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Supercritical Fluids (SCF's) and Waste Treatment

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Abstract:
Recently, a lot of consideration has been guided towards discovering alternatives to conventional solvents. The chemical industry, overall, depends intensely on solvents, which has contributed to the large volume of solvent related waste created to date. This waste is not just toxic to humans however can cause antagonistic impacts to the surrounding environment and ecosystems and in that capacity a substitute is required. Some of the proposed ideas incorporate solid state reactions, greener solvents and alternative solvent systems. This paper focuses on supercritical fluids (SCF's) as an alternative solvent system.

Keywords: *Supercritical Fluids, Waste Treatment, conventional Solvents*

1. Introduction

Solvents possess the majority of the concentration in the domain of green chemistry. Solvents play crucial roles in various chemical reactions they are not generally essential also, the substitution of these conventional systems can eliminate the immense of solvent related waste. The environmental impact from solvent waste of chemical industries underscores the present need to find 'greener' and more sustainable alternatives. Supercritical fluids (SCF's) are one of the many green solvents which have received a lot of consideration. Supercritical fluid is a term that alludes to a substance exposed to temperatures and pressures above the corresponding critical point. There are various commonly studied SCF's including: carbon dioxide ($ScCO_2$), water (ScH_2O), propane (ScC_3H_8), methanol ($ScCH_3OH$) and nitrous oxide (ScN_2O) among others. Of these, $ScCO_2$, is the most commonly used, this is a result of its critical pressure and critical temperature. Most SCF's having next to no environmental impact and is non-toxic, non-combustible and relatively cheap, making these solvents an incredible contrasting alternative to the systems as of now set up. An attempt has been made in this review to present some of the applications of SCF's in waste treatment.

2. Waste Treatment

SCF's can apply in the field of waste treatment. ScH_2O can be used to treat organic waste by oxidizing it to produce CO_2, H_2O and N_2 in a procedure alluded to as Supercritical Water Oxidation (SCWO) [1]. The process is carried out at 600˚C and 23 MPa, at which point most organic compounds become soluble in ScH_2O. This change in solubility is because of the decrease in dielectric constant and ionic product of the solvent [2]. Subsequently, ScH_2O acts as a non-polar solvent that is miscible with most gases, for example, O_2 and promotes the rapid oxidation of the waste water [2]. Other materials contained in the waste stream, as inorganic salts, remain insoluble and can be precipitated out of the solution and collected independently [3]. The efficiency of this procedure can achieve values of up to 99 % with a process time of few seconds. Moreover, this pathway offers the extra advantage of devastating hazardous waste and isolating inorganics in a solitary reactor [3]. Also, this process does not take into account the generation of other common air pollutants, for example, NO_x and SO_2, which would some way or another be formed in the cremation of such waste [2, 3]. The arrangement ordinarily used is a pipe reactor however this kind of reactor has the impediment of plugging if the waste stream, once treated, produces a lot of inorganic salts. However, there have been licenses advanced to deal with this problem, wherein the reactor contains two zones, one in which the SCF is contained and a second zone containing cold water at the same pressure as the ScH_2O. The reactor works as follows; as the organic waste is oxidized the corresponding gaseous products are vented from the top of the reactor, while the solid

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materials produced will sink into the cold water layer. Constant stirring is kept up in this layer to form slurry that would then be able to be effectively expelled [3]. However, there have been difficulties in fully optimizing this procedure because of the corrosive nature of ScH_2O and the byproducts of SCWO which in the long run prompt the degradation of the reactor vessel. Nevertheless, active research is being led to convey SCWO to an industrial scale [3].

3. Plastic Recycling

SCF's demonstrate guarantee in the production of chemically recycled plastics. Recently, noteworthy focus has been set on plastic recycling because of the realization that the degradation of such plastics is relatively inconceivable under normal biotic and abiotic conditions. This has prompt problems, for example, landfill overflow. There have been some attempts to discover other options to the present products utilized, for example, PLA a polymer which is biodegradable under specific conditions. However, no distinct alternative has been found. Another area of research within this field is the chemical degradation of plastics by SCF's. By combining certain polymers with SCF's it is conceivable to depolymerize them to the corresponding monomers faster and in a more specific way than conventional techniques.

The monomers obtained are of decent quality such an extent that they can be recycled [4, 5]. Condensation polymers can be depolymerized by solvolysis using supercritical water or alcohol. Previous research has demonstrated that complete depolymerization of PET to monomer sized units can take place in $ScCH_3OH$ in a short time span without a catalyst, [4 - 8]. Addition polymers, like resins usually found in electronics, are built out of materials, for example, phenols which have a high thermal stability. When combined with ScH_2O and a slight Na_2CO_3 modifier, these materials can be disintegrated into the corresponding monomers in as short a timeframe with yields achieving 90 % [4, 5].

4. Conclusion

Solvents utilized for waste treatment contributes tremendously to the ecological contamination. In this manner, it is important to discover a few other options to the customary methods. There is a possibility for SCF's to replace traditional solvents in a few perspectives. SCF's can clearly offer a substitution to conventional solvents in many aspects and in waste treatment it would be incredibly useful to replace the customary solvents. SCF's offer an environment friendly method for which a greener and more feasible alternative can be looked for.

References

[1] Goto, M., Nada, T., Ogata, A., Kodama, A., Hirose, T. Supercritical water oxidation for the destruction of municipal excess sludge and alcohol distillery wastewater of molasses. *The Journal of supercritical fluids*, 1998. 13 (1), 277-282.

[2] Kritzer, P., Dinjus, E. An assessment of supercritical water oxidation (SCWO): existing problems, possible solutions and new reactor concepts. *Chemical Engineering Journal*, 2001. 83 (3), 207-214.

[3] Barner, H., Huang, C., Johnson, T., Jacobs, G., Martch, M., Killilea, W. Supercritical water oxidation: an emerging technology. *Journal of hazardous materials*, 1992. 31 (1), 1-17.

[4] Goto, M. Chemical recycling of plastics using sub-and supercritical fluids. *The Journal of Supercritical Fluids*, 2009. 47(3), 500-507.

[5] Adschiri, T., Lee, Y. W., Goto, M., Takami, S., Green materials synthesis with supercritical water. *Green Chemistry*, 2011. 13 (6), 1380-1390.

[6] Ozaki, J., Djaja, S., Oya, A., Chemical recycling of phenol resin by supercritical methanol. *Industrial & engineering chemistry research*, 2000. 39 (2), 245-249.

[7] Genta, M., Iwaya, T., Sasaki, M., Goto, M., Hirose, T., Depolymerization mechanism of poly (ethylene terephthalate) in supercritical methanol. *Industrial & engineering chemistry research*, 2005. 44 (11), 3894-3900.

[8] Subramaniam, B., McHugh, M., Reactions in supercritical fluids-a review. *Industrial & Engineering Chemistry Process Design and Development*, 1986. *25* (1), 1-12.