Brief Introduction of Slow/Controlled Release Fertilizer Industry of China & Related Standards

Gang LIU
Shanghai Research Institute of Chemical Industry (SRICI)
China National Technical Committee for Standardization of Fertilizer & Soil Conditioner (CNTCS of F&SC)

Outlines

1. Introduction to SRICI and CNTCS of F&SC
2. Slow/Controlled Release Fertilizer Industry in China
3. China’s Standards on Related Fields
4. Future Plans and Prospects
Introduction to SRICI & CNTCS of F&SC

- Shanghai Research Institute of Chemical Industry (SRICI)
  Founded in Sep. 1956
  Key Research Institute of China Chemical Industry
  Founder and Frontier of China Fertilizer Industry

- China National Technical Committee for Standardization of Fertilizer & Soil Conditioner (CNTCS of F&SC), i.e., SAC/TC 105
  Standardization Administration of the People’s Republic of China/Technical Committee 105 (SAC/TC 105)
  Corresponding to ISO/TC134
  Founded in 1988, the 5th Committee up to now
  Chairman & Secretary-general---- both from Shanghai Research Institute of Chemical Industry
  ISO/TC134 WG1 Convener: Prof. Gang LIU

Slow/Controlled Release Fertilizer Industry in China

China: one of the most important countries among the world on slow/controlled release fertilizer production and application

The consumption of China accounted for 1/2 of the world (2012)
Yield/sale of slow/controlled release fertilizer in China=1,350,000t, including:
- Polymer-sulfur double coated fertilizer=550,000t
- Sulfur coated fertilizer=500,000t
- Polymer coated fertilizer=200,000t
- Urea formaldehyde fertilizer=100,000t

>30 research institutes in China engaged in slow/controlled release fertilizer research
>70 enterprises & units engaged in the industrialization, production and extension of slow/controlled release fertilizer in China

Including: Shandong Kingenta Ecological Engineering Co., Ltd, Shanghai Hanfeng Slow-Release Fertilizer Co., Ltd, Shikefeng Chemical Industry Co., Ltd, etc.
7 national & industrial standards in the field of slow/controlled release fertilizer established in China
China’s Standards on Related Fields

6 product standards & 1 standard of rapid-detection method in the field of slow/controlled release fertilizer in China

- GB/T 23348-2009 National Standard of <Slow Release Fertilizer>
- HG/T 3997-2008 Chemical Industry Standard of <Sulfur Coated Urea>
- HG/T 4135-2010 Chemical Industry Standard of <Stabilized Fertilizer>
- HG/T 4137-2010 Chemical Industry Standard of <Urea Aldehyde Slow Release Fertilizer>
- HG/T 4215-2011 Chemical Industry Standard of <Controlled Release Fertilizer>
- HG/T 4216-2011 Chemical Industry Standard of <Fast Methods to Determine the Longevity and Release Rate of Slow/Controlled Release Fertilizers>
- HG/T 4217-2011 Chemical Industry Standard of <Inorganic Material Coated Compound Fertilizer (Complex Fertilizer)>

GB/T 23348-2009 National Standard of <Slow Release Fertilizer>

- **Slow Release Fertilizer**: The available nutrient content of fertilizer could be slowly released over time via chemical or physical reaction within the nutrient.

- **Partial Slow Release Fertilizer**: Fertilizer containing a nutrient with partial slow release characteristics, which is made by blending slow release fertilizer and conventional fertilizer, to make some nutrient content have the character of slow release.

- The products shall be divided, by key categories, into: slow release nitrogenous fertilizer, slow release potash fertilizer, slow release compound fertilizer, slow release complex fertilizer, slow release bulk blending fertilizer (BB fertilizer), etc.

- The slow release performance characterized by several factors: nutrient release period, initial release rate of nutrient, 28d cumulative release rate of nutrient, cumulative release rate of nutrient during nutrient release period, slow release nutrient content, etc.
### Requirements on Slow Release Fertilizer

<table>
<thead>
<tr>
<th>Items</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High Concentration</td>
</tr>
<tr>
<td>Mass ratio of total nutrient (N + P₂O₅ + K₂O)/%</td>
<td>40</td>
</tr>
<tr>
<td>Mass ratio of water-soluble P to effective P, %</td>
<td>60</td>
</tr>
<tr>
<td>Mass ratio of water, %</td>
<td>≤2.0</td>
</tr>
<tr>
<td>Particle size (1.00mm – 4.75mm or 3.35 – 5.60mm), %</td>
<td>≥90</td>
</tr>
<tr>
<td>Nutrient release period, month</td>
<td>Declaration</td>
</tr>
<tr>
<td>Initial release rate of nutrient, %</td>
<td>≤15</td>
</tr>
<tr>
<td>Cumulate release rate of nutrient in 28 days, %</td>
<td>≤ 80</td>
</tr>
<tr>
<td>Cumulate release rate of nutrient during nutrient release period, %</td>
<td>≤80</td>
</tr>
</tbody>
</table>

### HG/T 3997-2008 Chemical Industry Standard of \(<\text{Sulfur Coated Urea}>\)

- **Sulfur Coated Urea**: A slow controlled fertilizer with sulfur as the main material coating urea particles, to realize slow release of nitrogen.
- Applicable to the slow/controlled release fertilizer with sulfur as the main material coating urea particles to realize slow release of nitrogen, and also applicable to the slow/controlled release fertilizer containing sulfur coated urea.
- The controlled-release performance characterized by factors as: initial release rate of nutrient, seven days dissolution rate, controlled-release nitrogen nutrient content, etc.
**Requirements on Sulfur Coated Urea**

<table>
<thead>
<tr>
<th>Items</th>
<th>Type I</th>
<th>Type II</th>
<th>Type III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass fraction of total nitrogen (N) (%)</td>
<td>37.0</td>
<td>34.0</td>
<td>31.0</td>
</tr>
<tr>
<td>Initial release rate of nutrient (%)</td>
<td>27</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Seven day dissolution rate (TVA, SDDR method) (%)</td>
<td>35</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Mass fraction of sulfur (S) (%)</td>
<td>10.0</td>
<td>15.0</td>
<td>20.0</td>
</tr>
<tr>
<td>Mass fraction of biuret (%)</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass ratio of water (%)</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Particle size (1.00mm ~ 4.75mm or 3.35 ~ 5.60mm) (%)</td>
<td>90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HG/T 4135-2010 Chemical Industry Standard of <Stabilized Fertilizer>**

- **Stabilized Fertilizer**: a kind of nitrogen fertilizer (including those binary and tertiary nitrogen fertilizer as well as straight nitrogen fertilizer) which longevity could be extended by adding urease inhibitor and (or) nitrification inhibitor; The urease inhibitor in the soil can help prevent the hydrolysis of urea, while the nitrification inhibitor could suppress the nitrification process of ammonium nitrogen.

- Applicable to those **Stabilized Fertilizers which contain nitrogen (amide-nitrogen/ammonium nitrogen)** produced by adding urease inhibitor and/or nitrification inhibitor. (For those fertilizer produced by adding urease inhibitor, urea must be contained)

- The controlled-release performance characterized by several factors: urea residual difference rate & nitrification inhibition rate
Requirements on Stabilized Fertilizer

<table>
<thead>
<tr>
<th>Item</th>
<th>Stabilized Fertilizers type 1 (containing urease inhibitor only)</th>
<th>Stabilized Fertilizers type 2 (containing nitrification inhibitor only)</th>
<th>Stabilized Fertilizers type 3 (containing both urease inhibitor and nitrification inhibitor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>urea residual difference rate /% ≥</td>
<td>25</td>
<td>/</td>
<td>25</td>
</tr>
<tr>
<td>nitrification inhibition rate /% ≥</td>
<td>/</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

HG/T 4137-2010 Chemical Industry Standard of <Urea Aldehyde Slow Release Fertilizer>

- **Urea Aldehyde Slow Release Fertilizer**: one kind of organic slightly soluble nitrogen slow release fertilizers obtained by urea and aldehydes reacting under certain conditions

- Applicable to organic slightly-soluble nitrogen slow release fertilizer obtained by urea and aldehydes reacting under certain conditions. Main products include urea formaldehyde/methylene urea (UF/MU), isobutylidene diurea (IBDU) and crotonylidene diurea (CDU), as well as compound fertilizer or bulk blending (BB) fertilizer which containing urea aldehyde slow release fertilizer

- The controlled-release performance characterized by several factors: cold water insoluble nitrogen (CWIN), hot water insoluble nitrogen (HWIN), slow available nitrogen (SAN), activity index (AI, %)
Requirements on Urea Aldehyde Slow Release Fertilizer

<table>
<thead>
<tr>
<th>Items</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>urea formaldehyde / methylene urea (UF/MU)</td>
<td>isobutylidene diurea (IBDU)</td>
</tr>
<tr>
<td>Mass fraction of total nitrogen (TN) % ≥</td>
<td>36.0</td>
</tr>
<tr>
<td>Mass fraction of urea nitrogen (UN) % ≤</td>
<td>5.0</td>
</tr>
<tr>
<td>Mass fraction of cold water insoluble nitrogen, CWN% ≥</td>
<td>14.0</td>
</tr>
<tr>
<td>Mass fraction of hot water insoluble nitrogen, HWN% ≥</td>
<td>16.0</td>
</tr>
<tr>
<td>Mass fraction of slow available nitrogen % ≥ ≥</td>
<td>8.0</td>
</tr>
<tr>
<td>Activity index, AI % ≥</td>
<td>40</td>
</tr>
<tr>
<td>Mass ratio of water % ≤</td>
<td>3.0</td>
</tr>
<tr>
<td>Particle size (1.00mm ~ 4.75mm or 3.35 ~ 5.60mm) % ≥</td>
<td>90</td>
</tr>
</tbody>
</table>

HG/T 4215-2011 Chemical Industry Standard of <Controlled Release Fertilizer>

- **Controlled Release Fertilizer**: A fertilizer, of which, the nutrient release rate is well controlled according to the assured rate (%) and duration (d) of release.

- **Partial Controlled Release Fertilizer**: Fertilizer containing a nutrient with partial controlled release characteristics, which is made by blending controlled release fertilizer and conventional fertilizer.

- Performance characterized by: **stated release longevity of nutrient, initial release rate of nutrient, 28d cumulative release rate of nutrient, cumulative release rate of nutrient during the stated release longevity of nutrient, controlled-release nutrient content, etc**

- The **7d initial release rate of nutrient, 28d cumulative release rate of nutrient as well as the period during which stimulated release rate reaching 80% should be marked on the package. The nutrient release curve should be given whenever required by the consumer**

- The detailed requirements on controlled release fertilizer is very similar to that of slow release fertilizer.
Other Related Standards on Slow/Controlled Release Fertilizer

- **HG/T 4216-2011 Chemical Industry Standard of <Fast Methods to Determine the Longevity and Release Rate of Slow/Controlled Release Fertilizers>
  For polymer coated urea (PCU), polymer-sulfur coated urea (PSCU) (slow-controlled release urea), the controlled release nutrient determined by the refractive index method
  For slow release compound fertilizer (complex fertilizer), slow release blending fertilizer, slow release potassium fertilizer, the controlled release nutrient determined by the conductivity method

- **HG/T 4217-2011 Chemical Industry Standard of <Inorganic Material Coated Compound Fertilizer (Complex Fertilizer)>
  Type I: Coated by calcium magnesium phosphate fertilizer or calcium hydrophosphate
  Type II: Coated by magnesium ammonium phosphate fertilizer
  Performance characterized by: kernel coating rate, mass ratio of slow-release nitrogen to the total nitrogen, mass ratio of slow-release nitrogen (for Type I >40%, for Type II >50%), etc

Future Plans and Prospects

- Research & standardization work on “Rapid stimulated test for slow/controlled-release performance within 7 days”

- Research & standardization work on the environmental safety (i.e. degradation performance) of coating materials used in slow/controlled-release fertilizers

- Establishment of a kind of universal analytic methods on the performance for different kinds of slow/controlled-release fertilizer

- Establishment of world-wide acceptable International Standards on slow/controlled-release fertilizer series

Thank you for your attention!