Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

17 June 2013

Sub-Committee of Experts on the Transport of Dangerous Goods

Forty-third session

Geneva, 24– 28 June 2013

Item 11 (a) of the provisional agenda

Issues relating to the Globally Harmonized System of Classification and Labelling of Chemicals: corrosivity criteria

Sub-Committee of Experts on the Globally Harmonized System of Classification and Labelling of Chemicals

Twenty-fifth session

Geneva, 1 – 3 July 2013

Item 2 (c) of the provisional agenda

Classification criteria and hazard communication: corrosivity criteria

Harmonisation of the skin corrosion classification criteria in the UN Model Regulations on the Transport of Dangerous Goods with those in GHS

Transmitted by the European Chemical Industry Council (CEFIC)

Background

1. In the context of harmonization of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS) with the UN Model Regulations on the Transport of Dangerous Goods (TDG Regulations) the different protective aims of the two regulatory regimes need to be considered. The focus for supply and use is communication of the hazard for a safe daily handling of a substance or mixture including appropriate protective measures for repeated contact with the substance over a long period of time. Regarding the hazard “corrosive to skin” the hazard is communicated with one H-statement. This means in the communication there is no scaling in GHS.

2. For transport only incidental contact needs to be considered. This means the hazard-based approach leads into class 8 but to assign the appropriate transport conditions there are 3 different packing groups (PG) which are assigned.

3. When discussing the harmonization of GHS with the TDG Regulations, the intended one-to-one relation of the GHS sub-categories 1A, 1B and 1C for skin corrosivity with the assignment of PGI, II and III for transport of Class 8 substances and mixtures, causes unexpected problems. Such a simple approach for the harmonization of the classification criteria implies an upgrade to PGI for numerous chemicals and generates much stricter transport conditions without adequate safety-related justification or benefit. The reason for this is that the classification in almost every case is not based on *in vivo* data, but based on derived data (new in vivo tests need the permission of the competent authorities, in order to reduce animal testing).

4. Checks in industry reveal that when applying this simple approach, about >80% of all corrosive mixtures would end up in PGI instead of PGII or III. Whereas today, only about 5% of all corrosive materials are assigned to PGI.

5. As an example, figures on mixtures classified using the additivity or non-additivity approach according to the Dangerous Preparations Directive (DPD)[1] and GHS are given below:

DPD R-phrases		GHS/CLP category / subcategory		ADR/IMDG-Code/ICAO-TI current classification		Revised classification for transport based on GHS classification
R35	> 70%	1	approx. 30%	PG I	approx. 5%	approx. 90%
		1A	approx. 60%			
R34	< 30 %	1B	approx. 10%	PG II	approx. 40%	approx. 10%
		1C	approx. 1%	PG III	approx. 60%	approx. 1%
1/3 of the DPD classifications have already been transferred into a GHS classification						

6. The mixtures considered for the results displayed in the table above belong mainly to the following product groups: Cleaner and detergents, chemicals for metal pre-treatment and treatment, adhesives, disinfectants and biocides, medical devices and pharmaceuticals, paints and chemicals for water treatment.

7. For supply and use, the ratio of substances assigned to the highest category seems always to be different from the ratio in transport without any impact to the safety of transport. Moving most of the products into the highest packing group (PGI) will reduce the perception of the hazard.

International implementation of GHS

8. There are several systems implemented all over the world to align national legislation to GHS. These systems provide lists of substances with classifications which are in most cases binding for supply and use. A comparison of 8 substances in the lists of Japan – Republic of Korea – New Zealand – European Union – UN Model Regulations on the Transport of Dangerous Goods showed the following results: Japan and the Republic of Korea only assign category 1 without sub-categorization. The comparison of the European CLP-list with the list of New Zealand showed that the assignment of sub-categories in the CLP-list is stricter than in the list of New Zealand. However the classification applied by New Zealand is pretty much in line with the UN Model Regulations on the Transport of Dangerous Goods. The comparison is documented in annex I.

9. This shows that even these official systems for the implementation of the GHS are not yet harmonized and that for the same substance different countries provide different classifications. Due to the threat of inconsistent declarations, these lists cannot be applied for the classification of corrosive substances for transport. Only the list in the UN Model Regulations on the Transport of Dangerous Goods, describing the proper transport conditions, is internationally applicable and accepted. The entries in the UN Model Regulations on the Transport of Dangerous Goods are based on intrinsic hazards and, in addition, on elements like human experience and expert judgement. This results in current best practice for the assessment of specific transport conditions and reflects multi-modal transport requirements.

[1] Directive 1999/45/EC of the European parliament and of the Council of 31 May 1999 concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations.

10. The table below shows the classification criteria of corrosive substances before and after implementation of GHS in the European Union. Coming from a two level system established by the previous Dangerous Substances Directive (DSD)[2] and DPD for mixtures, the new CLP/GHS system[3] requires a three level classification. However, the differences between the threshold criteria revealed incompatibility with respect to the assignment of the sub-categories.

<table>
<tr><th colspan="3">67/548/EEC / 1999/45/EC</th><th colspan="3">GHS / CLP (2008/1272/EC)</th></tr>
<tr><th>Exposure</th><th>Observation</th><th>Classification</th><th>Exposure</th><th>Observation</th><th>Classification</th></tr>
<tr><td rowspan="2">≤ 3 min.</td><td rowspan="2">≤ 14 days</td><td rowspan="2">C, R35</td><td>≤ 3 min.</td><td>≤ 1 hour</td><td>Corrosive Cat. 1A</td></tr>
<tr><td rowspan="2">> 3 min. - 1 hour</td><td rowspan="2">≤ 14 days</td><td rowspan="2">Corrosive Cat. 1B</td></tr>
<tr><td rowspan="2">> 3 min. - 4 hours</td><td rowspan="2">≤ 14 days</td><td rowspan="2">C, R34</td></tr>
<tr><td>> 1 hour - 4 hours</td><td>≤ 14 days</td><td>Corrosive Cat. 1C</td></tr>
</table>

11. The classification for supply and use in almost every case of single substances is not based on *in vivo* data, but based on derived data. In order to reduce animal testing new *in vivo* tests need the permission of the competent authorities. Therefore, in some regions a conversion table has been implemented, based on a worst case consideration to solve the mismatch between the new and previous classification systems. Therefore, e.g. in the European Union R35 is assigned to sub-category 1A and R34 is assigned to sub-category 1B. Furthermore it is recommended to assign sub-category 1B even in cases where it seems to be possible to apply 1C.

12. The result of this approach is documented in Annex VI of the CLP regulation, where only sub-category 1A and 1B are assigned and where there is no substance listed in sub-category 1C. Furthermore contradictions to other classification schemes are apparent, e.g. Potassium hydroxide solution 10% is named as a reference substance for the *in vitro* test according to OECD Test Guideline 431 as corrosive to skin (not severe corrosive) in 440/2008/EEC (B.40) but assigned to sub-category 1A according Annex VI as a solution of 5%.

13. This is not suitable for transport. In case of a side by side description of transport declaration and CLP or other regional GHS implementations this would lead to ostensibly inconsistent declarations and the need of explanations.

---

[2] Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances;

[3] Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006.

Extreme pH-value

14. In the GHS, an extreme pH-value is an indicator for corrosivity, although it is said that this is not a perfect correlation. In addition the buffering capacity (assessment of acid or alkali reserve) should be known to use the pH-value. But if no other data is available substances or mixtures with an extreme pH-value are considered to be corrosive and assigned to category 1 without sub-categorisation. Assignment to PGI would be a worst case classification without scientific judgment, which cannot be supported, as most of the substances and mixtures are today shipped as PGII or PGIII or even as non-hazardous products without difficulties. Assignment to PGII by default would be the most adequate solution, which is supported also by a study carried out in the United States of America (see annexes I and III).

15. The following examples demonstrate that, in addition to the extreme pH-value, the buffer capacity needs to be considered.

Example 1: Cleaner for automotive

Formulation				
Hazardous component	CAS no.	Content	Classification according GHS	Classification acc. 67/548/EEC
Trisodium nitrilotriacetat	5064-31-3	10 - 25%	Acute Tox. 4, H302 Eye Irr. 2, H319 Carc. 2, H351	Carcinogenic, category 3, R40 Xi, irritant, R36 Xn, harmful, R22
Isotridecanol, ethoxylated	69011-36-5	1 - 5%	Acute Tox. 4, H302 Eye Dam. 1, H318	Xi, irritant, R41
Alcohols, C12-C14 ethoxylated	68891-38-3	1 - 5%	Skin Irr. 2, H315 Eye Dam. 1, H318	Xi, irritant, R38, R41

pH-value
pH-value: 11,5 – 12,7

Measured material:
10 % solution in demineralized water

Ingredients
All ingredients are non-corrosive. Even taking into consideration synergistic effects of the other components, the assignment of PGI is not justified.

Example 2: Metal surface treatment

Formulation				
Hazardous component	CAS no.	Content	Classification according GHS	Classification acc. 67/548/EEC
oxalic acid	144-62-7	60 - 80%	Acute Tox. 4, H302 Acute Tox. 4, H312	Xn, harmful, R21/22
water	7732-18-5	40 – 2%	--	--

pH-value
pH-value: 1,1 – 1,8

Measured material:
Product

Ingredients
All ingredients are non-corrosive. Even taking into consideration synergistic effects of the other components, the assignment of PGI is not justified.

Remark: The pH value is no absolute value. It is a proportion figure, therefore it is also dimensionless. It is depending to the amount of water and to other ions (like dissolved salts) which have a strong influence to the pH value. This causes that a solution with only a small amount of acid in water could have an extreme low pH value but a much higher concentration buffered in a system with salts not. A comparison might be boiling water. If you get in contact you will burn your skin. But only a small amount (like 1 ml) with the same temperature will not have the capacity to damage the skin. So temperature is only an indication but not an always appropriate criterion.

Consequences

15. The inflationary use of PGI for the assignment to Class 8 substances leads to a lack of differentiation and perception of the hazard and may lead to a loss of safety awareness in cases where it would be urgently needed.

16. According to the table of precedence of hazards in the UN Model Regulations on the Transport of Dangerous Goods, the assignment of PGI results for class 8 in many cases to become the main class. This might cause a problem for the emergency response in case of an accident due to misleading information, as the table was worked out on a basis of operational experiences

17. Significant changes in the assignment of the packing group will lead to an increasing number of the filling operations and transports, as the use of Intermediate Bulk Container (IBC) are prohibited for products assigned to PGI and alternative smaller packagings like drums with less volume have to be used. If the classification changes from class 8, PGII to class 8 PGI, the required tank instruction for bulk transport increases from T11 to T14. The main difference between T11 and T14 is that T11 allows bottom openings and T14 does not allow them. But most of the tank containers available in the market have bottom openings. If a lot of materials are reclassified as class 8, PGI, producers will be unable to find in the market enough capacities to ship their materials.

18. Overall, the assignment of stricter packing groups will not generate safety gains but will cause significant downstream consequences and lead to higher operational risks and environmental impact (carbon dioxide emission) in the transport of packed goods of Class 8.

19. Additionally, the assignment of PGI might also exclude Class 8 substances from shipments as limited or excepted quantities for all modes of transport. This has a severe

impact especially for retailers and small medium enterprises (SMEs), despite the fact that today's transport conditions have proven to be safe.

20. There are also effects in the specific regulations for the different modes of transport: e.g. according to ADR 1.1.3.6, the maximum total quantity per transport unit would be limited to 20 kg (l) instead of 333 kg (l), which again has an enormous impact for SMEs. For air freight these substances would be banned or limited to very small amounts, at least for passenger aircrafts.

21. Additional impacts and downstream consequences are expected on approvals for storage and plants/production sites in some countries, as they refer to packing groups and requirements for waste transports of the substances handled at the facility.

22. Also, if the material is part of a liquid or powder which will be sprayed in an aerosol, it would be no longer allowed (aerosols with PGI materials are not allowed).

Way forward

23. The approach should reflect the multi-modal transport requirements without compromising the general GHS principles.

24. Following these underlying principles with regard to both hazard and risk, additional factors have to be considered for Class 8 substances when linking GHS sub-categories for skin corrosivity with packing groups for transport. As a result PGI would be assigned exclusively to very critical Class 8 substances as currently done in the UN Model Regulations on the Transport of Dangerous Goods which would also apply to mixtures containing a considerable amount of such substances.

25. The proposed additional criteria were discussed controversially. However, it should be stressed that the harmonization of GHS and transport is a formal act and should not end up in a severe change of packaging groups and transport conditions without necessity. For the time being, taking into account the available data sets, it doesn't make sense to pursuit this approach. This has been already described before in paragraphs 5 and 6 (International lists).

26. Another reasonable approach proposed by the United Kingdom (see annex II, section 1) was the assignment of sub-category 1A to PGII and sub-category 1B and 1C to PGIII when using the alternative methods. Only if PGI substances listed in the dangerous goods list of the UN Model Regulations on the Transport of Dangerous Goods are present in amounts above the threshold limit of GHS (5%), PGI needs to be assigned.

27. The harmonization of GHS/TDG classification criteria for corrosive substances should not substantially change the current assignments for transport documented in the dangerous goods list of the UN Model Regulations on the Transport of Dangerous Goods. This approach would be consistent with that for other Classes in transport and would provide a comparable method for the evaluation of risk, i.e. a comparable level of safety by the assignment of the packing group. It would also be in line with the common practice that existing classifications should remain valid unless they have been properly reassessed and a proposal for a change made at UN level with appropriate consideration of both hazard and risk. The dangerous goods list represents current best practice for classification in transport based on human experience with incidents involving accidental exposure.

Proposal

28. To enable a harmonised approach for classification, a change to GHS and to TDG is required. The following general way forward is proposed. Details on the new text in the TDG and the assignment of the packing groups need to be further discussed. The proposal reflects the general approach as this needs to be agreed on.

Amendments to GHS

29. As the sub-categories 1A, 1B, 1C do not have effect on the communication of the corrosion to skin hazard they should be removed from chapter 3.2 in GHS.

Amendments to the UN Model Regulations on the Transport of Dangerous Goods

30. The UN Model Regulations on the Transport of Dangerous Goods should implement the following elements/principles in chapter 2.8 to be harmonized with GHS:

(a) expert judgement and total weight of evidence as the principle for classification (see annex II, section 2);

(b) bridging principles;

(c) additivity approach for mixture with the limits as prescribed in the GHS (see annex II, section 3);

(d) non-additivity approach for mixture containing certain ingredients or ingredients with an extreme pH-value (see annex II, section 4) for which the additivity approach is not applicable (decision based on expert judgement and weight of evidence). The assignment of the packing group is based on the packing group of the relevant ingredient(s).

31. The assignment of the packing group for ingredients is strictly limited to the transport list or to test data. The proposed tables in annex II (sections 3 and 4) need to be amended with the appropriate text based on the GHS but amended for TDG.

Justification

32. The subcategories have been implemented to GHS to harmonize with the transport regulations. As this is now causing problems and the subcategories are not used for any purpose in GHS, they can be deleted.

33. It makes no difference in classification or any other aspect in supply systems based on GHS whether a corrosive substance is sub-category 1A, 1B or 1C as the symbol, signal word and hazard statement are all the same (see Table 3.2.5 in GHS). Indeed Table 3.2.1 in GHS, second column makes it clear that these sub-categories for corrosivity only apply to some authorities. In transport, assigning or changing the packing group is particularly significant as it determines the requirements for the containment and downstream consequences relating to the transport operation.

34. Implementing the alternative methods in the transport regulations strengthens the harmonisation with GHS. The assignment of packing groups only in the TDG allows adjusting the assignment based on the safety aims and needs for transport. Without the assignment of sub-categories in GHS and the resulting national lists of chemicals all over the world, the discrepancies between GHS and TDG are reduced to an absolute minimum without loss of information or safety.

Annex I

Comparison of classifications results for butylamine; diethylamine; triethylamine; sodium hydroxide; (S)-2-chloropropionic acid; 3,3'-iminodipropylamine; acetic acid and phosphoric acid in Japan, the Republic of Korea, New Zealand, European Union and the UN Model Regulations on the Transport of Dangerous Goods

Note by the secretariat: For practical reasons this document is circulated separately as INF.26/Add.1 (TDG) – INF.9/Add.1 (GHS).

Annex II

Section 1:
Contribution to the work of the joint informal correspondence group on corrosivity classification – approaches to classifying corrosive mixtures under Class 8 (Document UN/SCETDG/41/INF.53, UN/SCEGHS/23/INF.18 (United Kingdom))

- PGI: assigned to specific extreme substances only as currently done in the dangerous goods list (this would also apply to mixtures containing a considerable amount of such substances)
- PG II: Skin corrosion Cat.1A except those covered by the above
- PG III: Skin corrosion Cat.1B and 1C and Corrosive to metals Cat.1.

Section 2:
Expert judgement and total weight of evidence

(This text is added to the Annex just for information. It is the original text from GHS and is based on the 4th edition of GHS. It may be that this text needs to be amended for TDG)

2.1. This means that all data and information for a substance need to be considered validated and judged on and the most appropriate classification needs to be assigned to the substance or mixture. This is quite similar to the text in 2.8.2.2 – 2.8.2.4 but needs to be extended to the new implemented methods. Therefore it makes sense to use the text already available in GHS.

2.2 In the GHS the definition of expert judgement and total weight of evidence are as follows. If it is only implemented in chapter 2.8 of the UN Model Regulations on the Transport of Dangerous Goods all reference to other classes (like exposure routes, etc.) can be deleted.

(a) Expert judgement:

The approach to classifying mixtures includes the application of expert judgement in a number of areas in order to ensure the existing information can be used for as many mixtures as possible to provide protection for human health and the environment. Expert judgement may also be required in interpreting data for hazard classification of substances, especially where weight of evidence determinations are needed.

(b) Total weight of evidence:

- Paragraph 1.3.2.4.9.1

  For some hazard classes, classification results directly when the data satisfy the criteria. For others, classification of a substance or a mixture is made on the basis of the total weight of evidence. This means that all available information bearing on the determination of toxicity is considered together, including the results of valid in vitro tests, relevant animal data, and human experience such as epidemiological and clinical studies and well-documented case reports and observations.

- Paragraph 1.3.2.4.9.2

  The quality and consistency of the data are important. Evaluation of substances or mixtures related to the material being classified should be included, as should site of action and mechanism or mode of action study results. Both positive and negative results are assembled together in a single weight of evidence determination.

- Paragraph 1.3.2.4.9.3

  Positive effects which are consistent with the criteria for classification in each chapter, whether seen in humans or animals, will normally justify classification. Where evidence is available from both sources and there is a conflict between the findings, the quality and reliability of the evidence from both sources must be assessed in order to resolve the question of classification. Generally, data of good quality and reliability in humans will have precedence over other data. However, even well- designed and conducted epidemiological studies may lack sufficient numbers of subjects to detect relatively rare but still significant effects, or to assess potentially confounding factors. Positive results from well-conducted animal studies are not necessarily negated by the lack of positive human experience but require an assessment of the robustness and quality of both the human and ST/SG/AC.10/C.3/2012/74 animal data relative to the expected frequency of occurrence of effects and the impact of potentially confounding factors.

- Paragraph 1.3.2.4.9.4

  Route of exposure, mechanistic information and metabolism studies are pertinent to determining the relevance of an effect in humans. When such information raises doubts about relevance in humans, a lower classification may be warranted. When it is clear that the mechanism or mode of action is not relevant to humans, the substance or mixture should not be classified.

- Paragraph 1.3.2.4.9.5

  Both positive and negative results are assembled together in the weight of evidence determination. However, a single positive result performed according to good scientific principles and with statistically and biologically significant positive results may justify classification

Section 3:
Table 2.8.3.2.3: Concentration of ingredients of a mixture classified as skin corrosive that would trigger classification of the mixture in Class 8 and assignment to Packing Groups I, II and III

Sum of ingredients assigned to:	**Concentration triggering classification of a mixture as Skin Corrosive and assignment of packing groups:**
Packing group I > 5%	I
Packing group I < 5%, Packing group I + II > 5%	II
Packing group I and II < 5% and packing group I and II and III > 5%	III

Section 4:
Example for the assignment of packing groups based on the non-additivity approach

Mixture contains a corrosive surfactant (> 1%) assigned to packing group III ➔ mixture is assigned to class 8, packing group III

Mixture contains an acid with an extreme pH-value (> 1%) assigned to packing group II ➔ mixture is assigned to packing group II

Table 2.8.3.3.3: **Concentration of ingredients of a mixture for which the additivity approach does not apply, that would trigger classification in Class 8, together with the appropriate assignment of packing group**

Ingredient not applicable for additivity approach	**Concentration:**	**Mixture assigned to:**
Acid with pH ≤ 2	≥ 1%	Packing group of relevant ingredient(s). If more than one ingredient needs to be considered the strictest packing group is assigned
Base with pH ≥ 11.5	≥ 1%	
Other corrosive ingredients	≥ 1%	

Annex III

INVITRO INTERNATIONAL

17751 Sky Park East, Ste. G

Irvine, CA 92614

(949) 851-8356 www.invitrointl.com

(949) 851-0563 invitro@invitrointl.com

BULLETIN: COT 003-040194 **FOR FURTHER INFORMATION:**
REVISED: 05/05/95 U.S. Technical Service (800) 2-INVITRO

TECHNICAL REPORT: pH VALUES CANNOT BE EMPLOYED TO ASSIGN PACKING GROUPS

EPA regulations (40 C.F.R. §261.22) define a substance to be corrosive if it "is aqueous and has a pH less than or equal to 2 [≤ 2.0] or greater than or equal to 12.5 [≥ 12.5]." However, this definition has at least three important limitations. First, scientific studies have shown that there are many substances whose pH falls within the presumably noncorrosive range of 2.0 to 12.5 that actually **are corrosive**. Second, it is impossible to use a pH value, by itself, to permit accurate assignment of Packing Groups as required by DOT regulations for Class 8 corrosive materials. Third, this definition refers to aqueous solutions and is not applicable for solids. Consequently, reliable testing procedures, other than the measurement of pH, are required in order to accurately identify and classify corrosives.

The failure of pH to predict corrosivity has been demonstrated in two ways. Initially, an examination of information published in 49 C.F.R. §172.10 was conducted. This study revealed that 32% of all compounds whose pH was in the range 2.0 to 12.5 were considered to be corrosive as judged by either *in vivo* testing or DOT assignment. Subsequently, the CORROSITEX test was employed to characterize the corrosivity of 442 chemicals and chemical formulations of known pH. The results of these studies are summarized in Table 1 and Figure 1.

TABLE 1. Relationship Between pH and Packing Group: Results of Corrositex Testing

Packing Group	pH ≤ 2.0		2.0 < pH < 12.5		pH ≥ 12.5	
	N	%	N	%	N	%
I	15	11.8	1	0.4	0	0.0
II	91	71.7	49	22.1	60	64.5
III	9	7.1	25	11.3	17	18.3
Non-Corrosive	12	9.4	147	66.2	16	17.2
Total	127	100.0	222	100.0	93	100.0

These findings demonstrated, as expected, that most very acidic compounds were found to be corrosive. However, somewhat unexpectedly, the results of CORROSITEX testing also indicated that nearly 1 in 10 of the compounds whose pH was less than or equal to 2.0 could be considered to be noncorrosive. When chemicals whose pH was in the range of 2.0 to 12.5 were evaluated, the results of the CORROSITEX test were nearly identical to those previously observed for *in vivo* testing, i.e., one third of all tested compounds were found to be corrosive rather than noncorrosive. When very alkaline materials were examined, the CORROSITEX test demonstrated that only 83% of these materials were corrosive. Taken together, these findings provided clear evidence that the measurement of pH alone did not provide an adequate description of the corrosivity of many common chemicals and chemical formulations.

While the measurement of pH does not permit assignment of Class 8 Packing Groups, the CORROSITEX test has been specifically designed to provide this information. As shown in Table 1 and Figure 1, the results of CORROSITEX testing clearly demonstrated that only 16 of the 442 tested compounds (3.6%) should be classified as Packing Group I corrosive materials. With only one exception, all of these compounds were very acidic in nature. Packing Group II materials were observed to be the most frequently encountered type of corrosive material, with 200 of the 442 tested chemicals (45.2%) being classified in this manner. As would be expected, Packing Group II materials were most often found to be strongly acidic or strongly basic. However, a surprising number of compounds (22.1%) that would have been considered to be noncorrosive as judged strictly by their pH were found to be classified as Packing Group II materials when evaluated with the CORROSITEX test. Interestingly, materials classified in Packing Group III were essentially equally distributed among highly acidic, neutral and extremely alkaline compounds.

The CORROSITEX test provides an additional benefit when compared to the measurement of pH, i.e., the CORROSITEX test has been specifically constructed to determine the corrosivity of either liquids or solids. By contrast, pH measurements can only be conducted on aqueous solutions.

These investigations have clearly demonstrated that the measurement of pH is an inadequate means of establishing the corrosivity of chemical compounds and this test is not suited for the designation of corrosive materials Packing Groups. By contrast, the CORROSITEX test provides a simple, accurate and reproducible method for identifying both corrosive liquids and solids and assigning them to the appropriate Packing Group. This is particularly important to both the manufacturers and transporters of all types of chemical formulations because, for the first time, it is now possible to utilize a simple *in vitro* test to eliminate the excessive costs of over-packaging improperly classified materials as well as avoiding the risks of under-packaging misclassified corrosive materials.