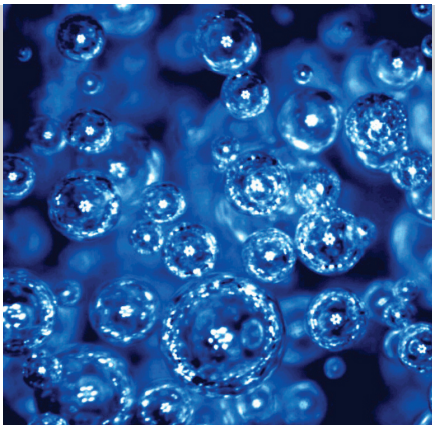


HYDROGENATED HYDROCARBON RESINS (HHCR)

Buss ChemTech is the leading supplier for resin hydrogenation technology and the only one to offer continuous hydrogenation technology for slurry processing.

Our experience with specialty as well as more standard products, combined with our comprehensive development capabilities, enables Buss ChemTech to provide its clients with optimized process designs, resulting in cost effective and high performance solutions.

Naturally, our hydrogenation technology is based on the proven performance characteristics of the Buss Loop® Reactor, which achieves the highest mass transfer rates for this and numerous other gas/liquid reactions in comparison to other technologies. Our HHCR technology allows clients to reduce solvent usage, minimize catalyst consumption and deliver consistently high quality water white resins. Our experience also includes partial and selective hydrogenations in which the degree of saturation and aromatic content of the final product is of great importance.

Hydrogenation Plant with Buss Loop® Reactor

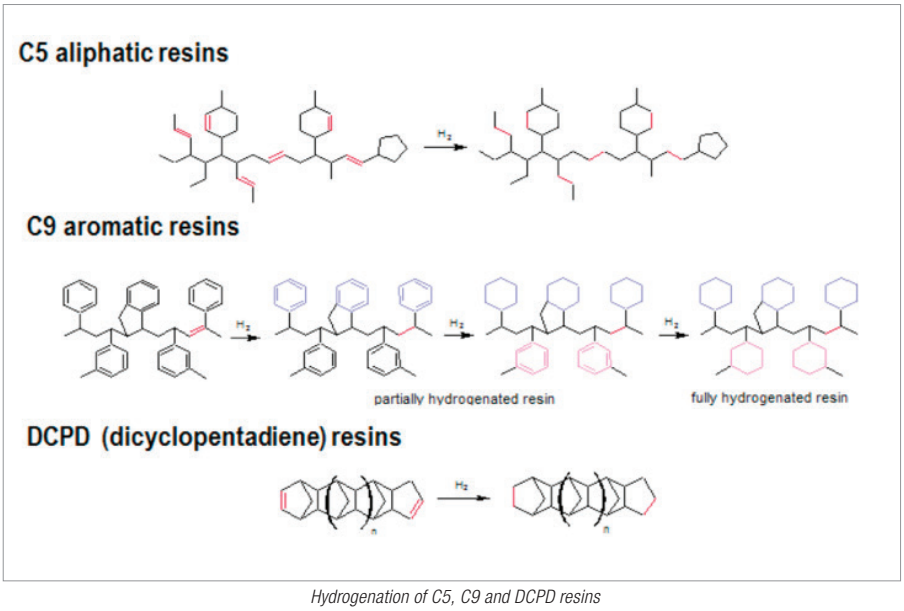
CHEMISTRY

Several types of petroleum-based resins are used as raw materials. The major characteristic defining these types is the nature of the double bonds: aliphatic or aromatic. The most important hydrocarbon resins are:

- Aliphatic C5
- Cycloaliphatic (dicyclopentadiene or DCPD)
- Aromatic C9

The figure shows the chemistry of the most typical resins.

Hydrogenation of hydrocarbon resins is primarily done to improve color and stability (UV and heat resistance) of the resin by removing vulnerable double bonds. Full, partial and selective hydrogenation are methods used to produce resins with broad compatibility and good stability. Depending on the desired target, Ni or Pd catalysts are used.



Hydrogenation of C5, C9 and DCPD resins

PROCESS

The resin hydrogenation process is predominantly a high temperature, high pressure reaction. The specific operating conditions will vary depending on the desired product, degree of hydrogenation and reactor type used.

The main reactor types are:
- Fixed (Trickle) Bed Column Reactor
- Stirred Tank Reactor (slurry)
- Buss Loop® Reactor (slurry)

The main characteristics for the different technologies are shown in the table below.
The Buss Loop® Reactor provides a number of advantages.

	BLR (Buss Loop® Reactor)	Fixed Bed Reactor	STR (Stirred Tank Reactor)
Catalyst	+ reduced loads and consumption ○ moderate attrition	+ low attrition – limited available surface – channel creation / hot spots – catalyst replacement leads to interruption	○ moderate attrition – higher loads and consumption
Hydrogen recycling	+ not necessary	– complex – very expensive (hydrogen compressor)	+ not necessary
Reaction Time	+ fast reaction time		○ moderate reaction time
Heat Removal	+ very high cooling capacity due to external heat exchanger	– poor cooling capacity due to limited heat transfer surface	– poor cooling capacity due to limited heat transfer surface
Operation Mode	Batch & Continuous	Continuous	Batch & Continuous
Product quality	+ high consistent product quality + full and partial hydrogenation	– very difficult to achive stable product quality + full and partial hydrogenation	+ high consistent product quality + full and partial hydrogenation
Flexibility	+ flexible; easy product change	– time consuming cleaning steps at product change	+ flexible; easy product change
Operating costs	+ moderate catalysts consumption + high resin concentration > 50% + low distillation costs	+ low catalyst consumption + no product/ catalysts separation – low resin concentration – high distillation costs – energy consumption of compressor	– high catalyst consumption – low resin concentration
Investment costs	○ moderate to high	○ high to moderate	+ moderate
Time to market	1-½ years	3-4 years	1-2 years

SUMMARY

Water white resins produced using technology from Buss ChemTech are recognized as having the highest quality on the market. In addition, there are numerous benefits from using a Buss Loop® Reactor, including:

- Smooth operation (high heat removal capacity)
- High mass transfer rate (optimized process and catalytic efficiency)
- Higher resin concentrations: less solvent, less energy cost (distillation)
- Homogeneous mixing (no hot spots)
- Closed system, no hydrogen recycling required
- Batch or continuous operation possible
- Consistently high product quality
- Less complex plant to run successfully
- Fastest time to market

BUSS ChemTech

www.buss-ct.com

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BUSS ChemTech AG | Hohenrainstrasse 12A | 4133 Pratteln 1 | Switzerland | Tel. +41 61 825 64 62 | Fax +41 61 825 67 37 | info@buss-ct.com