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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS

Sub-Committee of Experts on the Transport of Dangerous Goods
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MISCELLANEOUS DRAFT AMENDMENTS TO THE MODEL REGULATIONS ON THE TRANSPORT OF DANGEROUS GOODS

Listing and classification

Testing of liquid and solid substances as dangerous goods of class 8, packing group III, according to their corrosive properties on steel or aluminium
Specification of the Test regulations

Transmitted by the expert from Germany

1. BACKGROUND

This document concerns problems with the execution of the test method of 2.8.2.4 (c) (ii) of the Model Regulations which is related to the determination of the corrosion rate on steel or aluminium surfaces. These problems refer to the execution of the test, the material, the reaction receptacle, the volume-surface relation of the corrosion medium, the preparation of the metal samples, the test temperature, the working period, the test criteria, the test evaluation, the test evaluation for local corrosion, the corrosion test for liquids, which react corrosively under the influence of water, the corrosion test for solids and the corrosion test for substances which are chemically unstable.

Discussion

Test of the corrosive effect on steel or aluminium of substances according to their classification as Dangerous Goods of class 8, packing goup III

Test criteria

The test in order to determine the corrosion rate on steel and aluminium surfaces at contact with the substances to be assessed at a test temperature of 55 °C is described in ADR/RID, the UN Model Regulations and the IMDG Code and this description is relatively insufficient because for different test methods different results are obtained.

The test of the corrosive effect of liquids on steel and aluminium surfaces shall be carried out according to 2.8.2.4 (c) (ii) of the Model Regulations, the IMDG Code (page 8004, Amdt 28-96) or ADR/RID (test criteria of class 8, packing group III) according to ASTM G31-72 (reapproved in 1990). This standard is nearly unknown in Europe and contains only general hints for the execution of corrosion tests. Criteria concerning test period, immersion depth of metal samples and evaluation are not sufficiently determined. This standard corresponds to a large extent to the German standard DIN 50 900 and the following, which describe the fundamentals of the corrosion tests. The corrosion test necessary for the classification (permanent immersion test) in liquids,without mecanical load, may be carried out according to the above mentioned DIN standards.

Material

The Model Regulations provide for the tests **steel type P235 [ISO 9328 (II) : 1991**] **or a similar type and for testing aluminium, non-clad types 7075-T6 or AZ5GU-T6**.
As the unalloyed steel P 235 (ISO 9328 (II): 1991) is hardly known in Europe or not available we recommend for the tests the uncoated steel of material no. 1.0037 (St 37-2) as an alternative. The corrosion behaviour of both unalloyed steels may be considered to be equivalent. The aluminium alloys are available in Europe.

Reaction receptacle

The reaction receptacle should be of glass or PTFE. In the ASTM Standards as well as in the DIN 50 905, part 4, reaction receptacles are described. The design of the receptacle is insignificant. 3l cup-like reaction receptacles with face cut top and three cuts NS 29/32 as well as one cut NS 13 have proved successful on the market. The entrance of air, however, into the receptacle has to be guaranteed. Aluminium- and steel-samples have to be tested in different reaction receptacles.

Volume/surface relation

In order to carry out the corrosion test the corrosion medium shall have a certain minimum volume. This is even more important if the corrosion is not caused by the material to be tested but by its quantitatively small amount of impurities. In the ASTM G31-72 20 ml/cm^2 or 40 ml/cm^2 are recommended, 10 ml/cm^2, however, in the DIN 50 905, part 1. As to the experiences of BAM the volume/surface relation of 10ml/cm^2 is sufficient.

Preparation of metal samples

Metal sheets with the measurements 80 X 20 X 2 mm have proved to be of a suitable size. After polishing the sheets with emery paper of granulation 120, the clearing away of grinding dust with alcohol in the ultrasound bath and the degreasing with acetone the metal samples shall be weighed out to ± 0.0002 g. For the hanging up of the sheets non extruded PTFE-threads have proved to be suitable. Metal wire shall not be used. The test with the so prepared metals shall be initiated the same day. Now one metal sample has completely to be dipped into the water, another one only half way and a third one shall hang in the gas phase. The distance between the upper edge of the sample and the surface of the liquid is supposed to be 10 mm. Losses of liquidity have to be refilled.

Test temperature

The test temperature of 55 °C ± 1 should be maintained constant and should be reached in the gaseous phase as well.

Operation period

The test standard ASTM G31-72 mentioned in the Model Regulations gives no information concerning the operation period. For choosing the operation period, it has to be considered that the corrosion may take the following different courses:

a) The surface related mass loss rate is proportional to the time like, for instance, in the case of the effect of an acid on metal. The resulting corrosion products are soluble in the acid and there will be no top coat.
b) The surface related mass loss rate is low but after an incubation time a local corrosion attack will be registered (e.g. pitting corrosion or through-shaped corrosion)
c) At the beginning a relatively high surface related mass loss rate will be noticed with constant data later. This effect may occur due to a protecting top coat.

The extrapolation of the results of a corrosion test does not only show the statistical spread of the test results but differs the more from the annual statement according to the corrosion course the shorter the test period is. The test period should be chosen such that the effect of the initial corrosion in relation to the complete result is negligible. Due to these considerations a test period of 5 weeks seems reasonable and necessary, taking into account that the transport of dangerous goods by ship may take 2 months.

Test evaluation

After finishing the test the metal samples shall be rinsed off and cleaned with a brush with synthetic or natural bristles (no metal). Using a corrosive agent for polishing adherent coatings this polishing agent shall contain an inhibitor. The blind value determined under the same test conditions (time, temperature, concentration) shall be considered. After the final cleaning with alcohol and acetone in the ultrasound bath and drying the metal samples are going to be weighed. The resulting weight under consideration of the specific weight of the metal leads to the corrosion rate (mm/year).

Test evaluation at local corrosion

In the case of local corrosion besides the constant corrosion plot in form of surface corrosions the rate of the deepest hole will be added to the constant corrosion plot so that the ultimate penetration of the medium into the metal sample will be considered.

Test of corrosive properties of liquids which react corrosive under the influence of water

Acid chlorides belong to the substances which react corrosive with water, evolving hydrochloric acids. Therefore these substances have to be tested according to their corrosive properties in water.The aqueous solution with the highest corrosion rate which mostly is in the middle concentration range, has to be determined by a test (see test of corrosive properties of solids).

Test of corrosive properties of solids

Solids as e.g. aluminium sulphate which is hygroscopic do not react corrosive in dry state on the above mentioned steel and aluminium materials. Therefore dry aluminium sulphate is not classified as dangerous. Depending on the transport conditions the hygroscopic aluminium sulphate sometimes decomposes or sticks on. The surrounding material (material of the packages or packagings) may be corroded by the corrosive sulphate solution so that it may leak. As the mentioned corrosion tests refer only to liquid mediums the aqueous solution with the highest possible corrosive effect on metals has to be determined.

Established by experiences, aqueous solutions in the middle concentration range have the highest corrosive effect on metallic materials. In case the most aggressive concentration is not known by the tester he has to approach the concentration with the highest corrosiveness in steps of 10%. Therefore two or three tests have to be carried out at the same time.

Test of the corrosive properties of substances being chemically unstable

The decomposition of chemically unstable substances is normally prevented by adding stabilizers or inhibitors or cooling. In case a chemically unstable product flows out of a tank or a packaging it has to be taken into account that the product itself as well as the reaction product(s) may damage the material of the transport unit.

Therefore in case of chemically unstable products the substance as well as the reaction product(s) have to be tested according to their corrosive effect on steel and aluminium. The corrosion test has to be carried out with the necessary safety precautions.

Proposal

The experts of the Sub-Committee are requested to comment on the individual points and to communicate their experiences with respect to the above mentioned test method. The expert from Germany offers to submit the necessary amendments to the Model Regulations for incorporation in the 13th revised edition of the UN Recommendations, if necessary, establishing a working group. Furthermore, reference has to be made to the fact that in the future test methods especially for metal corrosions of class 8 have to be included in the Manual of Test and Criteria.