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Slick talking by Cuadrilla's Lord Browne

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On 22 September 2014 Lord Browne, CEO addressed the North and Western Lancashire Chamber of Commerce in Preston on the '*potential benefits of Shale Gas to Lancashire*'. Lord Browne claimed that Cuadrilla only uses one chemical, **polyacrylamide**, during fracking, and that this is non-toxic. I decided to investigate this claim. What I discovered has direct relevance to public health if fracking fluid ever contaminates drinking water.

A member of the audience for Lord Browne's speech wrote in *InFocus* (Elswick community magazine):

"I saw the Lord Browne speech that he gave at the Chamber of Commerce meeting at the Salmesbury [sic] *Hotel. In it he claims that his company Cuadrilla only use one chemical, which is non toxic. This is Polyacrylamide. This is not the case when it is heated above 84 degrees. It then becomes a neuro-toxin. When placed as an ingredient in the fracking fluid , pumped down into the deep earth it will change. So, although it is OK to state Polyacrylamide is safe at room temperature it is not OK to use it as a fracking ingredient. particularly in close proximity to people. Robert Silverwood"*

I could not find any evidence to back up Mr Silverwood's claim that polyacrylamide becomes a neurotoxin when heated. However, this set me off on a path to investigate polyacrylamide, the chemical which provides the 'slick' in slickwater fracking.

Polyacrylamide is a common chemical used in the water industry. In the oil industry is is used as a friction reducer, to make water 'slick', both in conventional wells and in fracked wells. In fracking for shale gas (or oil) high volumes of slickwater are used, hence the acronym HVHF (high volume hydraulic fracturing). I prefer the alternative term super-fracking (http://scitation.aip.org/content/aip/magazine/physicstoday/article/67/8/10.1063/PT.3.2480), introduced by Don Turcotte and colleagues in summer 2014, to denote the kind of fracking that is of environmental concern, and which has nothing in common with the older low-volume, lower-pressure fracking of conventional oil wells or geothermal boreholes.

Cuadrilla used a friction reducer, FR-40 (http://www.cuadrillaresources.com/wp-content/uploads/2012/02/Chemical-Disclosure-PH-1.jpg), when fracking the Preese Hall-1 well in 2011. It declared that "This product does not contain any reportable hazardous components as defined in 29 CFR 1910.1200" This code belongs to the Occupational Safety & Health Administration (https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10099) of the United States Department of Labor. Presumably the UK did not have its own standard, administered by the Environment Agency and/or the Health & Safety Executive. It would be pertinent to ask whether this is **yet another gap in UK fracking legislation**.

FR-40 was supplied to Cuadrilla by CESI Chemical (http://www.flotekind.com/catalog/specialty-chemicals/cesi-chemicals/stimulation), a company which does not list this product. It is likely that it was obtained indirectly from Raven Chemicals Inc (http://www.ravenchem.com/)., a US company which does market FR-40, and other similar chemicals based on polyacrylamide, used in hydraulic fracturing.

Polyacrylamide is made from **acrylamide**. There has been scientific controversy for around thirty years about whether polyacrylamide can be degraded back to acrylamide. It turns out that some results apparently supporting the breakdown of polyacrylamide to acrylamide are better explained by the fact that there is always some residual acrylamide (http://www.sciencedirect.com/science/article/pii/S003238610300003X) content after the manufacture of polyacrylamide.

Acrylamide is a highly toxic chemical, which can lead to endocrine gland disruption, cancer, nerve problems, decrease of lifespan, and so on. It is so toxic that the Maximum Contaminant Level Goal has been set by the US Environment Protection Agency (EPA) (http://water.epa.gov/drink/contaminants/basicinformation/acrylamide.cfm) at zero. The World Health Organisation has set a guideline value of 0.5 µg/l of acrylamide in water (pdf (http://www.davidsmythe.org/frackland/www.who.int/water_sanitation_health/dwq/chemicals/acrylamide.pdf)), which it states may be present from the residual levels of acrylamide in the polyacrylamide used to treat drinking water. The state of Minnesota has set a much lower guide value (pdf (http://www.davidsmythe.org/frackland/www.health.state.mn.us/divs/eh/risk/guidance/gw/acrylainfo.pdf)), based on "protecting Minnesotans from cancer" of **0.2 parts per**

billion.

Since we are dealing with large volumes of polyacrylamide containing residual quantities of acrylamide, as used in hydraulic fracturing, it becomes important to estimate whether potential contamination of water supplies could occur. Here are some figures.

The proportion of polyacrylamide in fracking fluid is around 0.05% by volume. In that polyacrylamide there is a residual 0.1% of acrylamide (SNF Floerger handbook pdf (http://www.davidsmythe.org/frackland/snf.us/wp-content/uploads/2014/08/Polyacrylamide-Emulsion-Handbook.pdf)). So fracking fluid contains of the order of 0.00005% acrylamide, or $\mathbf{5.\ 10^{-7}}$ in scientific notation. Let us now turn to the permissible upper limit of acrylamide in drinking water. We can ask: by how much do we have to dilute neat fracking fluid to bring it below the safe limit. Bearing in mind that **the only real safe limit, according to the EPA, is zero**, we adopt the conservative Minnesota value of a 'safe' upper limit, which in scientific notation is $\mathbf{2.\ 10^{-10}}$. Then we simply divide the proportion of acrylamide in frack fluid by the safe limit to get the dilution factor; this is $5.\ 10^{-7} / 2.\ 10^{-10}$ **= 2500**. In words, **neat fracking fluid will become safe to drink** (as far as its acrylamide content is concerned) **as long as it is diluted by at least 2500 times** with pure water (see diagram below).

dilution 2500 (http://www.davidsmythe.org/frackland/wp-content/uploads/2014/12/dilution-2500.jpg)

The blue disc is 2500 times larger in area than the black dot to the left.

Now we need to estimate pathways by which a given volume of the 60-80% 0f fracking fluid which is left in the subsurface could make its way via faulty wells, abandoned wells, or via natural faults and fractures into drinking water aquifers and wells. We would also need to estimate the volume of drinking water available in the given aquifer, and predict (by modelling) plausible mixing processes to see whether the fracking fluid is in fact diluted by a factor of 2500 or more, to render the drinking water safe. But this is not my job. The onus should be on the fracking companies to undertake this kind of study before even one well is fracked. But before this kind of modelling prediction could be considered meaningful they would have to have undertaken meticulous surveys in 3D of the geology of both the shale volume to be fracked, and of the rocks above and around.

Currently in the UK the fracking companies do not even consider the problem of acrylamide. Lord Browne has declared his polyacrylamide to be a safe chemical. Knowledge of geological pathways of the fracking fluid from the fracked shale back to the surface is either deliberately not sought, or else is ignored. On the subject of man-made pathways, the industry and the government fall back on the empty assertion that UK regulation is among the best in the world.

In conclusion, **the precautionary principle implies that slickwater fracking, using polyacrylamides, should be made illegal forthwith**. Not so slick, Lord Browne!

Categories: Cuadrilla