## **Petrol**

## AdBlue - Eliminating product quality risks with the Synthesis production

The author compares the Synthesis production of AdBlue with the Decomposition of solid urea and works out the impact on quality, logistics and cost.





To fulfil the Euro IV and Euro V standards and the future Euro VI standards, the manufacturers of diesel engines for heavy means of transport adopted the SCR (Selective catalytic reduction) technology, an emission treatment system that, by using AdBlue, converts nitrogen oxides (NOx) of exhaust gasses in non-dangerous substances such as nitrogen and water vapour.

For the SCR system to work in a stable manner and without any technical problem for long periods, the AdBlue used must be of quality and comply with specific and limiting quality principles both for what concerns production and for packaging and transport.

Quality standards were defined by the CEFIC (European Chemical Industry Council) and by the International Organization for Standardisation (ISO 22241) to guarantee users that AdBlue has the performance requested by manufacturers of diesel engines.

There are two production processes of AdBlue:

1) Synthesis production - by deriving the product directly from a urea system and diluting it with demineralised water on the line of the plant

2) Decomposition of solid urea in demineralised water by using small mixing units.

The process and related risks are detailed below.

## AdBlue synthesis production

The synthesis production of AdBlue assumes upstream the existence of a plant operated continuously

for the production of technical urea [1].

A urea plant requires big investments (ca. 300 M $\in$ ) and now difficult to authorise in Europe since the starting base for the reactions requires in turn NH<sub>3</sub> (ammonia).

Moreover, synthesis production plants of AdBlue would not be justified only for producing AdBlue since the minimum critical mass of a urea plant is 200,000 tons/y of 100 % product.

The process is detailed below:

The urea is industrially synthesised by using the Bosch-Meiser process that is based on the synthesis of ammonium carbamate, from carbon dioxide and ammonia, and on the following reaction of decomposition of the carbamate that provides urea and water:

- 1. 2  $NH_3 + CO_2 \rightarrow H_2N-COONH_4$
- 2.  $H_2N$ -COON $H_4 \rightarrow (NH_2)_2CO + H_2O$

[1] Technical urea is used for the production of glues and bonding agents and represents only 6-8 % of the overall production of urea in the world. Urea is mainly applied as fertiliser for agriculture. Technical urea has higher characteristics and therefore needs more advanced plants.



When coming out from the decomposition station (yellow box) the 100 % urea in liquid state is extracted from the plants and diluted with demineralised water in percentage to obtain AdBlue.

Therefore, the synthesis production has the following advantages:

 1) On-line control of production: all the parameters are checked during the process continuously guaranteeing full compliance to standards.
2) Big production capacities
3) Product quality consistency
4) Full compliance of product quality: the parameters are widely lower than the expected standard parameters
5) Impossibility of contamination during production.
6) Lower costs

Therefore, the synthesis production has the following disadvantages:

7) Due to the special type of production, logistics must be organised starting from the plant. Since AdBlue mainly consists of water (67.5 %) and since dedicated tanks must be used for transporting, logistics costs are very high.



AdBlue produced with decomposition of solid urea in demineralised water by using small mixing units is a highly risky solution.

The production of AdBlue from 100 % solid technical urea is risky alternative to the recommended (by all truck manufacturers) synthesis production of AdBlue.

A decomposition plant does not require big investments (ca. 200,000 €) nor special authorisations since it only mixes and melts (by using recirculation pumps) urea in prills (grains) with demineralised water.

Urea is usually purchased in grains and in big bags (1000kg) from a plant of synthesis urea.

Therefore, the production requires (as shown by the diagram) other phases:

- At the urea plant
- 1) Evaporation process
- 2) Prilling or granulating proces
- 3) Drumming process in big ba
- 4) Storage in a sheltered are
- 5) Transportation to the mixing plant
- At the mixing plant
- 1) Big bag handling and storage
- 2) Decomposition

The only advantage of this kind of production is:

1) The production occurs near the place of consumption and therefore logistics is less burdensome.

However mixed urea production compared with synthesis production has the following disadvantages:

2) More likelihood of product being contaminated during the transportation, storage and handling phases

- 3) Small production capacity (usually 20 tons/8hr)
- 4) Product quality inconsistency: each lot is much different than the previous lot

5) Difficult compliance of product quality: when the parameters meet the standards, their values are very close to the limits of ISO 22241

6) Lack of homogeneity of product density due to improper mixing (anti-lumping must be added to the product in grains to avoid lumps; this addition remains in the mixture and can cause damages to the catalyser).

Recapitulating:

AdBlue produced by mixed urea is highly risky, AdBlue produced by hot melt urea (synthesis production) is safe and recommended by all truck manufacturers

Important instructions that should be considered in any case are set below:

1) Each lot of product must be checked to make sure that it is fully compliant with specifications

2) A detailed Analysis Certificate is issued for each lot and it should accompany every delivery. The certificate of conformity is not enough.

3) All the products are identified univocally by a lot number that allows complete traceability of the production chain and logistics in compliance with the specifications set by VDA and CEFIC.

Claudio Mascialino is a Mechanical engineer graduated from the University of Brescia, with several courses in Management of R&D, actual PhD at the University of Surrey in Renewable Energy. He has a 20 years experience in managerial position in the automotive sector and is actual president and MD of RESNOVA srl.