

Comprehensive analysis of photocatalytic and photoreactor challenges in photocatalytic wastewater treatment: A case study with ZnO photocatalyst

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پوخته

چارمسه کردنی ئاوی پیسی فوتوكاتالیتیک پروسیمه کی گونجاوه و تیچووی کمم و دوستی ژینگمیه که پاشماوهی لاومکی دروست ناکات. ئم بابته پیداچوونووهی نەھەدیاتەکانی چارمسه کردنی ئاوی پیسی فوتوكاتالیتیک بۇ دوو بواری سەرمکی بېلین دەکات: دیزاینی فوتوریاکتور و دروستکردنی فوتوكاتالیست. بە تابیهتی سەرنج دەخاتە سەر چارمسەرە پېشىار كراوهەكان لەلایم توپىزمانوھ، بە بەکارھینانی فوتوكاتالیست ZnO وەک توپىزینووهی کمیس. بۇ ئەم مەبەستە، پیداچوونووهی گشتگىر بە ئەندىبىات ئەنجامدرا بۇ شىكىرنەمەھى ئاستەنگە گرنگ و كارىگەرەكان لە دیزاینی رياكتورەكان، كاردانمەھى فوتوكاتالیتىكىيەكان بەسەر فوتوكاتالیستەكان، و گەورەکردنی پرۆسەکەدا. ئەم بەرەستەنەی كە لە دیزاینی فوتوریاکتوردا ھەن برىتىن لە دابەشكەردنی ڕووناکى، كارىگەرەيە نەرىنیيەكانى زىادبۇونى پلەي گەرمى، سۇورداركەرنى گواستتەمەھى بارستە، جىاکىرنەمەھى فوتوكاتالیست لە ئاوەرۇي چارمسەرەکار، و مەرگەتنەمەھى فوتوكاتالیست. ستراتىزىيەكان بۇ زىلۇون بەسەر تەھەدیاتەكان لە دیزاینی فوتوریاکتورەكاندا برىتىن لە جىيەجىنەرەنلىكىنەن بېكەتەنەي نوئى فوتوریاکتورەكان، بەکارھینانی ئەندازمېيە جىاوازەكانى ژىرخان، بەکارھینانى سەرچاوهى ڕووناکى جىاواز و ھەندى. لە روانگەمى كاتالىزۆرەوه، تەھەدیاتەكان برىتىن لە بۆشايى فراوانى فوتوكاتالیستەكان، بېكەمەگرەدانى كونە ئەلکترۆنەكان، و سۇورداركەرنى گواستتەمەھى بارستە لە ناووه بۆشايىيەكانى فوتوكاتالیست، نەمژىنی كەمى پىسکەرەكان، ناسقامگىرى ھەندىيەك فوتوكاتالیست لە ژىر بارودۇخى كاركىرەندا، و كەمترىن مژىنی فوتونەكان لەلایم فوتوكاتالیستەكانوھ. ئم بابته پیداچوونووهی ئامانجىيەتى بەشدارى بکات لە بەرزىرنەمەھى كارايى چارمسەرەکردنی ئاوی پیسی فوتوكاتالیتیک لە تىكچوونى فوتوى پىسکەرەكان و گەورەکردنى بەكارھینانى وەک رېنگىيەكى سەرمکى بۇ چارمسەرەکردنی ئاوی پیس. پیداچوونووهكە ئامازە بە رۆلى كارىگەرەي بېكەتەنەي فوتوریاکتور دەکات لەسەر دابەشكەردنى ڕووناکى، گەيانىنەكان بۇ فوتوكاتالیست، و دروستکردنى جۆرە چالاکەكان، بەمەش كارىگەرە لەسەر كارايى پرۆسەكە دەبىت. سەرەر اى ئەوش، كارىگەرە تابىتەندىيە فيزىيە و كيميايىيەكانى فوتوكاتالیست لەسەر جوولە و گواستتەمەھى بارستەنەي كارلىكى فوتوكاتالیست ئاشكرا دەکات.

Abstract

Photocatalytic wastewater treatment is an affordable, low-cost, and environmentally friendly process that does not generate secondary waste. This review article categorizes challenges in photocatalytic wastewater treatment into two main areas: photoreactor design and photocatalyst synthesis. It specifically focuses on the proposed solutions by researchers, using ZnO photocatalyst as a case study. For this purpose, a comprehensive literature review was conducted to analyse the significant and impactful challenges in reactor design, photocatalytic reactions over photocatalysts, and scaling up the process. The obstacles existing in photoreactor design include light distribution, adverse effects of temperature increase, mass transfer limitations, photocatalyst separation from treated effluent, and recovery of photocatalyst. Strategies to overcome the challenges in photoreactor design include implementing new configurations of photoreactors, utilizing various substrate geometries, employing different light sources, etc. From a catalysis perspective, challenges include the wide bandgap of photocatalysts, electron-hole recombination, and mass transfer limitations within the photocatalyst cavities, insufficient adsorption of contaminants, the instability of certain photocatalysts under operating

conditions, and minimal adsorption of photons by photocatalysts. This review article aims to contribute to enhancing the photocatalytic wastewater treatment efficiency in photodegradation of pollutants and scaling up its application as a primary method for wastewater treatment. The review indicates the influential role of photoreactor configuration on light distribution, the delivery of photons to the photocatalyst, and the generation of active species, thereby impacting process efficiency. Additionally, it reveals the impact of the physicochemical properties of the photocatalyst on the kinetics and mass transfer of the photocatalytic reaction.



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