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G2- Greenness Grid as a powerful tool to chemical processes evaluation

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PURPOSE OF THE ABSTRACT

Since the proposal of the Green Chemistry framework and its 12 principles by Paul Anastas et al. in the 1990s,1 several strategies have been created to assess how sustainable processes in the chemical industry are. Amongst these, some take a qualitative approach (i.e. the GlaxoSmithKline metrics,2 the EcoScale3 or solvent selection guides4 while others consider quantitative approaches, for example, the Life Cycle Assessments5-8 or the method proposed by De Vierno Kruder et al.9 in which a metric was established for each principle of Green Chemistry using data from different sources, such as the Globally Harmonized System of Classification and Labelling of Chemicals (GHS). More recently, Pinto et al.10 developed a green chemistry grid-G2, which varies from 0 (worst scenario) to 15 (best scenario), with a well-defined quantitative and qualitative scale containing a final ?green index (Unsustainable Process [0-3[; Critical Process [3-6[; On Path Process [6-9[; Potential Process [9-12[; Sustainable Process [12-15])?. This grid allows transversal classifications of process/products from different areas or industries.
In order to validate the grid with practical data, greenness grid-G2 was applied to two different case studies based on previously published articles on: (i) the synthesis of benzoic hydrazide [11] and (ii) anionic polyacrylamide copolymers, using hydrolysis and copolymerization strategies [12,13]. Both articles discuss the greenness of the processes, however the aim of this work is not to evaluate the authors' considerations, but to use the articles' data to validate the grid-G2 and then compare the obtained data with the data described in both papers.
According to G2, for the synthesis of benzoic hydrazide, the grid suggests that he authors improved the traditional synthesis process from 4.44 - Critical process to a 12.51 - Sustainable process. Considering anionic polyacrylamide copolymers, the Green Index of the ?Copolymerization? process was inferior to the Green Index of the ?Hydrolysis? process (8.04 vs 10.29, respectively). This means that, according to the proposed Green Chemistry grid's Green Index, the ?Hydrolysis? process is considered a Potential process (Green Index between 9.00 and 12.00) while the ?Copolymerization? process is considered an On Path process.
It should be noted, however, that the proposed Green Chemistry grid is based on what is considered a ?Sustainable Process? in the chemical industry, at the time of writing. This is subject to change over time as, for example, technologies evolve or laws change, and consequently, a process that is considered ?Green? today may become ?Unsustainable? tomorrow.

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FIGURES

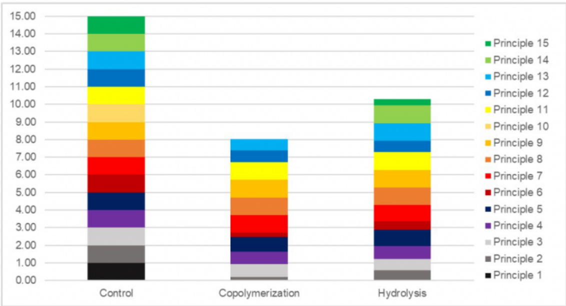

FIGURE 1

Copolymerization vs Polymerization+Hydrolysis

Summary results for the assessment of each principle for the synthesis of anionic polyacrylamide following a copolymerization or copolymerization+hydrolysis routes

FIGURE 2

KEYWORDS

Green chemistry Grid | Copolymerization vs Polymerization+Hydrolysis | Chemical Processes Ranking | Green Chemicval Routes

BIBLIOGRAPHY