High-Pressure Hydrogenation

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The role and technology of high-pressure hydrogenation chemistry plays a significant role in the pharmaceutical, agrochemical, petroleum, and food industries of today. Furthermore, it appears regularly in academic research pertaining to drug development, total synthesis, and other areas of importance.

Hydrogenation itself has been around for 200 years, developed initially by French Chemist Paul Sabatier who shared the 1912 Nobel Prize for his work in this area.

The reaction has an exceptional breadth of literature demonstrating various homogenous and heterogeneous methodologies. Various methods or substrates will often require the usage of high-pressure hydrogenation specifically.

For a technique guide on using standard autoclaves, see David Ryffel's **Technique of the Week**.
For a methodology outline of Rh/CAAC-catalyzed dearomative hydrogenation, see Annie Hooper's **Method of the Week.**

Some Key Points to Highlight

These laboratory autoclaves are exceptional for most academic uses as they can be performed in a fume hood behind a blast shield. **However, they are only rated to approximately 750 psi and are not rated for any significant heating.**

VS

These autoclaves are reinforced and are built to withstand over 6,000 psi and can be heated up to 250 °C (limited only by the O-rings sealing the vessel). They are also built to fit into a rocker for mixing and homogenous heating via thermocouplers.

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1. Acquire a vial with a small hole bored into the top. (This will allow hydrogen to get into your reaction vessel once loaded into the reinforced autoclave).

Tip: *To bore this hole, it is recommended to utilize a hot metal rod to penetrate the vessel. However, this can also be accomplished carefully with a drill and small drill head.*

2. Load the vial with your substrate, catalyst, and solvent. (for the purposes of this demonstration, an air sensitive catalyst was utilized and thus everything was loaded in a glovebox)

3. Load the sample into the autoclave, packed tightly around the vial with cotton. (This will prevent the vial from shifting during the rocking process)

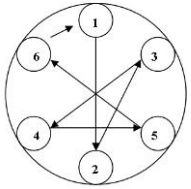
Tip: *Mark the vessel with a piece of tape or indicator of the part of the autoclave facing upward during the rocking process. Align the bored hole with this marker to prevent spilling.*

4. Seal the vessel tightly with the sample in place and remove it from the glovebox.

Tip: *Do not rotate the vessel, always keep the solution upright during transport!*

5. Tighten the bolts on top of the autoclave with a torque wrench, remembering to always seal in a star-pattern, depicted below.

Tip: *You'll want the vessel secured by tightening the bolts significantly, however, be mindful not to strip or damage the ports. For this setup, I'll usually tighten to about 250 lbs of resistance.*



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6. Load the autoclave into the rocker and make sure the vessel is secure. Next, secure the reinforced steel line from the gas tanks to the vessel.

Tip: *Set the rocker to rest upright while loading the autoclave, this will not only minimize chances of spilling solution, but will make the process of loading the heavy autoclave much easier!*

7. To connect the compressed gas to the system, the valves connecting the tanks to the autoclave must be opened and routed accordingly to the vessel. Next, utilizing the valves fixed on the opposite side of a reinforced wall, you can begin to pressurize and flush the vessel.

Tip: *For the sake of being extra careful, the vessel is pressurized to 200 psi with nitrogen slowly and released 3 times. Next, the vessel is pressurized to 200 psi with hydrogen and depressurized 2 times before being pressurized to the desired psi.*

PSI readout inside the vessel

Current temperature in the vessel

Desired temperature of the vessel

Heating temperature limit (Before system override)

8. Once connected to the system and pressurized, the rocker can start, and the temperature can be set. To start the rocker, simply connect the motor of the rocker to the power supply. Set the desired temperature using the digital interface and set the high temperature limit at least 60 °C above this temperature to allow sufficient variance in the temperature oscillation during equilibration. After setting everything, press start.