Ammonia Fuel Safety

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Ammonia Capacity in North America: 5-Year Projection, November 2017

Metric tons of ammonia per year. Source: https://ammoniaindustry.com as of 10/31/2017
Global Ammonia Production, 1947 - 2014

1959 – 1988: CAGR 8.5%
1995 – 2014: CAGR 2.0%
Global Ammonia Production, forecast to 2050 @ 2% compound growth


The graph shows the global ammonia production from 1956 to 2046, with a forecast to 2050 at a 2% compound growth rate. The production increases significantly over time, reaching approximately 370 million metric tons in 2046.

The graph includes data for the world total production, China, the Netherlands, and Australia.
Global Ammonia Production, forecast to 2050 @ export strength

Australia: proposed project, renewable ammonia for export:
- 500 GW solar power, in 10,000 km² (area = 20% of the Pilbara)
- 12 MWh per metric ton ammonia
- 1,000,000 ton capacity … PER DAY.
Vice President Mahamudu Bawumia visited the site of the accident early Sunday where he pledged that the government would work to curb such tragedies.

"Eight of these explosions in three years is too much," he said while at the LNG filling station near Legon, a suburb of Accra.

*Chicago Tribune*, October 8, 2017
Risk Homeostasis Theory

1. Perceived costs and benefits of action alternatives
   a. Target level of risk
   Comparator, summing point
   c. Desired adjustment: |a - b| = 0

2. Decision making skills
3. Vehicle handling skills

4. Perceptual skills
   b. Perceived level of risk
   d. Adjustment action

f. Lagged feedback

e. Resulting accident loss
Ammonia Fuel Safety: Two studies

*Comparative Quantitative Risk Analysis of Motor Gasoline, LPG, and Anhydrous Ammonia as an Automotive Fuel*

Quest Consultants Inc, USA
2009

LINK: [http://nh3fuel.files.wordpress.com/2013/01/nh3_riskanalysis_final.pdf](http://nh3fuel.files.wordpress.com/2013/01/nh3_riskanalysis_final.pdf)

*Safety Assessment of Ammonia as a Transport Fuel*

Risø National Laboratory, Denmark
2005

LINK: [http://nh3fuel.files.wordpress.com/2013/05/riso-ammonia-transport-safety-report.pdf](http://nh3fuel.files.wordpress.com/2013/05/riso-ammonia-transport-safety-report.pdf)
Ammonia Fuel Safety: Two studies

Quest:

“In summary, the hazards and risks associated with the truck transport, storage, and dispensing of refrigerated anhydrous ammonia are similar to those of gasoline and LPG ...

The risks associated with all three fuels would fall into the acceptable category for all referenced risk criteria.”

Risø:

“An overall conclusion is that the hazards in relation to ammonia need to be (and probably can be) controlled by technical and regulatory options ...

When these safety systems are implemented, the risks of using ammonia is similar, if not lower than for the other fuels.”

Quest: p. 53 of 59 (6-13)

Figure 6-2
Vulnerability Corridors and Zones for the Truck Transport of Gasoline, LPG, and Refrigerated Ammonia
Figure 6-6
Risk Contours for a Service Station Storing and Dispensing Anhydrous Ammonia
Figure 6-5
Risk Contours for a Service Station Storing and Dispensing LPG
Ammonia Fuel Safety: Conclusions

Risø:

“The acceptance of ammonia will not be based on the results of numerical risk analysis, but will also be influenced by the public’s perception of the threats of ammonia.”

Risø: p. 40

Dave Garman:

“Ammonia isn’t sexy. It just works.”

David Garman, former Under Secretary of Energy, US Department of Energy
The Curse of Shiny Objects, NH3 Fuel Conference, 9/21/2015.
What additional investment to make these circles smaller?