

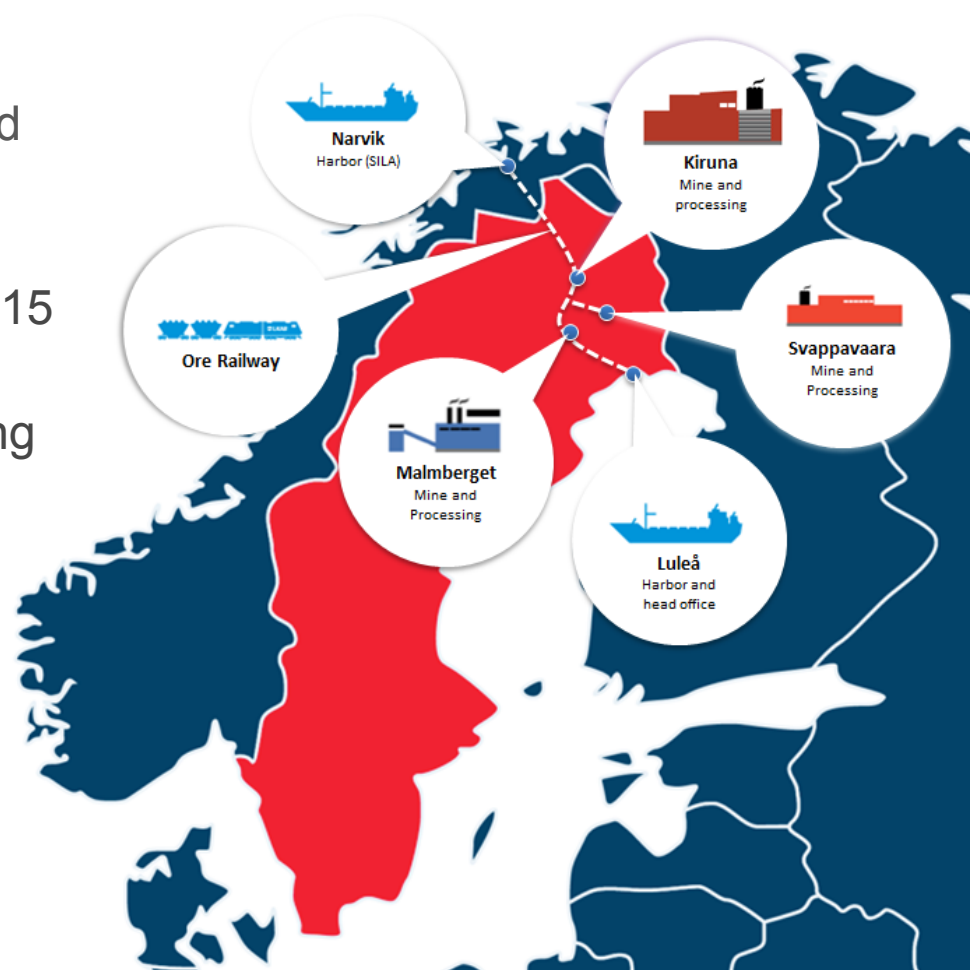
AN UPDATE ON HMM NATURAL MINERAL FLAME RETARDANT

Dr. Chris DeArmitt FRSC

- HMM work by Stefan Viering

THE LKAB GROUP IN BRIEF

- World leading producer of upgraded iron ore
- Delivered 25.5 Million MT in 2013, plan to grow to 37 Million MT by 2015
- Two underground mines in Kiruna and Malmberget and open pit mining in Svappavaara
- Producer of 90% of EU's iron ore
- ~4,400 employees
- 30 companies in 15 countries
 - E.g. Drilling, Concrete, Explosives, Railway, Harbour, Construction.
- Turnover 2013: SEK 23.65 Billion



FOCUS CREATES SPECIALISATION

We focus our R&D resources on mineral and application development in the areas of:

Civil Engineering and Construction



Polymers and Coatings



Refractory and Foundry



MAGNIF – HIGH PURITY MAGNETITE

ROTARY KILN



MAGNETITE ORE



1. Density 5.2 gcm^{-3}
2. Moh Hardness ~ 6
3. Semi-conductive
4. Thermally conductive
5. High specific heat capacity
6. Extremely pure



1. Sound deadening, weights
2. Solid surfaces
3. Anti-static, shielding, induction & microwave heatable
4. Lowers cycle time
5. Heat storage
6. Food contact approved

PHLOGOPITE MICA – VHAR REINFORCEMENT

MINERAL REINFORCEMENTS COMPARED

Particle Dimensions (Malvern)	Talc	Calcined Clay	Wollastonite	Phlogopite Mica PW80
D ₅₀	12	3	3.5	37
D ₉₀	40	10	13	95
Aspect Ratio	High	High	High	Very High

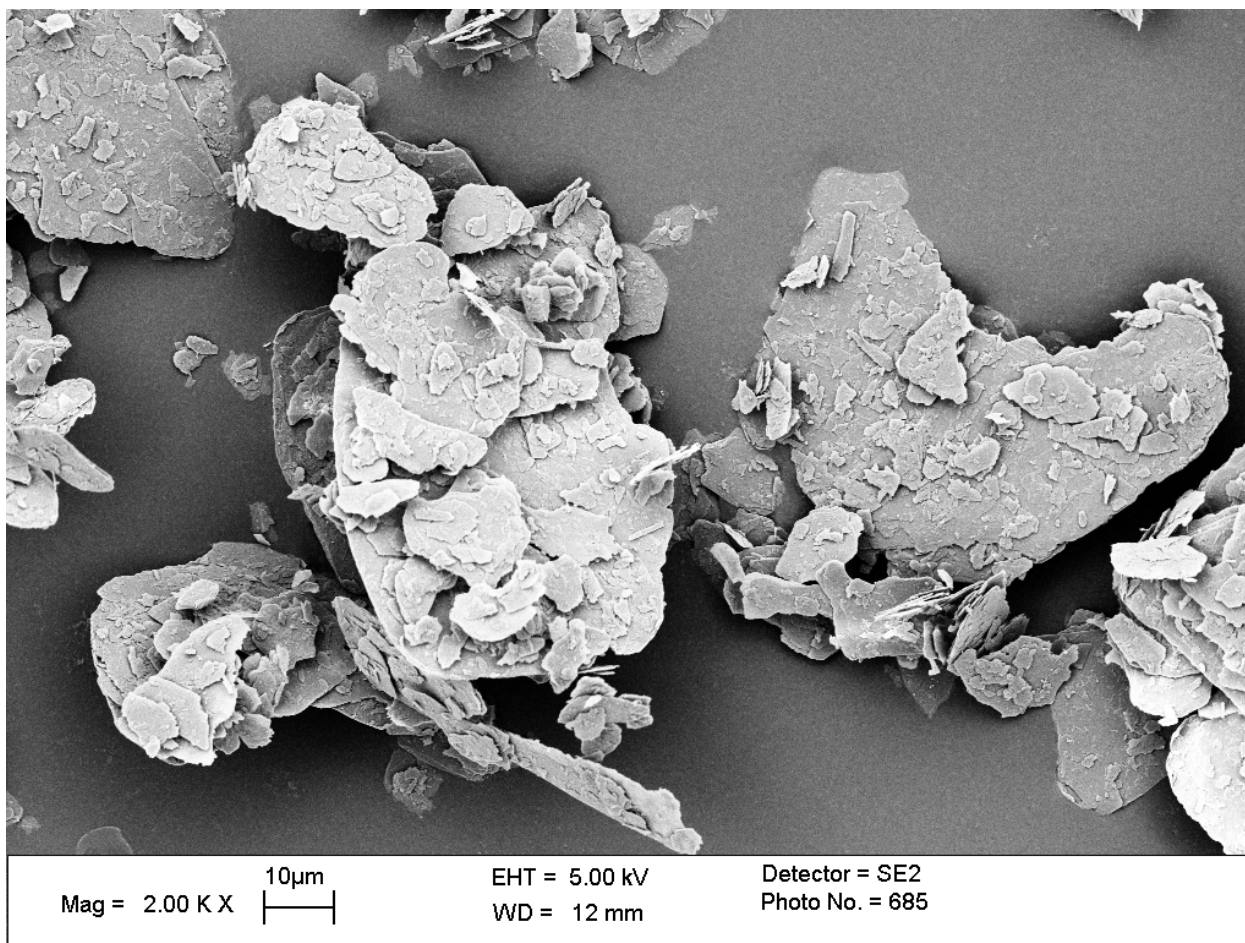
THE MINERAL

Phlogopite Mica

- Density 2.8 gcm^{-3}
- Refractive Index 1.60
- Hardness (Mohs) 2.5 – 3
- pH 8 - 9
- Color – pale bronze
- Loss on ignition 1000°C 1 - 3%
- Composition $\text{KMg}_3(\text{AlSi}_3\text{O}_{10})(\text{OH})_2$



SEM OF PHLOGOPITE MICA PW80



REINFORCEMENT COMPARISON IN PA6

Property	Talc 40%	Calcined Clay 40%	Wollastonite 40%	Phlogopite Mica 40%	GF 40%
Flexural Modulus (MPa)	7400	6120	5514	10370	11980
Flexural Strength (MPa)	120	150	135	155	290
Tensile Modulus (MPa)	7470	6313	5450	11160	13215
Break Stress (MPa)	74	87	83	95	195
Break Strain (%)	2.8	6.4	8.4	1.7	2.6
Unnotched Charpy (kJm ⁻²)	28.5	80	No Break	29	79
Notched Charpy (kJm ⁻²)	3.5	6.4	6.4	4.0	12.8
Shrinkage = (%)	0.65	1.31	1.06	0.58	0.1
Shrinkage (%)	0.97	1.66	1.64	0.87	0.98
Warpage (%)	0.32	0.35	0.58	0.29	0.88

CUSTOMER FEEDBACK

“It’s magic”

high performance coatings company

“It blew everything else out of the water”

leading plastics manufacturer

“significantly better than everything else”

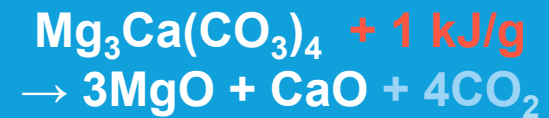
Fortune 500 company

ULTRACARB – NATURE'S OWN FLAME RETARDANT

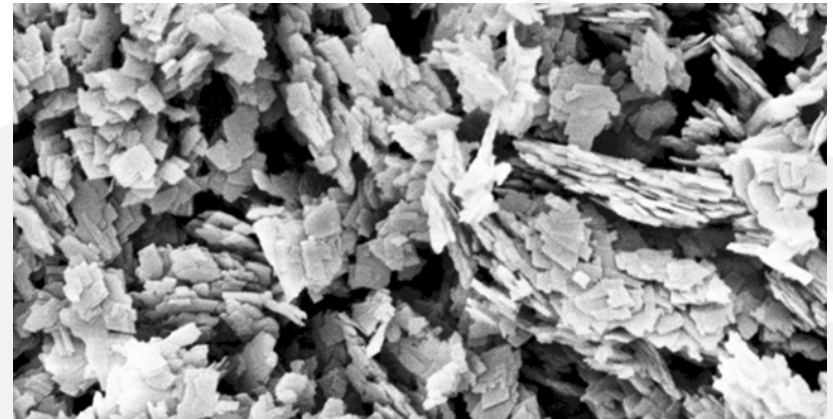
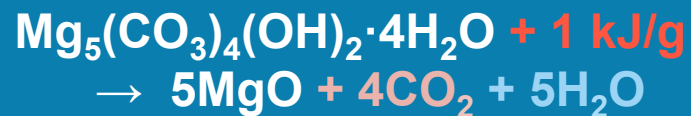
HMH: A BLEND OF TWO MINERALS



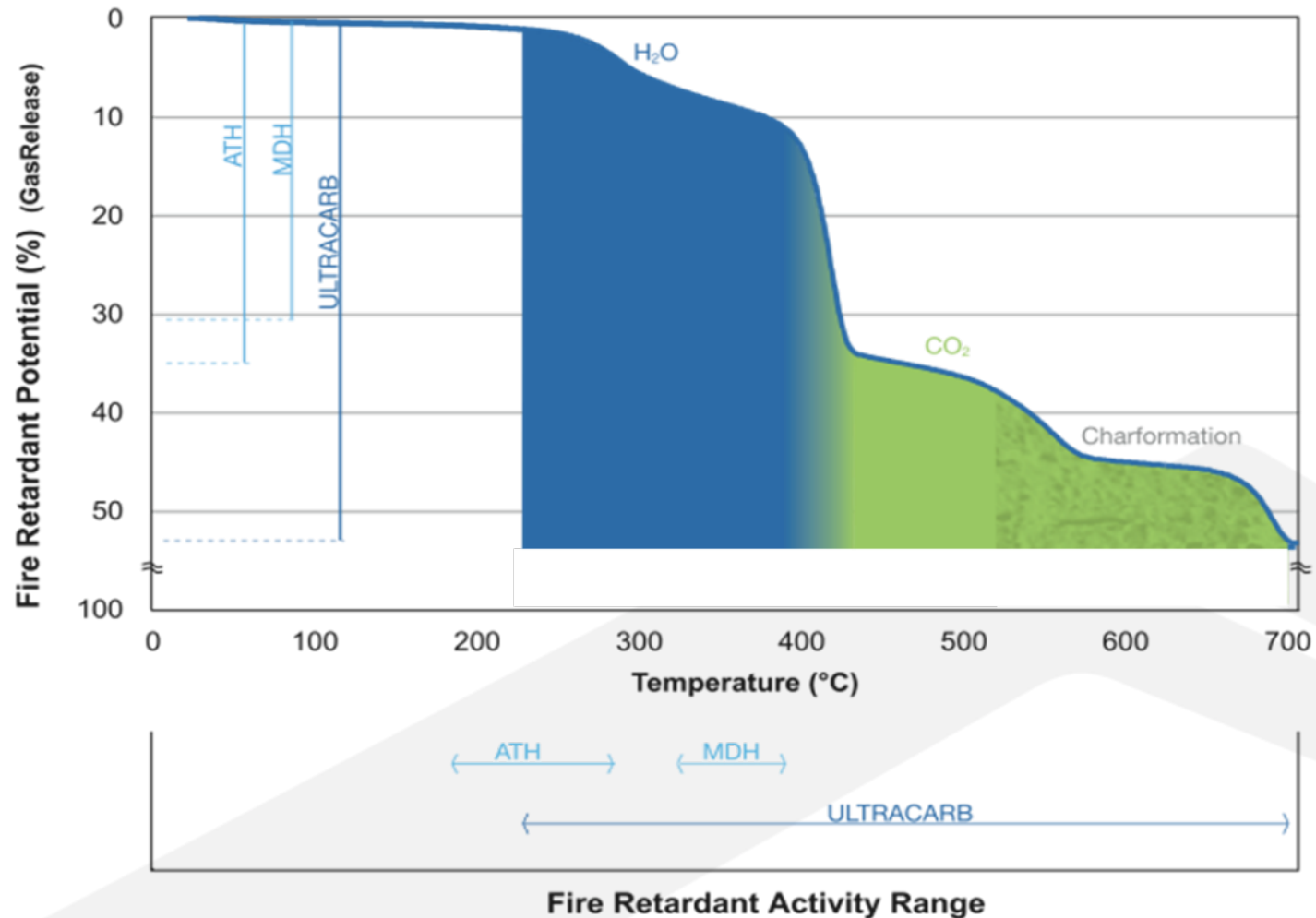
huntite:
magnesium calcium carbonate



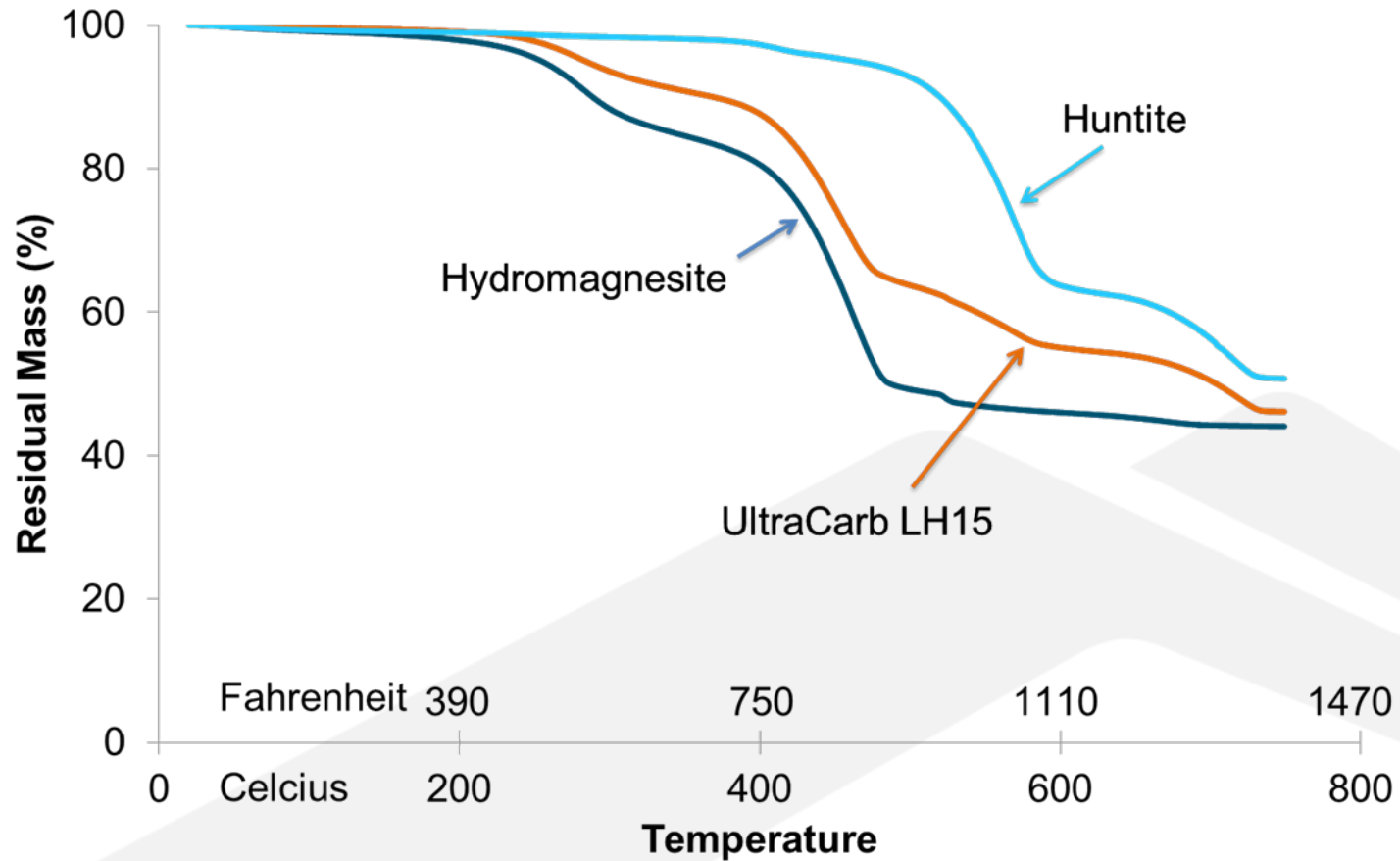
hydromagnesite:
hydrated magnesium carbonate



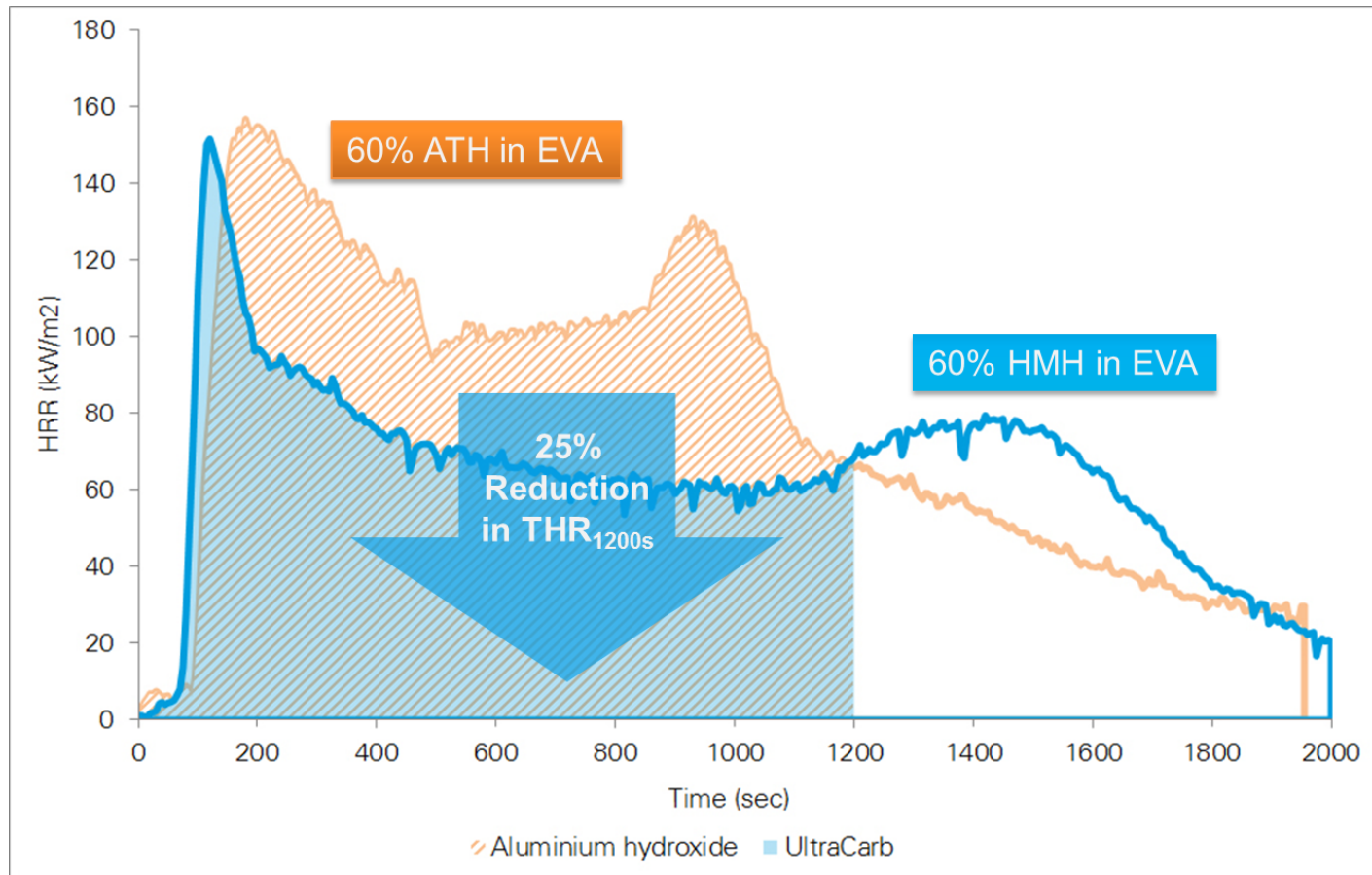
THE THREE STAGE FR MECHANISM OF HMM



HYDROMAGNESITE & HUNTITE DECOMPOSITION

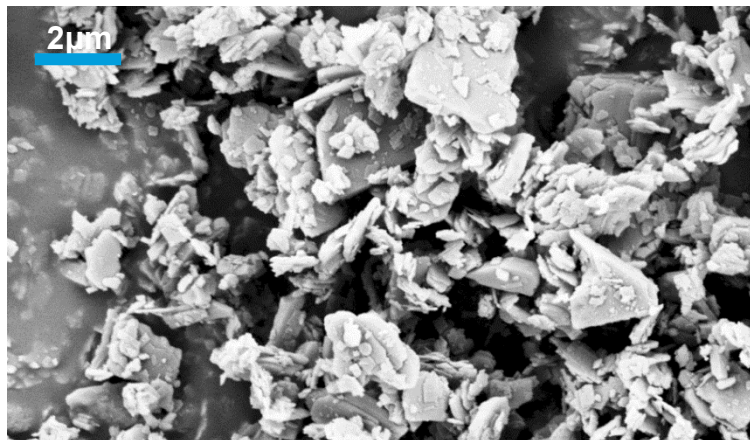


TOTAL HEAT RELEASE OF HMH AND ATH

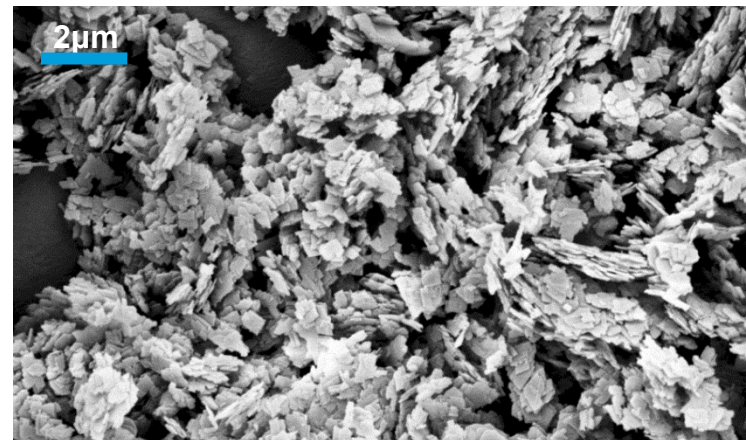


Data retrieved from 50kW cone calorimeter

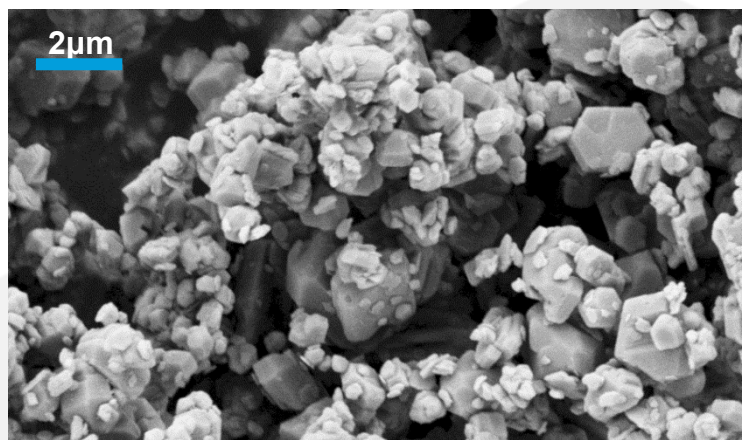
PARTICLE MORPHOLOGY



HMH



Huntite

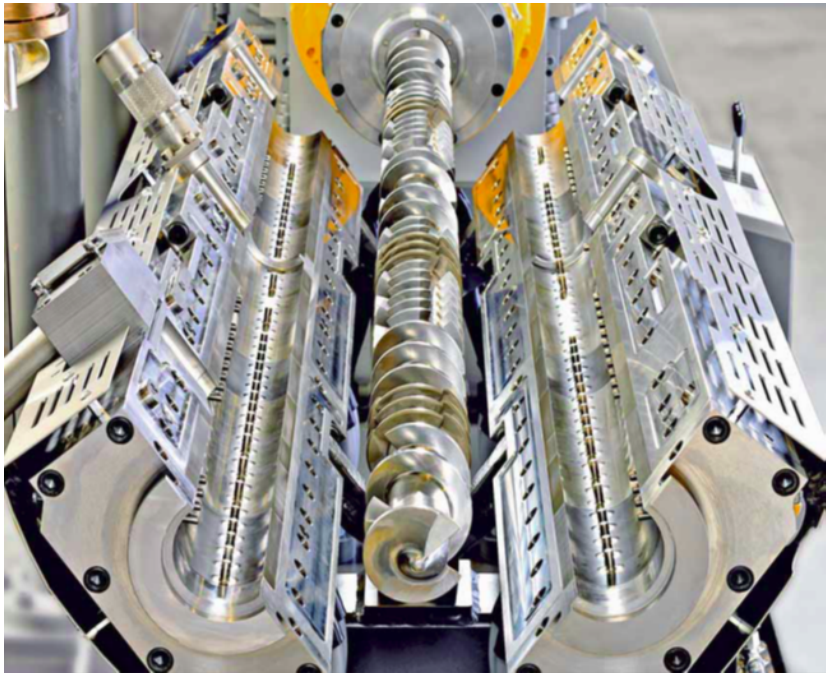


ATH

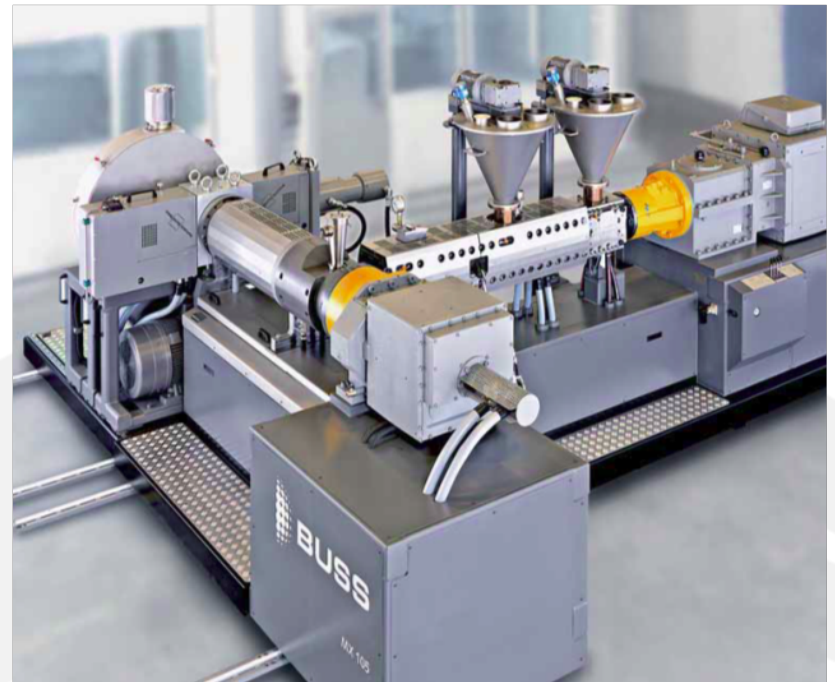
NATURAL HMH VERSUS SYNTHETIC ATH

	HMH	ATH
Shape	Platy	Spherical
FR activity range	220°C – 700°C	180°C – 280°C
Evaporation enthalpy	-1000 kJ/kg	-1000 kJ/kg
Water release	>220°C	>180°C
Cementitious char	Yes	No
Bulk density (at feeding)	0.3g/cm ³ (0.3g/cm ³)	0.6 g/cm ³ (0.4g/cm ³)
BET surface	10m ² /g (15m ² /g)	4m ² /g (7m ² /g)
Processing temperature	<220°C @ 1 bar	<180°C
High shear kneading	Yes	No

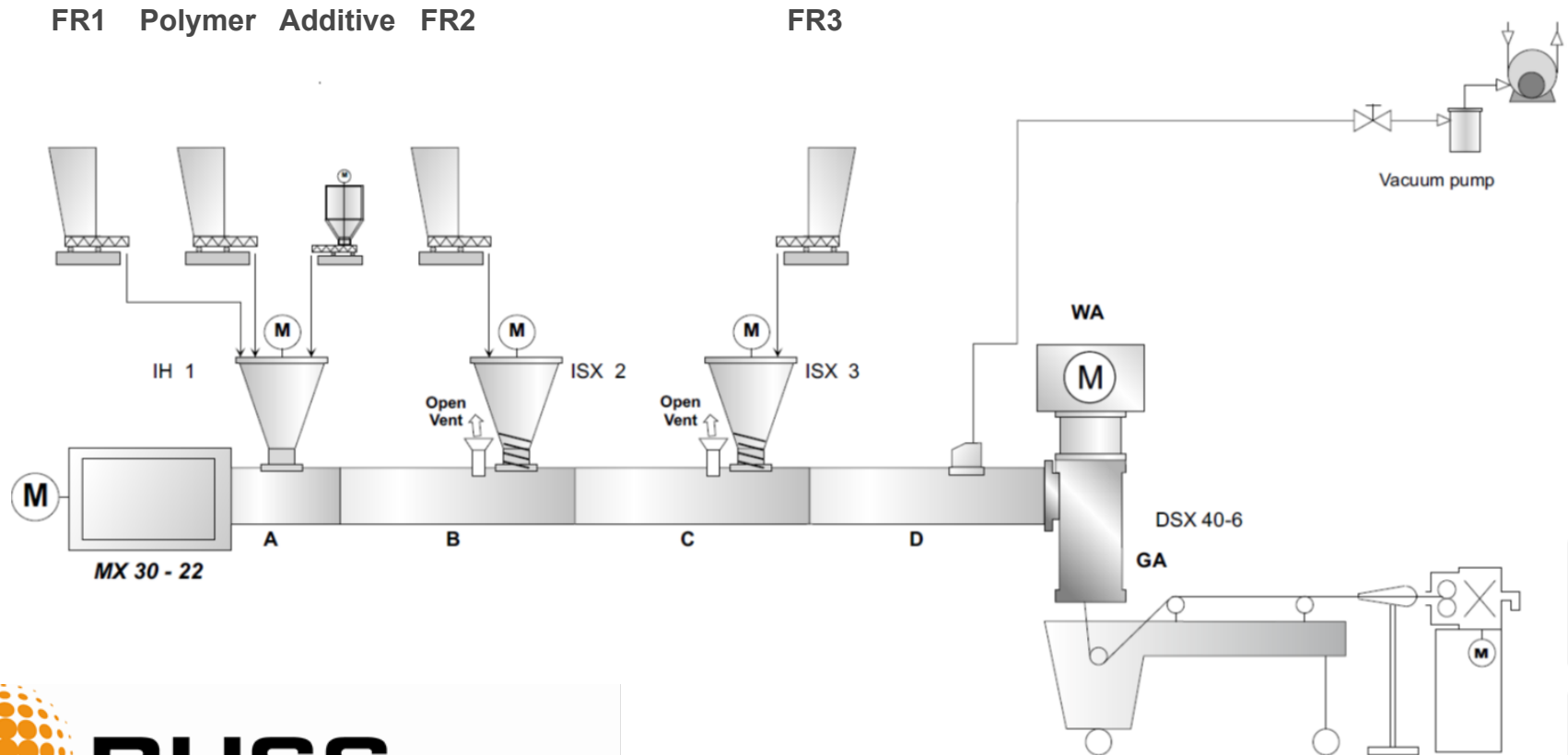
THE FOUR-FLIGHTED BUSS KNEADER

**BUSS**

excellence in compounding

BUSS
MX-Series

MX-30 SETUP



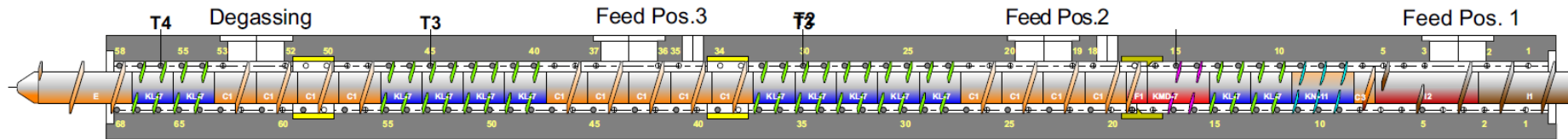
BUSS

excellence in compounding

KNEADER CONFIGURATION

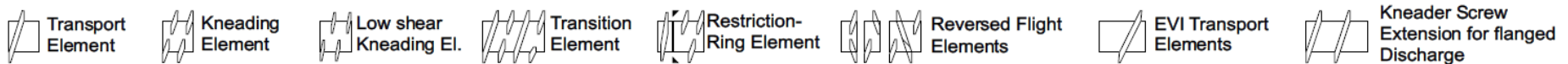
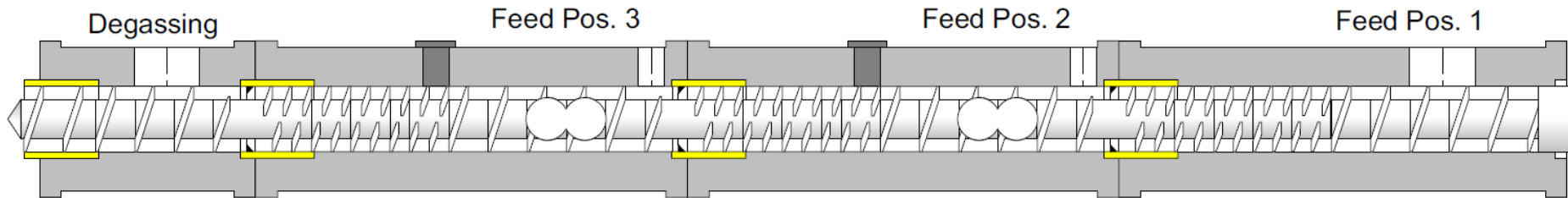
Screw MX 30 I/d=22

Four-flighted



Screw MKS 30 I/d=20

Three-flighted



EVA + ULTRACARB LH3 + PATH

Ingredients

- 26.5% Elvax 265 A (EVA)
- 3.75% Compoline CO/LL (MAH)
- 6.5% Eltex PF6130 AA (LLDPE)
- 1.5% Silmaprocess AL 1142A (Processing aid)
- 0.75% Silmastab AE 1527 (Stabilizer)
- 30.5% UltraCarb LH3 (oil abs. 25 ml/100g)
- 30.5% fine pATH (oil abs. 30 ml/100g)



Tensile Strength:	11 MPa
Elongation @ Break:	230%
Dispersion:	very good
LOI:	35.5

Instructions

Feed polymers, additives and processing aids in the first hopper of a Buss Co-Kneader MX-30, feed the UltraCarb LH3 in port 2, and the ATH in port 3.
Let it run at 600 rpm and 15kg/h.

EVA + ULTRACARB LH3

Ingredients

26.5% Elvax 265 A (EVA)

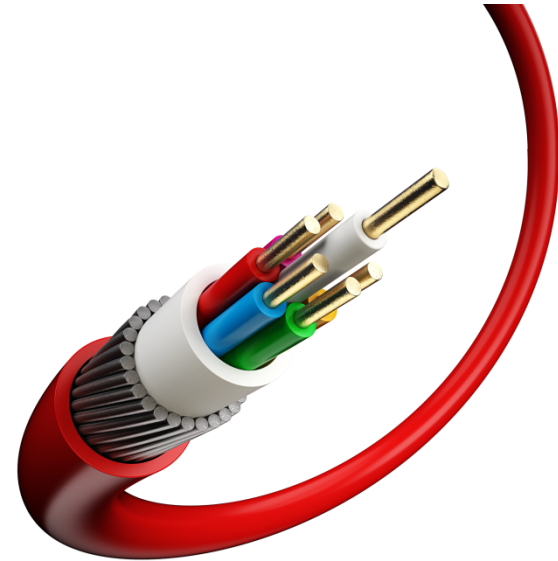
3.75% Compoline CO/LL (MAH)

6.5% Eltex PF6130 AA (LLDPE)

1.5% Silmaprocess AL 1142A (Processing aid)

0.75% Silmastab AE 1527 (Stabilizer)

61.00% UltraCarb LH3



Tensile Strength:	13 MPa
Elongation @ Break:	186%
Dispersion:	very good
LOI:	34.5

Instructions

Feed polymers, additives and processing aids in the first hopper of a Buss Co-Kneader MX-30 and split feed the UltraCarb LH3 in port 1+2 and let it run at 600 rpm and 15kg/h. Do not exceed 260°C (750rpm) as the EVA may start to degrade.

EVA + ULTRACARB LH3 + PLASTOMER

Ingredients

- 20.0% Elvax 265 A (EVA)
- 6.5% Lucene LC180 (Plastomer)
- 3.75% Compoline CO/LL (MAH)
- 6.5% Eltex PF6130 AA (LLDPE)
- 1.5% Silmaprocess AL 1142A (Processing aid)
- 0.75% Silmastab AE 1527 (Stabilizer)
- 61.00% UltraCarb LH3



Tensile Strength:	15 MPa
Elongation @ Break:	276%
Dispersion:	very good
LOI:	32.5

Instructions

Feed polymers, additives and processing aids in the first hopper of a Buss Co-Kneader MX-30 and split feed the UltraCarb LH3 in port 1+2 and let it run at 600rpm and 15kg/h.

CONCLUSIONS

- Mixtures of hydromagnesite and huntite are effective fire retardants proven in use since the 1980s
- Very high aspect ratio phlogopite combines exceptional heat stability, mechanical properties and barrier performance
- Magnetite offers electrical, thermal and radiation properties
- These minerals are 100% natural
- Security of supply and ISO certified
- Cost effective with global logistics
- Assistance to help customers find the best solution

Information herein is intended for guidance only and given in good faith but without guarantee. LKAB Minerals is not responsible for the product's suitability for a particular purpose. The only warranty LKAB Minerals makes is the express written warranty extended on the sale of its products.

THANK YOU! – QUESTIONS?