CHEMISTRY

Mysterious Explosive

Ammonium nitrate, so harmless that it can be hammered, and so incombustible that it does not burn, can explode to burn city.

➤ CHEMICAL mystery, unsolved after decades of investigation, is why ammonium nitrate explodes violently as it did in the ship at Texas City, yet won't explode when hammered or penetrated with high power rifle bullets.

The chemical villain in the Texas disaster is a harmless-looking white salt. It is not even classed as an explosive. It is usually safe to handle. A hundred million pounds are manufactured each year for fertilizer or explosives use.

Only infrequently does ammonium nitrate go off with great violence, as it did at Texas City and as it did at Oppau, Germany, in 1926.

As a leading explosive expert put it: "When ammonium nitrate explodes, it is always mysterious."

Always Mysterious

Often slightly wet from moisture it has drawn from the air, the white crystals cake like table salt on a humid summer day. The caked masses often become so hard that workmen use iron picks and shovels to break them up. They pound the lumps with hammers. As a demonstration of the chemical's safety, they have even shot high-powered rifle bullets into a mass of the salt. Very special kinds of detonators are required to set off blasting powder made of ammonium nitrate, and no amount of shock is known to have caused the pure salt, uncontaminated with any other material, to explode.

Neither will ammonium nitrate burn. This is expected from chemical theory, for burning is, in general, combination with oxygen and the salt already contains a considerable quantity of that element. Even when heated to the ordinary degree in chemical processes it will take up no more.

It is another story, however, when the ammonium nitrate is contaminated with burnable material. Organic matter, chips of wood from packing boxes, fuel and lubricating oil dripping from carelessly closed containers, any of the combustible waste and dust constantly underfoot, mixed with the harmless-looking salt, make a mixture where conditions are just right for a fire.

Organic material is made largely of carbon, often combined with hydrogen into forms which need to be heated only slightly to catch fire and burn in the oxygen of the air. We are so used to the fact of fire that we seldom think of the dangerous flammability of common materials.

Ammonium nitrate is, in comparison with most materials, not flammable by combining with the oxygen of the air. But when mixed with material that is flammable it helps combustion by giving up its own oxygen to help the fire along.

Exactly what happens when ammonium is heated to a high temperature is still unknown, for when it "lets go" the whole mass explodes and there are seldom any survivors to report what happened. By violent rearrangement of the molecules, huge stores of energy are let loose in an instant. Flame and hot gases spread destruction to other burnable materials, and a holocaust like that in Texas City is the result.

Compared to War

It is natural to compare the destruction to war damages, for essentially the same chemistry is involved. The ammonium nitrate which blew up the French ship Grand Camp was probably salvaged from war-time ammunition. For military use, the hazards of explosive material have been purposely increased. The energy-giving salt has been mixed with unstable chemicals to make explosives still more dangerous.

A question often asked is, "How does this explosion compare with that of the atom bomb?"

To the explosives chemist, who measures time in much shorter units than anyone else, the two types of explosion are very different. The huge vertical wall of blast pressure that moved out from Bikini was quite unlike the slower-moving wave set off by those types of ammonium nitrate explosives which have been thoroughly studied. Frequently used in coal mines for its effect in "heaving" rather than shattering coal, ammonium nitrate, making up as much as 95% of some blasting powder, is considered slow and safe, as explosives go.

For the future, explosives experts feel that no additional regulations are necessary, so far as pure ammonium nitrate uncontaminated with organic material is concerned. Stock of ammunition being reworked for agricultural use must always present more hazard than the newly formed chemical which has never been mixed with explosive material. Care in handling the salt will always be needed because, as one chemist put it, "wood that has been soaked in ammonium nitrate burns very nicely."

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BACTERIOLOGY

Bacteria Corrode Concrete By Producing Sulfur-Acids

➤ BACTERIA that corrode solid concrete with sulfur-containing acids produced by their secretions have been discovered by Dr. C. D. Parker of the research laboratories of the Melbourne and Metropolitan Board of Works, Australia. He has named the new species *Thiobacillus concretivorus,* which transaltes as "sulfur-bacillus that eats concrete." It makes a good deal of trouble in concrete sewer pipes.

Actually, the bacteria do not literally eat the concrete; they feed on the complex mixture of decaying materials in the sewage, as do many other kinds of microorganisms. Sewage contains proteins and related compounds; breakdown of these yields sulfur compounds of varying degrees of complexity. It is on these sulfur compounds that some of the bacteria feed, for which reason they have appropriately been named thiobacteria or sulfur-bacteria.

One thing puzzled Dr. Parker at first: his concrete-eaters require a rather highly acid medium in which to live, and the surface of fresh concrete is quite definitely alkaline. He discovered upon further investigation that the way was prepared by other bacteria, operating in two stages. First came a group of mixed bacteria that could tolerate the concrete's alkalinity, then one already-known species, *Thiobacillus thioparus,* which could tolerate some alkalinity and also live under increasingly acid conditions. Finally, the newfound concrete-eaters took over at a higher degree of acidity, increasing it to a point where the acids are able to corrode the concrete.

Dr. Parker has reported his discovery to *Nature* (March 29).

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