Gas exhaust study by RGA in JET after disruptions and impurity seeding

D. Alegre\textsuperscript{1}, M. Oberkofler\textsuperscript{2}, A. Drenik\textsuperscript{3}, U. Kruezi\textsuperscript{4}, S. Brezinsek\textsuperscript{5}, F.L. Tabares\textsuperscript{6}, G. Maddison\textsuperscript{4}, C. Reux\textsuperscript{6} and JET EFDA Contributors\textsuperscript{*}

\textsuperscript{1} Laboratorio Nacional de Fusion, CIEMAT, Av. Complutense 40, 28040 Madrid, Spain  
\textsuperscript{2} Max-Planck-Institut für Plasmaphysik, 85748 Garching b. München, Germany  
\textsuperscript{3} Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia  
\textsuperscript{4} Culham Centre for Fusion Energy, Abingdon, Oxon, OX14 3DB, United Kingdom  
\textsuperscript{5} IEF-Plasmaphysik FZ Jülich, 52425 Jülich, Germany  
\textsuperscript{6} CEA, IRFM, F-13108 Saint-Paul-lez-Durance, France

ITER will start with a full tungsten divertor, so the lifetime of the initial target tiles, ideally determined by W sputtering erosion, must be addressed. This sputtering is caused by intrinsic impurities as Be, O, N, and C; or by deliberately seeded ones for either reducing divertor heat loads by radiative cooling: N\textsubscript{2}, Ne and Ar, or disruption mitigation by Massive Gas Injection (MGI). JET with its ITER-Like-Wall (ILW) offers a unique environment to study the gas impurities in conditions relevant for ITER. This work will concentrate on the qualitative effects of disruptions on the wall conditions. Gas impurity concentration studies are conducted in real-time during and after plasma discharges utilising the magnetically shielded Residual Gas Analyser (RGA) of JET sub-divertor neutral gas analysis diagnostic. After an unmitigated disruption during non-seeded experiments due to the surface heating the impurity level is reduced: the main ones, H\textsubscript{2}O (18 AMU) and D\textsubscript{2}O (20 AMU), a 10-20\%, whereas the effect detected in N\textsubscript{2} and O\textsubscript{2} (28 and 32 AMU) is very slight (in ILW hydrocarbons are irrelevant). Conversely, after MGI application impurity levels are sizeably reduced in comparison: H\textsubscript{2}O + D\textsubscript{2}O around 20-30\%; and specially N\textsubscript{2}, a 30-40\% lower. On the other hand, during seeded discharges, Ar and Ne are expected to have a low retention in JET-ILW, but N\textsubscript{2} can be trapped in the form of surface tungsten nitrides \cite{1}. In non-seeded discharges, if the previous heavily-seeded N\textsubscript{2} discharge ended in a MGI, the 28 AMU signal is 15-25\% lower than if the previous one had a normal termination. Additionally, the 16 and 17 AMU signals, which are a measure for NH\textsubscript{3}, are much reduced indicating a removal of the N related to subsequent NH\textsubscript{3} production. A similar low NH\textsubscript{3} production is detected at low-level N\textsubscript{2} seeded discharges and during its unmitigated disruptions. However, different parameters like plasma energy, plasma density, seeding rate of N\textsubscript{2}, etc., have an effect on the efficiency of the removal and further investigations are required to disentangle them.

Induced MGI disruptions can be applied to control tokamak impurity levels, especially N\textsubscript{2} as it can be retained in tungsten and influence subsequent discharges. The amount of impurities released depends on the mitigated plasma stored energy, but also on the percentage of argon in the mix. Larger argon concentrations seem to favour H\textsubscript{2}O and D\textsubscript{2}O release; meanwhile N\textsubscript{2} show a slightly lower release. The latter might be explained because the elimination of tungsten nitrides, mainly developed during N\textsubscript{2} seeding, is dominated by chemical sputtering with deuterium rather than argon due to its low sputtering yield \cite{1, 2}. Furthermore, consecutive many MGI application at larger argon concentrations leads to a detectable, yet small, retention in subsequent discharges, not seen during normal operation.

\cite{1} K. Schmid et al. \textit{Nucl. Fusion} \textbf{50}, 025006 (2010).
\cite{2} D. Alegre et al, \textit{Romanian Reports in Physics}, In press

\textsuperscript{*}F. Romanelli et al., Proceedings of 24th IAEA Fusion Energy Conference 2012, San Diego, USA (Appendix)