Integrated design for demonstration of efficient liquefaction of hydrogen (IDEALHY)

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Publishable summary

Hydrogen is seen as an important energy carrier for the future which offers carbon free emissions at the point of use. In particular, hydrogen could be used to power vehicles using hydrogen fuel cell technology and thereby replace the use of petrol and diesel. In the absence of a hydrogen pipeline supply network, which would be costly and take considerable time to build, hydrogen could be supplied using road tankers. However, transporting hydrogen by road as a compressed gas is very inefficient and supplying liquefied hydrogen (LH2) by road tanker is seen as the most effective way forward in the medium term. This will require large quantities of LH2 to be produced, stored and transported for re-fuelling vehicles.

The IDEALHY project receives funding from the European Commission’s 7th framework programme (FP7/2007-2013) for the Fuel Cells and Hydrogen Joint Technology Initiative. The project has the aim of developing a new hydrogen liquefaction process which will enable LH2 production to be undertaken at increased scale (50-200 tpd) and with significantly increased efficiency. The production of large quantities of LH2 and the subsequent road transportation and storage at vehicle re-fuelling stations (often in urban areas) present new challenges in terms of ensuring the safety of the public. For these reasons, as part of the IDEALHY project, the safety of the proposed production and supply system is to be considered.

This report presents the results of two HAZard IDentification (HAZID) exercises, one on the transport by road tanker and storage of liquid hydrogen at re-fuelling stations, and the other on the liquefaction of hydrogen and storage of the liquid hydrogen at the production site. The HAZIDs were carried out by the partners of the IDEALHY project. The purpose of the HAZIDs was to identify untoward events that could occur as a result of handling the hazardous materials involved in the proposed new hydrogen liquefaction process developed as the main objective of the IDEALHY project. In addition a review of related incidents involving liquid hydrogen was performed.

Following completion of the HAZIDS and the incident review, analysis of their results was undertaken. The purpose of this analysis was to identify the causes and consequences of the incidents to provide information that can eventually be used to assess the risk of such operations.

Analysis of the causes of incidents showed that design or construction failure, equipment failure or procedural deficiency dominated the causes of both the reviewed incidents and the untoward events identified through the HAZIDs. These three causes involve the greatest amount of human involvement which may account for the higher proportion of incidents/untoward events compared with the other causes.

Analysis of the consequences of incidents showed that the majority result in a release of either gaseous or liquid hydrogen. About half of these releases are ignited and of these fires and explosions occur in about equal proportions. Sometimes both a fire and an explosion occur during the same incident. In one incident both a fire and a BLEVE occurred.
Key words
Liquid hydrogen, HAZID, accumulation, dispersion, fire, explosion, BLEVE

Abbreviations
BLEVE  Boiling Liquid Expanding Vapour Explosion
HAZID  Hazard Identification
LH2    Liquefied Hydrogen
LOC    Loss of containment
MR     Mixed refrigerant
RPT    Rapid phase transition
RTA    Road traffic accident
tpd    tonnes per day
Table of Contents

Acknowledgements ........................................................................................................ ii
Disclaimer........................................................................................................................ ii
Publishable summary.................................................................................................... iii
Key words ...................................................................................................................... iv
Abbreviations ................................................................................................................. iv
Table of Contents............................................................................................................ v
1 Background.............................................................................................................. 1
2 Introduction and Scope of Report.......................................................................... 2
3 Transport HAZID ...................................................................................................... 6
4 Liquefaction and Storage HAZID ............................................................................. 13
5 Review of incidents and Analysis of HAZIDs...................................................... 19
  5.1 Review of Incidents .......................................................................................... 19
  5.1.1 Road Transport Incidents .......................................................................... 19
  5.1.2 Liquefaction and Storage Incidents............................................................ 19
  5.2 Analysis of the HAZIDs..................................................................................... 21
6 Summary and Conclusions.................................................................................. 26
7 References ............................................................................................................. 26
Appendices.................................................................................................................... 28
  Appendix A Details of transport incidents.............................................................. 29
  Appendix B Details of liquefaction and storage incidents ..................................... 39