URBAN SEWAGE VALORIZATION TO BIODIESEL PRODUCTION: LIPID EXTRACTION THROUGH ADSORPTION ON SPUNBONDED NONWOVEN POLYPROPYLENE

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Introduction

In response to the increasing global demand for fuels, the decrease of fossil reserves and the climate change, the scientific research is focusing on alternative fuel sources, such as biodiesel, commonly known as FAMEs. Urban sewage sludge, deriving from the wastewater treatment process, is a very promising feedstock for the obtainment of biodiesel, for its abundant content of lipids. The classical method of recovery of lipids from sludge is based on the extraction through organic solvents (e.g. n-hexane), by generating an exhausted sludge wet of organic solvent. Therefore, the most important issue related to the recovery of lipids from sludge is the optimization of a clean route, possibly avoiding the direct contact of organic solvents with the sewage sludge.

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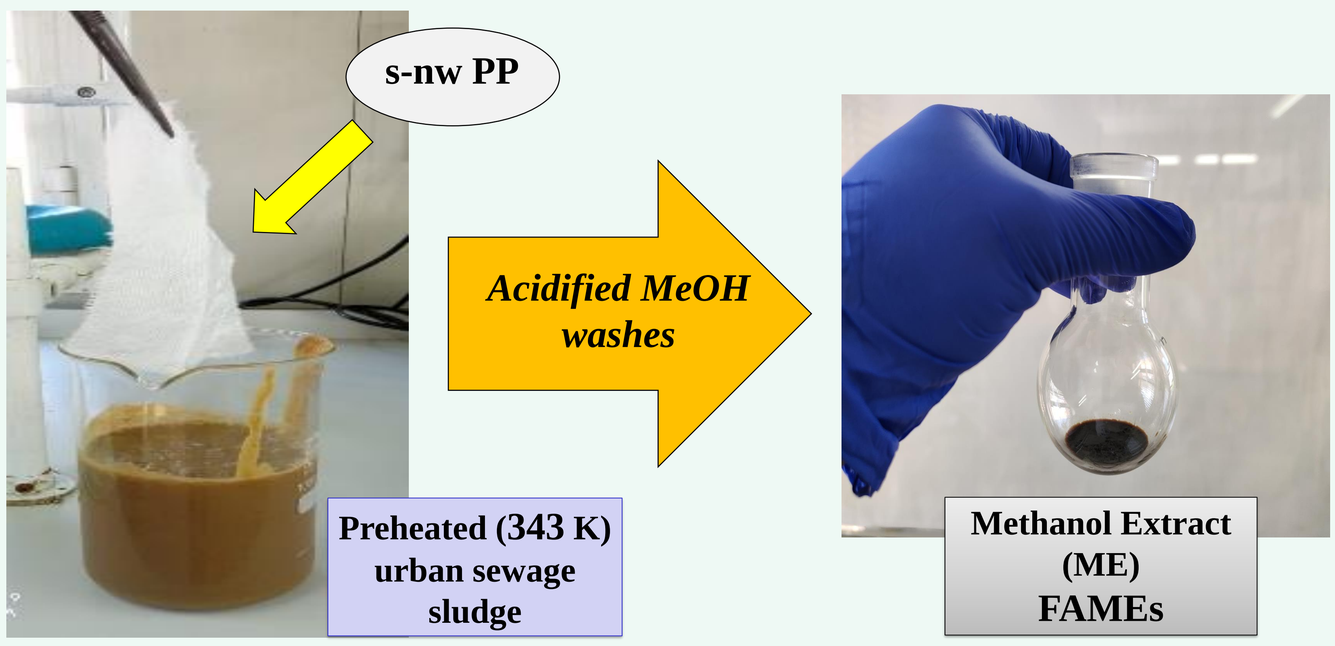
Aim of the work

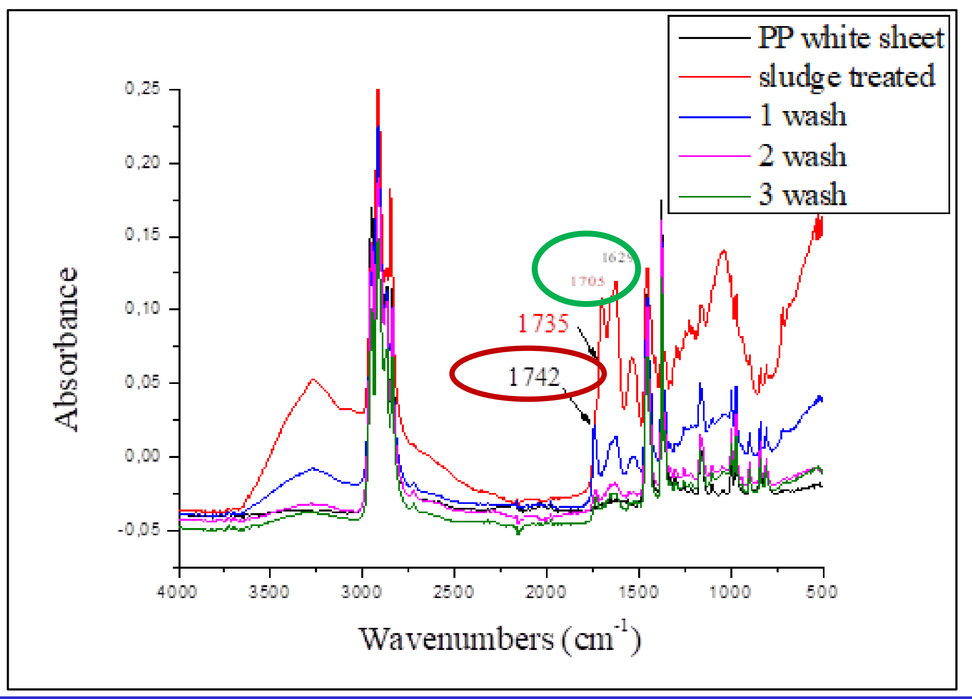
In this work we studied a novel solvent-less extraction of the lipid component from sewage sludge, to produce FAMEs, based on the physical and chemical adsorption on surfaces composed of non-polar polymeric materials. The commercial product Spunbonded nonwoven polypropylene (s-nw PP) SP30-001 IDR was deeply investigated. After tested the virgin s-nw PP, we focused on the polymer recovered from the surgical masks, widely used to counteract the pandemic virus Sars Cov 2. The primary sewage sludge studied was sampled from the wastewater treatment plant located in Putignano (Puglia, Italy), and it was preliminarily characterized: pH 6,9; TS: 6.9%, Lipids: 24.6%$_{TS}$, FFAs: 17%$_{TS}$).

Langmuir **2015** 11, 30

Lipid Extraction from Urban Sewage Sludge through Adsorption on Spunbonded nonwoven polypropylene (*s-nw PP*)



An enrichment of free fatty acids on the surface of the s-nw PP sheets can be achieved and the lipids can be recovered and simultaneously esterified with acidified methanol to obtain FAMEs.



After the contact with the preheated sludge, the ATR-FTIR signal of the carbonyl group of fatty acids at ***1700 cm^{-1}*** was detected; after washing with acidified methanol, the intensity of this absorption decreased while, on the contrary, a signal at ***1741 cm^{-1}***, attributable to the FAMEs, increased considerably.

Results & Discussion

Influence of the starting pH of the sludge

The low extractive performance on the raw urban sewage sludge can be attributed to the adsorption on the s-nw PP of calcium soap of fatty acids, as evidenced by the ATR-FTIR analysis.

pH	% FAMEs (in ME)	FAMEs RECOVERY YIELD %
6,9	22,4	6,6
1,2	39,0	24,1

When the urban sewage sludge was preliminarily acidified through the addition of HCl conc., it was registered a significant FAMEs enrichment in the methanol extract (ME), with an higher FAMEs recovery yield.

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Effect of the amount of the s-nw PP on the extraction process

The extractive performance improve significantly, working with a higher amount of s-nw PP as against the wet sludge weight; on the contrary, the content of FAMEs in the ME decreases slightly. We calculated the parameter R, as shown below.

R %	% FAMEs (in ME)	FAMEs RECOVERY YIELD %
3	39,0	24,1
6	33,9	38,8

$$R = \frac{s-nw\ PP\ sheets\ weight}{initial\ wet\ sludge\ weight}\%$$

Reuse of the s-nw Polypropylene

After the first cycle, the s-nw PP sheets were reused with a significant loss of extraction efficiency: this is due to the presence of dried residual material on the polymeric surface.

R %	FAMEs RECOVERY YIELD %	
	1° CYCLE	*2° CYCLE*
3	24,1	18,6
6	40,3	31,4

Conclusions

In this work it is studied a novel solvent-less approach to the extraction of the lipid content from the urban sewage sludge. Exploiting the physical chemical adsorption between non-polar compounds and a Spunbonded nonwoven Polypropylene surface, under appropriate experimental conditions, it is possible to extract free fatty acids and, simultaneously, to esterify them, obtaining FAMEs (biodiesel). We investigated some experimental parameters: the influence of the starting pH of the sludge, the weight ratio of polymer and wet sludge, and the possibility to reuse the s-nw PP in subsequent cycles were studied in order to optimize the process.