Treatment of TMAH solutions from microelectronic industry: a combined process scheme

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INTRODUCTION

In the microelectronics industry, the production of semiconductors is a process that involves several treatments in separate units and it is constantly developing. In these production cycles, large quantities of ultra-pure water are required, and thus a huge amount of polluted process water is produced, that has to be treated and, if it reaches a sufficient level quality, reused. All over the world the microelectronics industry is trying to adopt production processes accompanied by water treatment processes for production of ultra-pure water at a reasonable cost, involving water reuse. The first step for such a strategy is to find reliable processes for the treatment of such industrial wastewaters. The semiconductor and electronic component manufacturing plants typically generate high-strength wastewaters containing high concentrations of Tetramethyl Ammonium Hydroxide (TMAH, $(CH_3)_4NOH$) that is recognized as a poisonous, corrosive, slow to biodegrade and eutrophic to aquatic environments. Disposal of TMAH wastewaters from an industrial plant is a difficult and costly issue.
In this paper, an integrated process stream is proposed for the degradation of TMAH in a real liquid waste of electronic industry, in which a sequence of treatments, chemical-physical and biological, are carried out for both the depuration of the outlet stream, and for the recovery of TMAH as well as for water reuse. An overall mass balance on the whole scheme is presented, based on the removal efficiencies obtained in preliminary experimental tests.

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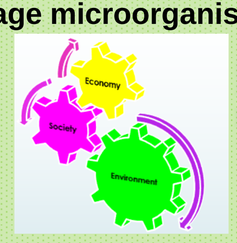
PARTNER OF THE PROJECT

- ✓ **L- foundry**
  Industrial partner -Responsible
  (Provided wastewater, support for all activities)
- ✓ **UNIVERSITY OF L'AQUILA (Italy)**
  Scientific partner
  (Laboratory tests of biodegradation, hydrocavitation and process analysis)
- ✓ **BME Biomaterials & Engineering S.R.L. (Italy)**
  (Process analysis)
- ✓ **B.F.C. Sistemi Srl (Italy)**
  (designs and constructs chemical plants and mechanical systems for industry)

AIMS OF THE PROJECT

- ❑ **Design, construction and validation of a semi-industrial pilot plant enabling the treatment of spent photoresist/tetramethylammonium hydroxide (PR/TMAH), and other mixed solutions generated by the E&S (Electronic & Semiconductor) manufacturing processes**
- ❑ **Demonstrate, at industrial scale, the biodegradation of TMAH to non-toxic biomass plus NH3 by using some specific savage microorganisms selected during the previous R&D phase**
- ❑ **Prove the cost sustainability of the process**



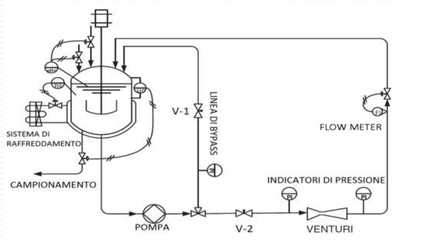
- ❑ **Set up a more efficient water management approach proving that it is possible to reduce the net water consumption by saving water and evaluate the total reuse of treated wastewater in the company's industrial plant.**

Three types of wastewaters are treated in the pilot plant coming from production of printed circuit

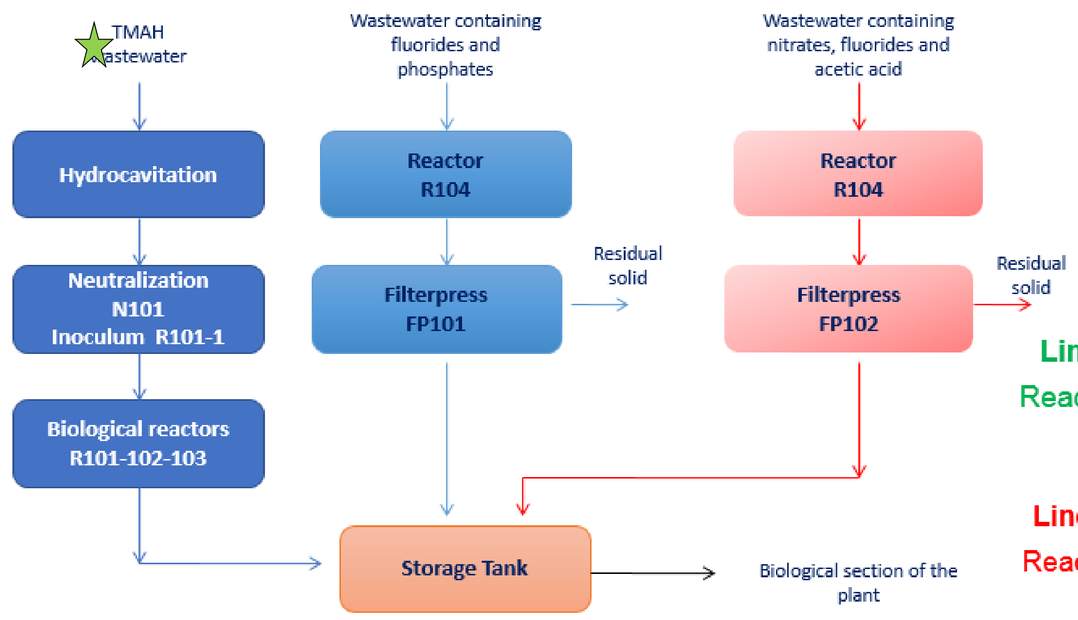
DANGEROUSNESS OF TMAH

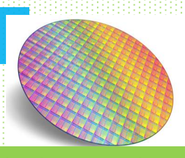
During the process of realization of integrated circuits, tetramethylammonium hydroxide, also known as TMAH it is used.

Focus: hydrocavitation of TMAH



Block scheme of the plant





Results (lab scale)

Line 1

Removal yield of TMAH
1. 52% R101
2. 75% R102
3. 83% R103

Total yield: 98%

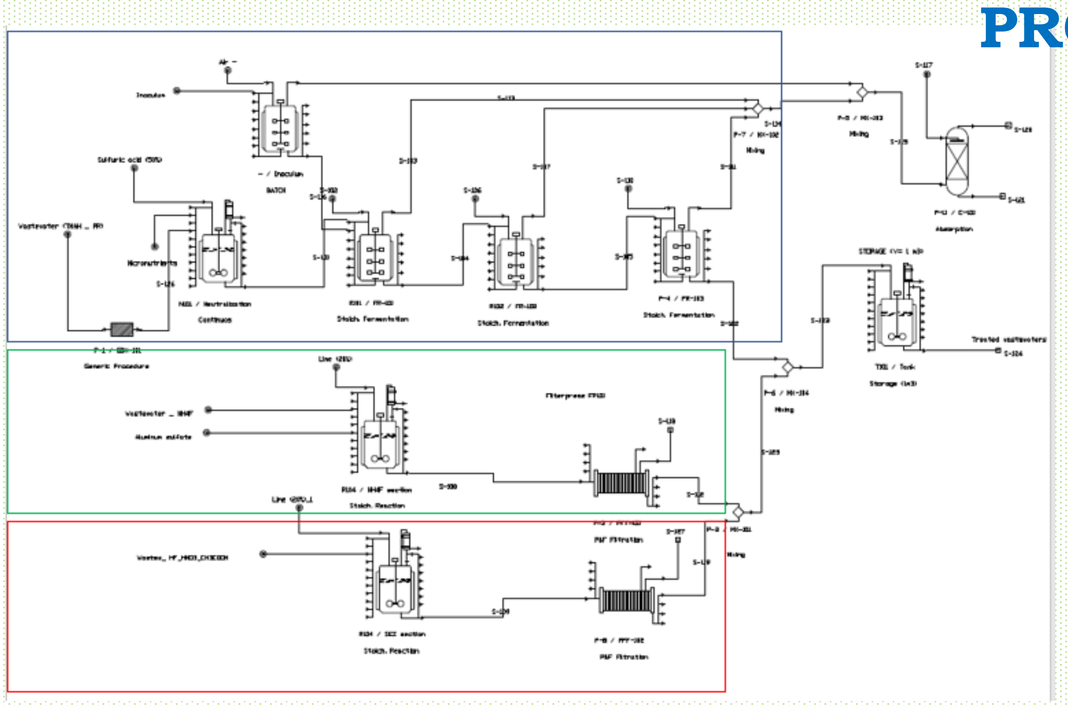
Line 2

Reaction yields for the removal of the impurities ~100%

Line 3

Reaction yields for the removal of the impurities ~100%

LABORATORY APPARATUS FOR THE HYDROCAVITATION OF TMAH



PROCESS ANALYSYS

Input - Wastewater	Unit
WastewaterTMAH Line 1	25 kg/h
Wastewater Line 2	60 kg/d
Wastewater Line 3	16 kg/d

Input – Reagents – Line 1	kg/h
Sulfuric acid for neutralization	0.1

Output –Line 1	kg/h
Treated wastewater	27

Input – Reagents - Line 2	kg/d
Lime solution	21.84
Aluminum sulfate	2.4

Output– Line 2	kg/d
Treated wastewater	75
Residual solid	9

Input – Reagents - Line 3	kg/d
Lime solution	9.29

Output – Line 3	kg/d
Treated wastewater	24.6
Residual solid	1.28

ACKNOWLEDGMENT
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