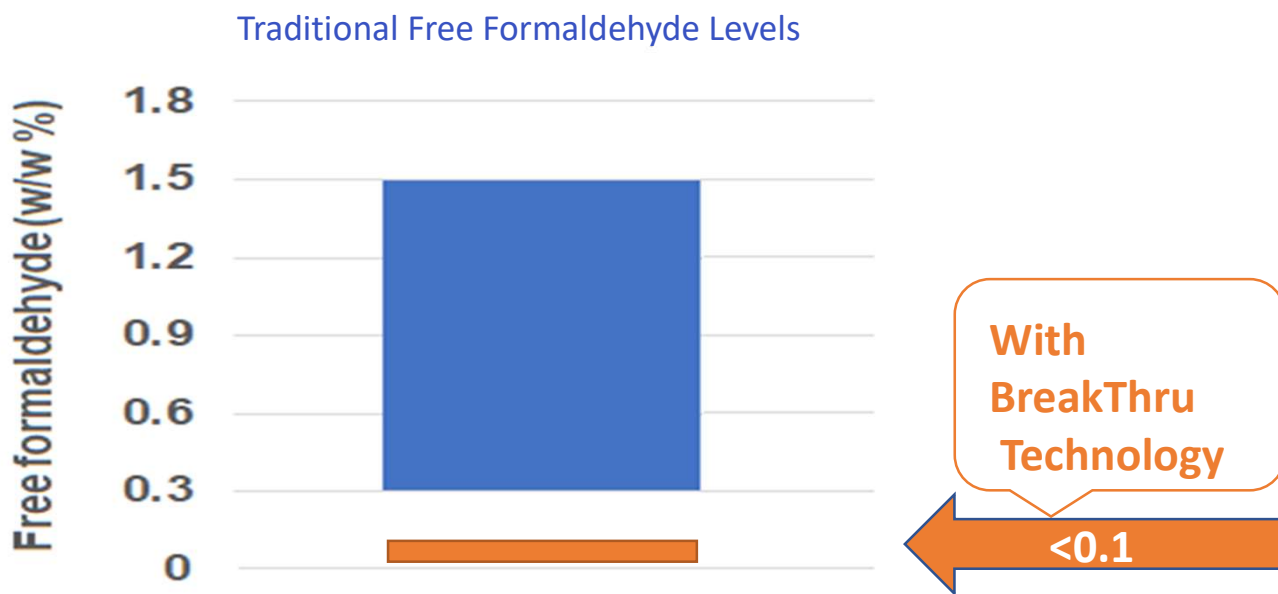


BREAKTHRU™ TECHNOLOGY FOR PHENOLIC RESINS

Georgia-Pacific Chemicals phenolic products are used around the globe as a primary component of FRP composites, abrasives, filtration, honeycomb and in other industrial uses. Phenolic resins traditionally contain free formaldehyde levels ranging from 0.3% to greater than 1.5%. Reducing this residual formaldehyde is a frequent request to resin suppliers from manufacturers.

New proprietary BREAKTHRU™ technology from Georgia-Pacific Chemicals addresses that desire. It has shown to lower formaldehyde in phenolic resins to below 1000ppm (or less than 0.1%) in laboratory analyses.

Extensive analyses of phenolic resins made with this proprietary technology comparing it to typical commercial resins, have shown the ability to significantly reduce free formaldehyde as well as reduce free phenol while maintaining comparable cure profiles. In honeycomb applications, the new technology indicated performance improvements could also be possible. Water-based, the technology can also eliminate the use of solvent borne resins in some applications.



Comparative Analyses Performed

The characterization of a typical commercial PF resin was compared to a phenolic resin with the new BREAKTRHRU technology utilizing:

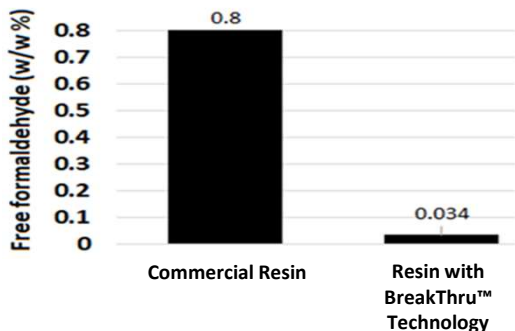
Thermal Analysis - Differential Scanning Calorimetry and Dynamic Mechanical Analyzer to compare pre-cure, onset of cure, end of cure, cure maximum temperatures, loss modulus maximum and tan delta maximum.

Chromatography - High-performance liquid chromatography and gas chromatography to compare free formaldehyde and free phenol and molecular weights.

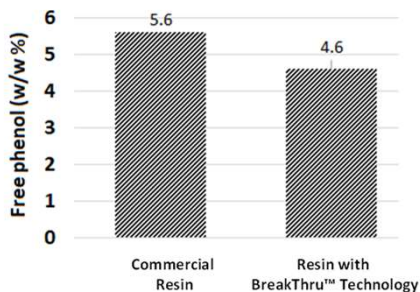
TYPICAL PROPERTIES	Commercial PF Resin (Control) (S1)	PF Resin with BreakThru™ Technology (S2)
Non-volatiles (w/w %)	75	75
Viscosity (cP)	2900	3520
pH	8.7	9.3
Free Formaldehyde (w/w%)	0.8	0.034
Free Phenol (w/w%)	5.6	4.6
Solvent	Water	Water

BREAKTHRU™ TECHNOLOGY FOR PHENOLIC RESINS

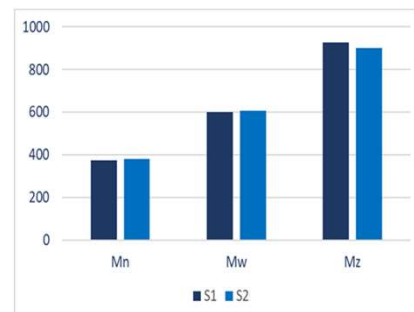
Free Formaldehyde Content



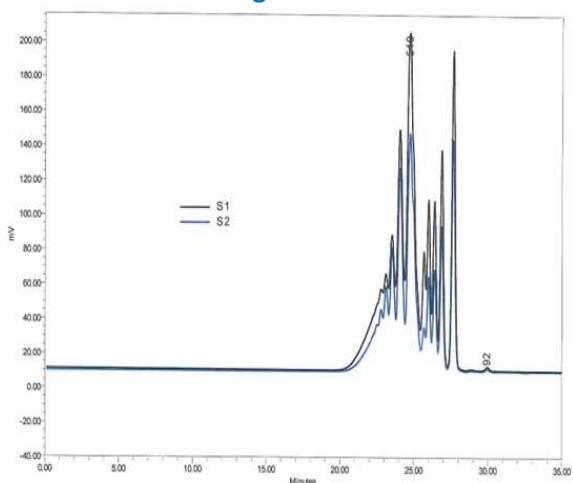
Free Phenol Content



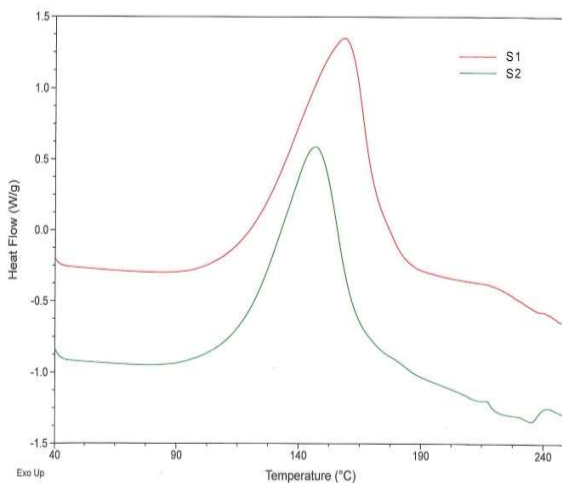
Adjustable Molecular Weights



Comparable Molecular Weight Distribution



Comparable Curing Heat Flow Performance



S1 Commercial Resin
S2 Resin with BreakThru™ Technology

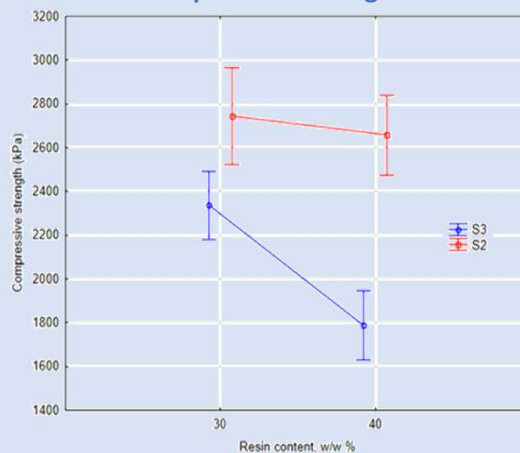
The curing profiles for the commercial resin and the BreakThru™ technology sample (S2) were comparable.

HONEYCOMB ASSESSMENTS

A honeycomb assessment was performed between a waterborne resin with the BREAKTHRU technology (S2) and a standard solvent-borne commercial phenolic resin (S3) used in honeycomb applications. The resin with BREAKTHRU technology contained less free formaldehyde and less free phenol. Significantly, as a waterborne resin, using it as a replacement for solvent borne resin carries additional advantages.

The compressive strength of the two resins were assessed. The testing showed the resin with BREAKTHRU technology had improved compressive strength compared to that of the commercial resin, particularly at 40% resin content. This study indicates the new technology could provide improved performance.

Compressive Strength



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