



# Watson's Notes

Innovative Solutions  
for Difficult Problems

## "You have recently been in Afghanistan, I perceive"

With these words was born the most famous team in detective fiction; Sherlock Holmes and his trusted comrade and biographer, Dr. John H. Watson.

In the spirit of Watson, who chronicled the exploits of Holmes, we have created this newsletter named "Watson's Notes".

In the pages of "Watson's Notes", modern day scribes document the discoveries, unusual cases and other news of Investigative Science Incorporated, our scientific consulting firm in Burlington, Ontario, Canada.

Please contact us if you have comments, and please read on.

**ISI** INVESTIGATIVE  
SCIENCE  
INCORPORATED

Scientists and Technical Consultants

1050 Cooke Blvd., Unit 2

L7T 4A8

(905)634-4200

mail@investigativescience.com

www.investigativescience.com

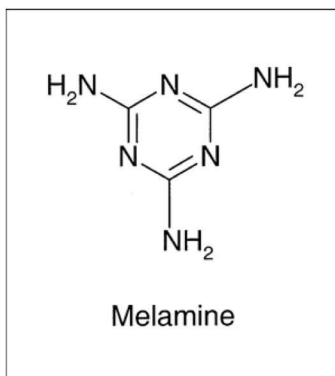
# Toxic Chemical Substitutions; Are They Affecting Your Business?

For those of us in the industrial problem-solving business, a sinister new issue is just beginning to come into focus. It has always been present as a remote possibility, but recently the number of incidences has increased rapidly. Welcome to the world of **toxic chemical substitution**. Lets call it TCS for short. TCS is the deliberate substitution of one chemical for another in a consumer product, with no regard for its toxicity to humans or animals.

## Milk Products & Pet Foods

There have been many examples of TCS in the news recently. Milk ingredients from China have been identified as the source of melamine poisoning implicated in the illness of tens of thousands of Chinese infants and the deaths of at least four to date. So far melamine has been found in infant formula, a milk-based dessert, an instant coffee product, cake and candies.

Another well known case involving melamine occurred with wheat germ. In this case many cats and dogs died after ingesting name brand pet foods which contained wheat germ from China.



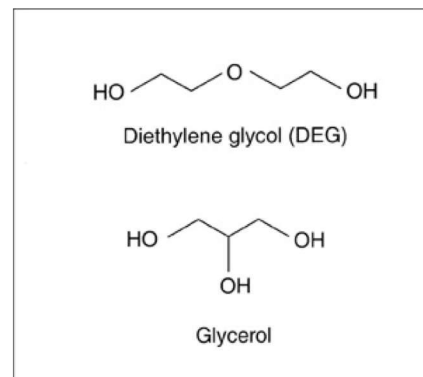
This chemical was added to fool a test for protein. In the food test world, a general test for nitrogen is used to determine the protein content of wheat & milk products. You will notice in the picture that melamine contains lots of nitrogen. The key point here is that melamine is toxic. It was deliberately added to enhance the "value" of the wheat germ and milk ingredients by

giving a falsely high protein (nitrogen) assay result.

## Cough Syrup

In Panama, 94 people died after ingesting cough syrup containing 15% diethylene glycol, or DEG, a common component of anti-freeze. It is known to be toxic to humans.

How did it come to be in the syrup? As far as we know, someone in a factory in China, substituted diethylene glycol for what should have been there, glycerol (also known as glycerin). Why would someone do that? The reasons are partly explained by examining the structures shown in the Figure below.



As you can see from the diagram, these two chemicals are very similar. Both are thick syrupy liquids and are sweet to the taste. In a thick, sweet syrup like cough medicine, they would be virtually indistinguishable.

The over-riding feature of diethylene glycol, though, is that it is cheap compared to food grade glycerol. To illustrate, diethylene glycol can be purchased from a typical North American supplier for about \$23/kilogram. The price for food grade glycerin is about \$110/Kg, or nearly 5 times the price. Large bulk purchasers can probably get a better price, but the ratio of the two prices should be accurate. A large manufacturer could therefore cut their raw material costs by about 80% by substituting diethylene glycol for food grade glycerin.

# ELEMENTARY MY

## DEAR WATSON

Sherlock Holmes said to Dr Watson: 'I can tell you exactly what you've been doing today.'

Watson replies, 'That's incredible, Holmes. Tell me.'

So Holmes said, 'You had egg and bacon for breakfast, read a book until 11 o'clock, had lunch in your favourite restaurant, walked in the park for almost two hours, then went home in a taxi.'

Watson said, 'That's astounding, Holmes, how did you know?'

'I was with you all day', said Holmes.

### Toys

In another well-publicized example, the date rape drug precursor, 1,4-butanediol, was found in a popular toy called "Aqua Dots", reportedly manufactured in China. These small beads can be assembled into myriad shapes, and then sprayed with water to set the glue. The chemical that is supposed to be present is 1,5-pentanediol; generally regarded as safe. As you can see from the chemical structures in the Figure below, these two chemicals are again very similar. The only difference between the two molecules is that one contains four carbons and the other contains five.



1,5-Pentanediol



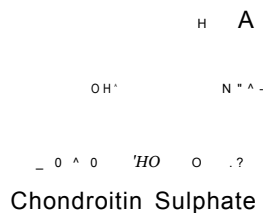
1,4-Butanediol

The problem is that 1,4-butanediol is converted into the "Date Rape" drug,  $\gamma$ -hydroxy butyrate, in the body. It can induce unconsciousness and death. Several children in the U.S. and Australia fell into coma after ingesting "Aqua Dots".

Again, someone made a chemical substitution here. Why? 1,4-Butanediol would be expected to have the same desired chemical properties as the pentanediol, but, again, it is cheaper. A large purchaser of these materials could reduce their raw material costs by more than 85% by substituting the butanediol for the pentanediol. The fact that the substitute is a deadly chemical, banned in Canada, was apparently of no concern to whoever made the decision.

### Heparin

Recently, heparin, (an injectable anticoagulant also used as a coating for medical devices) was found to be contaminated with oversulphated chondroitin sulphate (a chemically-modified version of the ingredient used in the treatment of osteoarthritis). Both chemicals are glycosaminoglycans, polymers containing variably sulphated saccharide chains, but according to USFDA data, the oversulphated chondroitin sulphate has been linked to serious adverse events and death (131 deaths between January 2007 and April 2008, with a sharp increase in the last 6 months!).



Chondroitin Sulphate

*note a OH change to OSO<sub>3</sub>M oversulphated contaminant*

Normally chondroitin sulphate contains fewer sulphate groups than heparin. But in this case, the chondroitin that was used was chemically enhanced (see Figure above) to contain more sulphate groups and thus fool the regulatory tests and potency assays. It is worth noting that chondroitin sulphate is widely available and is relatively inexpensive.

### Why is this happening?

In each of these four cases, someone made the decision to substitute one chemical for another. Their decision was apparently based solely on price and chemical similarity. The potential harm to consumers was clearly of little concern.

### How can ISI help?

Investigative Science Incorporated (ISI) is a team of chemists, biologists and analysts that has been helping industry solve complex technical problems since 1991. Toxic chemical substitution certainly qualifies as a complex problem, but it is not unsolvable. Using our unique combination of technical expertise, problem solving strategy and chemical analysis, our scientists can assist your firm to protect itself against the fallout from chemical substitutions in offshore products or raw materials.

**Don't get stuck facing an expensive product recall. Don't assume that these are all random accidents that will be picked up by your QA system. Don't assume those Certificates of Analysis are all valid! You don't want to become the lead story on the nightly news.**

**Call ISI today or visit [www.investigativescience.com](http://www.investigativescience.com).**

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