THE FOOD CHALLENGE

The global market, outlook and applications for Magnesium Sulphate - 14 May 2013, Oslo
Franz Loth, Head of Global Industrial Sales
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K+S Group
Focus on Two Strong Pillars

Revenues 2012: € 3.9 billion (2011: € 4.0 billion)
EBIT I 2012: € 808.5 million (2011: € 906.2 million)

Potash and Magnesium Products Business Unit

Salt Business Unit

Revenue / EBIT I in € million

Waste Management & Recycling  Logistics  Animal Hygiene Products  Trading business (CFK)

Complementary Activities (Revenues 2012: € 154 million; EBIT I 2012: € 21 million)
Potash and Magnesium Products

Loader (up to 20 tons)
Worldwide Presence of K+S Group

Production Sites and Sales Offices

Revenues by Region 2012

- Asia: 12%
- Africa, Oceania: 3%
- South America: 17%
- North America: 26%
- Europe: 42%

Production Sites and Sales Offices

Kassel
Potash and Magnesium Products
Production Sites in Germany

- Kieserite deposit

### Share of production capacity (in %)

1. Wintershall
2. Unterbreizbach (Integrated Werra Plant) 44
3. Hattorf
4. Zielitz 24
5. Neuhof-Ellers 16
6. Sigmundshall 11
7. Bergmannssegen-Hugo 5

(pure production site, no mining)

Source: Mainova AG
Haulage of potash crude salt: 36.5 million tonnes

Production of potash and magnesium products: 7.0 million tonnes
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Potash and Magnesium Products

Product Portfolio 2012 (Sales volumes in million tonnes)

Potash-containing products

2012: 5.7 million tonnes
(2011: 5.70)
- Potassium chloride
- Fertilizer specialities
- Industrial products

Non-potash-containing products

2012: 1.2 million tonnes
(2011: 1.2)
- Fertilizer specialities
  - ESTA® Kieserite
  - EPSO® Product family
- Industrial products
  - Magnesium sulphate
  - Magnesium chloride

Broad and less cyclical product portfolio allows flexible reaction on fluctuation in demand
Potash and Magnesium Products

World Market leader in various Magnesium Products

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**Kieserite**

\[ \text{MgSO}_4 \times \text{H}_2\text{O} \]

- Unique natural Resources in Germany. Mainly used as fertilizers.

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**Magnesium Chloride**

\[ \text{MgCl} \]

- Huge investments in capacity expansions in Germany
- Environmentally driven

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**Magnesium Sulphate**

\[ \text{MgSO}_4 \times 7 \text{H}_2\text{O} \]

\[ \text{MgSO}_4 \]

- Roughly 40 % global market share (with Epsom Salt and Anhydrous)
- All natural (borne by Kieserite thru recrystallisation)
Magnesium Sulphate
Fields of Application by Product

Basic Product

- Kieserite

Products

- Epsom Salt
  - MgSO₄ \times 7\text{H}_2\text{O}

- Kieserite
  - MgSO₄ \times 1\text{H}_2\text{O}

- Anhydrous Magnesium Sulphate
  - MgSO₄

Usage areas

- Agriculture: Fertilizer
  - (60 %)

- Animal food
  - (10 %)

- IP grade: Pharmaceuticals
  - (10 %)

- Industrial
  - (20 %)

- Agriculture: Fertilizer

- Industrial
  - Pulp and Paper
  - ABS
### Potash and Magnesium Products

#### K+S: Leading Position in Magnesium Products

<table>
<thead>
<tr>
<th>Magnesium Chloride</th>
<th>Magnesium Sulphate</th>
</tr>
</thead>
<tbody>
<tr>
<td>capacities worldwide</td>
<td>capacities worldwide</td>
</tr>
<tr>
<td>(~3.5 million tonnes in 2015)</td>
<td>(~3.0 million tonnes)</td>
</tr>
</tbody>
</table>

K+S KALI is one of the biggest producer and supplier of Magnesium Chloride and Magnesium Sulphate
Magnesium Sulphate
Value Chain

Raw Material
- Kieserite
- Magnesite Ore
- Sea Salt

Processing
- Crystallisation
- $\text{MgCO}_3 + \text{H}_2\text{SO}_4$
- $\text{MgO} + \text{H}_2\text{SO}_4$
- $\text{MgCl}_2 + \text{H}_2\text{SO}_4$

Trading
- Spot
- Contract

Logistics
- Road
- Sea
- River
- Railway

Consumption
- Industrial
- Agricultural
Magnesium Sulphate Heptahydrate
Production process based on crystallisation

Kieserite dissolving
filtration
crystallisation
dewatering

drying
cooling / dust removal

Quality Control

Kieserite  Steam  Water

QC
QC
QC
QC
QC

Epsom salt pure, techn.
Epsom salt chem. pure, FCC
Epsom salt Ph. Eur., USP

QC
A. Introduction K+S

B. Magnesium Products at K+S

C. Magnesium Sulphate
   Fields of Application
   - Agriculture
   - Industrial
   - Health Care

D. Magnesium Chloride

E. Major Markets and Outlook

F. 
"There are lies, damn lies, and statistics. We're looking for someone who can make all three of these work for us."
## Keeping in pace with changing Megatrends

<table>
<thead>
<tr>
<th>Resource efficiency</th>
<th>Urbanisation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Magnesium Sulphate</strong> increases the fire safety of insulating materials.</td>
<td><strong>Magnesiumchloride</strong> is used for dust binding to keep the modern megacities fine dust emissions at a low level.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Recycling</th>
<th>Growing wealth and the new economy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of waste has improved, therefore <strong>Magnesium Sulphate</strong> being used as density separation of plastics.</td>
<td>Demand for all industrial products is positive influenced (the industrial products of the K+S KALI GmbH are base chemicals and needed for multiple chemical products).</td>
</tr>
</tbody>
</table>
Magnesium Products
Industrial and Health Care Applications

High-quality raw materials for industrial purposes

- **Magnesium Sulphate**
  - 98%
  - Pulp and Paper
  - Detergents

- **Magnesium Chloride Solution**
  - dust and odor binding
  - Oil Drilling Muds

- **Epsom Salt tech. pure**
  - Construction Materials
  - Plasterboard Production

- **Epsom Salt technical**
  - ABS/EPS Plastic Production
  - Detergents

High purity salts for health care and food

- **Epsom salt chem. pure, FCC**
  - Food Additive

- **Epsom Salt 99.9 % K₂SO₄, Ph. Eur., DAC, FCC, E 515**
  - Pharmaceutical Industry

- **Epsom Salt 99.9 % KCl, Ph. Eur., USP**
  - Insulin Production
  - Production of Infusions and Haemodialysis Solutions

May 2013
Production of ABS/EPS Plastics

ABS plastics are valuable thermoplastics with an ever-increasing range of applications. In their production, by graft copolymerisation in emulsion, the polymer is separated by coagulation of the emulsifier. Salts with multivalent cations are applied as coagulants.

Magnesium sulphate is an expensive and easy to use product for this process and is therefore the most commonly used coagulant worldwide. It is also much less corrosive than other salts.
Magnesium Sulphate
Consumption in ABS-plastics

Consumption of Magnesium Sulphate in the emulsion polymerisation of ABS (MgO equivalents)

Source: SRI Consulting 2011
Usage in Pulp and Paper

Cellulose Production

Raw cellulose produced by the Kraft Process still contains residual lignin, which is responsible for the brown colour of unbleached pulp. Subsequent procedural steps minimise residual lignin to a large extent by oxidation of the chromophorous groups.

Magnesium sulphate has been successfully used as an additive in order to stabilise the cellulose during oxygen delignification. It is also beneficial in alkaine bleaching stages, in which hydrogen peroxide is used.
## Magnesium Sulphate

**K+S provides various certificates**

<table>
<thead>
<tr>
<th>Certificate Type</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPSO Top (ag-grade)</td>
<td>BCS (organic farmin)</td>
</tr>
<tr>
<td>Techn. pure</td>
<td>ISO 9001</td>
</tr>
<tr>
<td>KaSa Mag98</td>
<td>ISO 9001, QS, GMP+</td>
</tr>
<tr>
<td>Chem. pure, FCC</td>
<td>ISO 9001, Kosher, Halal, WHO</td>
</tr>
<tr>
<td>Pharma grade</td>
<td>ISO 9001, QS, GMP, Kosher, Halal, FDA, USP</td>
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Magnesium Sulphate
Usage for Health Care Application

- Used as bathing salt
- 100% natural resources
- Important for relaxing and health benefits
- Positive impact on skin, muscles and blood circuit
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Magnesium Chloride
Potential processed Products and Applications

Raw Material
- Raw material refining
- Potash Production
- SOP-Production

Intermediate
- MgCl₂-Solution
  - Energy (heating)
  - Dolomite
    - CaCl₂
    - Mg(OH)₂
  - CaCl₂
  - Mg(OH)₂
- MgCl₂-Flakes
  - Construction Industry
  - Water Treatment
  - De-Icing
  - Dust binding
  - Oil and Gas Drilling
- MgO
  - Refractory:
    - steel
    - cement
    - ceramic
    - glass

Processed Products
- Energy (Eletrolysis)
- Caustic soda
- Mg-Metal
- Mg(OH)₂

Application
- Oil and Gas Drilling
- Water Treatment
- Construction Industry
- Refractory:
  - steel
  - cement
  - ceramic
  - glass
Consumption of MgCl2 in the production of metallic magnesium

Source: SRI Consulting 2011
Magnesium Chloride
K+S: Investments in capacity expansions

Annual Capacity of MgCl₂ (33%)

Market orientated Options K+S

- Direct Marketing
  - Deicing
  - Dustbinding
  - Oildrilling

- Refined Products
  - Magnesiumoxide
  - Magnesiumhydroxide
  - Calciumchloride
  - Magnesiumchloride Flakes
# Magnesium Chloride, Solution and Flakes

## Market Characteristics

### Leading Producers

<table>
<thead>
<tr>
<th>Producer</th>
<th>Logo</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>K+S KALI</td>
<td><img src="image" alt="K+S KALI Logo" /></td>
<td>- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)</td>
</tr>
<tr>
<td>Nedmag Industries</td>
<td><img src="image" alt="Nedmag Industries Logo" /></td>
<td>- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)</td>
</tr>
<tr>
<td>Dead Sea Works</td>
<td><img src="image" alt="Dead Sea Works Logo" /></td>
<td>- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)</td>
</tr>
<tr>
<td>Compass Minerals</td>
<td><img src="image" alt="Compass Minerals Logo" /></td>
<td>- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)</td>
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<tr>
<td>Deusa</td>
<td><img src="image" alt="Deusa Logo" /></td>
<td>- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)</td>
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### Characteristics

- Low prices $\rightarrow$ limited international coverage (transportation costs relatively high)
- Volatile market because of seasonal needs (e.g. Deicing)
- Demanding logistics challenges:
  - Solution
    - Limited tank facilities
    - High inventory costs
  - Flakes
    - Packaging needs to ensure quality
- Moderate growth
  - Europe (CAGR 09 – 14) 0.6%
  - North America (CAGR 09 – 14) 1.0%
Dust binding agents using hygroscopic salts in form of pastes and solutions have been introduced to control dust. They humidify dusts causing them to settle. For this application magnesium chloride solution from K+S GmbH is used.

**Hippodromes, Park Paths, Tennis Courts etc.**
Due to its hygroscopic and water-retaining qualities, magnesium chloride is a popular dust binder that is used successfully on nearly all non-solid surfaces such as paths, sports facilities, exhibition areas, construction sites and parking lots.
Magnesium chloride
Presence in the most attractive de-icing salt markets of the world

**Great Lakes**
- Continental climate with distinctly stable winters
- High population density
- Stable de-icing salt business with high volumes

**US East Coast**
- Atlantic climate
- Relatively volatile, partly very harsh winters
- Very high population density
- Relatively stable de-icing salt business

**Eastern Canada**
- Atlantic climate
- Relatively stable winters
- Lower population density
- Relatively stable de-icing salt business
- Long-term contracts

**Central Europe**
- Atlantic climate
- Milder winters with occasional upward fluctuations
- Very high population density
- Relatively fluctuating de-icing salt business

**Scandinavia**
- More stable winters in comparison with Western Europe
- Relatively low population density
- Relatively stable de-icing salt business

May 2013
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Magnesium Sulphate
Capacities of Magnesium Sulphate heptahydrate/anhydrous

- Capacities of Magnesium Sulphate heptahydrate and anhydrous are used in Agriculture and Industry.
- Agriculture use is mainly for Foliar Fertilization and production of 100% soluble fertilizer mixtures or liquid fertilizers.
- Quantity ex China is aggregated from approx. 20 producers.

**Source:** K+S

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<table>
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<th>Capacity of Magnesium Sulfate</th>
<th>Remarks</th>
</tr>
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<td>Synthetic MgSO4</td>
<td>- Magnesium sulfate anhydrous and heptahydrate are used in Agriculture and Industry.</td>
</tr>
<tr>
<td>Natural MgSO4</td>
<td>- Agriculture use is mainly for Foliar Fertilization and production of 100% soluble fertilizer mixtures or liquid fertilizers.</td>
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<tr>
<td>kt per year</td>
<td>- Quantity ex China is aggregated from approx. 20 producers.</td>
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K+S Group / 31
**Magnesium Sulphate Market in Europe**

- **Total market:** approx. 650 kt

#### Agriculture
- Most important market
- Growing awareness of Magnesium as nutrient

#### Industry
- ABS plastics shrinking
- Pulp / paper stable

#### Outlook
- Overall growth estimated by 3 %
India

Export volumes Magnesium Sulphate

For last 15 years, CAGR is 23%

Future outlook is bright and for next 10 years; growth should be around 8-10% in exports.
India

Magnesium Sulphate Domestic Consumption

Fertilizer consumption (in tons)

68% CAGR for last 6 years

Source: FAI Report
India
Magnesium Sulphate Outlook

Market Growth:

- Expectation of local market growth is 15% ~ 20% in next 10 years
- Expectation of export market growth is 8% ~ 10% in next 10 years
- However, exports in 2012 decreased by 10%

Industry:

- Fertilizer industry is maturing and more organized players are coming
- Opportunity for organized players is more as small players are not able to leverage

Outlook:

- 15 – 20 % domestic growth YOY

Source: K+S
China
Magnesium Sulphate (all grades) Exports 2002 - 2012

Source: China stats
## China

### Exports of Magnesium Sulphate Outlook

**Overall Market Growth:**
- Since 2010 annual growth rate of 7.7%

**Exports by Region:**
- SEA + Africa: stable (lower Palm oil price)
- Europe: growth rate > 10%
- North-America + Oceania: around 10,000 t each

**Outlook:**
- Predicted export market growth is 8% ~ 10% YOY in next 10 years

Source: K+S
Salt Mining Chamber in Germany
THE FOOD CHALLENGE

Thank you for your attention!