

# LA FITODEPURAZIONE DELLE ACQUE REFLUE: ORIGINE E SVILUPPO

## PARTE SECONDA

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### 9. I meccanismi di rimozione degli inquinati e il ruolo delle piante: una sintesi

Dopo i primi anni settanta un numero sempre crescente di ricercatori ha studiato molti aspetti, teorici e pratici, inerenti la fitodepurazione. Attualmente, le pubblicazioni scientifiche internazionali che si occupano delle zone umide costruite, sono molto numerose. Praticamente, in ogni nazione vi sono studiosi che hanno relazionato, in modo rigoroso, su qualche argomento connesso con la fitodepurazione. In particolare, molto è stato scritto su due aspetti che costituiscono il “cuore” del sistema: a) i meccanismi di rimozione degli inquinanti, b) il ruolo delle macrofite.

Sappiamo che si possono realizzare differenti zone umide costruite, anche molto diverse tra loro, ma tutte utilizzano, in termini qualitativi, gli stessi processi biologici, chimici e fisici per rimuovere gli inquinanti. In termini quantitativi, l'azione disinquinante è diversa tra sistema e sistema. La descrizione dettagliata dei meccanismi di rimozione esula dalle finalità di questa pubblicazione, pertanto nella tabella 4, sono sinteticamente indicati i principali processi che avvengono nei sistemi di fitodepurazione.

	Meccanismi di rimozione
Sostanze organiche biodegradabili (quantificabili come BOD)	<ul style="list-style-type: none"> <li>• Degradazione microbica in ambiente aerobico, anossico e anaerobico</li> <li>• Adsorbimento</li> </ul>
Azoto	<ul style="list-style-type: none"> <li>• Ammonificazione</li> <li>• Nitrificazione</li> <li>• Denitrificazione</li> <li>• Assimilazione delle piante</li> <li>• Adsorbimento</li> <li>• Volatilizzazione dell'ammoniaca</li> </ul>
Fosforo	<ul style="list-style-type: none"> <li>• Adsorbimento</li> <li>• Assimilazione delle piante</li> </ul>

Metalli	<ul style="list-style-type: none"> <li>• Adsorbimento</li> <li>• Scambi ionici</li> <li>• Complessazione</li> <li>• Precipitazione</li> <li>• Assimilazione delle piante</li> <li>• Ossidoriduzione microbica</li> </ul>
Patogeni	<ul style="list-style-type: none"> <li>• Filtrazione</li> <li>• Sedimentazione</li> <li>• Adsorbimento</li> <li>• Secrezione di sostanze antibiotiche dalle radici delle macrofite</li> </ul>
Solidi sospesi	<ul style="list-style-type: none"> <li>• Sedimentazione</li> <li>• Filtrazione</li> </ul>

**Tabella 4.** Sintesi dei processi che avvengono nelle zone umide costruite.

Il ruolo delle macrofite acquatiche, nei sistemi di fitodepurazione, è stato l'argomento maggiormente studiato. Un gran numero di pubblicazioni, che trattano le funzioni delle macrofite, sono presenti nella letteratura internazionale. In questo lavoro è possibile solo riassumere (tabella 5) alcuni aspetti delle funzioni delle macrofite nella fitodepurazione delle acque reflue.

<b>Ruolo delle macrofite acquatiche nella fitodepurazione</b>
Parte libera della pianta
<i>Attenuazione della luce, con conseguente riduzione della crescita del fitoplancton</i>
<i>Isolamento termico, (importante nei periodi invernali e nei climi freddi)</i>
<i>Riduzione della velocità del vento, con minore ondeggiamento dell'acqua in superficie: migliore sedimentazione dei solidi sospesi.</i>
<i>Accumulo delle sostanze nutritive</i>
Parte sommersa della pianta
<i>Azione di filtrazione</i>
<i>Riduzione della velocità del flusso idrico</i>
<i>Fornisce un'estesa superficie per la formazione del biofilm</i>
<i>Produzione di ossigeno fotosintetico, con incremento della degradazione aerobica</i>
<i>Assimilazione dei nutrienti</i>
Radici e rizomi

<i>Stabilizzano la superficie del sedimento</i>
<i>Ostacolano l'occlusione nel materiale inerte</i>
<i>Assimilazione dei nutrienti</i>
<i>Rilascio di ossigeno con incremento della degradazione microbica</i>
<i>Rilascio di antibiotici</i>

**Tabella 5.** Compendio delle funzioni delle macrofite nella fitodepurazione delle acque reflue. (Brix, H., 2003. *Plants used in Constructed Wetlands and their functions*. 1 st International Seminar on the Use of Aquatic Macrophytes for Wastewater Treatment in Constructed Wetlands. Lisboa, pp. 1-30)

## Conclusioni

Dopo gli anni delle prime sperimentazioni, e nel periodo di cinque decenni di studi, verifiche e applicazioni pratiche, la fitodepurazione è diventata una tecnica affidabile, utilizzata in tutto il mondo per il trattamento di acque reflue urbane, industriali, agroalimentari, e percolato delle discariche. In modo particolare, negli ultimi due decenni, nei Paesi in via di sviluppo è notevolmente cresciuto l'interesse per i sistemi di depurazione con le macrofite. Attualmente, le varie zone umide costruite sono considerate una valida alternativa ai trattamenti convenzionali. La fitodepurazione rappresenta un'ottima soluzione anche in termini economici, con un alto rapporto benefici costi, e con un fabbisogno di energia modesto o nullo. La tecnica è particolarmente adatta per il trattamento di reflui provenienti da piccoli e medi centri abitati, campeggi, agriturismi e alberghi, distanti da impianti di trattamento convenzionali. Inoltre, la gestione e la manutenzione delle zone umide costruite, richiede un impegno meno gravoso di quello necessario nei processi tradizionali. Tuttavia, resta il vincolo professionale del gestore nel garantire che la conduzione e la manutenzione siano affidate a personale specializzato che abbia ben presente che la rimozione delle sostanze inquinanti, che avviene nei sistemi di fitodepurazione, rappresenta il risultato di eventi **molto complessi** (ancora non completamente decifrate) che coinvolgono processi biologici, chimici e fisici. Naturalmente, anche la fitodepurazione è soggetta a criticità e limitazioni pertanto, sono necessari ulteriori studi e miglioramenti.

Una semplice breve rassegna dei temi trattati nell'ultima «IWA 15th International Conference Wetland Systems for Water Pollution Control - Gdansk, Poland, Settembre 2016», è utile per capire la vastità delle problematiche connesse con i sistemi di fitodepurazione.

Gli argomenti oggetto di relazioni sono stati molti e solo per indicarne alcuni evidenziamo quelli di idrologia, biochimica, microbiologia, selezione delle piante, gestione della vegetazione, modellazione e ottimizzazione degli impianti, costi d'investimento e di manutenzione.

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