RECYCLING PROPELLANTS AND EXPLOSIVES INTO THE COMMERCIAL EXPLOSIVE INDUSTRY

Alliant Techsystems' demilitarization experience with the commercial conversion of military ordnance materials in the Former Soviet Union

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ABSTRACT

As part of environmentally safe recycling of unwanted ordnance, the commercial blasting industry is a significant potential user of recovered energetic materials. Their industry utilizes significant quantities of explosive materials on an annual basis and can easily become an even larger consumer of military energetics if their requirements are properly addressed. This paper identifies their concerns and offers methods for satisfying them.

Background

Alliant Techsystems is a world leader in both the manufacture of conventional ordnance and in the environmentally safe conversion of military materials into civilian uses. Our commercial efforts in the Former Soviet Union (FSU) have been showcase operations demonstrating that environmentally safe conversion of military ordnance is not only possible, but, based on reclamation values alone, can be economically profitable. Our commercial efforts in the FSU are internally funded and not funded by the U.S. government.

Alliant Techsystems, formally known as the Honeywell Defense Systems Division, was spun off by Honeywell Inc. in October 1990. Prior to that time, any demilitarization efforts were regarded by corporate management as being outside of corporate interests. Efforts to develop environmentally safe methods for demilitarization of munitions had begun as early as 1983, but received minimal support because of corporate's refusal to fund further development.

When Alliant Techsystems was released from Honeywell in October 1990, a more creative and environmentally responsive management took control. Within 20 days of the company's formation, Alliant Techsystems sent engineers to study existing environmentally safe European demilitarization technologies. Within 45 days of becoming a new company, Alliant Techsystems was already sectioning the first projectiles, while an aggressive concurrent engineering program was developing the production processes. Three short months after spin-off, the systems were sufficiently mature to brief the U.S. Department of Defense on the

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potential for environmentally safe conversion of ordnance. After being a company for only ten months Alliant Techsystems began formal presentations to the Soviet Union to promote converting their unnecessary munitions into commercially usable materials for their economy. Since 1990 the Soviet Union has gone through many dramatic changes, but Alliant Techsystems' early engineering efforts and willingness to work with former enemies have successfully furthered the cause of defense conversion.

Alliant Techsystems has been a driving force in the development of high-pressure fluids for the safe conversion of explosive ordnance. Our independent research performed in the 1991-1992 timeframe demonstrated that high-pressure fluids could be controlled to safely cut explosives ranging from PETN and TNT at pressures of up to one gigapascal (147,000 psig). I presented the results of our testing on the first 178,000 high-explosive projectiles to the DDESB in the summer of 1992. Since then, our recycling efforts have expanded significantly so that we currently count in metric tons rather than individual units.

Our current recycling operations are centered in two major facilities located in the countries of Belarus and Ukraine. From these operations, we are presently processing large caliber artillery rounds through our joint ventures with these two nations' governments. The operations are reclaiming valuable metals, such as brass, copper, and steel from the unexpended ordnance. Even more important for environmental considerations is our conversion of the recovered propellants and high explosives for use in Belarus' and Ukraine's commercial blasting industries. These recycling efforts have been very successful on the pilot scale and we are currently bringing full-scale production operations into service this summer.

These last few months have seen over 500 metric tons of propellant from our pilot operations being converted into commercial mining explosive. These activities have been a substantial benefit for Belarus' and Ukraine's mining industry. The net results of these munition conversion efforts include:

- an environmentally safe conversion of unnecessary munitions
- employment for countries converting their military to market economy businesses
- an improved mining product to improve production yields
- a profitable revenue for all participants.

The next step in expansion of our operation is the high-volume, automated production facilities for the safe removal, recovery and reprocessing of high-explosive fillers. Our facilities in Ukraine will be operational this August and our operation in Belarus, later this fall. Each facility has the capability of processing approximately 25 metric tons of TNT a day while recycling nearly all of the water used in our washout systems. The remaining water is lost through evaporation or as water taken out with the explosives. The explosive is then dewatered and processed for use in the local commercial blasting industry. As a basis for the comparison of our production line's size, TNT manufacturing lines[1] in the United States

[1]Kaye, Semour; Encyclopedia of Explosives and Related Items, Vol. 9, page T-236. 1980. AD A097 595

during the World War II were rated at only 59 metric tons per day.

Alliant Techsystems' experiences in the FSU and our research and experience in the United States converting nitrocellulose propellants and high explosives into commercial explosives have allowed us to make the following observations.

Conversion of Smokeless Powders and High Explosives for Commercial Mining

The use of smokeless powders, high explosives and propellants for commercial blasting goes back at least 30 years to the major expansion efforts on the Mesabi and Vermilion iron ore deposits, collectively known as the Iron Range, north of Minneapolis, Minnesota.

The post-World War II availability of propellants and explosive materials allowed entrepreneurial blasters to mix differing proportions of propellants and explosive materials with oxidizers and blending agents to form high grade blasting slurries that could outperform either dynamite or ammonium nitrate/fuel oil (ANFO). ANFO had already become the standard in the commercial blasting industry[2] during the 1950s as it displaced the much more expensive dynamites and blended dynamites. The major drawbacks with the use of ANFO are poor water resistance and low brisance. Many areas in the Iron Range have hard rock that limits the effectiveness of ANFO despite its low cost. In addition, many of the boreholes drilled in the Iron Range are drilled days before they are loaded and may sit for many days after loading before they are shot. When water seeps through the cracks in the borehole and causes a wet hole, the explosive can be desensitized and the shot not function properly. In order to overcome the problems associated with ANFO, numerous explosive mixtures were attempted until slurry explosives were developed.

The first slurry explosive shot was accomplished by CIL in Canada using an ammonium nitrate and TNT mixture with a thickening agent. Dr. Melvin Cook's research continued this line of work in the United States with ammonium nitrate/TNT slurries on the Iron Range in 1956 through the introduction of his DBA brand slurry explosive in 1959. The slurry explosives containing TNT were especially well suited[3] for applications that required blasting underwater or under high-pressure, such as in very deep holes. Soviet commercial explosives[4] followed with their TNT blend a few years later.

The early 1960s saw a tremendous rise in the use of government surplus smokeless powders being used in the manufacture of slurried explosives. Both single-based and double-based propellants were extensively used by the entrepreneurial explosive companies to gain market

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[2]Dick, Richard; The Impact of Blasting Agents and Slurried on Explosive Technology; U. S. Dept. of Interior, Bureau of Mines Information Circular 8560; 1972.

[3]Cook, Melvin; The Science of Industrial Explosives; Graphic Services & Supply; 1974; Page19.

[4]Rossi, B.; Commercial Explosives and Initiators - A Handbook; Nedra Press, Moscow; 1971. AD 786 785 (N.B. In this translation, trotyl should have been translated as TNT.)

advantage over established explosive industries. Much of the Iron Range and mining in northern Michigan utilized these smokeless powder-based explosives during the pre-Vietnam War era. The combination of high performance, increased safety and lower cost for ANFO and slurry explosives pushed major manufactures of dynamite out of production by the 1970s. The slurries perform in hard rock and wet conditions as well as dynamite, but at a fraction of the cost. Although there are still specialized uses for dynamites, the slurried explosives and slurried blasting agents stole almost all of the above ground mining business away from the dynamites. Today, most of the explosives used in mining are variations on ANFO, slurries and, most recently, emulsions.

The explosive energy of TNT or smokeless powder slurries varies according to their mixtures of water, oxidizers and additional fuels. Most of the mixtures contain ammonium nitrate as the oxidizer, and many slurries also contain fuels such as sugar or aluminum powder as well. The result of these mixtures developed in the 1960s is excellent, high strength explosive with energy levels exceeding conventional blasting materials such as ANFO. Mixtures of ammonium nitrate with either 20% single based smokeless powder, 15% aluminum and 20% water are 30% more powerful than the equivalent weight of ANFO. Mixtures of TNT and aluminum powder in optimal amounts are among the most powerful of all commercial explosives. The increase in explosive energy is only an additional benefit to the more principal features of hard rock fracturing and water resistance that make slurried explosives an attractive alternative to ANFO.

The use of smokeless powder and high explosives in slurries diminished during the build-up for the Vietnam War in the mid-1960s. As government surplus supplies diminished, the cost of the materials became uneconomical compared to other materials. Today, the use of smokeless powders or high explosives in the manufacture of explosive slurries is a rarity in the United States. The application of recycling these energetic materials into the commercial explosive industry has become either lost or a dim memory for many individuals in the explosive industry. We are aware of at least one company that has received federal funding to determine the feasibility of recycling smokeless powders into commercial explosives in the last few years and tried to patent the successful product. Unfortunately for them, the patent office sent them back no less than 14 similar patents that dated from the 1960s for virtually identical mixtures.

The mixtures of fuels, oxidizers and additives that can make an effective slurry explosive are almost infinite. The Bureau of Mines has been most helpful in supplying older research efforts to us, as has the Society of Explosive Engineers. From these two sources, an amazing amount of historical data exists on the use of surplus smokeless powders, high explosives and rocket fuels for use in the formation of commercial explosives. A brief compilation of mixes is given in Table 1.

Since Alliant Techsystems goals are for an environmentally safe and yet profitable solution to the demilitarization of conventional weapons, the recycling of the salvaged smokeless powders and high explosives into commercial mining explosives is an ideal fit. Our partners in the FSU have been willing to experiment with the small tonnage of materials that we have

recycled so far and have found these mixes ideal for use in their aboveground mining operations. Of the 500 metric tons of propellants processed so far, most of the material has been used in the quarrying industry. The use of quarries for test shots is identical to the process that the Bureau of Mines follows when they evaluate explosive materials and processes here in the United States.

The basic results of the testing overseas is that the recycled energetic materials perform as predicted and can substantially improve their mining industry's efforts to become profitable. Since slurry explosives use up to 30% explosive and up to 20% water, ammonium nitrate supplies can be stretched to make about twice the amount of mining explosives that they previously had. This activity keeps the mining industry from taking additional ammonium nitrate away from the agricultural sector where it is used as a fertilizer. One of the more interesting items of our research to date is the need for larger explosive particle sizes for successful slurry explosives. Small particles of explosives or propellants are not as desirable as large (> 30 mesh) pieces. This was especially beneficial as it is both easier and safer to process energetic materials to coarse pellets than to fine powders.

Current Problems with the Conversion of Smokeless Powders and High Explosives for Commercial Mining in the United States

Several significant barriers exist in the United States that inhibit the use of recycled propellants and explosives into the commercial mining industry.

First, the reclaimed energetic materials cannot be economically used if the EPA identifies them as hazardous waste. If the material is considered a hazardous waste, the burden of the regulations far outweigh any cost benefit that could be realized through recycling. The second major issue is that even minor changes in feedstock technically identifies the blended slurry material as a "new" explosive under the law. The most minor variations in the blends still require full recertification by the Department of Transportation. The third major problem is the lack of adequate quantities of ordnance being released into the demilitarization market to supply sufficient explosive and propellant materials for the consumers. We have been informed by operators on the Iron Range that in order to realistically get into the Iron Range explosive market, an explosive blender would need to be able to contract for at least 1.6 million pounds of smokeless powder a year. The release of that type of quantities is evidently in conflict with current government practices. Changes in U. S. policy and establishment of constituent ranges for DOT explosive classification of slurry explosive mixes would significantly aid U. S. propellant and explosive recycling efforts.

Conclusion

Alliant Techsystems has demonstrated that the technologies currently exist for the environmentally safe and profitable demilitarization of ordnance and the conversion of smokeless powders, explosives and solid propellants into commercially desirable mining explosives. Administrative and regulatory issues limit the economical exploitation of recycling these materials into the domestic North American markets. These impediments

could easily be removed by simple changes in policy and the establishment of constituent ranges for DOT explosive classification of slurry explosive mixes.

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Table 1

Common Explosive Mixtures Using Surplus Energitic Materials

Designation	Sensitizer	Water
Slurry Exp. - TNT[5]	17 to 60 % TNT	8 to 40%
Slurry Exp. - Comp B	15 to 35% Comp B	12 to 16%
Slurry Exp. - Single Base	20 to 60% SB Prop.	2 to 20%
Slurry Exp. - Dbl Base	20 to 60% Dbl Base	2 to 20%
Slurry Exp. - TNT/Al	5-25/0.5-40% TNT/Al	10 to 30%
Slurry Exp. - Propellant/Al	10-25/1-40 Prop./Al	12 to 30%
Zernogranulite 50/50V[6]	50% TNT	
Zernogranulite 30/70V	70% TNT	
Akvatol 65/356	27 to 30% TNT	
Akvatol M-15	21 to 22% TNT	

[5]Cook; op cit. Pg. 19.
[6]Rossi; op cit. Pgs. 45-61.

Table 1. Common Explosive Mixtures Using Surplus Energitic Materials