What we are talking about when we talk about "Binary Sarin"

By Dan Kaszeta

Since the August 21st chemical attacks in Syria last year, it is abundantly clear to me now that an awful lot of people are talking about nerve agents, in particular Sarin. Not everyone seems to use the technical terms correctly, and this leads to much confusion and misunderstanding in discourse. Much of this can be attributed to the fact that very little of the body of knowledge about nerve agents is in the public domain and some people in positions of authority have made confusing statements themselves. For example, if one is referring to a chemical weapon, are they referring to the chemical compound itself (e.g. Sarin) or to the delivery system (e.g. a rocket). Or are they referring to both in combination? Conflicting usages and examples are replete in current media sources. So, in order to clear up confusion and prevent misunderstanding in the future, I have prepared the following glossary of binaries to aid everyone.

Binary Chemical Warfare Agent: A chemical agent that is produced by adding two non-chemical warfare agent precursor compounds together. The chemical reaction that produces the desired chemical warfare agent is a Binary Reaction. It should be noted that such a combination does not necessarily result in just the desired chemical agent. By-products are often produced. Some significant binary chemical warfare nerve agents include the following nerve agents:

> Binary Sarin (GB2): 1 mol Methylphosphonyl difluoride (DF) + 1 mol Isopropyl Alcohol, yielding 1 mol Sarin + 1 mol Hydrogen Fluoride (HF), in which the HF is the byproduct.
>
> Binary Soman (GD2): 1 mol DF + 1 mol pinacolyl alcohol yielding one mol Soman and one molecule HF.
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> Binary VX2: O-Ethyl O-2-diisopropylaminoethyl methylphosphonite + Sulfur, yielding VX.

It is well established now that the Syrian government used Sarin in a binary form. In other words, it kept the necessary ingredients (binary components) on hand to make Sarin but not actually keep any Sarin stockpile. This could have been for a variety of reasons, such as safety, security, and shelf life. (Sarin made by a the primary binary reaction generally has poor shelf life due to residual HF.)

It should be strongly stressed that a binary chemical agent is not the same thing as a binary munition. The binary chemical agent is the contents and the binary munition is the packaging.

Binary Components: The ingredients needed for a binary reaction to occur in a binary process. These can include the following:

Precursors: The actual ingredients needed for the binary reaction. DF and isopropyl alcohol are precursors in the binary sarin

Additives: Things deliberately added to the mixture for some reason. Isopropylamine was an additive in one US binary weapon to scavenge the HF acid byproduct. Other amines are useful for the same reason.

It is also important to note that other things can be inadvertently present in binary components. The following are overlapping definitions:

Byproducts: Things left over in the precursors due to some artifact of the manufacturing process.

Contaminants: Some things may have crept into the manufacturing process of one or more of the other components, either as a byproduct or through some other means. There might, for example, be an impurity in the isopropyl alcohol.

Degradation products: A binary component may degrade into other things over time, and such may be present.

Binary Munition: A device designed to produce a binary chemical warfare agent in flight. Binary munitions, such as rockets, aerial dropped bombs, and artillery shells, are designed to create the conditions for the necessary binary reaction shortly before dispersal. One example of a binary munition (and one of the only ever fielded) was the US M687 artillery shell. This was a 155 mm artillery shell that contained two different canisters. One canister contained DF and the other contained isopropyl alcohol and an additive, isopropylamine. The shock of the firing from the 155mm howitzer would rupture the barrier between the two canisters, and the spin of the warhead was specially designed to mix the components.

As best as anyone can tell, the “Volcano” rockets used on 8/21 in Ghouta are not a binary munition as there seems to be no provision for mixing components in flight. My own hypothesis that the Ghouta attacks may have involved binary munitions were discarded once adequate information was available on the simple construction of the Volcano. As we have not seen enough of an exemplar to go by, there is evidence to indicate if the smaller 140mm rocket was a binary munition. I have reasons to strongly suspect that the 140mm rocket was also not a binary munition, but in the absence of more information, they remain strictly that – suspicions.

It should be strongly noted that a binary process and binary reaction can occur in any setting, not just in a binary munition. The binary reaction can be done in a binary process either in a munition or outside of a munition. While the concepts of binary chemical warfare agent and binary munition are related, they are not the same thing. A binary chemical warfare agent can be produced in a variety of settings. A binary munition is one, and only one, of the ways in which a binary chemical warfare agent can be made.

Binary Process: A binary process is the actual means by which the binary chemical agent is produced by the binary reaction. This could be a mixing process in a binary munition or some sort of industrial process in a factory or laboratory. It could even be a crude process on the side of the road, although such processes were tried and abandoned in the Iran-Iraq war. A “mix in flight” binary munition is one example of a binary process. A factory process that mixes binary components and then fills them into non-binary chemical munitions is another example of

Binary Reaction: The binary reaction is the actual chemical reaction that occurs combining two different precursor molecules to create a chemical warfare agent molecule, either with or without a byproduct.

Conclusion:

There’s a lot of ways you can look at this. One of the best ways of simplifying these different terms is to use a cooking analogy.

Binary Components: The list of ingredients

Binary Process: The procedural steps of the recipe.

Binary Reaction: The chemistry that happens that transforms the ingredients into a cooked product.

Binary Munition: One way of cooking the product, but not the only way.

Binary Chemical Warfare Agent: The finished product.