Handling, transportation and storage of AdBlue®.

Key elements of ISO 22241 part 3:

1. *Terms and definitions*
   For the purposes of this document, the following terms and definitios apply.
   a. ***Shelf life:*** period of time starting with the completion of the production of the batch, in which AdBlue® stored under specific conditions, remains within the **specification defined in ISO 22241-1:2006, Table 1**.
   b. ***Production batch:*** quantity of AdBlue® produced at one operation at a site where the product has (last) been physically or chemically modified to reach compliance with the specifications as defined ISO 22241.
   Note: Mixing of AdBlue® volumes does not constitute a physical or chemical modification, as long as the quality of the volumes before mixing complies with the specification given in ISO 22241-1:2006, Table 1.

   c. ***Bulk operation:*** Handling of AdBlue® in large containers.
   Note: examples of large containers are road tankers, rail cars, storage tanks and tank vessels.

   d. ***Packaged shipment:*** handling of AdBlue® in small containers.
   Note: Examples of small containers are drums, cans, bottles, intermediate bulk containers (IBCs) and totes.

2. *Requirements for the use of materials compatible with AdBlue®*
   To avoid contamination of AdBlue® and to resist corrosion of the devices used (containers, tubes, valves,

   Fittings, gaskets, hoses, etc.), all materials in direct contact with AdBlue® during handling, transportation and storage, (including sampling), shall be compatible with AdBlue®.

   Note: In case of material with uncertain compatibility to AdBlue®: **contact Quality Manager** for advice.

Table A: Examples of recommended materials

Highly alloyed austenitic Cr-Ni-steels and Cr-Ni-Mo-steeds, f.e according EN 10088-1 to -3 (i.e. 1.4541 and 1.4571) or stainless steel 304 (S30400), 304L (S30403), 316 (S31600) and 316L (S31603) and/or in accordance with ASTM A240, ASTM A276 and ASTM A312.
Titanium
Ni-Mo-Cr-Mn-Cu-Si-Fe alloys, f.e hastelloy c/c-276
Polyethylene, free of additives
Polypropylene, free of additives
Polyisobutylene, free of additives

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Poly(perfluoroalkoxy) PFA, free of additives
Polyfluoroethylene PFE, free of additives
Polyvinylidenefluoride PVDF, free of additives
Polytetrafluoroethylene PFTE, free of additives
Copolymeres of vinylidenefluoride and hexafluoropropylene, free of additives
Note 1: The sequence given in this list does not constitute a ranking of the materials recommended Note 2: materials made of plastics may contain various kinds of additives used either for processing or for special kinds of serviceability. These additives may possible migrate into the AdBlue® solution. For this reason special care should be taken for testing the contamination of AdBlue® by additives from plastic materials used in direct contact with AdBlue® Note 3: Table A & B have been compiled in accordance with the state of art and with the best knowledge at the time of publication of ISO22241-part3.

Table B: Materials NOT recommended.

Materials forming compounds as a result of reaction with ammonia, which may negatively interfere with the SCR system: carbon steels, zinc coated carbon steels, mild iron.
Non-ferrous metals and alloys (copper, copper alloys, zinc, lead)
Solders containing lead, silver, zinc or copper
Aluminium, aluminium alloys
Magnesium, magnesium alloys
Plastics or metals coated with nickel

3. *Physical conditions during storage and transportation.*
    a. *General recommendation*
        i. In order to prevent decomposition of the urea, as well as the evaporation of water in the case of vented containers, prolonged transportation or storing above 25 °C should be avoided.
        ii. In order to prevent solidification of AdBlue® storage below -5ºC should be avoided.
            Note: solidified AdBlue® has an approximately 7% larger volume than the liquid and therefore, may cause a fully filled, closed container to burst. Solidified AdBlue®, which has been warmed up carefully at temperatures not above 30ºC will not be impaired in quality and can be used as soon as the warmed up solution is free from solids.
        iii. In order to avoid excessive temperature rise, AdBlue® should be protected from sunlight.
        i. In order to protect AdBlue® from any contamination carried by the air, well-closed containers or vented containers with filters should be used.

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b. *Shelf life*
Throughout the entire distribution chain, AdBlue® is expected to remain within the specifications given in ISO 22241-1 for at least the time periods specified in Table C as a function of the constant ambient temperature at which the AdBlue® is stored.

Table C: shelf life

Constant ambient storage temperature ºC	Minimum shelf life months
< 10	36
< 25[a]	18
< 30	12
< 35	6
> 35	--[b]
Note 1: The main factors taken into account to define the shelf life in this table are the ambient storage temperature and the initial alkalinity of AdBlue®. The difference in evaporation between vented and non-vented storage containers is an additional factor.	
[a] To prevent decomposition of AdBlue® , prolonged transportation or storage above 25ºC should be avoided. [b] Significant loss of shelf life: check every batch before use.	

c. *Cleanness of surfaces in contact with AdBlue®*
   i. All surfaces in direct contact with AdBlue shall be free of foreign matter such as fuel, oil, grease, detergent, dust and any other substance.
   ii. The use of tap water should be avoided (esp. too high concentrations of Mg, Ca and Na). However if demin water is not available, it is sufficient to clean the material using tap water provided the last rinse is done using fresh AdBlue®

d. *Recommendation on further properties*.
Information on further properties of AdBlue® should be given in the **MSDS**, which contains indications on the hazard ranking and regulations to be respected as well as measures required to be taken for the protection of persons and the environment when handling the product.

4. *Quality Assurance* ***(see Quality Supply Chain procedure)***

a. General
   i. Each container of AdBlue® brought to the market shall be traceable back to production batches via a unique batch number. Recommendation: include date of original manufacturing and/or last certification.
   ii. The quality of AdBlue® taken at any point in the distribution chain shall meet the specifications defined ion ISO 22241-1.
b. *Sampling (**see QSC procedure**)*
   i. Written operating procedures should be available
c. *Testing (**see QSC procedure**)*
   i. The quality of each production batch shall be verified prior to shipment

d. *Procedures for product release and handling of non-conforming product (see QSC procedure)*
   i. Production batches may be released if the results of testing fully conform the specifications ISO 22241-1, or if the manufacturing process verification data demonstrate that the product is in conformance with ISO 22241-1.
e. *Quality monitoring (**see QSC procedure**)*
   i. For each batch of AdBlue® delivered, the manufacturer should supply a quality certificate.
   ii. A typical, but not exhaustive, list of properties for product identification is f.e. density and refractive index.
f. *Audits*
   i. All parties of the distribution chain have the responsibility to audit their portion of the chain so as to ensure the quality of the AdBlue®.
   ii. Actions should be taken by the responsible parties to resolve any problem identified.
   iii. All audits within GreenChem will be coordinated by the Quality Manager.
   iv. External audits will be executed by VDA.
g. *Documentation*
   Procedures and records of the distribution chain of AdBlue® concerning production, product delivery, loading, storage, sampling, testing, product release and handling, as well as audits, shall be documented in accordance with the guidelines of ISO 9001.

   Quality documents should be kept on file for **5 years**.

5. *Procedures for handling of containers and equipment*
   a. *General*
      i. All handling equipment for packaged shipment and for bulk operations should be dedicated or thoroughly cleaned and proven clean for the use with AdBlue® . The equipment should be identified accordingly.
      ii. To avoid any contamination, dedicated containers (or proven clean) should be used.
      iii. Temperature control means may be necessary to maintain the AdBlue® within the recommended temperature range as indicated in table C.
      iv. The components of the filling and emptying equipment should be emptied, cleaned and closed off after use in order to prevent contamination of AdBlue® from the surroundings. Hoses, in particular, should be dedicated and closed after every use, and handled and stored in a controlled manner.
      v. See further **QSC procedure and procedure for return IBC's**
   b. *Single use non-bulk containers*
      i. Every container shall have an identification label or stamp, so that its content can be traced back to the original production batch of AdBlue® of the supplier.
      ii. The inside of the containers should be check visually prior to the filling in accordance with a written procedure.
      iii. During the filling of a series of small containers with AdBlue®, a one liter sample should be taken from the first container filled. The sample should be kept as a retention sample.
      iv. Filled containers should be sealed unless the container is a vented design.

   c. *Dedicated bulk operation.*
      i. Means of bulk operation which are exclusively used for transportation or storage of AdBlue® need not be cleaned before loading, provided all valves, openings and hoses have been closed and handled without contamination.
      ii. All bulk and unloading operations should be established as operating instructions with appropriate checklists.
      iii. Prior to any loading or unloading of AdBlue® the results of the following inspections should be documented as a minimum:

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1. Proper closure of all valves and apertures after completion of the loading or unloading procedure
2. Check of the certificate of cleanness
3. Visual verification of the means of bulk transportation or storage on defects or faults
4. Identification of products in accordance with the delivery documents

iv. In case of any irregularities during loading or unloading, the operation should be **stopped immediately.** A sample from the filled bulk compartment should be analyzed and based on result of analysis, proper actions to be taken.

d. *Non-dedicated bulk operation*.
   i. Cleaning thoroughly prior to the use with AdBlue®
   ii. Cleaning process takes in consideration the chemical nature of the last 3 (three) products transported.
   iii. Documented in a certificate of cleanness.
   iv. Prior to loading this certificate should be presented at the site of filling.
   v. In addition: the outlet, the inlet and the interior of the means of transportation should be checked visually.
   vi. After loading, a sample should be taken (make sure the sample is representative for the full load)

e. *Non-dedicated equipment used for filling containers.*
   i. Cleaning thoroughly prior to the use of AdBlue®
   ii. Cleaning process takes in consideration the chemical nature of the last 3 (three) products transported.
   iii. A sample taken from the first container filled with AdBlue® should be analyzed to confirm compliance with the specification ISO22241-1.
   iv. The products previously filled with this loading equipment and the results of analysis after the product exchange should be documented.

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