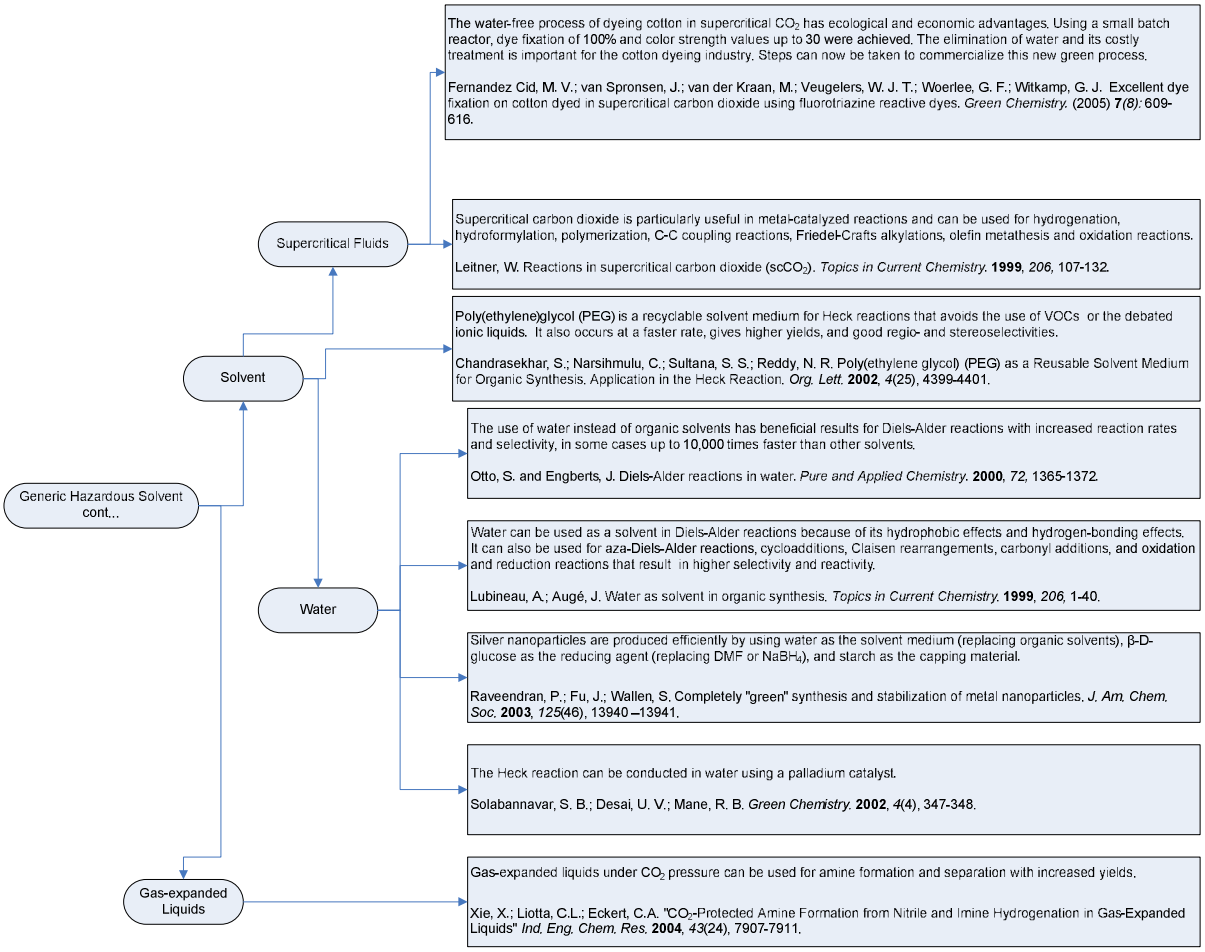
Generic Hazardous Solvent cont...
Solvent
Supercritical Fluids
Water
Gas-expanded Liquids
The water-free process of dyeing cotton in supercritical CO_2 has ecological and economic advantages. Using a small batch reactor, dye fixation of 100% and color strength values up to 30 were achieved. The elimination of water and its costly treatment is important for the cotton dyeing industry. Steps can now be taken to commercialize this new green process.
Fernandez Cid, M. V.; van Spronsen, J.; van der Kraan, M.; Veugelers, W. J. T.; Woerlee, G. F.; Witkamp, G. J. Excellent dye fixation on cotton dyed in supercritical carbon dioxide using fluorotriazine reactive dyes. *Green Chemistry.* (2005) **7***(8):* 609-616.
Supercritical carbon dioxide is particularly useful in metal-catalyzed reactions and can be used for hydrogenation, hydroformylation, polymerization, C-C coupling reactions, Friedel-Crafts alkylations, olefin metathesis and oxidation reactions.
Leitner, W. Reactions in supercritical carbon dioxide ($scCO_2$). *Topics in Current Chemistry.* **1999**, *206,* 107-132.
Poly(ethylene)glycol (PEG) is a recyclable solvent medium for Heck reactions that avoids the use of VOCs or the debated ionic liquids. It also occurs at a faster rate, gives higher yields, and good regio- and stereoselectivities.
Chandrasekhar, S.; Narsihmulu, C.; Sultana, S. S.; Reddy, N. R. Poly(ethylene glycol) (PEG) as a Reusable Solvent Medium for Organic Synthesis. Application in the Heck Reaction. *Org. Lett.* **2002**, *4*(25), 4399-4401.
The use of water instead of organic solvents has beneficial results for Diels-Alder reactions with increased reaction rates and selectivity, in some cases up to 10,000 times faster than other solvents.
Otto, S. and Engberts, J. Diels-Alder reactions in water. *Pure and Applied Chemistry.* **2000**, *72,* 1365-1372.
Water can be used as a solvent in Diels-Alder reactions because of its hydrophobic effects and hydrogen-bonding effects. It can also be used for aza-Diels-Alder reactions, cycloadditions, Claisen rearrangements, carbonyl additions, and oxidation and reduction reactions that result in higher selectivity and reactivity.
Lubineau, A.; Augé, J. Water as solvent in organic synthesis. *Topics in Current Chemistry.* **1999**, *206,* 1-40.
Silver nanoparticles are produced efficiently by using water as the solvent medium (replacing organic solvents), β-D-glucose as the reducing agent (replacing DMF or $NaBH_4$), and starch as the capping material.
Raveendran, P.; Fu, J.; Wallen, S. Completely "green" synthesis and stabilization of metal nanoparticles. *J. Am. Chem. Soc.* **2003**, *125*(46), 13940 –13941.
The Heck reaction can be conducted in water using a palladium catalyst.
Solabannavar, S. B.; Desai, U. V.; Mane, R. B. *Green Chemistry.* **2002**, *4*(4), 347-348.
Gas-expanded liquids under CO_2 pressure can be used for amine formation and separation with increased yields.
Xie, X.; Liotta, C.L.; Eckert, C.A. "CO_2-Protected Amine Formation from Nitrile and Imine Hydrogenation in Gas-Expanded Liquids" *Ind. Eng. Chem. Res.* **2004**, *43*(24), 7907-7911.