

Chapter 4

Chemical and Biological Processes for Nutrients Removal and Recovery

Dafne Crutchik Pedemonte
University of Verona, Italy

Nicola Frison
University of Verona, Italy

Carlota Tayà
University of Vic-Central University of Catalonia, Spain

Sergio Ponsa
University of Vic-Central University of Catalonia, Spain

Francesco Fatone
University of Verona, Italy

ABSTRACT

This chapter gives an overview on the main technologies for nutrient removal from industrial wastewater by focusing on principles and operational parameters of real applications. A plethora of technologies can achieve the nutrients removal from wastewater depending mainly on their concentration and forms; however, biological nitrification and denitrification and chemical precipitation are the most common processes used today to remove nitrogen and phosphorus, respectively. Stripping, adsorption and membrane based processes for nutrients recovery can be economically viable only when nitrogen concentration is higher than 1.5-2 gN/L. On the other hand, phosphorus recovery should always be pursued and struvite crystallization is the most common option that should be evaluated together with biological phosphorus accumulation in sludge or plants for the following post-processing and valorization.

INTRODUCTION

Nitrogen and phosphorus are essential elements of life, however, the continuous release of excess nitrogen and phosphorus into the environment during naturally occurring processes (e.g. weathering, leaching, erosion) and anthropogenic activities (e.g. surface run-off from agricultural and livestock activities, wastewater treatment plants, etc.), which may lead to eutrophication (i.e. algae bloom and oxygen depletion

DOI: 10.4018/978-1-5225-1037-6.ch004

in aqueous systems) in natural water systems. The eutrophication problem is expected to increase due to the increasing population, agricultural intensification and industrialization. Nevertheless, eutrophication can be reversed by reducing the nutrients load to water bodies. One such solution is to decrease the load of nutrients discharged from wastewater treatment plants. Thus, efficient and reliable nutrients removal and/or recovery technologies are required. Nitrogen and phosphorus removal/recovery from wastewater can be achieved by biological or physical-chemical processes. The selection of nutrients removal/recovery technologies is determined by the nitrogen and phosphorus concentrations, and consequently the cost-effectiveness of the process. The nutrients removal/recovery technologies can be classified into three concentrations ranges (Mulder, 2003):

- Diluted wastewater with phosphorus concentration <40 mg P/L and ammonium concentration <0.1 g N/L. In this nutrients concentration range, biological nutrients removal is the preferable process based on cost-effectiveness. In addition, chemical phosphorus precipitation can be an option for phosphorus removal from diluted wastewater.
- Concentrated wastewater with phosphorus concentration >60 mg P/L and ammonium concentration in the range 0.1 - 5 g N/L. Chemical phosphorus precipitation processes are identified as interesting alternatives for the simultaneous recovery of phosphorus and nitrogen as an agricultural fertilizer (struvite) or phosphorus recovery as a raw material for the phosphorus industry (calcium phosphates). For nitrogen, biological treatment processes are also to be preferred.
- Concentrated wastewater with ammonium concentration >5 g N/L. In this range, the physical-chemical process for ammonium removal can be technically and economically feasible (e.g. ammonia stripping, selective ion exchange and breakpoint chlorination).

Thus, this chapter summarizes the methods and technologies commonly used for nitrogen and phosphorus removal/recovery from wastewater. While the processes for nutrients removal, such as biological nutrients removal or chemical phosphorus precipitation from diluted wastewater, have been widely adopted in nutrient removal plants, strategies for its recovery are still being studied. One such technology is the phosphorus recovery by struvite crystallization from wastewater streams with high phosphorus concentration. Moreover, ammonium removal from concentrated wastewater by ammonia stripping can be used because of its simple operation and high efficiency.

NITROGEN AND PHOSPHORUS IN INDUSTRIAL WASTEWATER

The characteristics of industrial wastewater vary essentially with the type of industry and the type of industrial process used (Table 1). Agro-industrial effluents, like piggery effluents or fishery discharges, slaughterhouses and meat processing, food processing, frequently combine high concentration both in ammonium, phosphorus and organic matter. For many industrial wastewaters, especially in chemical and petrochemical industry, reduction of effluent total nitrogen is difficult because of batch production operations and the refractory nature of many complex organic nitrogen compounds in process chemicals.

34 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/chapter/chemical-and-biological-processes-for-nutrients-removal-and-recovery/170021

Related Content

The Squatters

(2022). *Leadership Approaches to the Science of Water and Sustainability* (pp. 140-151).
www.irma-international.org/chapter/the-squatters/311565

The Zinc Mines

(2022). *Leadership Approaches to the Science of Water and Sustainability* (pp. 52-62).
www.irma-international.org/chapter/the-zinc-mines/311558

Multi-Temporal Landsat Remote Sensing for Forest Landscape Fragmentation Analysis in the Yoko Forest, Kisangani, DRC

Jean-Fiston Mikwa Ngamba, Ewango Corneille Ekokinya, Cush Ngonzo Luwesi, Yves-Dady Botula Kahindo, Muhogwa Jean Marieand Hyppolite Nshimba Seya (2019). *Hydrology and Water Resources Management in Arid, Semi-Arid, and Tropical Regions* (pp. 173-198).
www.irma-international.org/chapter/multi-temporal-landsat-remote-sensing-for-forest-landscape-fragmentation-analysis-in-the-yoko-forest-kisangani-drc/230275

General Review of Calibration Process of Nonlinear Muskingum Model and Its Optimization by Up-to-Date Methods

Umut Krdemirand Umut Okkan (2020). *Decision Support Methods for Assessing Flood Risk and Vulnerability* (pp. 61-83).
www.irma-international.org/chapter/general-review-of-calibration-process-of-nonlinear-muskingum-model-and-its-optimization-by-up-to-date-methods/233458

A Spatial Database of Hydrological and Water Resources Information for the Nyangores Watershed of Kenya

Luke O. Olang, Mathew Herrnegger, Doris Wimmerand Josef Fürst (2018). *Hydrology and Best Practices for Managing Water Resources in Arid and Semi-Arid Lands* (pp. 121-136).
www.irma-international.org/chapter/a-spatial-database-of-hydrological-and-water-resources-information-for-the-nyangores-watershed-of-kenya/186055