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ANALYSIS OF

CHEMICALS USED IN OIL AND NATURAL GAS DEVELOPMENT AND DELIVERY IN NEW MEXICO

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Introduction

This project was designed to explore the health effects of the products and chemicals used in drilling, fracturing, and recovery of oil and natural gas. It provides a glimpse at the pattern(s) of possible health hazards for those living in regions where oil and gas development are taking place. In order to do this, we collected lists of products and chemicals which we placed in a spreadsheet. We make no claim that this list is complete.

In the process of researching the literature, we discovered that drilling companies have access to hundreds of products, the components of which are in many cases unavailable for public scrutiny. This analysis addresses only those chemicals and products for which there is evidence that they are being, or have been used in New Mexico.

The products and chemicals included on this list were compiled from the Tier II reports sent to the state of New Mexico from Halliburton Energy Services, Inc., BJ Services Company, USA, and Schlumberger Technology Corporation, and from MSDS sheets.

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1. Our list consists of 214 products used in oil and natural gas development and delivery. These products contain 172 chemicals and cover all stages of production and development.

2. The four most common adverse health effects for the chemicals on the list are skin and sensory organ toxicity, respiratory problems, neurotoxicity, and gastrointestinal and liver damage.

3. Examination of the products used in oil and gas development and delivery shows that 93% have one or more adverse health effects. Of the 14 products without health effects, we have no data on 11 of them.

4. The following figures are based on the data in the Chemicals Used in Oil and Natural Gas Development and Delivery in New Mexico Spreadsheet. They include the percentage and the actual number of chemicals in each health category. They are presented to define a pattern of the possible health effects of the chemicals and products that are being used. Health effects of the 172 chemicals break out as follows:

Percentage	Number	Effect
68%	117	skin and sensory organ toxicants
67%	115	respiratory toxicants
55%	94	gastrointestinal and liver toxicants
38%	66	neurotoxicants
35%	61	cardiovascular and blood toxicants
34%	58	kidney toxicants
31%	53	immunotoxicants
28%	49	reproductive toxicants
25%	43	carcinogens
23%	40	developmental toxicants
23%	39	wildlife toxicants
22%	38	result in other disorders
19%	32	endocrine disruptors
15%	25	mutagens

Of the **32** (19%) of the chemicals on the list that can vaporize:

Percentage	Number	Effect
100%	32	skin and sensory organ toxicants
91%	29	gastrointestinal and liver toxicants
91%	29	respiratory toxicants
81%	26	neurotoxicants
72%	23	cardiovascular and blood toxicants
72%	23	kidney toxicants
63%	20	developmental toxicants
59%	19	reproductive toxicants
47%	15	immunotoxicants
41%	13	carcinogens
41%	13	wildlife toxicants
38%	12	result in other disorders
28%	9	mutagens
28%	9	endocrine disruptors

Of the **62** (36%) of the chemicals on the list that are soluble, or miscible:

Percentage	Number	Effect
94%	58	skin and sensory organ toxicants
84%	52	respiratory toxicants
76%	47	gastrointestinal and liver toxicants
53%	33	cardiovascular and blood toxicants
53%	33	neurotoxicants
47%	29	kidney toxicants
42%	26	result in other disorders
40%	25	immunotoxicants
32%	20	reproductive toxicants
31%	19	wildlife toxicants
27%	17	developmental toxicants
26%	16	endocrine disruptors
24%	15	mutagens
19%	12	carcinogens

5. Fifty-four percent of the 172 chemicals listed have between four and 14 different reported health effects. Twenty-six percent of the chemicals have between one and three known health effects, and 20% have no health effects.

6. Many of the citations used to establish the health effects of the chemicals are old. For some of the chemicals we were unable to find studies newer than those done in the 60's or 70's. In some cases we were able to get data only from an abstract, not the full report or manuscript. In other cases, we were able to get quotations about the health effect(s) from toxic chemical databases, such as TOXNET, HAZMET, etc. Many reports submitted to the Environmental Protection Agency for the registration of some of these chemicals are not accessible.

7. Several reasons led to the lack of data about the health effects of some of the products and chemicals on the spread sheet:

(a) We found no health effect data for a particular chemical or product.
(b) Some products list no ingredients.
(c) Some products provide only a general description of the content, such as "plasticizer", "polymer" etc.
(d) Some products list the ingredients as "proprietary" or provide only the name of one or two chemicals plus "proprietary".

8. Much of the information about the composition of the products on the list comes from the Materials Safety Data Sheet (MSDS) for that product. The information on these sheets is limited to only those chemicals that are required by law to be disclosed. Ingredients are often labeled as "proprietary", or "no hazardous ingredients" even when there are significant health effects listed on the MSDS.

9. MSDS sheets are designed to provide information to protect those who handle, ship, and use the product(s). The sheets are also designed to protect emergency response crews in case of accidents or spills. The data in the MSDSs do not generally take into consideration the health impacts resulting from chronic or long-term, continuous, and/or intermittent exposure. Many chemicals have not gone through a rigorous and extensive scientific peer-review process that would permit conclusions to be drawn about "safe" and "hazardous" exposure levels.

10. The MSDSs are often sketchy and provide health effects information for only one or two chemicals in a product. In many cases the chemicals listed equal less than 100% of the product. In the case of mixtures, the health effects warnings are often not chemical specific.

11. Tier II reports are required by the Emergency Planning and Right to Know Act to help local communities protect public health, safety, and the environment from chemical hazards. This report consists of a list of chemicals at storage facilities. These reports were used as a major source of information our list. These reports require that at least one chemical be listed for each of the products in the inventory. While this does provide some hard data, we have discovered that a product can contain numerous chemicals which are not listed in these reports.

Comments

Chemical use and disposal

Fracturing of wells is a common practice in parts of the west, in which a million or more gallons of fluids are injected underground, creating a mini-earthquake that facilitates the release of natural gas. The gas industry claims that 70% of the material it injects underground is retrieved. While the fate of

the remaining 30% is unknown, the recovered product is placed in holding pits on the surface and allowed to evaporate. This results in many highly toxic chemicals being released into the air, as well as being dispersed into local surface waters. The condensed residues remaining in the pits are taken off-site and dealt with in two ways: (1) They can be re-injected in the ground posing concerns for aquifers, or (2) they can be "land farmed" by which they are incorporated into the soil through tilling. Land farming can release toxic chemicals to the air via volatile substances and dusts, or result in accumulation of mixtures of toxic metals in the soil.

At some locations, because of regional differences in geology and technology, 100% of the injected material may remain underground. The mobility of these residues in the environment, or their ability to contaminate ground water and aquifers has not been evaluated.

After development ceases on a pad and the well(s) goes into production, the residues in the evaporation pits are often bulldozed over. It is impossible to predict how long the buried chemicals will remain in place. Highly persistent and mobile chemicals could migrate from these pits into underground water resources.

Prior to use, these products must be shipped to and stored somewhere before being transported to the well site. They pose a hazard on our highways, roads, and rail systems, as well as to people living and working near the storage facilities. The recent evacuation of a neighborhood in New Mexico after a leak at a storage facility is one example of the dangers posed by these facilities.

It is important to note that once a well goes into production, the gas passes through a dehydrator to remove the water which is often stored in holding tanks on the pad. It is sometimes re-injected on site or can be trucked or piped to an evaporation pit where volatile chemicals escape. Any chemicals used during drilling and fracturing could be mingling with this gas production source of water.

Health Effects

We were unable to find health effects associated with 34 of the chemicals on the list. Of these, only 14 had been assigned a chemical identification number (CAS number) by the American Chemical Society enabling us to search the literature. We found no adverse health effects for these. However, we were unable to determine the safety of the other 20 chemicals because they were listed as proprietary or had chemical names that were so general that the specific chemical could not be identified (19), or were listed as "no hazardous ingredients" (1).

Many of the chemicals on this list have been tested for lethality and acute toxicity based on short-term contact. The majority have never been tested at realistic, environmentally relevant, chronic exposure levels, or for delayed effects that may not be expressed until long after exposure. Nor have adequate ecological studies been done. For example, most of the chemicals have not been tested for their effects on terrestrial wildlife or birds, fish, and invertebrates. It is reasonable to assume that the health endpoints listed above could very well be seen in wildlife, domestic animals, and pets.

The products labeled as biocides are among the most lethal on the list, and with good reason. Bacterial activity in well casings, pipes and joints can be highly corrosive, costly, and dangerous. Bacteria can also alter the chemical structure of polymers and make them useless. Nonetheless, when these products return to the surface either through deliberate retrieval processes or accidentally they pose a significant danger to workers and those living near the well and evaporation ponds. They can also sterilize the soil and inhibit normal bacterial and plant growth for many years.

In general, the volatile chemicals have more adverse health effects associated with them than the soluble chemicals. Not only are they more toxic, but in the area of skin and sensory organ toxicity 100% are associated with harm, and over 90 % are associated with harm in the gastrointestinal and liver, and the respiratory system.

The soluble chemicals are associated with more adverse health effects than the total number of chemicals. While they do not show as high a percentage of effects as the volatile chemicals, between 75% and 94% can cause harm to the same systems as listed above.

The use of respirators, goggles and gloves is advised on many of the MSDSs for products on this list. This indicates serious, acute toxicity problems that are not being addressed in the recovery process when the chemicals come back to the surface. It raises concern over possible hazards posed to those living in regions where development activity is taking place

Full Disclosure

When comparing the toxicity of the chemicals used in the four western states, the need for full disclosure became more evident. If it had not been for several accidents or spills where local citizens took it upon themselves to find out the names of products that were involved, TEDX would not have learned as much as we have. These accidents provided unique situations in which companies were inclined to more fully disclose product information and thus we gained greater insight about chemicals used to develop and deliver oil and natural gas. We know for certain, that a great deal more than water and soap is being used to drill a gas well.

The information we have for many products on the list is very limited. Almost half of the list (44%) has information on only the single chemical disclosed per product in a Tier II report. We have been unable to obtain MSDS sheets for these products. As our research has shown that most products contain two or more chemicals, this leaves a gap in the data. We have found that as we obtain MSDS sheets, the number of health effects for the products increases. Because of our current lack of information for so many products and chemicals on the list, we feel it is safe to say that our report *underestimates* the hazards of the situation.

A number of chemicals can be toxic when encountered in high concentrations, or, perhaps, during certain exposures (such as inhalation versus skin contact). Because only a small percentage of the total composition of most of the products on this list is available, we cannot say for certain whether such chemicals are harmless in their application. Under the present system, there are not enough data to determine the safety of products that contain mixtures of relatively “benign” ingredients and unknown chemicals, when the actual percentage composition is not provided.

This list provides only a hint of the combinations and permutations of mixtures possible and the possible aggregate exposure. Each drilling and fracturing incident is custom designed depending on the geology, depth, and resource available. The chemicals and products used, and the amounts or volumes used can differ from well to well. The only way to get a realistic picture of what is being introduced into our watersheds and air is for a complete record of information of the specific well site (state, county, township, section, etc.), the formulation of chemicals and products used at each stage, the quantity of each product (weight and/or volume), total volume injected and recovered, and the depths at which material/mixtures were injected and recovered, the composition of the recovered liquids and those liquids and solids removed from site. This needs to be public information.

As we have added products to the list, the percentages of health effects occasionally shifted. Changes such as this will continue as more products and chemicals are entered into the database. Thus far, despite small increases or decreases in percentage, the top four health effects of concern have remained the same. They are skin and sensory organ, gastrointestinal and liver, respiratory, and neurological system damage.