

AperTO - Archivio Istituzionale Open Access dell'Università di Torino

NO_x removal by vacuum ultra-violet light irradiation in flow reactors

This is the author's manuscript

Original Citation:

Availability:

This version is available <http://hdl.handle.net/2318/1643805> since 2017-06-30T12:25:42Z

Publisher:

Josef Krýsa

Terms of use:

Open Access

Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)

NO_x REMOVAL BY VACUUM ULTRA-VIOLET LIGHT IRRADIATION IN FLOW REACTORS

M. Minella^a, A. Gallo^b, C. Minero^a

^a University of Torino, Department of Chemistry and NIS Inter-departmental research Centre, Via P. Giuria 5, 10125, Torino, Italy, (marco.minella@unito.it)

^b Polytechnic University of Torino, DIATI, Corso Duca degli Abruzzi 24, 10129 Turin, Italy

The emission in atmosphere of massive amounts of nitrogen oxides (NO_x = NO + NO₂) from combustion processes represents a pivotal point from both the environment and the human health.[1] The main aspects related to the NO_x emission are not only their intrinsic toxicity, but also their active role in the ozone tropospheric production. Ozone itself represents a serious threat for the human health, but also a severe problem for plants because reduce significantly the photosynthesis. Secondly, the production of NO_x caused the formation in atmosphere of nitrogen acidic species (primarily HNO₃ and HNO₂) which can *i*) create serious damage to buildings and to the cultural heritage and *ii*) have a central role in the production of Particulate Matter (PM) especially in urban context.[2] The actual technologies proposed or in use for the NO_x abatement are not completely satisfying because *i*) not able to reach the total abatements of the pollutants; *ii*) expensive; *iii*) based on the use of precious and/or rare elements/metals; *iv*) employing additional reactants and *v*) characterized by high energy request.[3] In this light, a breakthrough in the field of the technologies for the NO_x abatement pollutants is mandatory.

In this work, the photolysis of NO by irradiation with a 172 nm Xe₂ excimer lamp was investigated in a perfectly mixed flow-through reactor (Continuous Stirred Tank Reactor, CSTR). This lamp shows a high efficiency for power energy to light conversion. The influence on the reaction rate of parameters such as the inlet flow, the substrate concentration, the photon flux entering into the reactor and the presence of oxygen was investigated. The experimental kinetic data were interpreted applying a general first-order kinetic model valid for CSTR, properly modified to take into account the changes in the experimental parameters. The pseudo first-order kinetic constant for the direct photolysis of NO under conditions of maximum irradiation was evaluated and the related reaction rate at different concentration computed. VUV photolysis of NO is a first-order process with respect to NO. The NO direct photolysis rate is linearly depended from the photon flux entering into the photo-reactor.

In the presence of oxygen two different reaction pathways are operative suggesting the presence of indirect mechanisms of transformation in which O₃ plays a key role. In the presence of O₂ an almost complete abatement of NO_x was observed.

The exploitation of this technology in real-world contexts seems to be feasible even if the presence of a successive step for the O₃ abatement is mandatory.

References

- [1] J.N. Galloway, A.R. Townsend, J.W. Erisman, M. Bekunda, Z. Cai, J.R. Freney, L.A. Martinelli, S.P. Seitzinger, M.A. Sutton, *Science* 320 (2008) 889.
- [2] B. J. Finlayson-Pitts, J.N. Pitts, Jr., *Chemistry of the Upper and Lower Atmosphere*, Academic Press, Elsevier Inc. London, United Kingdom, 2000.
- [3] US-EPA Technical bulletin, Nitrogen Oxides (NO_x), why and how they are controlled, EPA-456/F-99-006R November 1999.