Sulfur-Containing Amino Acids as Precursors for Hydrogen Sulfide Generation in the Food Industry

David A. Duffy, CIH
Occupational Disease Practice Leader
Chubb Global Risk Advisors

Situation/Problem:
It is known that hydrogen sulfide (H2S) can be generated from sulfur-containing amino acids, which are incorporated into proteins. The amino acids are incorporated into proteins in animal tissue and released during the process of cooking. However, in the food industry, the presence of H2S is not always easily detected, and its potential health effects are not always fully understood. This presentation aims to address sulfur compound exposure potential in the food industry, focusing on the possible precursors and production processes.

Methods:
To determine if hydrogen sulfide and related sulfur compounds were being generated into work areas within the food industry, area air monitoring was conducted for both qualitative and quantitative purposes. Personal breathing zone samples were also evaluated. Each of these methods was employed in an effort to identify the presence of sulfur compounds in the food industry.

Results:
Table 1 shows area H2S data as collected over an open pressure cooking vessel and over an open system. The data were scanned for this analysis, and three were detected. The purpose of the qualitative aspect of this project was to identify the range of potential sulfur compounds that could be generated from the food industry. The results indicated that high peak levels of H2S were detected in the steam cloud area. This sample profile did not represent an operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 2 shows qualitative and quantitative data for hydrogen sulfide generation. The results indicate that high peak levels of H2S were detected in the steam cloud area. This sample profile did not represent an operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 3 shows personal exposures during the production portion of the operation. This data is representative of exposure that was detected during the production portion of the operation. The data correlated that although there were no personal H2S exposures detected, there were levels that exceeded the recommended exposure limits. This is illustrated in Figure 3. High levels were recorded during the process of cooking. These levels varied depending on the position of the operator during the operation, which is not representative of the operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 4 shows qualitative and quantitative results for the personal exposure data. The results indicate that high peak levels of H2S were detected in the steam cloud area. This sample profile did not represent an operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 5 shows personal exposures during the production portion of the operation. This data is representative of exposure that was detected during the production portion of the operation. The data correlated that although there were no personal H2S exposures detected, there were levels that exceeded the recommended exposure limits. This is illustrated in Figure 3. High levels were recorded during the process of cooking. These levels varied depending on the position of the operator during the operation, which is not representative of the operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 6 shows qualitative and quantitative results for the personal exposure data. The results indicate that high peak levels of H2S were detected in the steam cloud area. This sample profile did not represent an operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.

Table 7 shows qualitative and quantitative results for the personal exposure data. The results indicate that high peak levels of H2S were detected in the steam cloud area. This sample profile did not represent an operator's exposure. The levels varied due to the dynamic nature of the vapor release. Due to the limited exposure time for a process opening, the steam cloud area was not representative of the operator's exposure.
Discussion:
The fact that cooking meats and certain vegetables has the potential for off-flavoring volatile sulfur compounds, including the production of hydrogen sulfide, and certain carboxylic compounds, has been known for many years. In this study, volatile compounds, primarily hydrogen sulfide and lower levels of organic sulfur compounds, were detected near the heat sources for the cooking activity. Area concentrations near the immediate areas of the equipment, where hot gases were released, presented the highest levels, exceeding the short term exposure limit (STEL) of 6.0 ppm and, in some cases, the OSHA Ceiling limit of 20 ppm. The operators’ short-term exposures were shown to be significant when attending to this equipment. Low to non-detectable exposure concentrations were detected in their general work areas, away from the cooking equipment. These employees did not work directly in the areas where there are emissions of hydrogen sulfide or other sulfur compounds. However, it is important to note that exposure concentrations may be lower than the STEL if the employees are exposed for longer periods of time and/or make more frequent visits. For these reasons, employees and their employers should still be cautious when handling these compounds.

Chubb Global Risk Advisors’ recommendations rest with the client not with Chubb Global Risk Advisors. This advice from legal counsel, nor are they intended to supplant any duty to provide a safe workplace, operation, product or premises. Any duty to provide a safe workplace, premises, product or operation. Chubb Global Risk Advisors’ loss control services are not intended as a substitute for the information. It is important to note that exposure concentrations may be lower than the STEL if the employees are exposed for longer periods of time and/or make more frequent visits. For these reasons, employees and their employers should still be cautious when handling these compounds.

Conclusion:
Based on the data generated for this report, as well as similar studies noted in the literature, cooking meats and vegetables can release hydrogen sulfide and organic sulfur compounds. The level of exposure will be affected by numerous variables, including the type of meat, the addition of sulfur-based amino acids, process temperatures and the proximity of operators to exposure sources. This was a limited study. To thoroughly assess the exposure potential for food workers, additional data is needed that incorporates more of these variables, including meat types and amino acid additions.

References:
2. Cysteine and hydrogen sulphide in the regulation of metabolism: insights from genetics and pharmacology; CRC critical reviews in food science and nutrition 6(2) September 2009; Jospeh A Maga, Ira Katz.
3. Human Health Effects from Exposure to Low-Level Concentrations of Hydrogen Sulfide; Occupational safety and Health, December 2012; Scott Dorfman & SM Aronson.
5. Analysis of Volatile Organic Compounds in Air Contained in Canisters by Method TO-15, SOP No. HW-31 Revision 6
8. Chubb Global Risk Advisors” is a service of EISI, Inc., a Chubb company. Chubb Global Risk Advisors® provides claim and risk management services. Chubb is the marketing name used to refer to subsidiaries of Chubb Limited providing insurance and related services. For more information, visit us at www.chubb.com