

TEDX

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CHEMICALS USED IN NATURAL GAS FRACTURING OPERATIONS:

PENNSYLVANIA

April 2009

INTRODUCTION

The following summaries are based on the possible health effects of the products and chemicals used in fracturing operations to produce natural gas in Pennsylvania. They provide a profile of the possible health hazards for those living and working in regions where natural gas activity is taking place. The names of the products and chemicals and their known or suspected health effects were entered in an EXCEL spreadsheet for easy sorting and searching. The health effects associated with the chemicals were listed under one or more of the 14 categories used in government toxicological literature.

In the fall of 2008, TEDX received lists of the products and chemicals proposed to be used to fracture natural gas wells in the Marcellus Shale. These lists came from the Pennsylvania Department of Environmental Protection (PDEP) and the Susquehanna River Basin Commission. Combined, these lists contained 41 products and 63 chemicals. TEDX makes no claim that the list of products and chemicals in this analysis is complete.

PRODUCT SUMMARY

Material Safety Data Sheets (MSDSs)

MSDSs are designed to inform those who handle, ship, and use the products about their physical and chemical characteristics, and their direct and/or immediate health effects, in order to prevent injury while working with the products. The sheets are also designed to inform emergency response crews in case of accidents or spills. The total reported composition of a product on an MSDS can be less than 0.1% up to 100%. MSDSs are not submitted to the Occupational Safety and Health Administration (OSHA) for review. The product manufacturers determine what is revealed on their MSDSs.

The health information on MSDSs most often warns of possible harm to the skin and eyes, gastrointestinal and respiratory tracts, followed by the nervous system and brain. Many MSDSs do not address the outcome of long term, intermittent or chronic exposures, or adverse health effects that may not be expressed until years after the exposure.

TEDX has obtained MSDSs for 8 of the 41 products proposed for use in Pennsylvania. All of the MSDSs list at least one chemical with a CAS¹ number and one MSDS lists another ingredient without a CAS number. The percent of the full composition disclosed for the products range from 10% to 100%. Three products include less than 50% of the composition and four provide between 50% and 100%. Only one product provides the complete composition with all ingredients identified by CAS numbers.

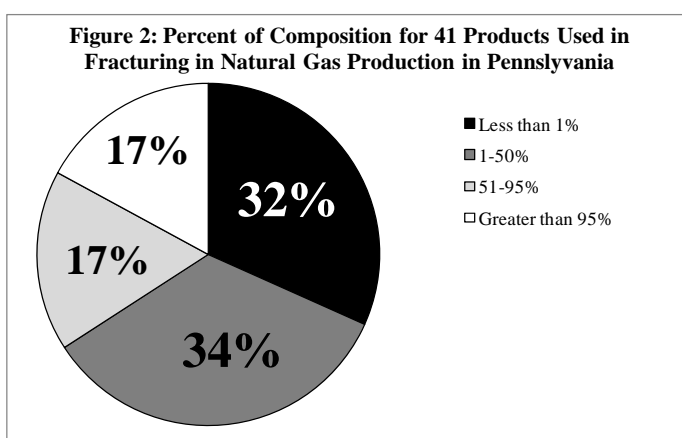
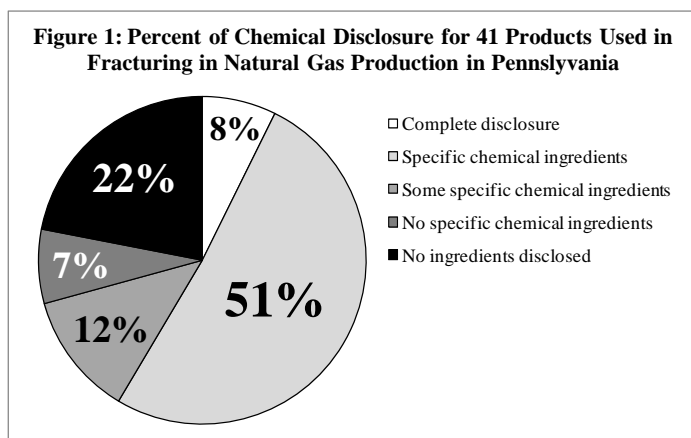
¹ CAS =Chemical Abstracts Service, provided by the American Chemical Society. This unique number is used to identify a specific substance. A single substance can have many different names, but only one CAS number. A substance may be a single chemical, an isomer of a chemical, a mixture of isomers, polymer, biological sequences, or a mixture of related chemicals.

Other Sources of Information

MSDSs could not be obtained for 33 of the products on TEDX's list and information about the products comes from the sources listed above. Eight of these products report only "no hazardous ingredients" and one lists ingredients as "not applicable." Three products provide ingredient names, but no CAS numbers and 15 list CAS numbers for all ingredients. Thirteen products provide no information on the percent of composition. Eleven products list less than 50% of the composition, four list between 50 and 84%, and three list 100% of the composition but with general chemical names or some CAS numbers. The two remaining products provide full disclosure of the percent of composition and a single ingredient with a CAS number.

Evaluation of the information available about the 41 products

Twenty-one products (51%) list specific chemical ingredients (Figure 1). Five products (12%) contain a combination of chemicals with and without CAS numbers and three (7%) contain chemicals with only general or non-specific names. No information is provided for nine (22%) of the products. The remaining three products (7%) disclose all of the ingredients.

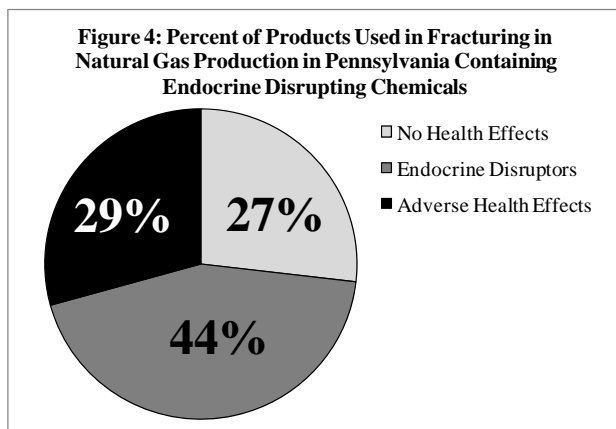
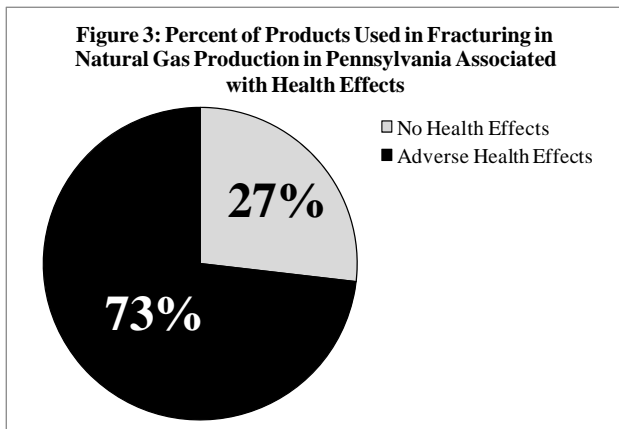


Less than 1% of the total composition is known for 13 (32%) of the 41 products in our spreadsheet (Figure 2). Less than 50% of the composition is known for 14 (34%) of the products, and between 51% and 95% of the composition is known for 7 (17%) of the products. Seven (17%) of the products have information about more than 95% of their full composition.

Evaluation of the health effects associated with the 41 products

Because of the limitations inherent in some of the data sources, the health effects of the products and chemicals in the following summary will not be comprehensive.

No health effects were reported for 27% of the products proposed to be used in Pennsylvania (Figure 3). The remaining 73% of the products had between 6 and 14 different health effects. Forty-four percent of the products contained one or more chemicals considered to be endocrine disruptors (Figure 4), chemicals that interfere with development and function.



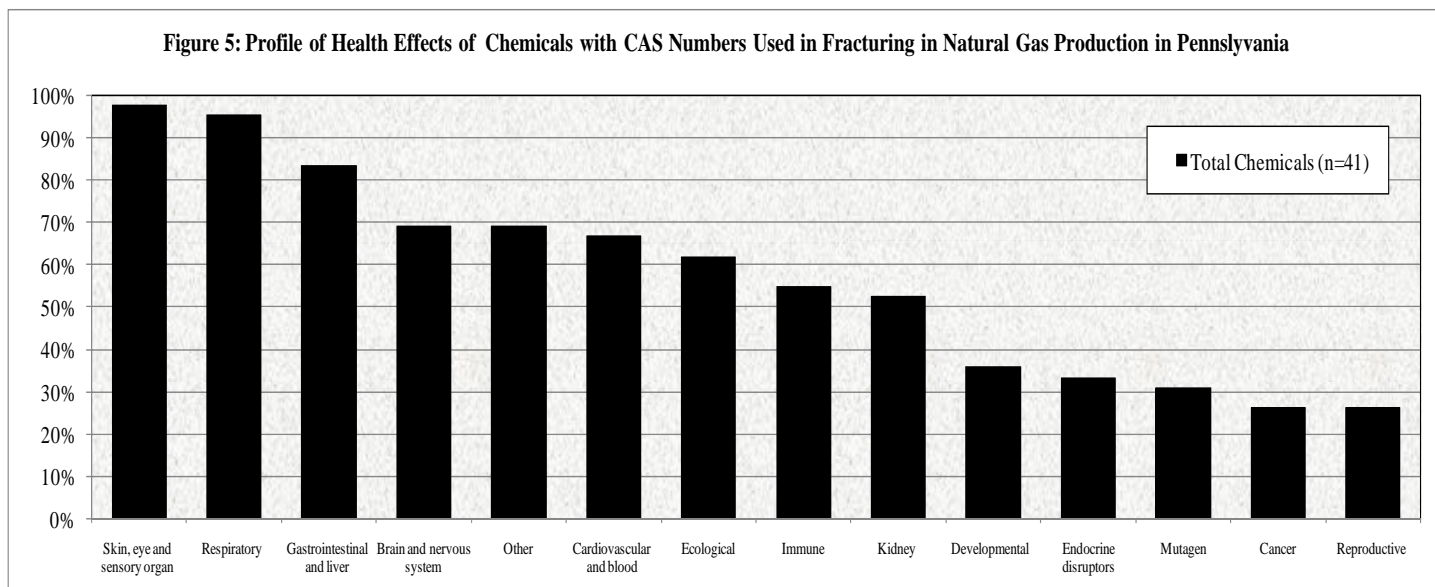
CHEMICAL SUMMARY

Evaluation of the information available about the 63 chemicals

Products may contain more than one chemical, and a given chemical may occur in more than one product. In the 41 products identified above, there were a total of 63 chemicals. Specific chemical names and CAS numbers could not be determined for 22 (35%) of the chemicals on TEDX’s list. The names provided were too general (e.g. polysaccharide, surfactant, etc.) to obtain specific information, or they were listed as “proprietary” or containing no hazardous ingredients. It was impossible to link the chemicals without CAS numbers to any health category.

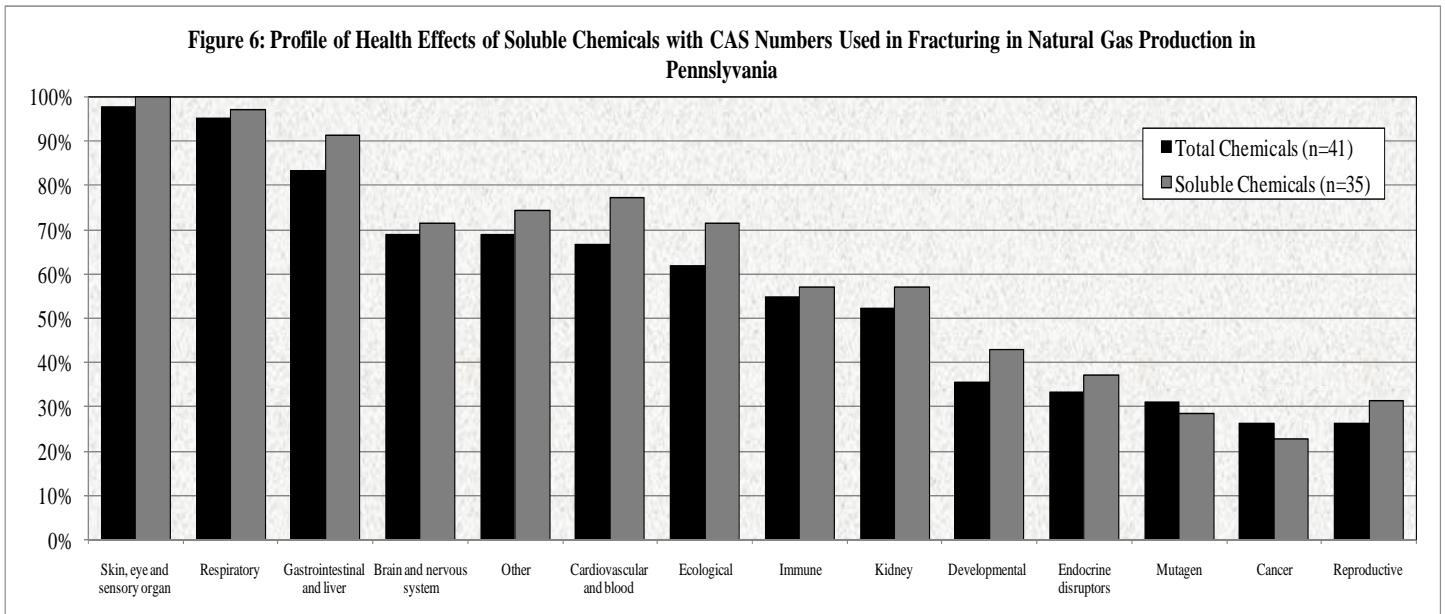
Summary of the health effects associated with the 41 chemicals with CAS numbers

Figure 5 provides a profile of the percentages of the 41 chemicals with CAS numbers associated with the general health categories used in government reports. Chemicals are often included in more than one category.



When all of the chemicals with CAS numbers are combined, 98% are associated with skin, eye or sensory organ effects. Ninety-five percent can cause respiratory effects and 83% are associated with gastrointestinal or liver effects. Sixty-nine percent can harm the brain and nervous system, 67% are associated with cardiovascular system effects, and 62% can have ecological effects (harm to aquatic species, birds, amphibians or invertebrates). Sixty-nine percent of the chemicals have health effects in the ‘Other’ category. The ‘Other’ category includes such effects as changes in weight or effects on teeth or bones, for example, but the most often cited effect in this category is the ability of the chemical to cause death.

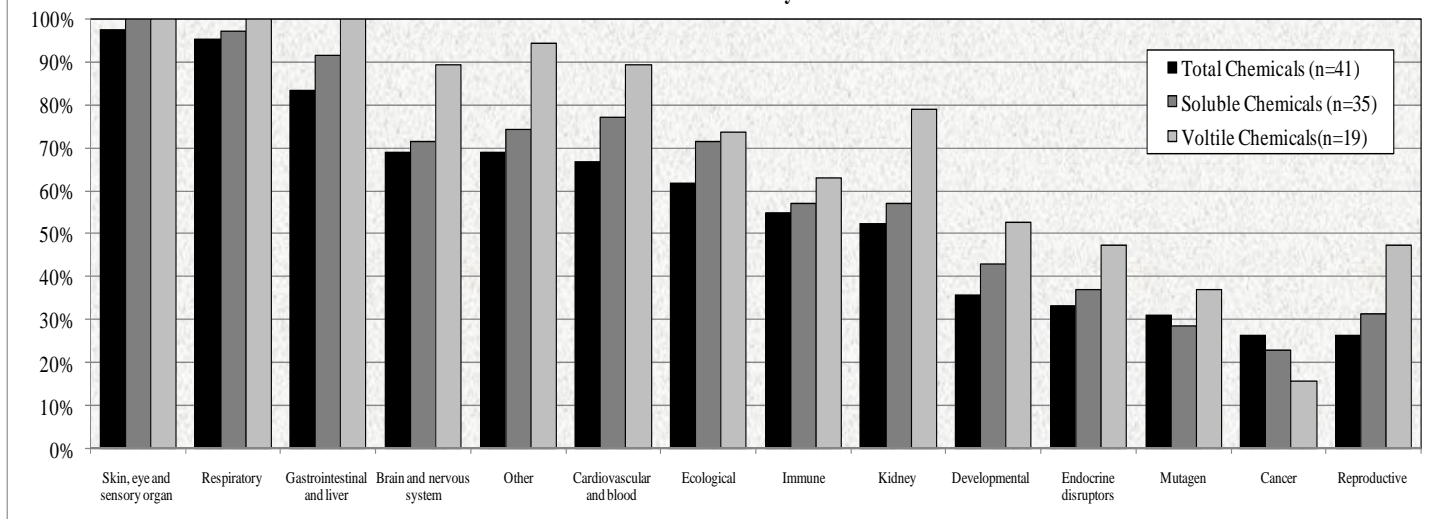
The health effects on the left side of the figure are those effects that are more likely to appear immediately or soon after exposure. These effects include symptoms such as burning eyes, rashes, coughs, sore throat, nausea, vomiting and diarrhea. The health effects on the right side of the figure are long term and would tend to appear months or years later, such as some cancers, the results of organ damage, harm to the reproductive system, or developmental effects as the result of prenatal exposure, all of which were associated with over 25% of the chemicals in this analysis.



Thirty-five (83%) of the chemicals with CAS numbers are water soluble. When examined alone (Figure 6), they produce a similar profile of health effects as all the chemicals combined, but with higher percentages in every category except Mutagens and Cancer.

Approximately 45% of the chemicals with CAS numbers are volatile (Figure 7); in other words, they can become airborne. All of these chemicals can harm the eyes, skin, sensory organs, respiratory tract, and gastrointestinal tract or liver. Eighty-nine percent can cause harm to the brain and nervous system and the cardiovascular system and 94% fall into the ‘Other’ category. Overall, the volatile chemicals produce a different profile with higher percentages than the water soluble chemicals. Because they can readily become airborne and can be inhaled as well as swallowed and can reach the skin, the potential for exposure to these chemicals is greater.

Figure 7: Profile of Health Effects of Soluble & Volatile Chemicals with CAS Numbers Used in Fracturing in Natural Gas Production in Pennsylvania



COMMENTS

The health effects summary for the chemicals used in Pennsylvania is not a weighted analysis. Each chemical is included only once in the summary whether it is in only one product or in many. Some of the most prevalent chemicals are among those associated with the most health categories. For example, of the eight chemicals that appear in three or more products, two are associated with 13 health categories (methanol, glutaraldehyde), and two are associated with 12 health categories (boric acid, ethylene glycol). The remaining four (isopropanol, propargyl alcohol, citric acid and potassium hydroxide) are associated with ten, nine, seven and seven health categories, respectively.

Methanol is reported in 8 products on this list. Both volatile and soluble, methanol is readily absorbed by inhalation, ingestion and dermal exposure. Methanol is associated with all of the health categories except cancer and less than an ounce can be fatal. Some of the most prominent consequences of exposure are damage to the eyes (blindness), the nervous system, the liver and kidney. It also causes birth defects.

The foamer and solvent, 2 butoxyethanol (2-BE), is reported in two products on the list. 2-BE is soluble (miscible) in water, colorless, tasteless and odorless at low concentrations, and evaporates at room temperature. It has a number of unusual health impacts that could baffle physicians and veterinarians, and also causes several kinds of cancers. If it were to penetrate a drinking water source, exposure could be through ingestion, inhalation, and the skin.

Crystalline silica (found in 2 products on this list) poses a hazard as a respirable dust that lodges permanently in the lungs, and can cause silicosis, emphysema, obstructive airway diseases, and lymph node fibrosis. It poses a long-term delayed health hazard, similar to asbestos, that can turn rapidly into a malignant lung cancer.

All of the chemicals and products on this list are used in the fracturing process. TEDX has no information about those products or chemicals used in the other stages of natural gas production (e.g. drilling, completion) that will be used in Pennsylvania.

FOR FURTHER CONSIDERATION

Prior to use, these products must be shipped and stored before being transported to the well site. They pose a hazard on highways, roads and rail systems, as well as to communities near the storage facilities.

Fracturing, frac'ing, and stimulation are terms used to describe a process commonly used to facilitate the release of natural gas and to improve production. In this process up to a million gallons or more of fluid under extremely high pressure are injected underground to open up fractures in the strata being mined. Data indicate that in the Marcellus Shale this is more likely to be two to three or more million gallons of fluid per fracture. The gas industry claims that from 30% to 70% of the material it injects underground is retrieved, but has provided no actual studies to confirm this estimate. At some locations, because of regional differences in geology and technology, 100% of the injected fracturing fluids may remain underground.

Cumulative exposure impacts are not addressed in this analysis; however, the accompanying EXCEL spreadsheet provides a hint of the combinations and permutations of mixtures possible and the possible aggregate exposure. Each fracturing event is custom-designed depending on the geology, depth and resources available. The chemicals and products used, and the amounts or volumes used, can differ from well to well. In addition, the fluids or vehicles that make up the balance of the full composition of a product frequently are not provided, and nowhere are there data accounting for the fluids that make up the million gallons of fluid used. Complete records for each well must be kept for a realistic picture of what is being introduced into watersheds, air, and soil. This information should include the exact location of the well (state, county, township, section, latitude, longitude, etc.), the complete formulation of every product used at each stage of development and production, the weight and or volume of each product used, the composition of the fluids comprising the total volume injected underground, the depths at which material/mixtures were injected, the amount and composition of the recovered liquids, and their disposal method and location. The hazard posed by natural gas operations to our health and the environment requires full disclosure of this information.