

RESEARCH REPORT

A recent collaboration was started in 2014 between the research team of Dr. Fabrizio Scala in Naples (Italy) and Prof. Kunio Yoshikawa (Tokyo Institute Of Technology - TIT). After his visit in Naples in January 2014, a joint research project was agreed on the theme of “Fluidized Bed Combustion of Paper Sludge after Hydrothermal Treatment” . In fact, the hydrothermal treatment is an innovative technique developed at TIT for the processing of waste and sludge in order to obtain a clean fuel for energy production (combustion, gasification). One of the materials tested by TIT was paper sludge (a residue of the paper production industry) in the framework of an industrial collaboration with a company in Thailand. Within this project, the Italian research team was in charge of testing the hydrothermally treated paper sludge in the lab-scale and pilot-scale fluidized bed combustion facilities available in the laboratories in Naples. The focus of the experimental activity was put on the following two aspects: 1) Effect of the hydrothermal treatment on the fluidized bed combustion characteristic, with special attention to NO_x emissions (by comparing the performance of hydrotreated vs. raw paper sludge). 2) Co-combustion characteristics of the treated paper sludge with coal, focusing on NO_x emissions and unburned carbon in fly ash. Two TIT students (one PhD and one MSc) stayed in Naples for 1 and 6 months, respectively, during 2014 and worked on this project under the supervision of Dr. Scala. The experimental activity was terminated successfully in December 2014.

After the end of the activity of the TIT students in Italy, Dr. Scala stayed in January 2015 for 14 days at TIT under the JSPS Short-term Fellowship Program, hosted by Prof. Kunio Yoshikawa. During this time Dr. Fabrizio Scala visited Prof. Yoshikawa’s laboratories and participated to a few lab-scale hydrothermal treatment experiments, carried out by the students of the Prof. Yoshikawa’s research team. Full explanation of this technique was provided by the students, giving Dr. Scala the possibility to gain insight into this innovative process. During his stay at TIT, Dr. Scala was also able to have multiple fruitful discussions with Prof. Yoshikawa and with the TIT students that stayed in Naples on the final results of the experimental activity carried out within the cooperation agreement. During these discussions the experimental results were deeply analyzed and explained, and final conclusions on the experimental activity were drawn. On the whole, the fluidized bed combustion results confirmed that the hydrothermally treated paper sludge had a better performance and would be a better choice compared to the original raw paper sludge. This result is very important, since the attractiveness of the hydrothermal treatment technique lies on the enhanced fuel properties and, in turn, on the more efficient conversion of the fuel. On the basis of these promising results, it was agreed to write and submit to international peer reviewed journals two articles. The tentative title of the two articles was agreed to be:

- 1) Fluidized bed co-combustion of hydrothermally treated paper sludge with two coals of different rank
- 2) Effect of hydrothermal treatment on primary fragmentation and attrition of paper sludge during fluidized bed combustion

During the stay of Dr. Scala at TIT, the writing of the first article was almost completed. It was agreed that the article would have been submitted shortly after the end of the visit, and in any case during February 2015. The writing of the second article was shifted to after the completion of the first one, and its submission was agreed to be before the end of March 2015. Both publications will explicitly state the JSPS fellowship support received by Dr. Scala in the acknowledgements.

On 19th January 2015 Dr. Scala delivered a lecture with the title: “An introduction to fluidized bed combustion of solid fuels” to the students and researchers of the Interdisciplinary Graduate School of Science and Engineering Environmental Science and Technology at TIT. After the lecture, a fruitful discussion with the audience was carried out, by answering to the questions regarding the lecture subject.

Finally, on the basis of the positive results of the collaboration so far, it was agreed between

Dr. Scala and Prof. Yoshikawa that this collaboration in the field of fluidized bed combustion/gasification of hydrothermally treated waste/sludge should continue, with a new exchange of visiting students/researchers between the two research teams in the future. The possible financial support of JSPS for this exchange of visiting students/researchers would be also explored.

During his stay in Japan Dr. Scala also visited some other professors who had cooperated with in the past (during the writing of the book: Fluidized bed technologies for near-zero emission combustion and gasification, edited by Dr. Scala).

On 26th January 2015 Dr. Scala visited Prof. Tadaaki Shimizu at Niigata University. During this day Dr. Fabrizio Scala visited Prof. Shimizu's laboratories and delivered to his students a lecture with the title: "Recent CO₂ capture technologies involving fluidized bed reactors". Dr. Scala and Prof. Shimizu also discussed of a possible cooperation in the field of fluidized bed reactors and of a possible exchange of visiting students/researchers between the two research teams.

On 28th January 2015 Dr. Scala visited Prof. Masayuki Horio (retired) and Prof. Hidehiro Kamiya at the Tokyo University of Agriculture and Technology (TUAT). During this day Dr. Fabrizio Scala visited Prof. Kamiya's laboratories and delivered a lecture with the title: "Recent CO₂ capture technologies involving fluidized bed reactors" to the students and researchers of the Graduate School of Bio-Applications Systems Engineering at TUAT. Dr. Scala and Prof. Kamiya also discussed of a possible exchange of visiting students/researchers between the two research teams. Dr. Scala was granted the status of visiting professor at TUAT.