ADJUVANTS FOR FERTILIZERS - GENERAL INFORMATION

Manufacturers are facing certain problems in the production of fertilizers (single and complex) which may be solved by using suitable chemical adjuvants. Below we list three chemical-physical phenomena which are causes of the main difficulties encountered in the production of fertilizers:

1. CAKING:

is a process by which a fertilizer loses its desirable free-flowing properties. We can consider caking as the agglomeration of fertilizer granules with the tendency to form hard concrete lumps of large dimension and strong mechanical resistance. Most theories regarding the caking phenomena imply that these problems are due to many different factors connected mainly with the moisture present in the granules. These factors may be for instance:

- Formation of crystal bridges between the fertilizer granules due to evaporation of water from the surface
- Capillary adhesion
- Diffusion of inorganic salts at the contact points of granules due to capillary forces that promote meniscus formation and ion migration.

*Figure 1

*crystal bridges due to evaporation of water from the surface*
- Plastic deformation of granules

- Changes of phase

- Chemical reactions between the components of fertilizers with ion exchange

- Growth of small crystals during storage

Figure 2*

*growth of crystals during storage

Of course, all these phenomena may coexist only in the case of complex fertilizers. When speaking about a single component fertilizer such as UREA, we can consider that the caking is caused mainly by the formation of crystal bridges as explained in picture 1.
The generally accepted method of preventing or at least reducing this problem is to coat of the granules with products such as surfactants or with special blends of hydrophobic substances.
These components operate by increasing the separation of the single particles, reducing the absorption of moisture and regulating the growth of crystals.
These products are called ANTICAKING AGENTS.
2. DUST FORMATION:

A second, equally important problem for fertilizer producers is the presence of dust in the end product which generates problems when removing heapstared fertilizers or during sacking, bulk transportation and spreading over fields. The formation of dust by the fertilizers is due to many different causes. The main ones are the following:

- The release from the surface of granules of the powders used as anticaking agents
- Non perfect success in the granulation or in the reddling of the granules
- The breaking up of caked fertilizers using mechanical equipment

In some cases the above-mentioned problem is very serious. To prevent dust formation treatments are usually carried out using oils or waxes. These are hydrophobic and therefore are able to affect the first two causes. Specific anticaking agents are needed for the last cause, which is the most important. KEPHAS S.r.l. scientifically studied the final treatment of fertilizers aiming at top quality products which can show a good antidusting power together with anticaking efficacy.

3. FOAMING:

This happens when phosphorites are treated with acids. Foam formation is caused by Carbon-Dioxide release from carbonates and/or organic substances, etc. which are always present in the phosphorites.

The problems which may arise in this case are:

- The overflow of pulp from reactors
- Flotation of the pulps which presents some difficulties during subsequent operations such as pumping or ammoniaction, etc.

Products used to reduce this problem and consequently to increase productivity are called ANTIFOAM AGENTS.
KEPHAS's chief selling factors are:

- Appropriate equipment in laboratories for the evaluation and testing of the adjuvants
- Technicians specialized in research who are working at developing the possibilities of production methods: our technical service team has many years of experience and a vast amount of cumulative knowledge in agricultural chemical products
- Large range of single adjuvants whose basic technologies are available in order to prepare sophisticated mixtures
- Uninterrupted research and updating of our products to maintain them constantly in advance and trying to solve each problem that our Customers might meet during the production or handling of fertilizers
- Constant high quality of our products which provides an expanding market both in Italy and abroad.
PRODUCT LIST

1. **AC FERT 100** – Anticaking for soluble fertilizers (Urea-Nitrates-Nitrites based formulation-Ammonium Sulphate)

2. **AC FERT S** - New generation Anticaking for soluble fertilizers (Urea-Nitrates-Nitrites based formulation-Ammonium Sulphate)

3. **CHRY AD** – Antidusting agent for soluble fertilizers

4. **CHRY AD S** – Antidusting agent (low viscosity) for soluble fertilizers.

5. **K-DOS 70** – Antifoam agent for the etching of the phosphorites during the production of Phosphoric Acid or complex NPK fertilizers.
Additives for soluble Fertilizers

In the last couple of years the fertilizers market has been considerably increasing the consumption of soluble products to be used both for ferti-irrigation and foliar absorption. This trend has brought involved. KEPHAS S.r.l. in compliance with its commercial policy and its capability to adapt production and technical assistance to the customers’ needs has faced the new requirements of the market integrating the traditional range of additives with new products, especially devoted to the soluble fertilizers.

As every manufacturer knows, the main inconveniences in production or handling are caking and dusting.

In order to solve such problems we offer the following products:

- **AC FERT 100** (Anticaking)
- **AC FERT S** (Anticaking)
- **CHRY AD** (Antidusting-Anticaking)
- **CHRY AD/S** (Antidusting-Anticaking)
AC FERT 100 (Anticaking)

The product consists of alkaline sulphonated elements completely soluble in water and it is particularly suggested as anticaking agent for soluble fertilizers and Salts as Sodium Nitrate, Nitrite, Urea and Ammonium Sulphate.

AC FERT 100 is very efficient in mixtures containing high percentage of ground urea and characterized by strong caking phenomena.

AC FERT 100 TECHNICAL DATA SHEET

PRODUCT SPECIFICATIONS

<table>
<thead>
<tr>
<th>Aspect:</th>
<th>Minute microcrystal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color:</td>
<td>Bright beige</td>
</tr>
<tr>
<td>pH value solution 1% to 20%C:</td>
<td>7,5 ± 1,0</td>
</tr>
<tr>
<td>Apparent density: g/ml</td>
<td>0,600 ± 0,100</td>
</tr>
<tr>
<td>Water behavior:</td>
<td>Soluble</td>
</tr>
</tbody>
</table>

PHYSICO-CHEMICAL SPECIFICATIONS

| Chemical composition:                     | Product mixture sulphonates and sulphates |
| Application sector:                       | Water soluble fertilizers                 |
| Active substance:                         | About 98%                                 |
| Effective ion charge:                     | Anionic                                   |
| Compatibility:                            | Compatible with anionic e non ionian products |
| Storage stability:                        | 24 months preserved in the original packaging and dry |
APPLICATION AND RESULTS

AC FERT 100 is normally used at a dosage of about 0.2% in Sodium Nitrate (in crystals or in powder form) and it grants excellent anticaking results. The treated products are completely soluble in water without producing foam. In the case of soluble fertilizers the suggested dosage changes from about 0.2 to 0.6%, according to the formulations, the raw materials and the environmental conditions. The use of AC FERT 100 produces first class results also for fertilizers made by raw materials which show very strong caking phenomena as, for instance, Ammonium Nitrate (not in very high percentage) or ground Urea. Moreover, AC FERT 100 shows synergy with synthetic Silica normally used and with our liquid product named CHRY AD, suggested as antidust-anticaking agent. In comparison with products normally used for these kinds of application, AC FERT 100 shows the following advantages:

- It is completely water soluble
- It doesn’t develop foam
- It doesn’t need to be sprayed or ground
- it is completely non toxic

The following results were obtained using a soluble fertilizer consisting of Urea, DAP, Ammonium Nitrate, etc. with a title at 20.10.10.

<table>
<thead>
<tr>
<th>Anticaking agent</th>
<th>% dose</th>
<th>Crushing load (index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>=</td>
<td>3,600</td>
</tr>
<tr>
<td>Synthetic silica</td>
<td>0,5</td>
<td>1,600</td>
</tr>
<tr>
<td>AC FERT 100</td>
<td>0,3</td>
<td>1,000</td>
</tr>
<tr>
<td>AC FERT 100 and Synthetic silica</td>
<td>0,3+0,2</td>
<td>600</td>
</tr>
<tr>
<td>AC FERT 100 and CHRY AD/AD-S</td>
<td>0,3+0,1</td>
<td>500</td>
</tr>
</tbody>
</table>

Such results have been widely confirmed during the industrial application of AC FERT 100 where the dosage fluctuates from 0.2 to 0.6, with peaks of 1 % for particular environmental conditions: this gets to ureic formulations (20.10.10; 28.14.14 and so on) with first class performances.

AC FERT 100 is stable and not subject to degradation, can be stored in accordance with the usual conditions foreseen for products packed in paper bags. It is not corrosive, inflammable or toxic.

AC FERT 100 and all its components are non toxic, non carcinogenic and non mutagenic.

LD 50 on rat > 2,000 mg/kg

Of course when using AC FERT 100 it is necessary to observe all the usual handling precautions foreseen for chemical products (gloves, glasses, clothes etc.). In case of:

- Direct contact with skin, wash thoroughly with soap and water
- Direct contact with eyes, rinse immediately with plenty of water for 10 minutes
- Ingestion, not dangerous, but it is possible to administer activated charcoal in water, or liquid paraffin to drink.
– For the same application, we can offer a very new generation product:

**AC FERT S (Anticaking)**

**PRODUCT SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Aspect:</th>
<th>Minute microcrystal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color:</td>
<td>Light beige</td>
</tr>
<tr>
<td>pH value solution 1% to 20%C:</td>
<td>7,5 ± 1,0</td>
</tr>
<tr>
<td>Apparent density: g/ml</td>
<td>0,600 ± 0,100</td>
</tr>
<tr>
<td>Water behavior:</td>
<td>Soluble</td>
</tr>
</tbody>
</table>

**PHYSICO-CHEMICAL SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Chemical composition:</th>
<th>Sodium salt of Acid Naphtalenmethansulphonate (with white Naphtaline)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application sector:</td>
<td>Water soluble fertilizers</td>
</tr>
<tr>
<td>Active substance:</td>
<td>About 98%</td>
</tr>
<tr>
<td>Effective ion charge:</td>
<td>Anionic</td>
</tr>
<tr>
<td>Compatibility:</td>
<td>Compatible with anionic e non ionian products</td>
</tr>
<tr>
<td>Storage stability:</td>
<td>24 months preserved in the original packaging and dry</td>
</tr>
</tbody>
</table>
APPLICATION AND RESULTS

**AC FERT S** used at a dosage of about 0.2 - 0.6% grants excellent anticaking results and allows to get fertilizers with good stability. The product, chemically similar to **AC FERT 100**, may be used in alternative to the previous one in order to obtain good results with all soluble formulas, independently from the final titre or the raw materials used.

Also the **AC FERT S** shows the following advantages:

- It is completely water soluble
- It doesn’t develop foam
- It doesn’t need to be sprayed or ground
- It is completely non toxic, without Formaldehyde

The following results were obtained using a soluble fertilizer consisting of Urea, DAP, Ammonium Nitrate, etc. with a title at 20.10.10.

<table>
<thead>
<tr>
<th>Anticaking agent</th>
<th>% dose</th>
<th>Crushing load (index)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>=</td>
<td>3,600</td>
</tr>
<tr>
<td>Synthetic Silica</td>
<td>0,5</td>
<td>1,600</td>
</tr>
<tr>
<td><strong>AC FERT S</strong></td>
<td>0,3</td>
<td>1,000</td>
</tr>
<tr>
<td>AC FERT S and Synthetic silica</td>
<td>0,3+0,2</td>
<td>600</td>
</tr>
<tr>
<td>AC FERT S and CHRY AD/AD-S</td>
<td>0,3+0,1</td>
<td>500</td>
</tr>
</tbody>
</table>

The results obtained using the **AC FERT S** are similar to the **AC FERT 100** of which it is a complement. **AC FERT S** is stable and not subject to degradation, can be stored in accordance with the usual conditions foreseen for products packed in paper bags. It is not corrosive, inflammable, toxic, carcinogenic and mutagenic. LD 50 on rat > 2,000 mg/kg

Of course when using **AC FERT S** it is necessary to observe all the usual handling precautions foreseen for chemical products (gloves, glasses, clothes etc.).

In case of:

- Direct contact with skin, wash thoroughly with soap and water
- Direct contact with eyes, rinse immediately with plenty of water for 10 minutes
- Ingestion, not dangerous, but it is possible to administer activated charcoal in water, or liquid paraffin to drink.
CHRY AD/CHRY AD-S (Antidusting/Anticaking)

CHRY AD/CHRY AD-S are a surfactant polymer soluble in water, developed for the superficial treatment of soluble fertilizers and Ammonium Sulphate which confers caking stability and twodusting effect. The only difference is the molecular weight.

The products are used by spraying into the crystals of Ammonium Sulphate and soluble mixture and causes a drastic reduction of powders during production and handling. The formal suggested dosage is 0.1-0.2%.

CHRY AD/CHRY AD-S used in combination with the AC FERT 100 - AC FERT S shows synergetic effects in the nitrate based mixtures.

Combining AC FERT 100 or AC FERT S in powder, with the subsequent spray of CHRY AD/CHRY AD-S it is possible to give to the fertilizers Ammonium Nitrate based, a good caking stability.

TECHNICAL DATA SHEET

<table>
<thead>
<tr>
<th></th>
<th>CHRY AD</th>
<th>CHRY AD-S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance at 20 °C</td>
<td>Clear liquid</td>
<td>Clear liquid</td>
</tr>
<tr>
<td>Active content</td>
<td>99% mint</td>
<td>99% mint</td>
</tr>
<tr>
<td>Moisture</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>pH sol. 5% in water</td>
<td>5-7</td>
<td>5-7</td>
</tr>
<tr>
<td>Density at 20 °C</td>
<td>1,125 ± 0,010</td>
<td>1,110 ± 0,010</td>
</tr>
<tr>
<td>Character</td>
<td>Non ionic</td>
<td>Non ionic</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Complete</td>
<td>Complete</td>
</tr>
<tr>
<td>Composition</td>
<td>Water soluble polymer surfactant</td>
<td>Water soluble polymer surfactant</td>
</tr>
<tr>
<td>Flash point</td>
<td>&gt; 100 °C</td>
<td>&gt; 100 °C</td>
</tr>
</tbody>
</table>

The products are very stables and not subjects to any degradation.

The CHRY AD/CHRY AD-S handling don’t need any particular precaution because they are not aggressives, inflammables or toxics.

The products, completely non toxic, have LD 50 on rat > 5.000 mg/kg and they are available also in food grade.

Of course when using CHRY AD/CHRY AD-S it is necessary to observe all the usual handling precautions foreseen for chemical products (gloves, glasses, clothes etc.).

In case of:
- Direct contact with skin, wash thoroughly with soap and water
- Direct contact with eyes, rinse immediately with plenty of water for 10 minutes
- Ingestion, not dangerous, but it is possible to administer activated charcoal in water, or liquid paraffin to drink.
ANTICAKING EFFECT ON FERTILIZER - METHOD OF DETERMINATION
This test is very simple whether conceptionally or experimentally.

INTRODUCTORY REMARKS
Customer’s mixtures (e.g. inorganic Salts and Urea) are in form of powder mixtures or crystals and they show a strong tendency to the agglomeration and the consequence is that we have big problems during the application. It's necessary to utilize an additive that could be able to eliminate or to reduce these phenomena. The characteristics that this additive must have are:

- To be in powder form
- To be completely soluble in water
- Not to be toxic or phytotoxic
- To have a reasonable cost
- If possible not to be foaming

The tests consist simply in putting chemical stability under the charge of the formulations in comparison with a test in white.

MIXTURES PREPARATION
Starting from mother solutions (after eventual agglomerates desegregation) it's enough to introduce the analyzed product and to proceed for homogenizing all. The methodology more effective is to utilize a plastic bag slightly inflated in which you shake the mixture.

PUTTING IN STABILITY
The mixtures prepared as described are put in normal laboratory beckers of 250 ml with large mouths (about 50 g, that is to say until an height of 2.0-2.5 cm) and are put in stability under charge. The charge tests can be done putting on the samples under test some weights for simulating the stock situation in bags of finished products. Beside, to accelerate caking phenomena, it's necessary to effectuate tests at higher temperatures (from 40 to 54° C). At the end of stability you verify the caking in comparison with the tests in white. These are empirical tests, so it's necessary to execute all the valuations in a statistic way preparing 2-3 trials for every sample under examination.
This product consists of an anionic surfactant and it was developed as an antifoam agent for the etching of the phosphorites during the production of Phosphoric Acid or complex NPK fertilizers.

**APPLICATION**

**PHOSPHORIC ACID**

The production of Phosphoric Acid can be effected by different continuous processes, from which it is possible to obtain, as secondary products, bi-hydrate and semi-hydrate Calcium Sulphates.

In the case of production of phosphoric acid by the bi-istrate method, the phosphorite is solubilized by Sulphuric Acid (title 70 - 98%) in a series of reactors with agitators, which provides all the necessary conditions to precipitate Calcium Sulphate in the best morphologic form.

The pulp obtained is filtrated to separate the Phosphoric Acid (containing 28 - 32% of P2O5) from the residue, which are washed counter-current to remove the acid from the pannel. The Phosphoric Acid is then concentrated to obtain a solution with 54-56% of P2O5.

The main reaction of the process is briefly resumed below:

\[ \text{Ca}_3[(\text{P0})_4]_2 + 3\text{H}_2\text{SO}_4 + 6\text{H}_2\text{O} \rightarrow 2\text{H}_3\text{PO}_4 + 3\text{CaSO}_4 + 2\text{H}_2\text{O} \]

Among the numerous secondary reactions that occur during the acid etching there are those connected with the -CO3 group always present in the phosphorites:

\[ \text{CaCO}_3 + \text{H}_2\text{SO}_4 \rightarrow \text{CaSO}_4 + \text{CO}_2 + \text{H}_2\text{O} \]

During the reaction with sulphuric acid, the carbofluor apatite molecule disintegrates and all the compounds containing the CO3 group produce Carbonic Anhydride. The organic substances present stabilize the CO2 produced in a foamy phase.

The quantity of foam, which originates during the acid etching, is then proportional to the content of group -CO3 and to the organic substances present in the mineral.

**COMPLEX FERTILIZERS NPK**

During the production of complex NPK fertilizers through nitric etching of phosphorite (Odda cycle and others), generally remarkable quantities of foam occur. This quantity of foam is due to the formation of CO2 and Nitrogen Oxides resulting from redox reactions of the organic substances present in the phosphorite with the Nitric Acid.

During the etching and "ammoniation" steps the foam could overflow and, without the use of defoamers, the whole mass could be emulsified. In that case there would be a complete leakage of material from the reactors.

**PROPERTIES OF K-DOS 70**

The use of **K-DOS 70** in the production of Phosphoric Acid and complex NPK fertilizers gives the following advantages:

- Elimination of the foam during the etching step
- Maximum exploitation of the volume of etching and "ammoniaction"
- Lower phase emulsification during the reaction and consequent easier filtration of the pulp and higher etching yield
- Elimination of the foam during the concentration and "ammoniaction" of phosphoric acid.

All these points can be summarized as an increase in plant efficiency.
APPLICATION IN THE PHOSPHORIC ACID PRODUCTION

**K-DOS 70** must be used continuously without dilution in the medium acid of recycle or directly in the reactors, conveying in the better stirred areas.

The application dose depends on the type of phosphorite used and, normally, it is in the range from 100 to 200 gr/ton of etched phosphorite (0.3-0.6 kg/ton of P2O5). However, the right dosage of antifoam to be used must be determined directly in the plant because its behavior is influenced by the specifications of the raw materials and by the structure of the plant.

Eventual oversizing of antifoam could cause formation of foam during the subsequent concentration step.

APPLICATION IN THE FERTILIZERS NPK PRODUCTION

The antifoam agent can be introduced directly into the reactors as well as being premixed with the etching acid.

The dosage can vary from 0.1 to 0.3 kg/ton of P2O5 etched.

**K-DOS 70 DESCRIPTION AND SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Chemical composition</th>
<th>Alkylesters sulphonated in solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance at 20 °C</td>
<td>Limpid liquid</td>
</tr>
<tr>
<td>Ionic Character</td>
<td>Anionic</td>
</tr>
<tr>
<td>pH 2% solution</td>
<td>6 – 8</td>
</tr>
<tr>
<td>Active content</td>
<td>Min. 70%</td>
</tr>
<tr>
<td>Solubility in water</td>
<td>Soluble in all the proportions.</td>
</tr>
<tr>
<td></td>
<td>Solutions having concentration over 20 % are particularly viscous.</td>
</tr>
<tr>
<td>Storage stability</td>
<td>Stare at a temperature between +5 and +35 °C for no longer than 6 month.</td>
</tr>
</tbody>
</table>
HEAT AND COLD STABILITY OF K-DOS 70

The product is stable over the temperature range -5 to +100°C without changes in the appearance. Our tests at 50°C for several months showed no changes in the chemical composition of K-DOS 70.

- STORING

K-DOS 70 can be stored at any temperature between -5 and +50°C without any problems. We suggest using equipment with all metal parts of stainless steel. Indeed our corrosion trials showed that the K-DOS 70 was corrosive towards the iron but not for stainless steel because it contains about 20% of water. No other precaution are needed, because K-DOS 70 isn't inflammable and is not corrosive towards the rubber parts of the plant.

- TOXICITY OF K-DOS 70

K-DOS 70 and all its components are non-toxic, non-carcinogenic and non-mutagenic. LD 50 (Median Lethal Dose) on rat > 2,000 mg/kg. Of course when using K-DOS 70 it is necessary to observe all normal handling precautions for chemical products (gloves, glasses, clothes etc...).

In case of:
- Skin contact, take off all contaminated clothing and wash with plenty of water and soap.
- Eyes contact, rinse with water with the eyelids open for a sufficient length of time, then consult an ophthalmologist.
- Ingestion, give nothing to eat or drink and obtain a medical examination immediately
- Inhalation, remove casually to fresh air and keep warm and at rest.

*Figura 1

Tensioattivo
REGISTERED OFFICE:
Via San Rocco 2/B
24069 Cenate Sotto (BG)
ITALY

PLACE OF BUSINESS:
P.zza delle Erbe,25
15057 Tortona (AL)
ITALY

Tel.: 0131 1960180
Fax.: 0131 1960183
E-mail addresses: info@kephas.eu
Web site: www.kephas.eu