Air Bag Progress Report 9:

How much explosive power does and air bag have? The short answer to that is, "enough to kill you". In order to better understand this, however, we have to review a little combustion chemistry.

Every explosive has what is called a heating value, also known as the heat of combustion, and, in the case where the products of combustion are elements in their natural state, the heat of formation. When an explosive explodes, it changes chemically from its original chemical composition into what is the known as the products of combustion, while at the same time giving off a lot of heat. That heat raises the temperature and pressure of the surrounding air, if the explosion takes place in air, and the temperature and pressure of the products of combustion. That pressure increase in turn generates a shock wave which propagates into the surroundings at a high rate of speed, unless the explosion is contained in a rigid closed vessel. Unless the explosion is very weak, the generated shock wave will be very strong, sometimes strong enough to kill a person if that person is struck by the shock wave. Doctors generally refer to injuries caused by this phenomenon as concussion.

The heating value of an explosive is generally taken as the heat given off to the surroundings when the products of combustion are cooled back down to some reference temperature. It is generally defined as either the heating value at constant volume or the heating value at constant pressure. Usually, neither of these conditions will apply in practice, but they give us a way of comparing the power of various explosives. In the case where the products of combustion are elements in their natural state, the heat of combustion is equivalent to the heat of formation. This is the case with the air bag explosive, sodium azide:

$$2NaN_3 \rightarrow 2Na + 3N_2 + \Delta H_f$$

where ΔH_f is the heat of formation of azide and constant pressure. Defined this way, the heating value of sodium azide is approximately 80 calories per gram. This a good deal less that the heat of combustion of smokeless gunpowder, for example, which is around 1,100 calories per gram. The amount of azide in an air bag, however, is from 50 to 200 times as great as the amount of powder in a shotgun shell or rifle cartridge. It was the German physicist Rudolf Clausius who first showed that heat can be turned into work and work into heat by a fixed ratio. The term work is here used in its technical sense, i.e., force times distance. Thus, 1000 calories equals 3088 foot pounds, which is enough energy to lift one pound 3,088 feet or to lift 3088 pounds one foot. If you weigh 150 pounds it is enough energy to throw you 20 feet into the air.

Shotgun shells and rifle cartridges generally contain about a gram of powder, shotgun shells generally a little less, rifle cartridges a little more. If you stand 18 inches in front of a shotgun, about the same distance as a driver is seated from his air bag, and the shotgun is fired at you, it has enough power to take your head off. Let us see how much power an airbag has. A typical driver's side air bag has about 50 grams of azide in it. At 80 calories per gram, that works out to 4000 calories, or about four times the power of a shotgun shell. A typical passenger side air bag contains about 200 grams of azide, or about 16 times the power of a shotgun shell.

There are many videos on youtube of air bags being detonated. The best source for such videos is the Davids Farm channel on youtube. While a driver generally sits around 18 inches from the driver's air bag, a front seat passenger sits around 30 inches, more or less, depending on how the seat is adjusted, from the passenger's air bag. This is in a closed car, while even in the open air, spectators are careful to stand at least thirty feet away from the air bag before it goes off. The passenger air bag is generally located behind the glove compartment, which means it will blow out the glove compartment when it goes off. Even so, the large amount of azide in a passenger side air bag means that a passenger is, if anything, in even greater danger from the air bag than the driver. The power of the charge is such that it will go through the glove compartment like tissue paper. NHTSA has, for some time, been issuing hysterical warnings not to let children sit in the front passenger seat of automobiles. They admit that many children have been killed this way. They claim several hundred, but few adults. The FARS data base tells a different story. Of course they are careful not to list the cause of death and have even crossed out the death certificate numbers, just to make sure you can't find out. But a careful analysis of the data show that not hundreds, but thousands of motorists in this country have been killed by air bags, and most of them were adults, not children.

As we have already pointed out (abpr 4), azide is one of deadliest poisons known to man, so that if you have an imperfect seal on your air bag cartridge, and some of the azide leaks out, inhaling less than gram of the powder can kill you. The products of combustion of sodium azide are sodium and nitrogen. As you watch an airbag explosion you notice a lot of white powder being given off after the explosion. That white powder is sodium, which, when mixed with water, turns into lye. If you inhale some of the dust, as you are bound to do if you survive the explosion in a closed car, that sodium will turn into lye in your body and, if you inhale enough of it, it can kill you in a very painful manner.

All this being said, you may wonder why air bag manufacturers do not put some other explosive into their bags other than sodium azide. To answer that we have to review two other concepts in combustion chemistry, namely, the reaction rate coefficient and ignition delay. When a spark is applied to an explosive there is a delay between the time the spark is initiated and the time the explosion takes place. This is known as the ignition delay. It is temperature and pressure dependent and can vary anywhere from 3 ms to 10 ms or more. The reasons for this are too technical to enter into here, but based on the air bag theory, the airbag is required to fully deploy before the occupant hits it. Because this time is measured in milliseconds and because ignition delays can easily run to ten milliseconds or more, the air bag theorists needed an explosive with a short ignition delay. In addition, they needed an explosive which would react quickly. While it is not apparent to the casual observer, not all explosions proceed at the same rate. The reaction rate coefficient measures the rate at which an explosion proceeds. Again, because the bag had to deploy in milliseconds, what was needed was an explosive with a high reaction rate coefficient. Sodium azide best fulfilled both of these requirements, assuring, as they thought, that the bag would deploy before the occupant hit it.

In fact, as it turns out, even sodium azide may not fulfill these requirements. There are other delay factors, especially the accelerometer which is supposed to close the circuit to set off the spark. We shall discuss all these factors later in more detail, but what is striking is that every dummy test air bag video we have seen has obviously been falsified in some manner. Thus, we find that in one the seatbelt has been rigged so as to hold the dummy back until the airbag has inflated, and then releases; in another the accelerometer has been replaced by a contact detonator, which may be seen from the fact that the air bag deploys the moment the vehicle touches the wall, before it has begun to decelerate; in another video, the air bag actually starts to deploy before the vehicle even touches the wall!; in another the engine has obviously been removed from the vehicle, so that the front crushed two feet instead of one while the passenger compartment remains intact; in another they have moved the front seat way back so that the dummy will have further to go before it hits the bag, and on and on. All of these videos are faked in one manner or another. Also, there is really no way to tell how fast the vehicle in these tests is going because videos can so easily be speeded up or slowed down. The degree of crush doesn't tell you anything either because all of these vehicles can be structurally altered, or "prepared" in dummy test parlance. And of course the dummies can be programmed to move any way they want. In short, there is no evidence that they have been able to make this work, even in the lab. Even if they were able to make it work in the lab, that still wouldn't prove anything because the parameters in a real accident would be different.

One may well ask why they don't, at least, go to smaller air bags. As one can see from the many air bag videos (see references) air bags do come in a variety of sizes and strengths. The problem is that smaller air bags are in violation of federal law!(14)

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