7.42 **MIXED FORMULATIONS OF CS AND SC (ZC)**

# Introduction

A mixed formulation of CS and SC is ZC and is a stable suspension of microcapsules and solid fine particles, each of which contains one or more active ingredients. The formulation is intended for dilution into water prior to spray application. Formulating the active ingredients together eliminates the need for tank mixing, which can lead to incompatibility, and facilitates control of a wider range of pests with fewer applications. Like other aqueous liquid formulations, ZC formulations are easy to handle and measure, dust free, non-flammable and offer good miscibility with water.

One or more of the active ingredients is encapsulated for various purposes, such as to increase the residual biological activity, or to reduce the acute toxicity, or to obtain a physically or chemically stable water-based formulation. The purpose determines whether the “free” active ingredient and the “release rate” are relevant properties of a specific product.

Mixed formulations of CS and SC are not stable indefinitely and it is necessary to ensure that, after transportation and storage, the formulation remains suitable for use. Quantification of the following parameters, particularly after high and low temperature stability tests, serves this purpose.

* Active ingredient, determined and expressed as “total”, “free” and “release rate”, as required;
* Pourability;
* Spontaneity of dispersion and wet sieve tests (to ensure the sprayability of the diluted ZC).

Information about other properties may also be given, but these parameters do not constitute essential parts of the specification.

 Note for preparation of draft specifications. Do not omit clauses or insert additional clauses, nor insert limits that are more lax than those than given in the guidelines, without providing justification. From the “Notes” provided at the end of this guideline, incorporate only those which are applicable to the particular specification.

**[ISO Common name] MIXED FORMULATION OF CS AND SC**

[CIPAC numbers]/ZC (month & year of publication)

7.42.1 **Description**

 The material shall consist of a suspension of fine particles of technical …[ISO common name] complying with the requirements of the FAO/WHO specifications […./TC (date)], in the form of [derivative, if appropriate], combined with a suspension of microcapsules of technical …[ISO common name] complying with the requirements of FAO/WHO specification […./TC (date)], in the form of [derivative, if appropriate], in an aqueous phase together with suitable formulants. After gentle agitation the material shall appear homogeneous (Note 1) and be suitable for dilution in water.

7.42.2 **Active ingredients**

 7.42.2.1 **Identity tests** (Note 2)

 Each active ingredient shall comply with an identity test and, where the identity remains in doubt, it shall comply with at least one additional test.

 7.42.2.2 **[ISO common names] contents**

 7.42.2.2.1 **Total [ISO common name] content** (Notes 2 & 3)

The …[ISO common name] content shall be declared (g/kg or g/l at 20 ± 2ºC, Note 4) and, when determined, the average contents measured shall not differ from those declared by more than the appropriate tolerances, given in the table of tolerances, Section 4.3.2.

 7.42.2.2.2 **Free, non-encapsulated [ISO common names] content** (Notes 2 & 3), if required

 The free …[ISO common name] average content measured shall not exceed ….% of the determined total content.

 7.42.2.2.3 **[ISO common name] release rate** (Notes 2 & 3), if required

 The …[ISO common name] release rate measured shall comply with the following criteria: ……

7.42.3 **Relevant impurities**

 7.42.3.1 **By-products of manufacture or storage** (Notes 3 & 5), if required

 Maximum: …% of the total [ISO common name] content measured.

7.42.4 **Physical properties**

 7.42.4.1 **Acidity** and/or **Alkalinity** (MT 191) **or pH range** (MT 75.3), if required

 Maximum acidity: …g/kg calculated as H2SO4.

 Maximum alkalinity: …g/kg calculated as NaOH.

 pH range: …to…

 7.42.4.2 **Particle size distribution** (MT 187), if required

 …% of particles shall be in the range … to … (Note 6)

 7.42.4.3 **Pourability** (MT 148.2)

 Residue : ......%.

 7.42.4.4 **Spontaneity of dispersion** (MT 160.1) (Notes 7 & 8)

 Spontaneity of dispersion: minimum …% after 5 min in CIPAC standard water D at 25 ± 5 °C.

 7.42.4.5 **Suspensibility** (MT 184.1) (Notes 7 & 8)

 Suspensibility: minimum …% after 30 min in CIPAC standard water D at 25 ± 5ºC.

 7.42.4.6 **Wet sieve test** (MT 185.1) (Note 9)

 Maximum: …% of the formulation shall be retained on a … µm test sieve.

 7.42.4.7 **Persistent foam** (MT 47.3) (Note 10)

 Maximum: … ml after 1 min.

7.42.5 **Storage stability**

 7.42.5.1 **Freeze/thaw stability** (Note 11)

 After undergoing ... freeze/thaw cycles and following homogenization, the formulation shall continue to comply with the clauses for:

 - acidity/alkalinity/pH range (7.42.4.1),

 - pourability (7.42.4.3),

 - spontaneity of dispersion (7.42.4.4),

 - suspensibility (7.42.4.5),

 - wet sieve test (7.42.4.6),

 as required.

 An increase in free …[ISO common name] content (7.42.2.2.2) shall be permitted, to a maximum of ...% of the total content determined under 7.42.2.2.1.

 7.42.5.2 **Stability at elevated temperature** (MT 46.4)

 After storage at 54 ± 2ºC for 14 days (Note 12), the determined average total active ingredient content must not be lower than …% relative to the determined average content found before storage (Note 13) and the formulation shall continue to comply with the clauses for:

 - …[ISO common name] release rate (7.42.2.2.3),

 - by-products of manufacture or storage (7.42.3.1),

 - acidity/alkalinity/pH range (7.42.4.1),

 - pourability (7.42.4.3),

 - spontaneity of dispersion (7.42.4.4),

 - suspensibility (7.42.4.5),

 - wet sieve test (7.42.4.6),

 as required.

 An increase in free …[ISO common name] content (7.42.2.2.2) shall be permitted, to a maximum of ...% of the total content determined under 7.42.2.2.1.

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Note 1 All physical and chemical tests listed in this specification are to be performed with a sample taken after the recommended homogenization procedure. Before sampling to verify formulation quality, inspect the commercial container carefully. On standing mixed formulations of CS and SC usually develop a concentration gradient from the top to the bottom of the container. This may result in the appearance of a clear liquid on the top and/or sediment on the bottom. Therefore, before sampling, the formulation must be homogenized according to the instructions given by the manufacturer or, in the absence of such instructions, by gentle shaking of the commercial container (for example by inverting the closed container several times). After this procedure the container shall not contain a sticky layer of non-dispersed matter at the bottom (if the ZC has flocculated it may not be possible to re-disperse this sticky layer). A suitable and simple method of checking for a non-dispersed sticky layer (“cake”) is by probing with a glass rod or similar device adapted to the size and shape of the container.

Note 2 Method(s) of analysis must be CIPAC, AOAC or equivalent. Where methods have not yet been published, full details and appropriate method validation data must be submitted to FAO/WHO by the proposal.

Note 3 Separate tolerances for total content must be provided for each active ingredient, as defined in Section 4.3.2. Separate clauses must be provided for each relevant impurity.

 Clauses for free active ingredient content and release rate of the active ingredient are required only for the encapsulated active ingredient(s) and only if appropriate to the intended properties of the capsules. A clause to control release rate is usually required for capsules intended to possess slow- or controlled-release properties. A clause to control free active ingredient is usually required where encapsulation is intended to control the release or stability of the active ingredient, or to decrease the risk to users from accidental exposure to the active ingredient. If more than one active ingredient is encapsulated, limits must be provided for each. Methods for determination of free active ingredient and release rate may be product-specific.

Note 4 Unless homogenization is carried out carefully, it is possible for the sample to become aerated. This can lead to errors in the determination of the mass per ml, and in calculation of the active ingredient content (in g/l), if methods other than OECD 109 or MT 3.3 are used. If the buyer requires both g/kg and g/l at 20 °C, then in case of dispute the analytical results shall be calculated as g/kg.

Note 5 This clause should include only relevant impurities. Method(s) of analysis must be peer validated.

Note 6 Percentages may be specified in one or more ranges, as appropriate to the product. The determination of particle size range by laser diffraction is not an ideal criterion to ensure the suitability of liquid formulations. This should be evaluated by wet sieve test (MT 185.1) and suspensibility (MT 184.1) or dispersion stability (MT 180).

Note 7 Chemical assay is the only fully reliable method to measure the mass of active ingredient still in suspension. However, where the same limit applies to all active ingredients in the formulation, the simpler gravimetric method may be used on a routine basis provided that it has been shown to give equal results to those of chemical assay. In case of dispute, chemical assay shall be the referee method.

Note 8 Limits for spontaneity of dispersion and suspensibility must be provided for each active ingredient.

Note 9 This test detects coarse particles (e.g. caused by crystal growth) or agglomerates (crust formation). or extraneous materials which could cause blockage of spray nozzles or filters in the spray tank.

Note 10 The mass of sample to be used in the test should be at the highest rate of use recommended by the supplier. The test is to be conducted in CIPAC standard water D at 25 ± 5°C.

Note 11 After manufacture and during shipping it is often impossible for buyer or seller to guarantee that the formulation has not been exposed to freezing temperatures. As freezing of a ZC formulation may result in undesirable, irreversible changes, including (but not limited to) capsule failure caused by crystallization of the active ingredient, the ability of the formulation to successfully withstand repeated freezing and thawing is an important property. Unless otherwise agreed, the freeze/thaw stability test shall cycle the formulation between room temperature (e.g. 20 ± 2 °C) and -10 ± 2 °C on 18-hour-freeze/6-hour-melt cycles for a total of 4 cycles.

Note 12 Unless other temperatures and/or times are specified. Refer to Section 4.6.2 for alternative storage conditions.

Note 13 Samples of the formulation taken before and after the storage stability test may be analysed concurrently after the test in order to reduce the analytical error.