

AN: Understanding the Hazards



Essential, and hazardous

Ammonium Nitrate (AN) is a key part of many fertilizers and of the global food supply. It is also an indispensable ingredient in explosives for mining, quarrying, civil engineering and ammunition.

AN holds an oxidizing and a reducing group in one molecule. Its behaviour can be hard to predict, and safe-handling knowledge is not always applied, as accidents worldwide keep showing.

Appearances

AN is produced, stored, transported and used as crystals, prills and granules, pure or in blends and compound fertilizers. Some processes handle it as a hot concentrated solution. It is also part of emulsions, gels, suspensions and ANFO. Each form brings its own challenges for safe transport, storage and handling.

Hazardous properties

Depending on composition and physical state:

- Fertilizers with a high AN content may be detonable.
- Crystalline AN is oxidizing; contrary to what is often stated, many AN compounds are not.
- AN-based compound fertilizers may undergo selfsustaining decomposition.
- AN-based explosives may be thermally unstable, sensitive to heating under confinement, or detonable.

Testing and analysis

All test methods relevant to these properties are available at TNO. We add calorimetry, electron microscopy and X-ray diffraction to study the material properties, chemical behaviour and physical effects of AN-based substances.

Regulations

Transport of AN-based compounds falls under the UN Recommendations on the Transport of Dangerous Goods and the UN Manual of Tests and Criteria. The Manual has its own section and flowchart for AN-based fertilizers. Our experts took part in updating these classification criteria in Section 39.

TNO is a notified body

In Europe, AN with more than 28% nitrogen falls under Regulation (EU) 2019/1009. It requires frequent testing and sets the tasks of notified bodies. TNO is a notified body (NoBo) under this regulation.

Classification testing

We offer the following tests on a routine basis:

- Detonative properties (UN 1(a), 2(a) and 8(b)): a gap test that shows whether the material carries a detonation from a booster charge.
- Detonation resistance and oil retention under Regulation (EU) 2019/1009: required for high-nitrogen AN fertilizers on the EU market, carried out after thermal cycling of the product.
- Sensitivity to heating under confinement (UN 1(b), 2(b) and 8(c)): the Koenen test, heating the material in a steel tube with an orifice plate.
- Deflagration or self-sustaining decomposition (UN S.1): the trough test, which shows whether a decomposition started at one end spreads through the fertilizer.
- Oxidizing properties (UN O.1 and O.3): the burning rate of the material mixed with cellulose, compared with reference mixtures.
- Thermal stability of AN emulsions, ANE (UN 8(a)): whether the emulsion stays stable at elevated temperature.

Large-scale testing

TNO has carried out large-scale tests with stacks of big bags filled with technical-grade and fertilizer-grade AN, up to 2,000 kg. These tests gave insight into shockwave propagation, detonation effects and the response of neighbouring stacks of materials such as calcium ammonium nitrate (CAN). The results also improved our understanding of safe storage practice and of how to prevent sympathetic detonation. Smaller tests are available for screening materials, studying specific phenomena or supporting product development.

Safety distance calculations

Suppose your heap of stored ammonium nitrate detonates. Will this affect your nearest building, or your neighbour's site? How far away should the next heap be? Using our expertise, experimental data and validated calculation methods, we determine the required safety distances. We also advise on protective and mitigating measures, including storage layouts, separation distances between AN stockpiles and big-bag stacks, and ways to reduce the consequences of a detonation.

Consultancy

We support clients who develop new AN-based compositions. We bring know-how, testing capability and practical experience, with a focus on thermal stability, compatibility, classification and safe application.

Incident investigations

TNO is regularly involved in investigations of AN accidents around the world. Our experts have studied incidents during production, storage and transport. We help clients and authorities understand root causes and identify measures that improve safety.

Questions we help answer

- Is my product classified correctly for transport?
- Does my fertilizer meet the EU detonation-resistance requirement?
- Can a decomposition in one part of my store spread to the rest?
- How far apart must my stacks and buildings be?
- What caused this incident, and how do we prevent the next one?

Why TNO

We have decades of experience with AN safety. All relevant test methods are available in-house, from laboratory screening to tests with up to 2,000 kg. TNO is a notified body under Regulation (EU) 2019/1009, and our experts took part in updating the classification criteria for AN-based fertilizers in Section 39 of the UN Manual of Tests and Criteria.

About TNO Process Safety Solutions

Chemistry can involve dangerous reagents, energetic reactions and risky process conditions. Producing, storing, transporting and using chemicals must be safe, reliable and efficient, and that starts with understanding how a dangerous substance behaves. TNO has helped develop many tests and criteria for hazardous chemicals. Our "Coloured Books" are used worldwide as reference material in safety studies and as the basis for software models. TNO Process Safety Solutions combines this expertise with explosion safety know-how and specialized test facilities to support safe chemical handling and better process performance.

Contact Alexandre Olive

✉ alexandre.olive@tno.nl

☎ + 31 (0) 6 2132 3600

🌐 [linkedin.com/tno](https://www.linkedin.com/company/tno)

🌐 tno.nl/prosafe

