherical high-performance adsorbers. These spherical adsorbers are very porous. This structure produces an immensely large internal surface on which the filtered substances can safely be deposited.

The net result is a truly high-tech system that knows no equal in terms of efficiency, flexibility and above all safety in its protective effect.



Schematic of spherical adsorbers applied on textile carrier.

A QUALITY MANAGEMENT

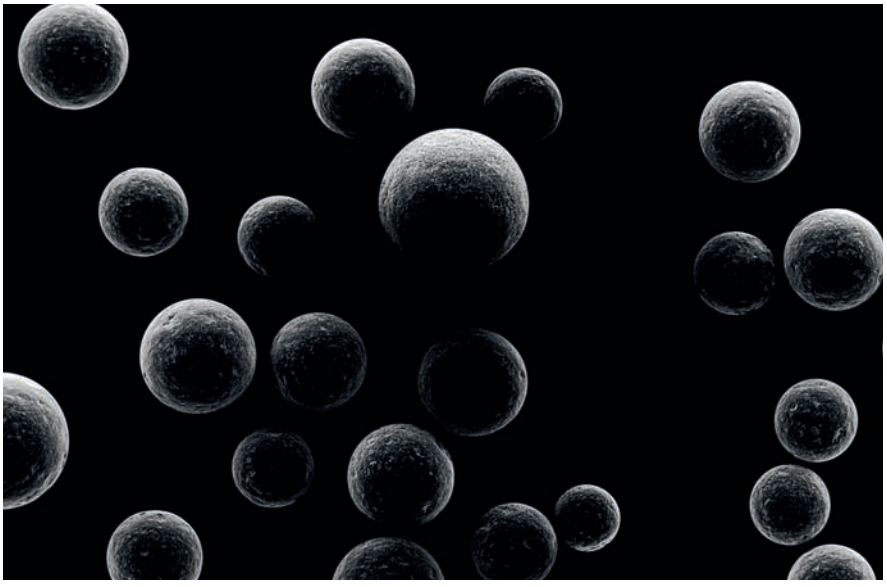
Successful innovations demand the most modern and efficient production methods. The Blücher-Group manufactures its core components solely in its own state-of-the-art plants in Germany and the United States. The entire range of the production process starting from raw materials to intermediate products, all the way up to sophisticated system solutions, is in Blücher hands and is constantly monitored and controlled by its own labs.

This ensures that their high quality standards are always met and that no deviations or inaccuracies can creep into the process. These checks continue right up until the finished product, which is then ultimately inspected and approved by independent, internationally recognised institutes.

This self-contained production process makes it possible to develop customised product solutions at any time and to the very highest degree of precision.

FLEXIBILITY AND VERSATILITY

Blücher filter technologies are used wherever undesirable or even hazardous pollution has to be eliminated.



Scanning electron microscope photo of spherical adsorbers.

The range is very varied, from odour adsorption, air and water filtration right through to personal protection against chemical and biological toxins.

The architectural blunders of past years still have far-reaching consequences. Contaminated buildings have to be completely remediated or even demolished, which often proves impossible. Special "Permasorb" wallpaper provides a fast, affordable and reliable remedy for this problem.

Pollutants such as PCB or formaldehyde in the walls are firmly and permanently bonded by the highly activated adsorbers, which can restore a healthy climate inside rooms.

DRESSED FOR FRESHNESS

It is often impossible to prevent the formation of odours in clothing and shoes that are worn frequently or used in sports.

Blücher offers a reliable filter system against the development of every type of odour. Around 500,000 adsorbers have been invisibly integrated into a single pair of shoes, for example. All odours are securely and reliably bonded on their overall inner surface area, the total size of which roughly corresponds to an area equivalent to two football pitches.

LIFE PROTECTION

Research, development and innovation have made Blücher a world market leader for CBRN protection. Over 8 million of Blücher's SARATOGA® brand protective suits and systems in over 40 countries speak for themselves. Even the most demanding task forces, including OPCW inspectors who are confronted with CBRN hazards every single day, rely on SARATOGA from Blücher.

The SARATOGA systems include not only CBRN but also ballistic protection as well as protection against foul weather, fire and cold, but comfort is also taken seriously. Integrated ventilation systems for cooling and moisture management with designed-in weight minimisation reduce the physical strain and ensure adequate mobility. What's more, the SARATOGA protective suits can be put on quickly and easily.

A BREATH OF FRESH AIR

The SARATECH® filter technology brand from Blücher provides clean air in aircraft and also in specialised vehicles that are deployed in environments that are hazardous to health.

The applications for SARATECH odour adsorbers that can be found in supporting roles relating to domestic equipment and air-purifying devices also guarantee a better quality of life.

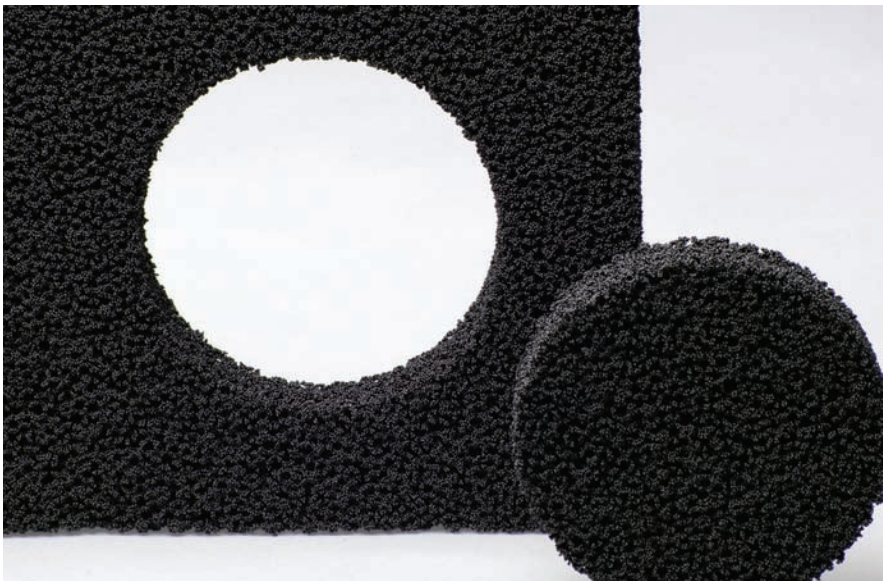
SARATECH products are even used in demanding industrial production processes that require the cleanest of air environments, such as semiconductor production.

CLEAN WATER, THE ELIXIR OF LIFE

The level of pollution in drinking water from industrial effluents as well as residues from pharmaceuticals and chemicals is rising.

This development is accompanied by growing demands on drinking water and industry needing increasingly high-purity water for its production processes.

Thanks to their purity, excellent adsorptive properties and mechanical strength, SARATECH adsorbers are singularly ideally suited for perfect ultrapure water filtration.



Air filter

TAILORED PROBLEM SOLVING

As a result of their unique production processes, the properties of the adsorbers can be individually adapted and tuned to meet a vast range of specialised requirements, needs and applications. Product characteristics such as the shape, mechanical and adsorptive properties can be individually determined and realised for specially tailored problem solving.

For more information contact:
Blücher GmbH
Mettmanner Straße 25
40699 Erkrath, Germany
Website: www.bluecher.com

AFS 4th Bi-Annual Emission Conference

By Edward C. Gregor

Practice always make things better and conferences apparently follow suit, as the 4th Bi-Annual American Filtration & Separations Society Emissions in Transportation Conference in Ann Arbor, MI had the highest level of speakers and information exchange since beginning this series of Emissions in Transportation Conferences from 2003.

The Conference began with a pre-conference day, as do all AFS Conferences, with Short Courses and/tour at a local filtration company or other facility. This year participants toured the Ford Research and Advanced Engineering Center in Dearborn, MI. Ford touts the center as the innovation hub of the company and it didn't disappoint. With over 200 patents a year from its staff, it clearly is an epicenter and heart and soul of the company's best ideas.

The two and half day conference, October 6-8th provided attendees with just about every aspect and bit of knowledge one can expect from a conference from a broad overview to specific insights into emission technology and activities. They learned what's new in engines from gasoline to lithium batteries, diesel fuels to hydrogen fuel cells and hybrids, even a 1935 German innovation called the Junker engine, being recycled with 21st century technology.

Leading the parade of speakers were many recognized industry experts offering exciting new technology and approaches to meeting regulations with innovative ideas. Cleophas Jackson, U.S. EPA led the conference with a plenary address updating everyone to the latest government emission regulations and timelines. Jim Parks from the Oak Ridge National Laboratory explained the CLEERS program and how it provides simulation tools to the design engineer for clean emissions. Dr. David Cole, Chairman of the Center of Automotive Research, who is televisions and major media automotive go-to industry authority, spoke on the subject of The Auto Future: A New Beginning and offered a macro overview of industry technology, direction, influences and future technology options.

Charles Freese, Executive Director of General Motors Powertrain Engineering gave an in-depth address on the industry powertrain choices and the relative merit of each. His address left little question, the industry has its act together. He also provided new ideas and technologies to achieve higher mileage and lower emissions. Dr. Dennis Assanis, Director of the W.E. Lay Automotive Research Center at the University of Michigan, spoke on Lean-Clean Engines, a new concept and technology for increasing engine mileage. Kevin Westerson, Executive Director, Cummins Engine Filtration R,T&E capped off the plenary sessions with detailed and meaningful insight from a major OEM engine producer. His remarks were particularly beneficial to understand what Tier 1 companies need to produce to satisfy industry standards.

Conference sponsors were Flow Ezy Filters, Cummins Emissions Solutions, Cummins Filtration, Donaldson Filtration Solutions and International Filter Testing Services, Inc. The technical program was organized by Dr. Tad Jaroszczyk (Conference Co-Chairman), Dr. Gerald Z. Liu and Neville Bugli, who was elected earlier this year to Chairman of the AFS for 2010.

Next spring, AIChE will be co-locating with the AFS at the 23rd AFS Annual National Conference, March 22-25, 2010 at the Grand Hyatt Hotel in San Antonio, TX. Emphasis at the conference will be on the subjects of Biotechnology, Energy, the Environment, Filtration Fundamentals and Applications. In the fall, the Water Quality Association (WQA) will join the AFS in Baltimore, MD for a joint Water Filtration Conference.

The American Filtration & Separations Society is the largest Filtration Society in the world and the principal educator of the industry.
Website: www.afssociety.org

Dr. Ernest Mayer Forms Independent Consultancy

Dr. Ernest Mayer, a Senior Level Consultant with 40 years of filtration and separations experience announced the formation of an independent consulting company, E. Mayer Filtration Consulting, LLC. This consultancy specializes in Solid/Liquid Separation (SLS) technology, general wastewater treatment and filter media evaluations.

Dr. Mayer is proficient in testing filter media by porometry, liquid permeability and glass bead challenges, and can address specific customer challenges with liquid/fluid. He has extensive experience at expediting ISOTD challenge tests, including testing a broad range of filter media for customer applications and recommending optimum choice based on flux, cake release, and resistance to blinding. Dr. Mayer is skilled in determining slurry properties from a solid/liquid separation viewpoint (i.e., pH, conductivity, TSS, PSD, CST, SCV, turbidity, etc.). Further services include: testing and optimization of proper polymer flocculant via jar tests, CST, and SCV; combined with mixing scale-up studies. Dr. Mayer is able to determine the proper filter aid for an application, including those that have a combined flocculant or PAC.

Dr. Mayer has been on the Editorial Advisory Board of Filtration News for ten years. He has published more than 200 papers, holds two patents and has been a member of the Board of Directors since 1988. He also has served as the Chairman of the Chapter Users/ Affairs Committee.

Dr. Mayer has received numerous awards for his work, including Tau Beta Pi, Sigma Xi, Deans' Lists, three Engineering Excellence Awards, seven Environmental Respect Awards, and a Class 'A' bonus recognized by the DuPont Company as a highly prestigious technical award. He has also been awarded the AFSS Frank Tiller Award in 1996, the AFSS Fellow Award in 2000, and the Lifetime Achievement Award in 2005, being honored as the first non-academic recipient. Dr. Mayer is a member of AWWA, AIChE, WEF, and AFSS and has been on the Board of Directors since 1988 for AFSS as well as the Chairman of the Chapter Users/Affairs Committee. In addition, Dr. Mayer has organized and chaired three technical conferences and co-chaired the World Filtration Congress in 2004.

For more information contact:
Dr. Ernest Mayer
E. Mayer Filtration Consulting, LLC
806 Highfield Drive Newark, DE 19713
Tel: 1-302-981-8060
Email: emayer6@verizon.net

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In return, the sponsors have venues of short courses and technical presentations that offer their employees an enhanced technical education and networking experience. Plus, the AFS Corporate Sponsors are featured on the AFS website with banners and signs at all AFS Events.

The current sponsors invite you to attend the 2010 Annual Meeting.

The AFS will be meeting in San Antonio, TX, March 22-25. This meeting is co-locating with AIChE and AFS attendees who will be able to attend AIChE technical sessions and exhibits at no extra charge.

AFS will be offering an outstanding technical program, short courses, networking opportunities, a student poster session, tours and tabletop exhibits.

For inquiries about AFS corporate sponsorship or exhibiting opportunities at the AFS Conference in San Antonio please email Suzanne Sower, kssafs@mac.com or call 612-861-1277.

Don't miss out on this important technical conference!
For updated information visit the AFS website: www.afssociety.org

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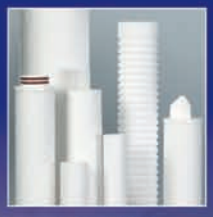
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