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# Biomass gasification and in-bed contaminants removal: Performance of iron enriched Olivine and bauxite in a process of steam/$O_2$ gasification

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## HIGHLIGHTS

- ▶ Iron enriched-Olivine and bauxite were tested in process of steam/$O_2$ gasification.
- ▶ Relevant differences were found in the raw gas for tar and particulate contents.
- ▶ Bauxite was effective in the removal of KCl, but not towards NaCl.
- ▶ No significant differences were found on gas composition and gas yield.

## ARTICLE INFO

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## ABSTRACT

A modified Olivine, enriched in iron content (10% Fe/Olivine), and a natural bauxite, were tested in the in-bed reduction of tar and alkali halides (NaCl and KCl) released in a process of biomass steam/$O_2$ gasification. The tests were carried out at an ICBFB bench scale reactor under the operating conditions of: 855–890 °C, atmospheric pressure, 0.5 steam/biomass and 0.33 ER ratios. From the use of the two materials, a reduction in the contaminant contents of the fuel gas produced was found. For the alkali halides, a decrease up to $70\%_{wt}$ was observed for the potassium concentration, while for sodium, the reduction was found to be quite poor. For the organic content, compared to unmodified Olivine, the chromatographically determined total tar quantity showed a removal efficiency of $38\%_{wt}$. Moreover, regarding the particulate content a rough doubling in the fuel gas revealed a certain brittleness of the new bed material.



## 1. Introduction

Gas cleaning is one of the most relevant key issues in achieving technological maturity of the biomass gasification process for commercial purposes, such as advanced applications for CHP production.

Downstream and in-bed methods are both open chances, since from the viewpoint of the efficacy of the solution to the problem, each one has significant advantages. However, the in-bed mode, leading potentially to a more simplified plant, can also provide advantages from an economical perspective, and thus appears to be potentially the most promising way to address the problem (Devi et al., 2003).

Among the different reactor configurations, several studies focus their efforts on the development of the biomass gasification process carried out with fluidized bed (FB) reactors as they are the most suitable for continuous process and scalability over a large range of sizes (Bridgwater, 2006). Moreover, the gasification in FB reactors has been tested with feedstocks of different origin, lignocellulosic and non, such as woody materials, agricultural residues and municipal solid wastes (MSW) (Alauddin et al., 2010; Arena et al., 2010; Huang et al., 2012; Subramanian et al., 2011); biomass/plastic blends have also been considered (Ruoppolo et al., 2012). With all these feedstocks, the technology of the FB reactors was found widely valuable, although in the case of some residues, such as straws and MSW, depending on the chemical composition and melting behavior of the ash, a higher attention in the selection and control of the operating conditions was found to be a key factor to avoid problems of particles agglomeration and consequent worsening in the bed fluidization (Arena, 2012; Calvo et al., 2012).

As is known, in reactors of these configurations a fluidizing agent (air, oxygen, water steam, etc.) is injected into a mineral bed at a rate such that the exerted drag force on the mineral particles exceeds the force of gravity. Under this condition the mineral bed behaves as a fluid: it transfers to the biomass the heat needed to drive the endothermic gasification reactions, and makes

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