Potassium Chloride Extended-Release Tablets

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Reason for Revision: Compliance

In accordance with the Rules and Procedures of the 2015–2020 Council of Experts, the Chemical Medicines Monographs 5 Expert Committee has revised the Potassium Chloride Extended-Release Tablets monograph. The purpose for the revision is to add Dissolution Test 5 to accommodate FDA-approved drug products with different dissolution conditions and tolerances than the existing dissolution tests.

The Potassium Chloride Extended-Release Tablets Revision Bulletin supersedes the currently official monograph.

Should you have any questions, please contact Ren-Hwa Yeh, Senior Scientific Liaison (301-998-6818 or rhy@usp.org).
Potassium Chloride Extended-Release Tablets

**DEFINITION**
Potassium Chloride Extended-Release Tablets contain NLT 90.0% and NMT 110.0% of the labeled amount of potassium chloride (KCl).

**IDENTIFICATION**

- **A. IDENTIFICATION TESTS—GENERAL (191), Chemical Identification Tests, Potassium**

  **Sample solution:** A portion of the filtrate, obtained as directed for the designated Sample stock solution in the Assay

  **Acceptance criteria:** Meet the requirements

- **B. IDENTIFICATION TESTS—GENERAL (191), Chemical Identification Tests, Chloride**

  **Sample solution:** A portion of the filtrate, obtained as directed for the designated Sample stock solution in the Assay

  **Acceptance criteria:** Meet the requirements

**ASSAY**

**• PROCEDURE**

[Note—If necessary, first score nonsugar-coated Tablets. Retain a portion of the filtrate of either Sample stock solution 1 or Sample stock solution 2 for use in Identification A and B.]

**Standard stock solution:** 19.07 µg/mL of potassium chloride, previously dried at 105° for 2 h, in water. This solution contains 10 µg/mL of potassium.

**Standard solutions:** To separate 100-mL volumetric flasks transfer 10.0, 15.0, and 20.0 mL, respectively, of Standard stock solution. To each flask add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume. The Standard solutions contain 1.0, 1.5, and 2.0 µg/mL of potassium, respectively.

**Sample preparation 1**

**Sample stock solution 1:** Nominally 0.06 mg/mL of potassium chloride prepared as follows. Place NLT 20 Tablets in a suitable container with 400 mL of water, heat to boiling, and boil for 20 min. Allow to cool, transfer the solution to a 1000-mL volumetric flask, and dilute with water to volume. Filter and discard the first 20 mL of the filtrate. Transfer a measured volume of the subsequent filtrate, equivalent to 60 mg of potassium chloride, to a 1000-mL volumetric flask, and dilute with water to volume.

**Sample solution 1:** Nominally 3 µg/mL of potassium chloride prepared as follows. Transfer 5.0 mL of Sample stock solution 1 to a 100-mL volumetric flask, add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume.

**Sample preparation 2** (for formulations containing crystals coated with hydrophobic polymers)

**Sample stock solution 2:** Nominally 0.06 mg/mL of potassium chloride prepared as follows. Place NLT 20 Tablets in a 2000-mL volumetric flask. Add 1200 mL of a mixture of acetonitrile and water (1:1), and shake by mechanical means, or stir using a magnetic bar for 90 min. Dilute with the mixture of acetonitrile and water (1:1) to volume. Allow to stand for 90 min. Pass through a filter of 0.2-µm pore size. Transfer a measured volume of the filtrate, and quantitatively dilute with water to obtain a solution with a concentration of 0.06 mg/mL. [Note—Alternatively, Sample stock solution 2 can be prepared by the following procedure. Nominally 0.15 mg/mL of potassium chloride from NLT 20 finely powdered Tablets, prepared as follows. Transfer an appropriate amount of the powder, equivalent to about 5–6 Tablets, to a suitable volumetric flask, add 10% of the final flask volume of acetone, and sonicate for 45 min with intermittent shaking. Add 80% of the final flask volume of water and sonicate for 45 min with intermittent shaking. Cool to room temperature and dilute with water to volume. Centrifuge a portion of the solution at 5000 rpm for 10 min. Transfer an appropriate amount of the supernatant to a 100-mL volumetric flask and dilute with water to volume to obtain a solution with a concentration of 0.15 mg/mL.]

**Sample solution 2:** Nominally 3 µg/mL of potassium chloride prepared as follows. Transfer an appropriate amount of Sample stock solution 2 to a 100-mL volumetric flask, add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume.

**Instrumental conditions**

(See Atomic Absorption Spectroscopy (852).)

**Mode:** Atomic absorption spectrophotometry

**Analytical wavelength:** Potassium emission line at 766.5 nm

**Lamp:** Potassium hollow-cathode

**Flame:** Air–acetylene

**Blank:** Water

**Analysis**

**Samples:** Standard solutions, Sample solution 1 or Sample solution 2, and Blank

Plot the absorbances of the Standard solutions versus the concentration of potassium, in µg/mL, and draw the straight line best fitting the three plotted points. From the graph, determine the concentration of potassium in the Sample solution (µg/mL).

Calculate the percentage of the labeled amount of potassium chloride (KCl) in each Tablet taken:

\[
\text{Result} = \left( \frac{C}{C_0} \right) \times \left( \frac{M_r}{A_r} \right) \times 100
\]

where

- \( C \) = concentration of potassium in the Sample solution as determined in this test (µg/mL)
- \( C_0 \) = nominal concentration of potassium chloride in the Sample solution (µg/mL)
- \( M_r \) = molecular weight of potassium chloride, 74.55
- \( A_r \) = atomic weight of potassium, 39.10

**Acceptance criteria:** 90.0%–110.0%

**PERFORMANCE TESTS**

**Change to read:**

- **DILUSSION (711)**

**Test 1**

**Medium:** Water; 900 mL

**Apparatus 2:** 50 rpm

**Time:** 2 h

**Standard stock solution:** 19.07 µg/mL of potassium chloride, previously dried at 105° for 2 h, in water. This solution contains 10 µg/mL of potassium.

**Standard solutions:** To separate 100-mL volumetric flasks transfer 10.0, 15.0, and 20.0 mL, respectively, of Standard stock solution. To each flask add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume. The Standard solutions contain, respectively, 1.0, 1.5, and 2.0 µg/mL of potassium.
2 Potassium

Sample stock solution: Filter the solution under test, and dilute with Medium to obtain a solution containing nominally 60 µg/mL of potassium chloride. Sample solution: Transfer 5.0 mL of the Sample stock solution to a 100-mL volumetric flask. Add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume.

Instrumental conditions
(See Atomic Absorption Spectroscopy (852).)
Mode: Atomic absorption spectrophotometry
Analytical wavelength: Potassium emission line at 766.5 nm
Lamp: Potassium hollow-cathode
Flame: Air-acetylene
Blank: Water

Analysis
Samples: Standard solutions, Sample solution, and Blank
Plot the absorbances of the Standard solutions versus the concentration of potassium in the Sample solution (µg/mL). From the graph, determine the concentration of potassium in the Sample solution (µg/mL).

Calculate the percentage of the labeled amount of potassium chloride (KCl) dissolved:

\[
\text{Result} = \left( \frac{C \times D \times (V/L)}{M_r} \right) \times \left( \frac{A_r}{A_s} \right) \times 100
\]

where:
- \( C \) = concentration of potassium in the Sample solution as determined in this test (µg/mL)
- \( D \) = dilution factor of the Sample solution
- \( V \) = volume of Medium, 900 mL
- \( L \) = labeled amount of potassium chloride (µg/Tablet)
- \( M_r \) = molecular weight of potassium chloride, 74.55
- \( A_r \) = atomic weight of potassium, 39.10

Tolerances: NMT 35% (Q) of the labeled amount of potassium chloride (KCl) is dissolved in 2 h. The requirements are met if the quantities dissolved from the Tablets tested conform to Table 1 instead of the table shown in Dissolution (711).

Table 1

<table>
<thead>
<tr>
<th>Stage</th>
<th>Number Tested</th>
<th>Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>( S_1 )</td>
<td>6</td>
<td>Each unit is within the range Q ± 30%.</td>
</tr>
<tr>
<td>( S_2 )</td>
<td>6</td>
<td>Average of 12 units ((S_1 + S_2)) is within the range between Q – 30% and Q + 35%, and no unit is outside the range Q ± 40%.</td>
</tr>
<tr>
<td>( S_3 )</td>
<td>12</td>
<td>Average of 24 units ((S_1 + S_2 + S_3)) is within the range between Q – 30% and Q + 35%, and NMT 2 units are outside the range Q ± 40%.</td>
</tr>
</tbody>
</table>

Test 2: If the product complies with this procedure, the labeling indicates that it meets USP Dissolution Test 2.

Standard stock solution and Standard solutions:
Prepare as directed in Test 1.

Medium: Water; 900 mL
Apparatus 2: 50 rpm
Times: 1, 2, 4, and 8 h

Sample stock solution: Transfer 4.0 mL of the solution under test into either a 50-mL volumetric flask (for 750-mg Tablet) or a 100-mL volumetric flask (for 1500-mg Tablet), dilute with water to volume, and filter.

Sample solution: Transfer 4.0 mL of the Sample stock solution to a 100-mL volumetric flask. Add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume.

Blank solution: To a 100-mL volumetric flask, add 2.0 mL of sodium chloride solution (1 in 5) and 1.0 mL of hydrochloric acid, and dilute with water to volume.

Instrumental conditions: Proceed as directed in Test 1, except do not use the Blank.

System suitability
Samples: Standard solutions
Suitability requirements
Linearity: Correlation coefficient NLT 0.99
Relative standard deviation: NMT 5.0% from 5 replicate analyses of the 1.5-µg/mL Standard solution

Analysis
Samples: 1.5-µg/mL Standard solution, Sample solution, and Blank solution
Calculate the percentage of the labeled amount of potassium chloride (KCl) dissolved:

\[
\text{Result} = \left( \frac{A_s}{A_r} \times C \times D \times (V/L) \right) \times \left( \frac{M_r}{A_s} \right) \times 100
\]

\( A_s \) = absorbance of potassium in the Sample solution
\( A_r \) = absorbance of potassium in the Standard solution
\( C \) = concentration of potassium in the Standard solution (µg/mL)
\( D \) = dilution factor of the Sample solution
\( V \) = volume of Medium, 900 mL
\( L \) = labeled amount of potassium chloride (µg/Tablet)
\( M_r \) = molecular weight of potassium chloride, 74.55
\( A_r \) = atomic weight of potassium, 39.10

Tolerances: See Table 2.

Table 2

<table>
<thead>
<tr>
<th>Time Point (h)</th>
<th>Time (h)</th>
<th>Amount Dissolved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10–30</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>30–50</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>60–80</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>NLT 80</td>
</tr>
</tbody>
</table>

The percentages of the labeled amount of potassium chloride (KCl), dissolved at the times specified, conform to Dissolution (711), Acceptance Table 2.

Test 3: If the product complies with this procedure, the labeling indicates that it meets USP Dissolution Test 3.

Medium: Water; 900 mL
Apparatus 2: 50 rpm
Times: 0.5, 2, 4, and 10 h
Mobile phase: 20 mM methanesulfonic acid in water

Standard solution: \((L/900) \) mg/mL of USP Potassium Chloride RS in water, where \( L \) is the label claim of potassium chloride in mg/Tablet, prepared as follows. Transfer an appropriate quantity of USP Potassium Chloride RS to a suitable volumetric flask. Add 50% of the flask volume of water and sonicate to dissolve. Dilute with water to volume.

Sample solution: Pass a portion of the solution under test through a filter with a suitable pore size and use the filtrate.
If the product complies with this procedure, the dissolution satisfies the following requirements:

**Dissolution**

*Dissolve sufficient Medium Water; 900 mL*

**Transfer 10 mL of 50 rpm Potentiometric (0.01 N silver nitrate solution)**

**Weak cation-exchange resin consisting of ethylvinylbenzene, 55% functional groups. Capacity NLT 2800 Eq/column (4-mm × 25-cm).**

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**System suitability**

Sample: *Standard solution*

Suitability requirements:

- **Tailing factor:** NMT 2.0
- **Relative standard deviation:** NMT 2.0%

**Analysis**

Samples: *Standard solution and Sample solution*

Calculate the percentage of the labeled amount of potassium chloride (KCl) dissolved at each time point (t):

\[
\text{Result, } = \left( \frac{r_v}{r_s} \right) \times C_s \times V \times (1/L) \times 100
\]

- \( r_v \) = peak response of potassium from the Sample solution
- \( r_s \) = peak response of potassium from the Standard solution
- \( C_s \) = concentration of USP Potassium Chloride RS in the Standard solution (mg/ml)
- \( V \) = volume of Medium, 900 ml
- \( L \) = label claim of potassium chloride (mg/Tablet)

**Tolerances:** See Table 3.

### Table 3

<table>
<thead>
<tr>
<th>Time Point (t)</th>
<th>Time (h)</th>
<th>Amount Dissolved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>15–35</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>40–60</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>60–80</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>NLT 80</td>
</tr>
</tbody>
</table>

The percentages of the labeled amount of potassium chloride (KCl), dissolved at the times specified, conform to Dissolution (711), Acceptance Table 2.\(^\text{**}^\text{2}\ (\text{RB 21-Aug-2019})\)

**Test 4:** If the product complies with this procedure, the labeling indicates that it meets USP Dissolution Test 4.

**Standard stock solution and Instrumental conditions:**

- **Medium:** Water; 900 mL, degassed
- **Apparatus 2:** 50 rpm
- **Times:** 2, 4, and 8 h
- **Sodium chloride solution:** 0.2 g/mL of sodium chloride in water
- **Hydrochloric acid solution:** Dilute 100 mL of hydrochloric acid with 300 mL of water.
- **Standard solutions:** To separate 100-mL volumetric flasks transfer 10.0, 15.0, and 20.0 mL, respectively, of Standard stock solution. To each flask add 2.0 mL of Sodium chloride solution and 4.0 mL of Hydrochloric acid solution, and dilute with water to volume. The Standard solutions contain 1.0, 1.5, and 2.0 μg/mL of potassium, respectively.

**Sample stock solution:** Pass a portion of the solution under test through a filter with a suitable pore size and use the filtrate.

**Sample solution:** Transfer 1.0 mL of the Sample stock solution to a suitable volumetric flask and dilute with water if necessary. To the final dilution, add 2.0% flask volume of Sodium chloride solution and 4.0% flask volume of Hydrochloric acid solution, and dilute with water to volume.

**Blank:** To a suitable volumetric flask, add 2.0% flask volume of Sodium chloride solution and 4.0% flask volume of Hydrochloric acid solution, and dilute with water to volume.

**System suitability**

Samples: *Standard solutions*

**Suitability requirements**

- **Linearity:** Correlation coefficient NLT 0.999
- **Relative standard deviation:** NMT 1.5% from the absorbance responses of 5 replicate analyses of each Standard solution

**Analysis:** Proceed as directed in Test 1.

**Tolerances:** See Table 4.

### Table 4

<table>
<thead>
<tr>
<th>Time Point (t)</th>
<th>Time (h)</th>
<th>Amount Dissolved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>22–42</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>44–64</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>NLT 80</td>
</tr>
</tbody>
</table>

The percentages of the labeled amount of potassium chloride (KCl), dissolved at the times specified, conform to Dissolution (711), Acceptance Table 2.\(^\text{**}^\text{2}\ (\text{RB 1-Aug-2019})\)

**Test 5:** If the product complies with this procedure, the labeling indicates that it meets USP Dissolution Test 5.

**Medium:** Water; 900 mL

**Apparatus 2:** 50 rpm

**Times:** 1, 2, and 8 h

**Dilute glacial acetic acid solution:** Dilute 25 mL of glacial acetic acid with 75 mL of water.

**Saturated potassium sulfate solution:** Dissolve sufficient quantities of potassium sulfate in a suitable volume of water until undissolved particles appear in the solution. **0.01 N silver nitrate solution:** Transfer 10 mL of 0.1 N silver nitrate VS to a 100-mL volumetric flask and dilute with water to volume.

**Standard solution:** (L/900) mg/mL of potassium chloride, previously dried at 105° for 2 h, in water, where L is the label claim in mg/Tablet. Pass the solution through a suitable filter.

**Sample solution:** Withdraw 10 mL of the solution under test at the specified time points and pass a suitable portion of the solution through a suitable filter. Replace each of the volume withdrawn with an equal volume of the Medium.

**Blank:** Medium

**Titrimetric system**

(See Titrimetry (541).)

**Mode:** Direct titration

**Titrant:** 0.01 N silver nitrate solution

**Endpoint detection:** Potentiometric

**System suitability**

Sample: *Standard solution*
Transfer 5 mL of Standard solution into a titration vessel and add 25 mL of water, 5 mL of Dilute glacial acetic acid solution, and 0.1 mL of Saturated potassium sulfate solution to the vessel. Titrate with Titrant and determine the endpoint potentiometrically.

**Suitability requirements**

- **Relative standard deviation:** NMT 2.0% from 5 replicate analyses

**Analysis**

**Samples:** Sample solution and Blank

Transfer 5 mL of each solution into separate titration vessels and add 25 mL of water, 5 mL of Dilute glacial acetic acid solution, and 0.1 mL of Saturated potassium sulfate solution to each vessel. Titrate with Titrant and determine the endpoint potentiometrically.

Calculate the concentration ($C_i$) of potassium chloride (KCl) in the sample withdrawn from the vessel at each time point ($i$):

$$\text{Result}_1 = (V_U - V_B) \times N \times F \times (1/V_S)$$

$$V_U = \text{volume of Titrant used to titrate the Sample solution}$$
$$V_B = \text{volume of Titrant used to titrate the Blank}$$
$$N = \text{actual normality of Titrant (mEq/mL)}$$
$$F = \text{equivalency factor, 74.55 mg/mEq}$$
$$V_S = \text{volume of Sample solution used in the test, 5 mL}$$

Calculate the percentage of the labeled amount of potassium chloride (KCl) dissolved at each time point ($i$):

$$\text{Result}_2 = C_i \times V \times (1/L) \times 100$$

$$\text{Result}_3 = [(C_2 \times V) + (C_1 \times V_w)] \times (1/L) \times 100$$

$$\text{Result}_4 = [(C_3 \times V) + (C_2 + C_1) \times V_w] \times (1/L) \times 100$$

$$C_i = \text{concentration of potassium chloride in the portion of sample withdrawn at the specific time point}$$

<table>
<thead>
<tr>
<th>Time Point ($i$)</th>
<th>Time (h)</th>
<th>Amount Dissolved (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>22–42</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>38–58</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>NLT 80</td>
</tr>
</tbody>
</table>

The percentages of the labeled amount of potassium chloride (KCl), dissolved at the times specified, conform to **Dissolution (711), Acceptance Table 2**.

**Uniformity of Dosage Units** (905): Meet the requirements

**Additional Requirements**

- **Packaging and Storage:** Preserve in tight containers, and store at a temperature not exceeding 30°.
- **Labeling:** The label states with which Sample preparation in the Assay the product complies only if Sample preparation 1 is not used. When more than one Dissolution test is given, the labeling states the Dissolution test used only if Test 1 is not used.

Add the following:

- **USP Reference Standards** (11)
  USP Potassium Chloride RS
  ▲ (RB 21-Aug-2019)