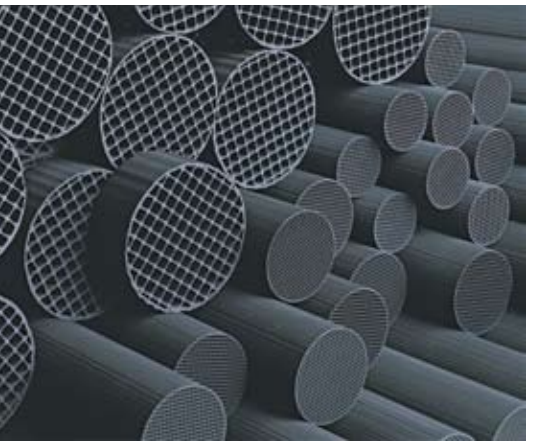
Edited by ***Ryan Gehm***

What's the buzz about honeycombs?



The open structure and small carbon particle size of the new activated carbon honeycomb increases adsorption performance and reduces the pressure drop (below) associated with traditional granular or pelletized carbons used in emissions-control, industrial, and chemisorption applications.

Activated carbon has been used for centuries to purify liquids and gases by means of the adsorptive properties of the large surface area density of the material. Over the last 40 years, **MeadWestvaco Specialty Chemicals** has worked to improve and customize the porosity and surface characteristics of activated carbon, allowing for specialized and selective adsorptive capabilities and high capacities.

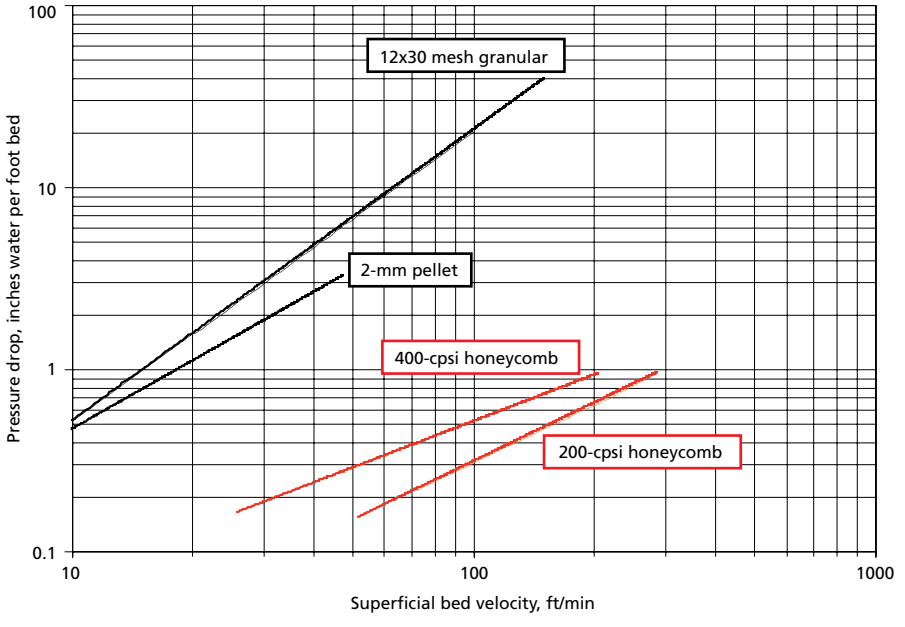
Advancements in producing large-diameter pelletized activated carbons have reduced the pressure drop that occurs at relatively high fluid velocities and expanded the utilization of the product. This lowered pressure drop has occurred at the sacrifice of adsorption capacity, because mass transfer kinetics are inhibited by the slow rate at which the adsorbate diffuses through the 1- to 5-mm (0.04- to 0.2-in) pellets.

Technology has also progressed, however, to allow for the production of very small and uniform activated carbon powders that allow adsorption and desorption processes to occur very rapidly. These powders are of limited use, unfortunately, because of the high pressure drop associated with powders and the difficulties with handling and filtering them from fluids. Many adsorptive systems could be refined and optimized by realizing the performance characteristics of a finely powdered activated carbon in a low-pressure drop and functional form without the need to filter the powdered carbon from the fluid. The utility of activated carbon could be further expanded in much the same way as it has by advancements in pelletization and control of porosity.

MeadWestvaco has responded to this commercial need by developing the activated carbon honeycomb. The honeycomb is an extrusion-formed, dustless ceramic device that contains 30 to 50% of micron-sized activated carbon powder with a plurality of cell densities ranging from 16 to 600 cells per square inch (cpsi). The open structure of the honeycomb results in a product with pressure drops many times lower than granular and pelletized carbons.

The cell wall thickness of the honeycombs can be made as thin as 0.13 mm (0.005 in), resulting in rapid adsorption and desorption plus full utilization of adsorption capacity at very high fluid velocities. The honeycombs may be made with diameters more than 20 cm (8 in) and in any extrudable shape, able to fit in a wide range of vessels and beds. Direct heating allows the honeycomb to be regenerated by thermal swing processes, requiring little to no purge gas. Moreover, the strength of the honeycomb structure permits it to be used in rapid pressure swing adsorption applications and high velocity environments with little to no product attrition.

The open structure of the honeycomb and the thermal conductivity properties of the ceramic backbone prevent hot-spots and reduce temperature swings resulting from adsorption and desorption, so the honeycomb allows for rapid, high adsorption rates and the complete utilization of the regenerative adsorption capacity. Honeycombs containing zeolites and aluminas are also available to allow



optimization of gas concentrators and catalyst support with temperature capabilities in excess of 800°C (1472°F) in air.

Opportunities to use activated carbon honeycombs include any application where high mass transfer rates are advantageous and low pressure drop is critical. The MeadWestvaco activated carbon honeycomb is standard equipment on California partial zero-emission vehicles to achieve regulatory standards for diurnal evaporative emissions control from the carbon canister. They are able to fully regenerate with limited purge air and capture practically all the diurnal bleed emissions from the primary carbon canister with little effect on the canister system pressure drop.

The carbon honeycombs are now finding application on hybrid and GDI (gasoline direct injection) engine vehicles to meet U.S. LEV (Low-Emission Vehicle) II/Tier II standards. The carbon canister systems on these vehicles have a very limited volume of available purge air, yet the honeycomb is able to completely regenerate and repeatedly adsorb a large quantity of canister bleed.

It is the unique combination of fine carbon particles, thin cell walls, and extremely low pressure drop of the carbon honeycomb that sets it apart from granular and pelletized carbons. When adsorbing 22% gasoline vapor in air at a load velocity of 29 m/min (95 ft/min), the activated carbon honeycomb has a working capacity six times greater than an 11 BWC (butane working capacity) carbon per kPa of pressure drop. Moreover, under the same load conditions the mass transfer zone is only two-thirds as long, so greater bed utilization is possible when using the honeycomb.

The positive effect is even greater when compared to pelletized carbons, where the adsorptive capacity in the center of pellets may not be used when superficial load velocities are high. Honeycombs are currently being designed for systems used to separate and concentrate solvents from large-volume airstreams, such as paint booth applications.

The carbon honeycombs may be impregnated for highly efficient chemisorption processes. Impregnated honeycombs are rapidly displacing impregnated carbon pellets in systems made to remove corrosive gases from air. Honeycomb systems may be designed to handle superficial air velocities of 150 m/min (492 ft/min) vs. 30 m/min (98 ft/min) for pellets, yet the total system has a lower pressure drop. The equipment footprint is reduced as is the energy consumed to power the blowers. In addition, the honeycombs resist attrition and generating dust, eliminating both the need for costly particulate filters and the possibility of entraining dust in the exhaust airstream.

As the industry looks at the shape of things to come, automakers can take advantage of new opportunities to apply the many properties of activated carbon to applications that until recently were limited to a few types of delivery systems.

Michael F. Tschantz, Product Development Manager, Carbon Technologies, MeadWestvaco Specialty Chemicals, wrote this article for *AEI*.

Timken collaborates on steel solution

Working with one of its major automotive customers, **Timken** engineers developed a hot-rolled temper process to produce steel that could be more easily machined for a **Bosch** diesel fuel injector used on truck engines.

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Bosch previously used a low-alloy steel that was hot-rolled annealed at its plant in Charleston, SC. According to Timken, this process produced steel with a high surface-to-core hardness gradient that was difficult for Bosch to machine. Excessive metal buildup on the tool edges led to reduced drill and tool life.

In 2005, Timken suggested a hot-rolled temper process, which would produce steel that would machine more efficiently and respond more effectively during Bosch's heat-treatment process. This hot-rolled process produced tempered steel with a higher hardness and reduced the temperature required for heat treatment by 350ºF (194ºC), according to David Henderson, Technical Services Specialist with the Timken Steel Group.

Henderson explained that the annealing process requires that the steel is heated to about 1650ºF (900ºC) and then slow-cooled. "The microstructure consists of ferrite and pearlite," he said. "Carbon segregates somewhat from the original hot-rolled structure. Since the surface of the bar cools faster than the center of the bar, the surface tends to be about 15 BHN [Brinell hardness number] harder than the center of the bar." The center hardness was typically 185 BHN and the surface 200 BHN.

"From Timken's own bearing business, [we have] learned that steel hardness levels less than 200 BHN can sometimes result in more expensive machining due to soft metal building up on tool surfaces," said Henderson. "Some steel materials machine better at hardness levels in the range of 210 to 235 BHN."

The grade of steel used in this Bosch application has a hardness of about 320 to 360 BHN as rolled off of the rolling mill, according to Henderson. The microstructure consists of predominantly bainite. "As rolled, the hardness of the steel is too high to machine. It needs to be softened, but a better choice than softening by annealing is to soften using a temper instead," he said.

Temperature and time required to do this is grade-dependent and has to be determined by trial and error, Henderson said. "A temperature under 1300ºF and time was chosen to temper the bainite down to a hardness near 215 BHN."

After conducting machining trials and component testing, Bosch confirmed the improved machinability of the steel using the Timken process. "The high pressure pulsation fatigue life of the hot-rolled tempered steel improved notably over that of the hot-rolled annealed steel," said Wilt Staples, Senior Purchasing Engineer at the Bosch Charleston plant.

Besides improved machinability, subsequent heat-treat response and improved cyclic fatigue are a few of the main benefits of this process. "An added advantage of the hot-rolled temper process over the annealed is that the surface and core hardness and microstructure are essentially the same, as microstructure is determined by the diffusion process rather than a cooling rate process," Henderson said.

According to Henderson, this process can be used for other supplier applications. "Any place where steel is ordered in the annealed condition could be investigated."

Ryan Gehm

briefs

NaturalNano has successfully run its first manufacturing-scale-trial of its halloysite clay nanotube technology, which is being developed as an additive to improve the strength characteristics of plastics. The trial was run as a machine-scale validation of the company's previous bench-top work performed at **Cornell University**. The trial was conducted independently at the facilities of a large-scale plastics manufacturer. The results demonstrated "excellent" runability on conventional equipment, and corroborated NaturalNano's previous lab tests showing the additive's ability to increase a plastic's strength, while improving ductility and flexibility. According to NaturalNano, this trial is a benchmark toward commercializing its Pleximer product line, and the results are aligned with its strategy of entering into a joint-development agreement with a strategic partner in the first quarter of 2007.

Volvo Technology Transfer has invested in **TranSiC** AB, which has developed an energy-efficient conductor made of silicon carbide for hybrid vehicles. The conductor is used when battery direct current is converted into alternating current in an electric motor. Silicon carbide is said to be as hard as a diamond and can withstand "extremely high temperatures." According to Volvo, the heat losses with silicon carbide are small, "so perhaps no cooling will be needed" for the motor and electronics.

Alcan will invest $9.5 million in its Specialty Sheet facility at Neuf-Brisach, France, to upgrade its existing automotive continuous annealing and quenching line. The investment will improve the aluminum strip's surface and mechanical properties, to better satisfy customer requirements and anticipate future developments in the aluminum car body market. The project is scheduled to come on stream in the first half of 2008. Prior to this announcement, Alcan Specialty Sheet had signed a multiyear agreement with **Valeo** to supply aluminum sheet for use in the automotive thermal systems manufactured in Valeo's European plants. The contract includes a supply agreement for air-conditioning as well as engine-cooling heat exchangers. The supply is to come from Alcan's Neuf-Brisach rolling mill.