Abel Test

This test on chemical stability was proposed by *Abel* in 1875. The test parameter determined is the time after which a moist potassium iodide starch paper turns violet or blue when exposed to gases evolved by one gram of the explosive at 82.2 °C (180 °F).

In commercial nitroglycerine explosives, for example, this coloration only develops after 10 min or more. In a more sensitive variant of the method, Zinc iodide – starch paper is employed.

The *Abel* test is still used in quality control of commercial nitrocellulose, but is currently no longer employed in stability testing of propellants.

Acceptor[1]

Empfängerladung; *charge réceptrice*

A charge of explosives or blasting agent receiving an impulse from an exploding → *Donor* charge.

Acremite

This is the name given by the US inventor *Acre* to his mixture of about 94% ammonium nitrate with 6% fuel oil. This mixture was at first prepared in a primitive manner by the users themselves to obtain a very cheap explosive for open pit mining under dry conditions. Like → *ANFO*, the material has widely displaced conventional cartridged explosives.

Actuator

Mechanical device operated by a solid propellant.

Adiabatic

Processes or phenomena assumed to occur in a closed system without energy exchange with the surroundings.

adiabatic flame temperature

The temperature obtained by thermodynamics calculations for the products of combustion of energetic materials neglecting energy loss to the surroundings.

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[1] Text quoted from glossary.

Explosives, 7. Edition, Rudolf Meyer, Josef Köhler, and Axel Homburg.

isobaric adiabatic flame temperature

Adiabatic flame temperature attained under constant pressure conditions.

isochoric adiabatic flame temperature

Adiabatic flame temperature attained under constant volume conditions.

adiabatic temperature

The temperature attained by a system undergoing a volume or pressure change in which no heat enters or leaves the system.

Adobe Charge

Auflegerladung; *pétardage*

Synonymous with → *Mud Cap*

ADR

Abbreviation for "Accord Européen Relatif au Transport des Marchandises Dangereuses par Route" (European Agreement Concerning the international Carriage of Dangerous Goods by Road). It is based on the Recommendations on the Transport of Dangerous Goods Model Regulations (United Nations).

Aerozin

A liquid fuel for rocket engines that is composed of 50% anhydrous hydrazine and 50% *asym*-dimethylhydrazine.

AGARD

Abbreviation for the NATO Advisory Group for Aeronautical Research and Development.

Airbag

Gasgenerator

The basic idea of the airbag as a passive restraint system in a motor vehicle was already patented for the first time in 1951 in Germany. However, it took nearly 20 years before development began on two basic types – pyrotechnic and hybrid gas generators. Both types are manufactured nearly exclusively in series production and were included in cars

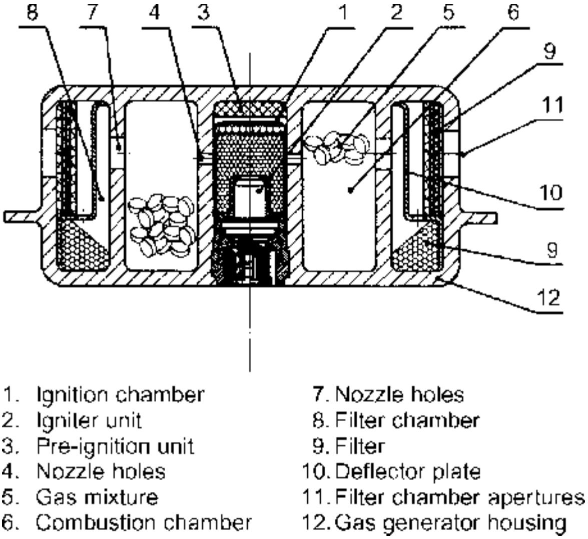


Figure 1 Sectional diagram of a pyrotechnical gas generator for airbags.

starting in 1975. Mainstream applications of airbag restraint systems in almost every car started in 1990.

Nowadays four main types of gas generating principles are used for airbag inflators in cars. Pyrotechnic gas generators inflate the bag by gaseous combustion products of pyrotechnic compositions. Hybrid gas generators are based on a combination of pressurized gas and pyrotechnic (heating) charge to deliver the gas. Both types are widely used in driver, passenger, side and curtain airbag applications. So-called cold gas generators utilize pressurized helium for bag inflation and are usually used for knee and side airbag systems. The latest development in gas generating principles uses a combustible mixture of pressurized hydrogen, oxygen and inert gas being applied for driver and passenger applications. Hybrid and pyrotechnic gas generators are the most common types used and are described in detail below. Their construction is shown schematically in Figures 1 and 2.

In the *hybrid* system the pre-pressurized gas (nitrogen, argon/helium) is stored in pressure containers fitted with a burst disc. Opening this membrane by pyrotechnic means allows the gas to flow out into the airbag. The cooling of the expanding gas is compensated or even overcompensated by the pyrotechnic charge. Since the total amount of pyrotechnic mixture is small in quantitative terms, the compulsory threshold values of the toxic impurities contained in the working gas can be adhered to relatively easily. This fact, in addition to the ideal temperature of the working gas, is the main advantage of *hybrid* gas generators.

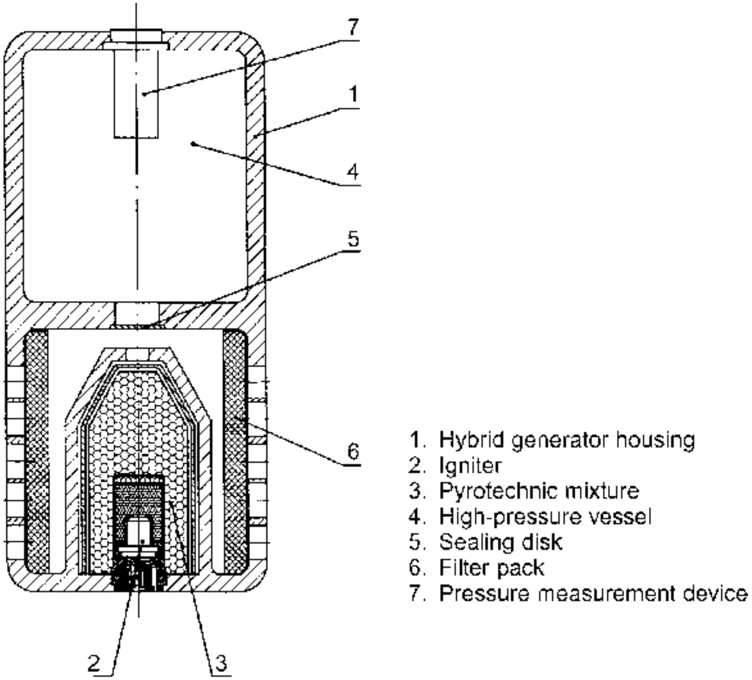


Figure 2 Sectional diagram of a hybrid gas generator for airbags.

The disadvantages are the larger weight compared to pyrotechnic gas generators, the more complex production technology needed and the subjection to pressure vessel regulation.

The unique feature of almost all *pyrotechnical gas generators* is the concentric assembly of three different chambers with designs corresponding to their pressure conditions and functions. The innermost chamber contains the booster unit consisting of a plug, squib and booster charge. An auto ignition charge is usually integrated in the booster setup, whose task is to ignite the pyrotechnic mixture without electric current in case of high temperatures, e.g. in case of fire. During standard electrical ignition the thin resistance wire of the igniter is heated and the ignition train started. The booster charge usually used in earlier times was boron/potassium nitrate. Nowadays pyrotechnic formulations with good ignition properties are used in pelletized grain design contributing noticeably to the overall gas yield of the generator. The hot gases and particles generated by this charge enter the concentrically arranged combustion chamber and ignite the pyrotechnic main charge. Both chambers are designed for high pressures up to 60 MPa. The pyrotechnic main charge consists generally of compressed pellets which

Table 1 Effluent gas limits according USCAR-24 regulation.

Effluent Gas	Vehicle Level Limit (ppm)	Driver-Side Limit (ppm)
Chlorine (Cl_2)	1	0.25
Carbon monoxide (CO)	461	115
Carbon dioxide (CO_2)	30 000	7500
Phosgene ($COCl_2$)	0.33	0.08
Nitric oxide (NO)	75	18.75
Nitrogen dioxide (NO_2)	5	1.25
Ammonia (NH_3)	35	9
Hydrogen chloride (HCl)	5	1.25
Sulphur dioxide (SO_2)	5	1.25
Hydrogen sulfide (H_2S)	15	3.75
Benzene (C_6H_6)	22.5	5.63
Hydrogen cyanide (HCN)	4.7	1.18
Formaldehyde (HCHO)	1	0.25

generate the working gas and slag residues by a combustion process. The products leave the combustion chamber through nozzles and enter the low pressure region of the filter compartment, where the slag is removed from the gas flow. The filter compartment is equipped with various steel filters and deflector plates. The gas then flows through the filter compartment nozzles into the bag.

The basic task of each gas generator is to provide sufficient nontoxic gas (see Table 1) within the required time frame of 11–30 ms to inflate the airbag to the specified pressure. The first pyrotechnic mixture used in airbag gas generators was based on sodium azide. During combustion, sodium azide reacts with oxidizing agents, which bond chemically the elemental sodium as the nitrogen is released. Established oxidizers were alkali and alkaline earth nitrates, metal oxides (e.g. CuO, Fe_2O_3), metal sulfides (MoS_2) and sulfur. If necessary slag forming agents (e.g. SiO_2, aluminosilicates) were also added. Advances in environmental awareness led consequently to the replacement of sodium azide, though pure nitrogen as a working gas was generated by this composition. Another factor to the detriment of sodium azide was the relative low specific gas yield and the unsolved disposal procedure for this type of pyrotechnic mixture.

With regard to azide-free gas mixtures, there have been numerous patents and initial applications since the early 1990s. These new gas mixtures generate more gas per gram (gas yields from gas mixtures containing NaN_3: 0.30–0.35 l/g) and thus enable smaller and to some extent a more lightweight construction of the gas generators.

They can be classified into two categories:

1. High-nitrogen organic compounds (C, H, O, N) are combined with inorganic oxidizers:
   The fuels are, for example, 5-aminotetrazole, azodicarbonamide, → *Guanidine nitrate*, → *Nitroguanidine*, dicyandiamide, → *Triaminoguanidine nitrate* and similar compounds, as well as salts of, for example, 5-nitrobarbituric acid, urea derivatives and also nitramines and similar compounds. The oxidizers are, for example, alkali or alkaline earth nitrates, → *Ammonium nitrate*, alkali or alkaline earth perchlorates and metal oxides.
   Gas yield of these mixtures: 0.50–0.65 l/g.
2. High-oxygen, nitrogen-free organic compounds (C, H, O) are blended with inorganic oxidizers. The fuels used are, for example, tri or dicarboxylic acids (e.g. citric acid, tartaric acid, fumaric acid) or similar compounds. The oxidizers used are especially perchlorates and chlorates with additional assistance from metal oxides. This enables any formation of NOx to be excluded. Gas yield of the mixture: 0.5–0.6 l/g.

The gas generator formulations are usually manufactured by grinding and blending the raw materials, which after a pre-compacting step are pressed into pellets or disks on rotary table presses. Some gas generator formulations using plastic (reactive) binders are manufactured by an extrusion process.

Air Blast

Druckwelle; *onde de choc*

The airborne acoustic or shock wave generated by an explosion → *Detonation*, → Fuel Air Explosives, → Thermobaric Explosives.

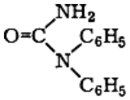
Air Loaders

Blasgeräte; *chargeurs pneumatiques*

Air loaders serve to charge prilled → *ANFO* blasting agents into boreholes. If the free-running prills cannot be charged by pouring, e.g. horizontal boreholes, boreholes with neglectable slope or boreholes with small diameters, they can be introduced by air loaders. This is done by loading the charge into a pressurized vessel and applying an air pressure of about 0.4 MPa; a valve at the lowest point of the machine, which can be controlled from the borehole to be filled, leads to a long hose; when the valve is opened, a stream of air containing the explosive charge in suspension is sent through it into the borehole. Other portable machines work on the injector principle.

Akardite I

diphenylurea; *Diphenylharnstoff*; *diphénylurée*



colorless crystals (molecular weight: 212.25 g/mol)
empirical formula: $C_{13}H_{12}N_2O$
energy of formation: −117.3 kcal/kg = −490.6 kJ/kg
enthalpy of formation: −138.2 kcal/kg = −578.2 kJ/kg
oxygen balance: −233.7%
nitrogen content: 13.21%
density: 1.276 g/cm^3

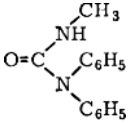
Akardite I serves as a → *Stabilizer* for gunpowders, in particular for → *Double-Base Propellants*.

Specifications

melting point:	at least 183 °C = 361 °F
moisture:	not more than 0.2%
ashes:	not more than 0.1%
chlorides:	not more than 0.02%
pH value:	at least 5.0
acid, 0.1 N NaOH/100 g:	not more than 2.0 cm^3

Akardite II

methyldiphenylurea; *Methyldiphenylharnstoff*; *N-méthyl-N′,N′-diphényl-urée*



colorless crystals
empirical formula: $C_{14}H_{14}N_2O$
molecular weight: 226.3 g/mol
energy of formation: −90.5 kcal/kg = −378.5 kJ/kg
enthalpy of formation: −112.7 kcal/kg = −471.5 kJ/kg
oxygen balance: −240.4%
nitrogen content: 12.38%
density: 1.236 g/cm^3

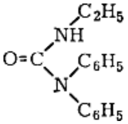
Akardite II is an effective → *Stabilizer* for double-base gunpowders

Specifications

same as for Akardite I,	
except melting point	at least 170–172 °C = 338–342 °F

Akardite III

ethyldiphenylurea; *Ethyldiphenylharnstoff*; *N-éthyl-N′,N′-diphénylurée*



colorless crystals
empirical formula: $C_{15}H_{16}N_2O$
molecular weight: 240.3 g/mol
energy of formation: −128.5 kcal/kg = −537.7 kJ/kg
enthalpy of formation: −151.9 kcal/kg = −635.5 kJ/kg
oxygen balance: −246.3%
nitrogen content: 11.65%
density: 1.128 g/cm^3

Akardite III is an effective → *Stabilizer* for double-base propellants. Both Akardite II and III are gelatinizers as well as → *Stabilizers*.

Specifications

same as for Akardite I,	
except melting point	at least 89 °C = 192 °F

Alex

Alex is an → *aluminum powder* formed by explosion of electrically heated aluminum wires in inert atmospheres with particle sizes between 50 and 200 nm. Due to a passivation layer of thickness between 2 and 4 nm, a substantial number of the particles are already converted to alumina, the formation of which should be avoided by *in situ* coating. In addition to the diffusion controlled oxidation at lower temperatures, a partial oxidation of the particles can occur by a fast chemically controlled reaction. Alex can increase the burning rate of solid composite rocket propellants up to a factor of two. An increase of detonation velocity is not confirmed but Alex might improve → *air blast* or fragment velocities of some high explosives, and viscosity increases in formulations with liquid binders.

Alginates

Salts of alginic acid which are capable of binding 200–300 times their own volume of water. They are added as swelling or gelling agents to explosive mixtures in order to improve their resistance to moisture and to → *Slurries* to increase viscosity.

All Fire

Mindestzündstrom; *ampèrage minime d'amorcage*

Minimum current that must be applied to an igniter circuit for reliable ignition of the primer charge without regard to time of operation.

Aluminum Powder

Aluminiumpulver; *poudre d'aluminum*

Aluminum powder is frequently added to explosives and propellants to improve their performance. The addition of aluminum results in considerable gain in heat of explosion because of the high heat of formation of aluminia (1658 kJ/mol, 16 260 kJ/kg) leading to higher temperatures of the fumes. Aluminum not reacted in the detonation front might be oxidized by atmospheric oxygen to induce post-heating in the fume zone and to increase the → *air blast* or even to initiate a delayed secondary explosion.

Widely used mixtures of explosives with aluminum powder include → *Ammonals*, → DBX, → HBX-1, → Hexal, → Minex, → Minol, → Torpex, → Trialenes, → Tritonal and *Hexotonal*. In addition, underwater explosives often contain aluminum powders.

The performance effect produced by aluminum powder is frequently utilized in → *Slurries*, also in → *Composite Propellants*.

Important characteristics of aluminum powders are shape and grain size of the powder granules. Waxed and unwaxed qualities are marketed. Propellant formulations often prescribe systematically varied grain sizes for obtaining optimal densities.

Amatex

A pourable mixture of trinitrotoluene, ammonium nitrate and RDX.

Amatols

Pourable mixtures of ammonium nitrate and trinitrotoluene of widely varying compositions (40 : 60, 50 : 50, 80 : 20). The composition 80 : 20 may be loaded into grenades, for example, using a screw press (extruder).

Ammonals

Compressible or pourable mixtures containing ammonium nitrate and aluminum powder; the pourable mixtures contain → *TNT*

Ammonium Azide

Ammoniumazid; *azoture d'ammonium*

NH_4N_3
colorless crystals
molecular weight: 60.1 g/mol
energy of formation: +499.0 kcal/kg = +2087.9 kJ/kg
enthalpy of formation: +459.6 kcal/kg = +1922.8 kJ/kg
oxygen balance: −53.28%
nitrogen content: 93.23%
density: 1.346 g/cm^3

Ammonium azide is prepared by introducing a solution of ammonium chloride and sodium azide into dimethylformamide at 100 °C. The solvent is then drawn off in vacuum. Owing to its high vapor pressure, this compound has not yet found any practical application.

Vapor pressure:

Pressure	**Temperature**	
(mbar)	**(°C)**	**(°F)**
1.3	29.2	84.6
7	49.4	121.0
13	59.2	138.6
27	69.4	157.0
54	80.1	176.2
80	86.7	188.1
135	95.2	203.4
260	107.7	225.9
530	120.4	248.7
1010	133.8	272.8

Ammonium Chloride

Ammoniumchlorid; *chlorure d'ammonium*

NH_4Cl
colorless crystals
molecular weight: 53.49 g/mol

energy of formation: −1371.6 kcal/kg = −5738.9 kJ/kg
enthalpy of formation: −1404.9 kcal/kg = −5878.1 kJ/kg
oxygen balance: −44.9%
nitrogen content: 26.19%
sublimation point: 335 °C = 635 °F

Ammonium chloride serves as a partner component to alkali nitrates in the so-called inverse salt-pair (ion-exchanged) explosives (→ *Permitted Explosives*).

Specifications

net content:	at least 99.5%
moisture:	not more than 0.04%
glow residue:	not more than 0.5%
Ca; Fe; SO_4; NO_3:	not more than traces
pH value:	4.6–4.9

Ammonium Dichromate

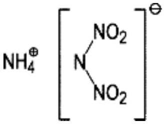
Ammoniumdichromat; *dichromate d'ammonium*

$(NH_4)_2Cr_2O_7$
orange red crystals
molecular weight: 252.1 g/mol
energy of formation: −1693.1 kcal/kg = −7083.9 kJ/kg
enthalpy of formation: −1713.1 kcal/kg = −7167.4 kJ/kg
oxygen balance: ±0%
nitrogen content: 11.11%
density: 2.15 g/cm^3

Ammonium dichromate decomposes on heating, but is not an explosive. It is a component of pyrotechnical charges, and is an effective additive that is introduced into ammonium nitrate-based propellants in order to catalyze the decomposition reaction. According to the → *REACH* regulation ammonium dichromate is identified as a substance of very high concern with carcinogenic, mutagenic and reproduction toxic properties. Therefore ammonium dichromate is included in the Annex XIV of the REACH regulation and after a transitional period it can no longer be placed on the market or used by any manufacturer, importer or downstream user unless authorization has been granted.

Ammonium Dinitramide

Ammoniumdinitramid; *ADN*



empirical formula: $H_4N_4O_4$
molecular weight: 124.06 g/mol
energy of formation: −259.96 kcal/kg = −1086.6 kJ/kg
enthalpy of formation: −288.58 kcal/kg = −1207.4 kJ/kg
oxygen balance: +25.8%
nitrogen content: 45.1%
volume of explosion gases: 1084 l/kg
heat of explosion
  (H_2O liq.): 3337 kJ/kg
  (H_2O gas): 2668 kJ/kg
specific energy: 843 kJ/kg
density: 1.812 g/cm^3 at 20 °C
melting point: 93.5 °C (decomposition starts at melting point)
impact sensitivity: 4 N m, friction sensitivity: 64 N

Ammonium dinitramide is obtained by ammonolysis of dinitroamines, which are formed by the step-wise nitration of urethanes, *β*,*β*-iminodipropionitrile or nitramide. The last nitration step in each case requires the most powerful nitration reagents, such as nitronium tetrafluoroborate or dinitrogen pentoxide. Other methods pass via the direct nitration of ammonia with dinitrogen pentoxide to a mixture of ADN and → *Ammonium Nitrate* or the nitration of ammonium sulfamate with nitric acid to a mixture of ADN and ammomium hydrogensulfate. On the basis of its good → *Oxygen Balance* and high → *Enthalpy of Formation*, ADN appears to be attractive as a halogen-free oxidizing agent for solid rocket propellants and is currently the subject of intensive studies.

Ammonium Nitrate

Ammoniumnitrat; *nitrate d'ammonium*; *AN*

NH_4NO_3
colorless crystals
molecular weight: 80.0 g/mol
energy of formation: −1058.3 kcal/kg = −4428.0 kJ/kg
enthalpy of formation: −1091.5 kcal/kg = −4567.0 kJ/kg
oxygen balance: +19.99%
nitrogen content: 34.98%
volume of explosion gases: 980 l/kg

heat of explosion
(H_2O liq.): 593 kcal/kg = 2479 kJ/kg
(H_2O gas): 345 kcal/kg = 1441 kJ/kg
melting point: 169.6 °C = 337.3 °F
lead block test: 180 cm^3/10 g
deflagration point:
begins decomposition at melting point,
complete at 210 °C = 410 °F
impact sensitivity: up to 5 kp m = 50 N m no reaction
friction sensitivity:
up to 36 kp = 353 N pistil load no reaction,
critical diameter of steel sleeve test: 1 mm

Ammonium nitrate is hygroscopic and readily soluble in water (the saturated solution contains about 65% NH_4NO_3). Transitions from one polymorph to another take place at 125.2, 84.2, 32.3 and −16.9 °C. The product shows a great tendency to cake. The difficulties therefore involved are avoided by transformation into → *Prills*. Ammonium nitrate is marketed as dense prills and as porous prills. Both can be introduced in industrial explosives after milling except → *ANFO* blasting agents, which need unmilled porous prills.

Ammonium nitrate is the most important raw material in the manufacture of industrial explosives. It also serves as a totally gasifiable oxygen carrier in rocket propellants.

Phase-stabilized ammonium nitrate (PSAN) and spray-crystallized ammonium nitrate (SCAN) are special qualities provided by the Fraunhofer ICT.

Specifications

net content (e.g. by N-determination):	at least 98.5%
glow residue:	not sandy, and not more than 0.3%
chlorides, as NH_4Cl:	not more than 0.02%
nitrites:	none
moisture:	not more than 0.15%
Ca; Fe; Mg:	not more than traces
reaction:	neutral
Abel test at 82.2 °C = 180 °F:	at least 30 min
pH:	5.9 ± 0.2
solubles in ether:	not more than 0.05%
unsolubles in water:	not more than 0.01%
acidity, as HNO_3:	not more than 0.02%

Specifications for prills

boric acid	0.14 ± 0.03%
density of grain:	at least 1.50 g/cm^3
bulk density:	at least 0.8 g/cm^3

Ammonium Nitrate Emulsion

ANE

Intermediate for →Emulsion (blasting) explosives. These emulsions are nonsensitized and are intended to produce an emulsion (a blasting) explosive only after further processing prior to use. Emulsions typically consist of ammonium nitrate (partly replaced by other inorganic nitrate salts), water, fuel, and emulsifier agents.

Ammonium Nitrate Explosives

Ammonsalpeter-Sprengstoffe; *explosifs au nitrate d'ammonium*

Ammonium nitrate explosives are mixtures of ammonium nitrate with carbon carriers such as wood meal, oils or coal and sensitizers such as → *Nitroglycol* or → *TNT* and → *Dinitrotoluene*. They also may contain → *Aluminum Powder* to improve the → *Strength*. Such mixtures can be cap-sensitive. The non-cap-sensitive ones are classed as → *Blasting agents*.

Mixtures of porous ammonium nitrate prills with liquid hydrocarbons, loaded uncartridged by free pouring or by means of → *Air Loaders* are extensively used under the name → ANFO blasting agents.

The resistance to moisture of powder-form ammonium nitrate explosives and blasting agents is low, but can be improved by addition of hydrophobic agents (e.g. calcium stearate). The densities of the powders are about 0.9–1.05 g/cm^3.

Higher density and better water resistance are obtained using gelatinous ammonium nitrate explosives. They are based on ammonium nitrate and 20–40% gelatinized nitroglycol or a nitroglycerine-nitroglycol mixture. The German ammongelites also contain low-melting TNT-dinitrotoluene mixtures. Ammonium nitrate gelatins have widely replaced the elder sodium nitrate nitroclycerine gelignites. The density of the gelatinous explosives is about 1.5–1.6 g/cm^3.

Water-containing ammonium nitrate mixtures with fuels are known as → *Slurries* and → *Emulsion Slurries*.

Many permitted explosives are ammonium nitrate in powder form or gelatinous explosives with added inert salts, such as sodium chloride or potassium chloride, which reduce their explosion temperature.

Ammonium Perchlorate

Ammoniumperchlorat; *perchlorate d'ammonium*; *APC*

NH_4ClO_4
colorless crystals
molecular weight: 117.5 g/mol
energy of formation: −576.5 kcal/kg = −2412.0 kJ/kg
enthalpy of formation: −601.7 kcal/kg = −2517.4 kJ/kg
oxygen balance: +34.04%
nitrogen content: 11.04%
volume of explosion gases: 799 l/kg
heat of explosion (H_2O liq.): 471 kcal/kg = 1972 kJ/kg
density: 1.95 g/cm^3
melting point: 244 °C; decomposition: 320 °C (10 K/min)
lead block test: 195 cm^3/10 g
deflagration point: 350 °C = 662 °F
impact sensitivity: 1.5 kp m = 15 N m

Ammonium perchlorate is prepared by neutralizing ammonia by perchloric acid. It is purified by crystallization.

Ammonium perchlorate is the most important oxygen carrier for → *Composite Propellants*. Unlike alkali metal perchlorates, it has the advantage of being completely convertible to gaseous reaction products.

Table 2 Specifications.

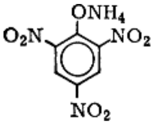
	Grade A	Grade B	Grade C
Net content: at least	99.0%	99.0%	98.8%
Water-insolubles: not more than	0.03%	0.01%	0.25%
Bromates, as NH_4BrO_3: not more than	0.002%	0.002%	0.002%
Chlorides, as NH_4Cl: not more than	0.15%	0.10%	0.15%
Chromates, as K_2CrO_4: not more than	0.015%	0.015%	0.015%
Iron, as Fe: not more than	0.003%	0.003%	0.003%
Residue from sulfuric acid fuming:			
Not more than	0.3%	0.3%	0.3%
Moisture: not more than	0.08%	0.05%	0.08%
Surface moisture: not more than	0.020%	0.015%	0.020%
Ash, sulfated: not more than	0.25%	0.15%	0.45%
Chlorate as NH_4ClO_3: not more than	0.02%	0.02%	0.02%
Na and K: not more than	0.08%	0.05%	0.08%
$Ca_3(PO_4)_2$:	none	none	0.15–0.22%
pH:	4.3–5.3	4.3–5.3	5.5–6.5

Granulation classes

Class 1	Through 420 and 297 micron sieve, retained on 74 micron sieve.
Class 2	Through 297 micron sieve.
Class 3	Through 149 micron sieve.
Class 4	50 to 70% through 210 micron sieve.
Class 5	Through 297 micron sieve, retained on 105 micron sieve.
Class 6	89 to 97% through 297 micron sieve.
Class 7	45 to 65% through 420 micron sieve.

Ammonium Picrate

ammonium-2,4,6-trinitrophenolate; *Ammonpikrat*; *picrate d'ammonium*; *explosive D*



yellow crystals
empirical formula: $C_6H_6N_4O_7$
molecular weight: 246.1 g/mol
energy of formation: −355.0 kcal/kg = −1485.2 kJ/kg
enthalpy of formation: −375.4 kcal/kg = −1570.7 kJ/kg
oxygen balance: −52.0%
nitrogen content: 22.77%
volume of explosion gases: 909 l/kg
heat of explosion
  (H_2O liq.): 686 kcal/kg = 2871 kJ/kg
  (H_2O gas): 653 kcal/kg = 2732 kJ/kg
density: 1.72 g/cm^3
melting point: 280 °C = 536 °F (decomposition)
lead block test: 280 cm^3/10 g
detonation velocity:
  7150 m/s = 23 500 ft/s at $\rho = 1.6$ g/cm^3
deflagration point: 320 °C = 608 °F
impact sensitivity: at 2 kp m = 19 N m no reaction

Ammonium picrate is soluble in water, alcohol and acetone, but is practically insoluble in ether. It is prepared by saturating an aqueous solution of picric acid with ammonia; a red form is formed first, which passes into the stable yellow form in the presence of water vapor, on prolonged storage or by recrystallization from water. Ammonium picrate has been employed as an explosive in military charges.

Amorces

This term denotes very small priming plates utilized in children's toys. They contain an impact-sensitive mixture of potassium chlorate and red phosphorus. The French word *amorce* means all initiating or inflaming devices.

ANFO

An abbreviation for ammonium nitrate fuel oil, a blasting agent composed of ammonium nitrate and liquid hydrocarbons. The application technique of these mixtures has now become very much easier owing to the fact that the material, which has a strong tendency to agglomeration, is commercially produced as porous prills. These are granules solidified from the liquid melt, sufficiently porous to take up about 6% of the oil, which is the amount needed to produce oxygen balance. The nitrate, and the explosive produced from it retain their free-flowing capacity (see also → Acremite).

The explosive must be utilized in the form of a continuous column, and must be ignited by a powerful primer. This means that it must be poured loose (not as cartridges) into the borehole, or else blown into it with an → *Air Loader*.

Its manufacture is very cheap, and may even take place on continuous mixers and wheels. The material has now almost completely replaced conventional explosives in cartridge form in open-pit mining and in potash mining.

density: 0.9 g/cm^3
weight strength: 75%

Heavy ANFO is a 50/50-mixture of ANFO and → *Emulsion Slurries*, which has higher loading densities than poured ANFO alone (→ bulk explosives).

AOP

Allied Ordnance Publication of NATO, which provides supporting guidance to a STANAG. For instance, AOP-39 provides guidance on the assessment and development of insensitive munitions (IM). The Agreement of NATO nations to use this AOP is recorded in → STANAG 4439.

APU

Auxiliary power unit. Propellant-powered device used to generate electric or fluid power.

Aquarium Test

The parameter measured in this test is the pressure of underwater explosion. Lead or copper membranes are employed and the membrane deformation as a function of the performance of the explosive and of the distance from the explosion site is estimated. The measuring apparatus, consisting of piston and anvil, resembles the *Kast* brisance meter. An alternative technique is to measure the deformation of diaphragms or copper discs accommodated inside an air-containing vessel such as a can.

In addition to the mechanical method described, there are also electromechanical measuring techniques in which the impact pressure is recorded by an oscillograph with the aid of a piezoquartz crystal.

The measurements can be carried out in natural waters. A basin, made of steel concrete and bulkhead steel, has a buffering floor made of foamed polystyrene. Air is blown in along the bulkhead walls for damping purposes, so that an air “curtain” is formed. → *Underwater Detonations*.

Argon Flash

Argon-Blitz; *éclair par détonation dans l’argon*

The intensity of the light appearing during a detonation is caused, primarily by compression of the surrounding air.

If the air is replaced by a noble gas such as argon, the light intensity increases considerably. The duration of the flash is only as long as that of the explosion, i.e. on the order of a few µs.

The recently developed ultra-short flash lamps work on the principle of detonation of an explosive in an argon medium. They are particularly suited to the illumination of detonation processes, since the detonation moment of the lamp can be accurately adjusted to the course of the detonation of the test specimen.

The intensity of the method can be considerably increased and the explosion time considerably reduced if the shock wave travelling from the explosive through the argon medium is reflected. This can be achieved by interposing a mass, which may be very small, such as a 0.2 mm-thick acetate foil, as an obstacle. The same effect can also be produced by using curved glass, such as a watch glass. It is mostly used in the orthogonal synchro-streak technique (OSST) to photograph the jet of a → shaped charge.

Armor Plate Impact Test

This is a test developed in the USA to study the behavior of a given explosive, employed as charge in a projectile, on impact against hard, solid targets. The explosive is charged into the test projectile and is fired from a "gun" against a steel plate. The impact velocity which causes the charge to detonate is determined. The test description: → *Susan Test*.

Armstrong Blasting Process

This is an extraction method used in coal mining in the USA. The highly compressed (71–81 MPa) air in the borehole is suddenly released by means of so-called blasting tubes equipped with bursting discs. The compressed air is generated underground by special compressors (see also → *Gas Generators*).

A similar method has received the name *Airdox*. The bursting elements in the blasting tubes have a different construction; the compressed air utilized in the method can be generated aboveground and distributed over a network of ducts.

ARDEC

US Army Armament Research, Development and Engineering Center; Picatinny Arsenal Dover, New Jersey, USA

Internationally acknowledged hub for the advancement of armament technologies and engineering innovation. As one of the specialized research, development and engineering centers within the US Army Materiel Command, the ARDEC has the responsibility for meeting this critical demand.

ASTROLITE

Stoichiometric mixture from hydrazine and ammonium nitrate. It was a spin-off from the US-rocket program in the 1960s. In 19th century, Sprengel (*Sprengel Explosives*) had already suggested that two nonexplosive components become cap sensitive after being mixed. Astrolite G and Astrolite A/A-1-5 (with 20% aluminum additive) are also called liquid landmines or binary explosives. The explosive strength of such mixtures is very high and even exceeds Nitroglycol in certain aspects. Detonation velocity of Astrolite G: 8600 m/s and Astrolite A/A-1-5: 7800 m/s.

Audibert Tube

Audibert-Rohr

This testing apparatus, which was first proposed by *Audibert* and *Delmas*, measures the tendency to → *Deflagration* of a permitted explosive. A cartridge containing the test sample is placed, with its front face open, in the tube and is packed tightly on all sides with coal dust. An incandescent spiral is placed in the cartridge opening; if the material is difficult to ignite (e.g. inverse salt-pair permissibles) the spiral is covered with a flammable igniter mixture. The tube is then closed by a perforated plate. The parameter measured is the minimum hole diameter at which the initiated deflagration arrives at the bottom of the cartridge.

In a modification of the method two cartridges placed coaxially one on top of the other are tested.

Aurol

T-Stoff; Ingolin

Concentrated (88–86%) hydrogen peroxide. It is employed in liquid fuel rocket engines as an → *Oxidizer* or, after catalytic decomposition, as → *Monergol*. For its explosive properties, see *Haeuseler*, Explosivstoffe 1, pp. 6–68 (1953).

Average Burning Rate

Mittlere Abbrandgeschwindigkeit; *vitesse moyenne de combustion*

The arithmetic mean (statistical average) burning rate of pyrotechnic or propellants at specific pressures and temperatures. Dimension: length/time or mass/time.

Azides

Azide; *azotures*

Azides are salts of hydrazoic acid (N_3H). Alkali metal azides are the most important intermediates in the production of → *Lead Azide*.

Sodium azide is formed by the reaction between sodium amide ($NaNH_2$) and nitrous oxide (N_2O). Sodium amide is prepared by introducing gaseous ammonia into molten sodium.

Ballistic Bomb

closed vessel; *ballistische Bombe*; *bombe pour essais ballistiques*

(→ *Burning Rate*)

The ballistic bomb (pressure bomb, manometric bomb) is used to study the burning behavior of a → *Gunpowder* or → *Propellant* charge powder. It consists of a pressure-resistant (dynamic loading up to about 1000 MPa (10 000 bar)) hollow steel body that can be bolted together and has a hole to adapt a piezoelectric pressure transducer. The pressure p in the bomb is measured as a function of time t.