JANUARY 2004 • $20

PanelWorld

VENEER • PLYWOOD • COMPOSITES • GYPSUM • LAMINATES ™

DIRECTORY/BUYERS' GUIDE:
PRODUCTS, MANUFACTURERS, MILLS

ALSO IN THIS ISSUE:

- MEADOW LAKE OSB
- WORLD OF ADHESIVES
- WOOD TECH CLINIC

EVOLVEMENT OF CERAMIC HEAT EXCHANGE MEDIA IN AN RTO FOR THE OSB INDUSTRY

New chemical resistant materials continue to undergo testing.

BY DAVID LEX, CHIRISTOPH HAGG and GEORG KOGLER

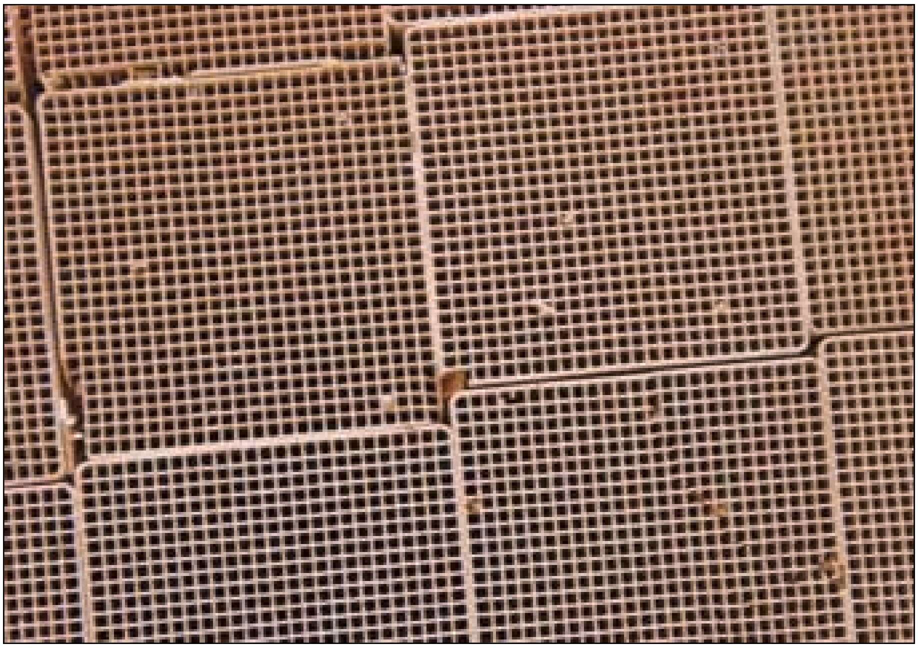


Figure 1: evidence of cracking and chipping

Figure 2: severely restricted airflow

In 1995 the need for pollution control equipment in a major oriented strandboard plant in the upper Midwest became evident, and in December 1996 two regenerative catalytic oxidizers (RCOs) each with four canisters were brought on-line.

The "North" and "South" units were filled with 1 in. ceramic porcelain saddles to a depth of 7 ft. with a top layer of 8-10 in. of 1 in. catalytic saddles. The units ran for approximately 840 hours between December 4, 1996 and January 8, 1997 and 192 hours between July 10, 1997 and July 18, 1997 with pressure drops in the range of 18-22 in. of water column. Washouts were common to keep the pressure of the system stable but the washouts completely turned the saddles to gravel. Moreover, VOC and CO levels that remained unprocessed were exceeding the legal allowable limits.

After a detailed study it was determined an RTO (regenerative thermal oxidizer) would be the most economical solution to meet the very low levels of CO and VOC required by the state. An RTO with random packing was considered but was rejected as a result of the problems of the frequent plugging of the saddle bed in the RCO. The most economical choice was to pack the RTO with monolith.

With the selection of monolith several issues remained uncertain: Random packing lasted less than 1000 hours. How long would the monolith bed last? Would plugging and washouts be more frequent and more difficult?

However, monolith did have a significant advantage in pressure drop. At RTO temperatures a monolith bed would have an expected pressure drop of 5-8 in. of water column whereas the same bed of random packing would have a pressure drop in the range of 18-22 in. of water column. The result is a savings of 40-60% in electricity.

After a change-out of the failed saddle bed to 5 ft. of monolith and an upgrade of other systems, the RTO unit was brought on-line on October 12, 1998, combusting CO and VOCs at 1650° F. As monolith was in short supply, the bed configuration was a mixture of several different types of material including but not limited to NT 40 cell, MK10 40 cell, cordierite 40 cpsi, and cordierite 25 cpsi. Other blocks were found in the beds that were unknown.

Early in 1999, Lexco was contacted by the technical manager of the drying, screening, energy and environmental area of the OSB plant to help with several problems associated with the monolith in the RTO. The main issue was chemical attack by earth alkaline contaminants to the interior of the RTO and ceramic heat exchange media. The only material that had demonstrated to have some resistance to alkali attack was the mullite HT (high alumina mullite monolith), but a testing program in an OSB plant was needed.

In late 1999, the decision was made to change out the top two layers of the North unit with HT 40 cell material. Several months later the South unit top layer was replaced with 40 cell cordierite. After about one year of operation (8,000 hours) the HT material was holding up well but some cracking and chipping was becoming evident (Figure 1).

These chips were caused by chemical attack from Na_2O and K_2O. The SiO_2inherent in most ceramic material bonds the Al_2O into a cohesive material. Na_2O and K_2O leach out the SiO_2 thus causing chipping. These chips would fall into the cells and become trapped in between lower layers of blocks causing a progressive pressure increase.

At the same time the cordierite in the South unit was exposed to the same gas stream as the HT in the North unit. The chemical attack from Na_2O and K_2O affected the cordierite in a different manner. The melting temperature of the blocks was reduced thus closing the cells restricting airflow severely (Figure 2).

With the problems experienced with both types of ceramic and the inability to use random packings, a new monolith was developed and tested in the actual bed of the North unit called HTH (a second generation alumina mullite monolith with a similar formulation to the HT) (Figure 3).

The two test blocks were returned to the lab for analysis on thermal shock resistance and alkali chemical attack resistance. The tests revealed that the HTH was an improvement over the standard HT material but has positive and negative findings. One positive effect was that more of the SiO_2 was chemically bonded in the block thus reducing the amount of chemical attack that caused chipping. However, a side effect of chemically bonding free SiO_2 was total porosity increased. The pores are fewer but larger in size. Few pores allow less intrusion sites for chemical attack, which is positive, but the larger size allows more Na_2O and K_2O to collect thus increasing the chemical attack. Thermal shock resistance was not changed from the HT material.

Figure 3: HTH monolith

Figure 4: cross section of monolith

Figure 5: same cross section as above

After less than one year of operation it became necessary to replace the cordierite in the South unit with a material that could better withstand the chemical attack caused by Na_2O and K_2O and other earth contaminates. With the early promising test results of the HTH from the actual test blocks from the North unit, a decision was made to remove the top two layers of cordierite monolith and replace with the HTH 25 x 25 cell monolith.

Because the lab results showed only a slight increase in chemical attack resistance test, blocks of the HTH from the South unit installation were returned to the lab when possible and the results were consistent with the original test blocks. However, the block did perform significantly better in the unit over the standard HT monolith. A factor that may have played a role in the increased performance on the HTH was that the monolith installed was a 25-cell material that has larger cell openings and thicker walls. Any chips that were formed in the unit did not completely block the larger cell openings. Also the thicker walls of the block may have slowed the rate of chemical attack (Figure 5).

Several problems with the unit began to surface that were unrelated to the monolith but consistant with chemical attack. The support system was beginning to fail in the rounded sections of the canister. The insulation was failing from the washing out process causing cracks and hot spots in the outer shell. Both units were in need of an overhaul to continue to operate safely and effectively.

With the increased performance and life of the HTH material, it was the heat sink media of choice for the retrofit. Discussions with the unit operators indicated that the larger cell blocks with more free open area were preferred as washouts and burnouts would be reduced in frequency; however, more thermal energy recovery was desired.

In a combined effort among all parties, a new cell structure was developed with increased open area over the 40 cell type and more active heat transfer surface than the 25 cell type. Both units were installed with the HTH 32 x 32 cell material in the first two quarters of 2003. During this retrofit, the bottom layers of blocks were removed for the first time in five years and replaced with NT 32 x 32 cell material (NT refers to non-porous porcelain monolith).

Several of the HTH 25 cell blocks that were in operation in the South unit were tested and the nature of the chemical attack was identified. Chemical analysis shows an increase in alkali content up to 8% (Na_2O+K_2O). X-Ray diffractometer indicates chemical reaction between alkalis from the gas with honeycomb material leading to formation of nepheline (mineral group “Foid”, Feldspar-like). The volume-expansion during crystallization in the pores of the block causes cracks and chipping. Pictures were taken under SEM (Scanning Electron Microscope).

Figure 4 identifies a cross section of four cells of a monolith. The dark areas are free space and the lighter areas are actual cell walls. Cracks can visibly be identified forming in the edge of the cell in the lower left corner. These cracks are the beginnings of chips caused by chemical attack

Figure 5 identifies the same cross section of the same block. The light blue area on the outside of the cell walls shows the distribution of Na (sodium) and K (potassium) in the cross section of honeycomb material "HTH" (light: alkali rich areas). The center dark blue area is virtually unaffected by alkali attack. An effort continued to improve the alkali resistance of the HTH. However the material has reached its potential and an entirely new compound was needed.

Developments of a new chemical resistant material begin in 2002. CR10 became the designation of the Chemical Resistant block. After a stable production matrix was established, laboratory tests for thermal shock and alkaline resistance began in late 2002 and early 2003. The alkali resistant test was to boil the monolith in NaOH (caustic soda) for five hours and measure the weight loss of the blocks due to leaching of ceramic binders and to measure the porosity changes.

The table identifies that the change in weight from the (virgin) untested material versus the tested material was highest among the HT and HTH series: The most material was leached from the HT (-7.24%) whereas the CR10 had the least (-1.58%). In addition, the surface area of the HT increases many times more than the CR10 (see graphs at right).

CR10 showed a significant increase in alkali resistance and thermal shock in laboratory tests. Cracking resistance is comparable with our NT material that is significantly higher than the HT or HTH materials. As discussed earlier, the HTH did see mixed results in lab testing but a significant increase in performance in the actual RTO. With the improvement in the laboratory tests of the CR10 over the HTH, the expected increased of the CR10 in actual RTO applications is expected to be considerable.

Currently CR10 32 x 32 cell material is in an actual OSB RTO for testing purposes. Preliminary results should be available early in 2004. CR10 is expected to completely replace the HTH and other materials in OSB and other wood products applications. With its increased alkali resistance, increased thermal shock resistance, and the reduction of leached surface area, CR10 is expected to have the longest life of all other chemical resistant materials being used in applications containing earth alkali contaminants. **PW**

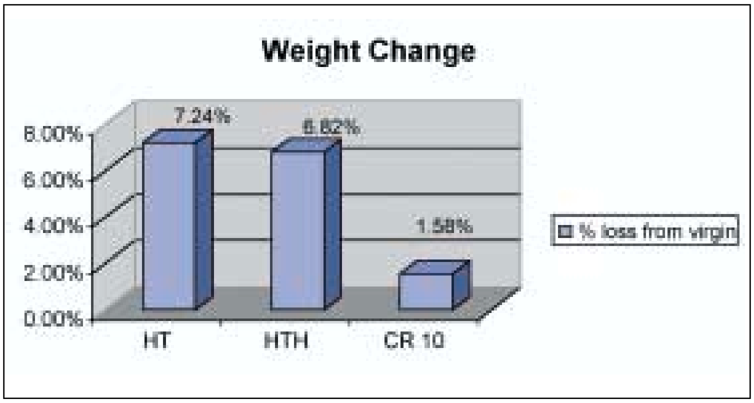
Leaching test in NaOH (25%)

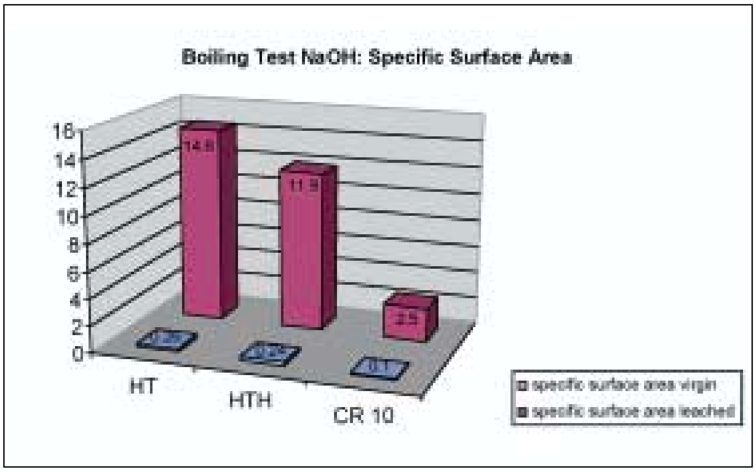
testing method:
honeycomb specimen
Concentration NaOH: 25%
boiling and stirring 5 hours

measurements:
weight loss
specific surface area by N_2-adsorption

results:

material	HT	HTH	CR10	
weight change	-7.24%	-6.82%	-1.58%	%difference from virgin
specific surface area virgin	0.26	0.24	0.1	M^2/g
specific surface area leached	14.6	11.9	2.5	M^2/g





David Lex is VP of Lexco Inc.; Christoph Hagg is in product management, non-catalyst non-catalytic honeycombs at CERAM catalysts and honeycombs; Georg Kogler is head of Material & Technology Development at CERAM catalysts and honeycombs. Contact David Lex at (330) 650-2010; e-mail: LEXCO@sprynet.com