PAPER TECHNOLOGY INTERNATIONAL

THE JOURNAL OF THE BIOFOREST PRODUCTS SECTOR

PITA PAPER*matters!* 2018 Conference & Exhibition at Lancaster University

KemRevive: Recovering starch from recycled fiber

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PAPER*matters* 2018!

The Presentations

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Kemira Chemicals

Where water meets chemistry ™

Mike Armitage is a relative new-comer to the Paper Industry with 4 ½ years experience with Kemira, firstly as a Technical Service Engineer and then as a Sales Representative. Mike's background in customer relations and digital applications, coupled with qualifications in Chemistry and Biology, has brought enthusiasm and expertise to push forward new Digital Technologies and Innovative Chemical Programmes.

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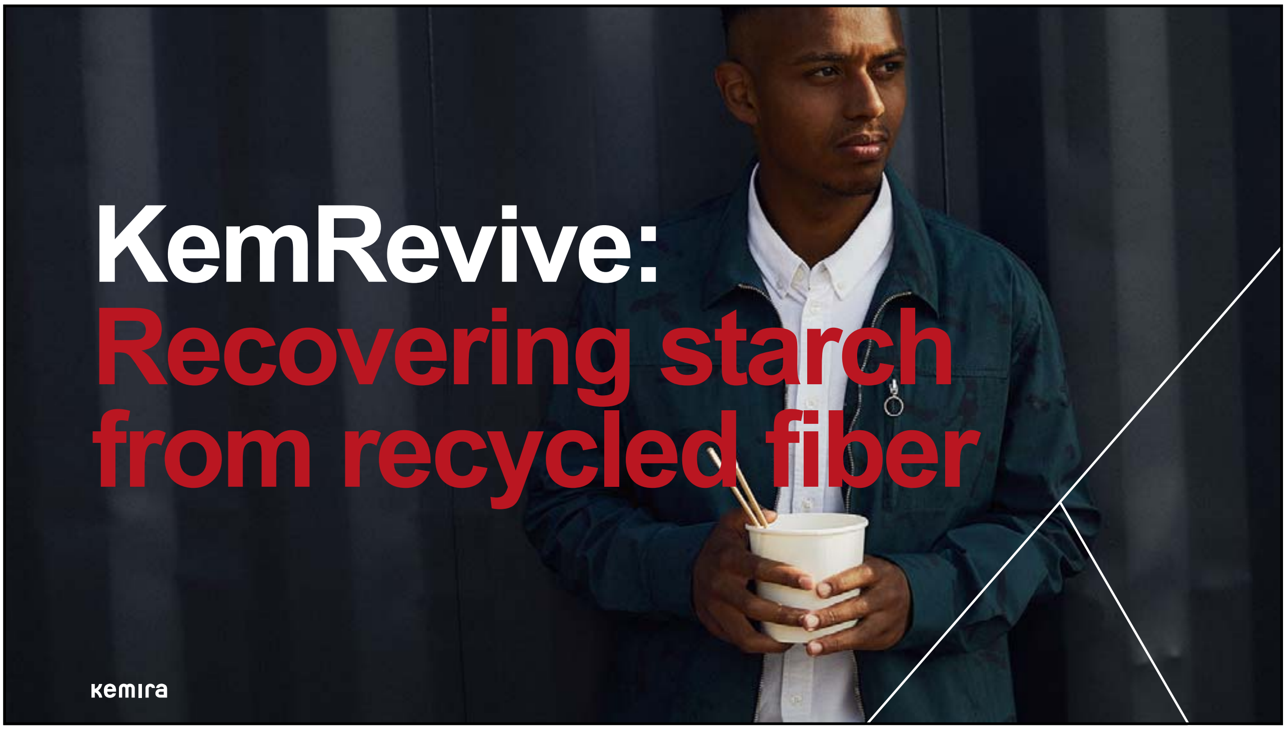
KemRevive:
Recovering starch from recycled fiber
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Overview
• The Opportunity
• Current Practice
• KemRevive Concept Overview
• Case Studies

Sustainability Through Reuse of Recycled Fiber Starch

For a mill producing 400,000 tons per year,

16,000 metric tons of starch from recycled fibre is **lost**

700 Truckloads or 2 per day of raw starch

Value of the lost starch is about **6 M€**

Represents area of corn field of around **3000 ha (7,500 acres)**

Number of times one can drive a car around the earth (CO2)

3,500

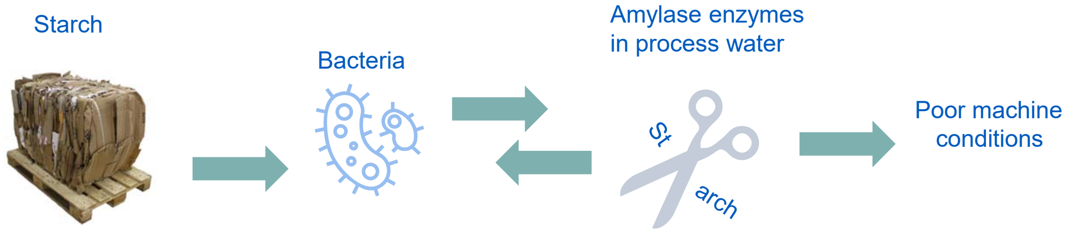
The Financial Opportunity

Recycled fiber contains high amounts of starch

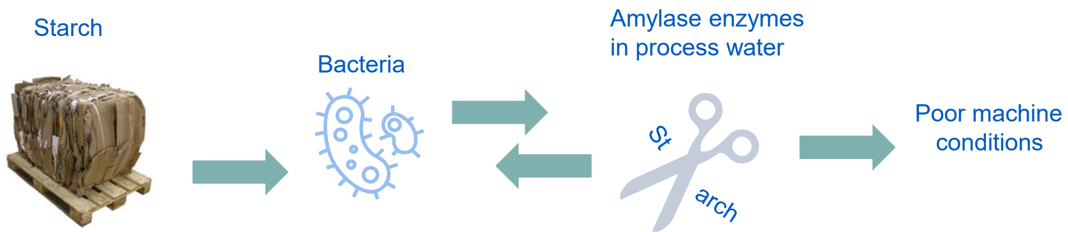
- ***Unprotected, this starch can become COD loading for the wastewater***
- ***It can become food for microbiological growth which produce detrimental by-products***
- ***Added starch costs are increasing. Allowing this "free" starch to be consumed is a financial burden.***

- **The ability to reuse starch provides a significant value potential**

Process issues due to starch degradation



Process issues due to starch degradation



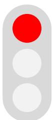
- High COD loading
- Increase in VFA's (Volatile Fatty Acids)
- pH depression
- Increased dissolved calcium concentrations
- Calcium scaling in waste water treatment
- Runability problems due to reduced chemical efficiency
- Increased use of biocides to combat high amounts of microbiological contamination

Starch Degradation in the Mill Environment

Worst Case Scenario

Anaerobic bacteria are prevalent and able to grow

Acid production, pH drop, Calcium dissolution, H2S production



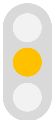
Traditional Strategy

Amylase enzymes in process water degrade starch into sugars

Starch from RCF is lost: COD and loss of yield

Potential for system variability

Higher than normal biocide consumption needed



KemRevive

Possible to reuse starch from recycled fiber

Stable wet-end pH and redox

Lower COD

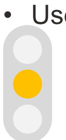
Increased yield

Lower VFA

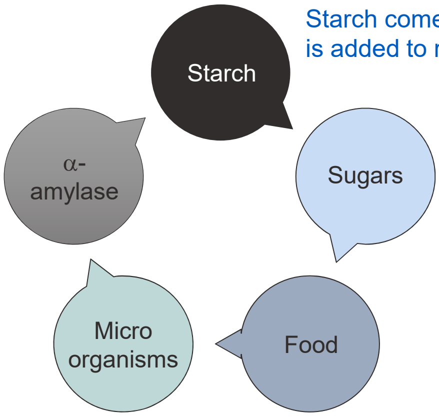
Further benefits

Traditional Strategies to Reduce Starch Degradation

- Eliminate majority of the amylase-producing bacteria in the process
  - Requires **much higher** biocide dosage than is necessary for the purpose of machine cleanliness
- Reduce water closure (use more fresh water)
- Retain starch coming in with the recycled fiber (reduce starch cycle up)
- Use non-contaminated recycled furnish



The cycle of starch degradation in paperboard process



Starch comes in with the raw material and/or is added to reach strength requirements

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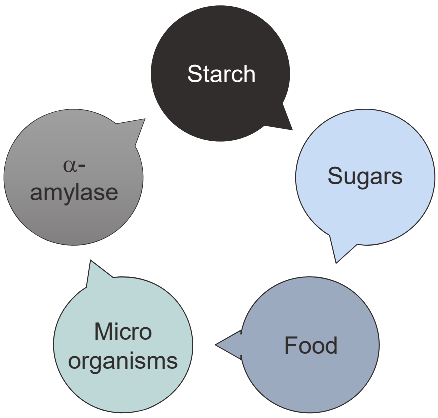
The cycle of starch degradation in paperboard process



Amylase enzyme breaks down the starch molecules into smaller sugar components

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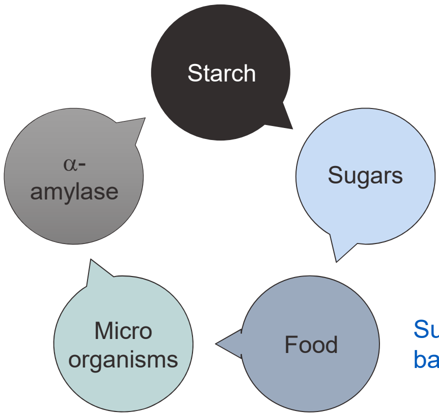
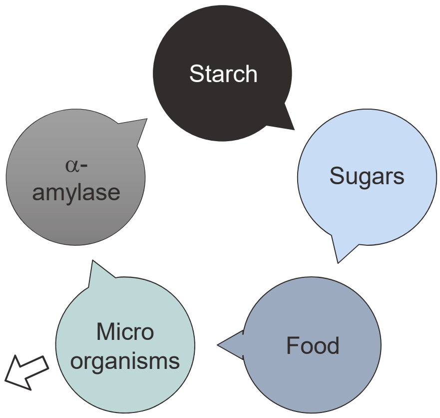
The cycle of starch degradation in paperboard process



Sugars are good energy source for bacteria

The cycle of starch degradation in paperboard process

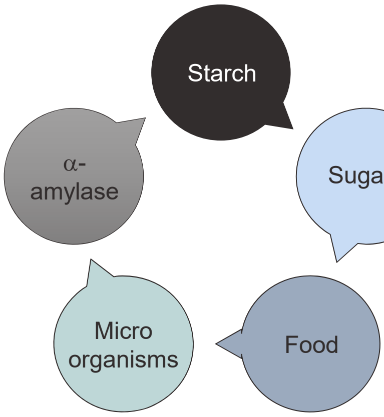


High microbe activity supported by high nutrient level in process waters

pH drop, Ca^{2+} solubilisation, Fermentation, VFA-Smell, Slime etc…

The cycle of starch degradation in paperboard process

High amount of amylase enzyme produced by bacteria to further break down the starch



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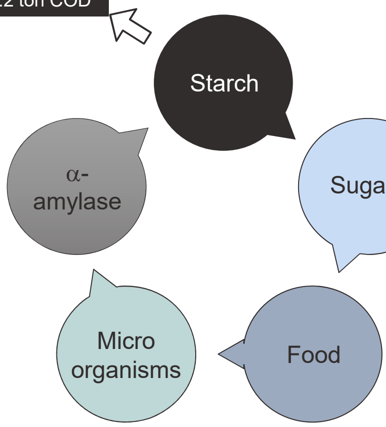
The cycle of starch degradation in paperboard process

COD / BOD
1 ton starch = 1.2 ton COD



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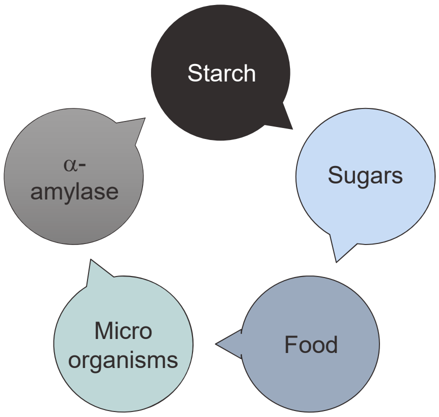
Keys to breaking the cycle of starch degradation

- Add enough inhibition chemistry such that we prevent amylase from degrading the starch
- If bacteria populations are not controlled to normal extent, the FennoSpec 1200 dosage would be cost prohibitive
- If starch is not retained in final sheet, benefits are greatly reduced

Therefore a successful KemRevive program consists of targeted inhibition, good MB control, and a retention program with the muscle to retain it



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KemRevive

Concept Overview

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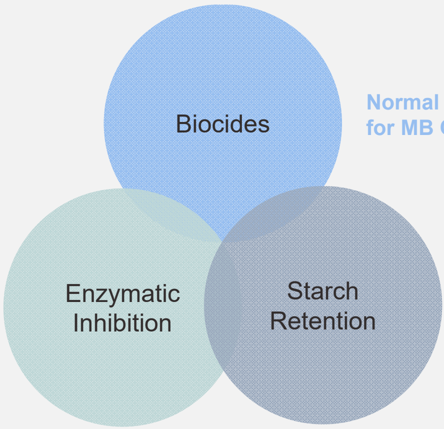
Kemira KemRevive: The Basics

Patent pending Technology



Normal biocide dosage for MB Control

Prevention of enzymatic degradation of starch polymers

Secondary starch retention improved with Kemira's Retention systems

Reclaiming Starch with KemRevive is a Two Step Process

STEP ONE – Protect

Amylase enzyme inhibitor (FennoSpec 1200)

Normal biocide use rate

STEP TWO – Retain

KemForm retention program

retain starch while maintaining/improving drainage

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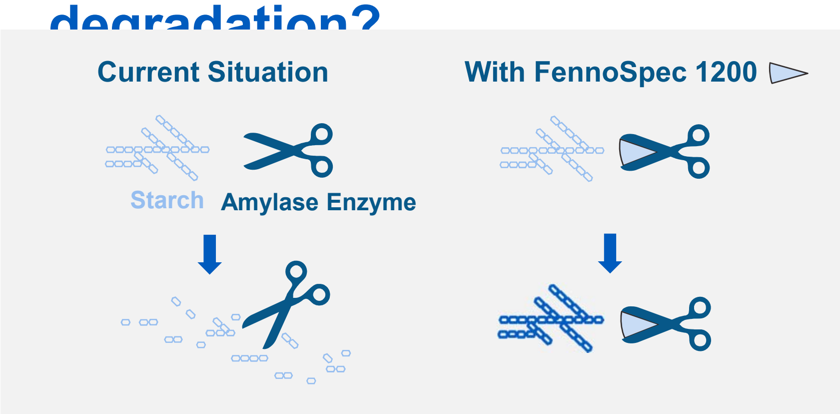
How does FennoSpec 1200 prevent starch degradation?



Alpha Amylase molecule – Calcium Ion

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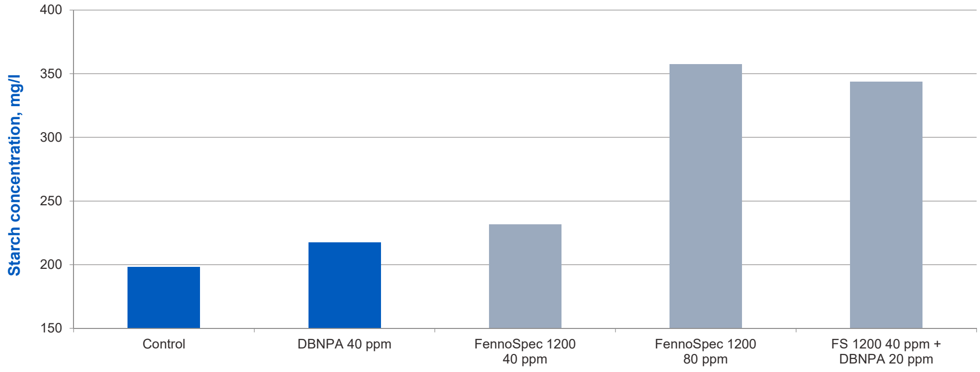
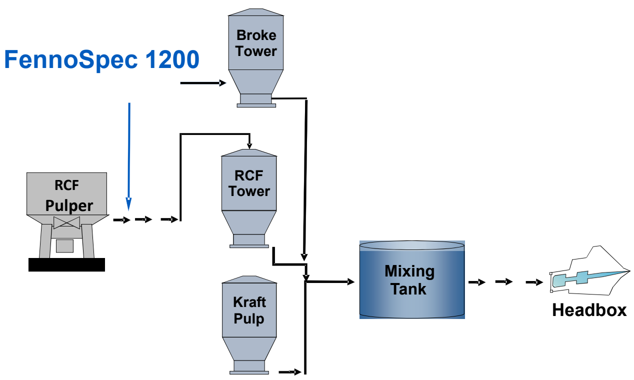
Amylase enzyme inhibitor provides an effect beyond biocides

RESIDUAL STARCH IN PROCESS WATER



Biocides alone do not prevent amylase activity

Typical dosage points



Typical dosage points

After pulper

Before storage towers

Into broke system.

Typical FennoSpec 1200 dosage depending on situation

0,5 to 1,5 kg/tonne as received on fibre

Reclaiming Starch with KemRevive is a Two Step Process

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Amylase enzyme inhibitor (FennoSpec 1200)

Normal biocide use rate

STEP TWO – Retain

KemForm retention program

retain starch while maintaining/improving drainage

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Kemira's KemForm Retention Concepts

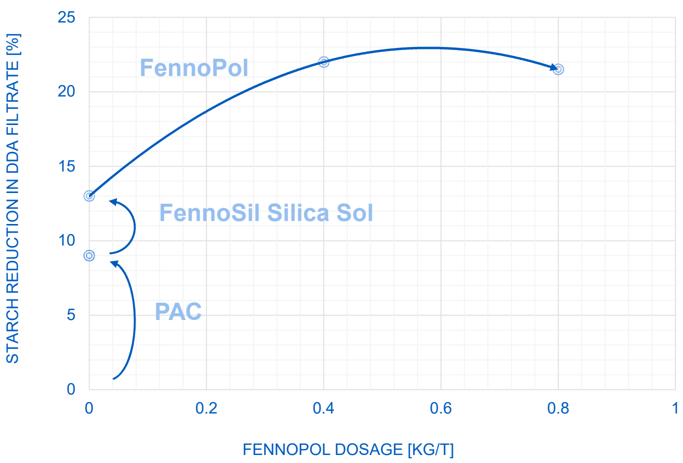
Process

Conditions:

Furnish:100 % OCC

Retention/dewatering system

PAC + FennoSil + FennoPol



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The Opportunities and Benefits

Significant benefits realised:

- Lower COD in waste water
  - Lower disposal costs
  - Improved yield
- Reduced odour
  - In final product and atmospheric
- Increased pH
  - Reduction in conductivity
  - Improved functional chemical efficiency
- Improved productivity

KemRevive

Process	Product	Sustainability
Increased pH	**Reduced Odour**	**Lower COD**
Improved yield	Lower Defects	Reduced Energy
Improved Productivity	Increased Ash	Lower Carbon Footprint
Reduced fresh Starch	Higher Strength	Less Sludge

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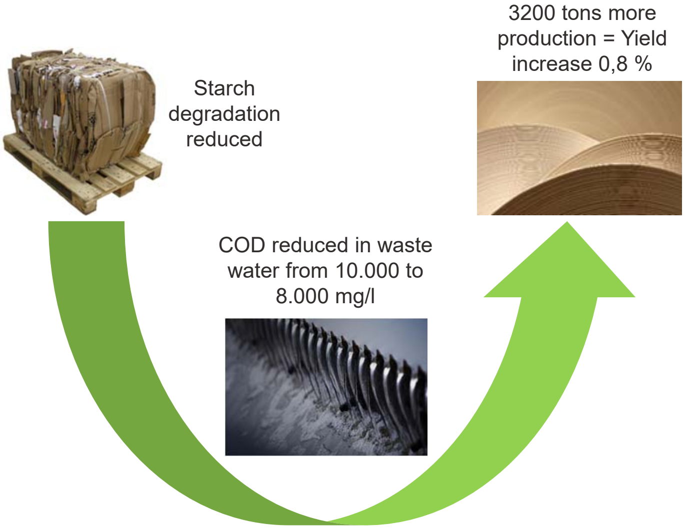
The effect of COD reduction on board machine yield

As an example consider:

- A 400,000 tpy board machine with a waste water amount of 4 m3 per produced ton of board.
- KemRevive reduces the COD by 2 kg/m3 of waste water
- With 1 600 000 m3 of waste water annually this means 3200 tons less COD into waste water
- This COD = the protected starch that ends up in the dry board as a yield increase



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Case Studies

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Case study

Program KPI

Customer requirements:

- Maintain fibre ratio waste/OCC ratio
  - To at least 50/50.
- COD reduction

Parameters measured

- Process water Redox, pH, conductivity
- Waste water COD
- Strength parameters of final board

VAT machine

Speed: 120 to 200 m/min

Production: 55 000 to 60 000 tonne/year

Grades: Chipboard at 320 to 900 gsm

Furnish: 100% RCF

Retention system: FennoLite UK @ 3,5 kg/t and FennoPol 4240T @ 660 g/t, PEI 1 kg/t

Biocide: Competitor Biocide program Glutaraldehyde and quat

Amylase enzyme inhibitor FennoSpec 1200 @ 1,0 to 1,2 kg/t

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Benefits to customer

KemRevive provided starch protection in the wet end enabling the mill to successfully alter the raw material ratio (waste/OCC) for the first time from 20/80 to 75/25

Potential gross savings for the mill 0,9 M€/year based on fibre costs

Other benefits observed:

- Starch degradation was reduced
- Waste water COD reduced
  - 11 000 mg/l down to 2750 mg/l
  - Average reduction 75%
- Process water quality improved
  - Cationic demand down 15%
  - Increase in average redox potential from -153 to -60 mV
  - Maintained pH with no NaOH addition
  - No more odour across mill site
- Reduction of retention aid polymer 18%
- Reduced fixative dosage 2%
- Good situation allowed the mill to close the water loop more than ever before
  - Decrease in conductivity 5000 μs to 2600 μs
  - Good runnability

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Summary

A new, sustainable and innovative way to reuse starch

Two-step concept:

- Amylase enzyme inhibitor decreases starch degradation
- Optimized retention system captures starch

Patented technology

BfR, FDA, and GB9685 compliant

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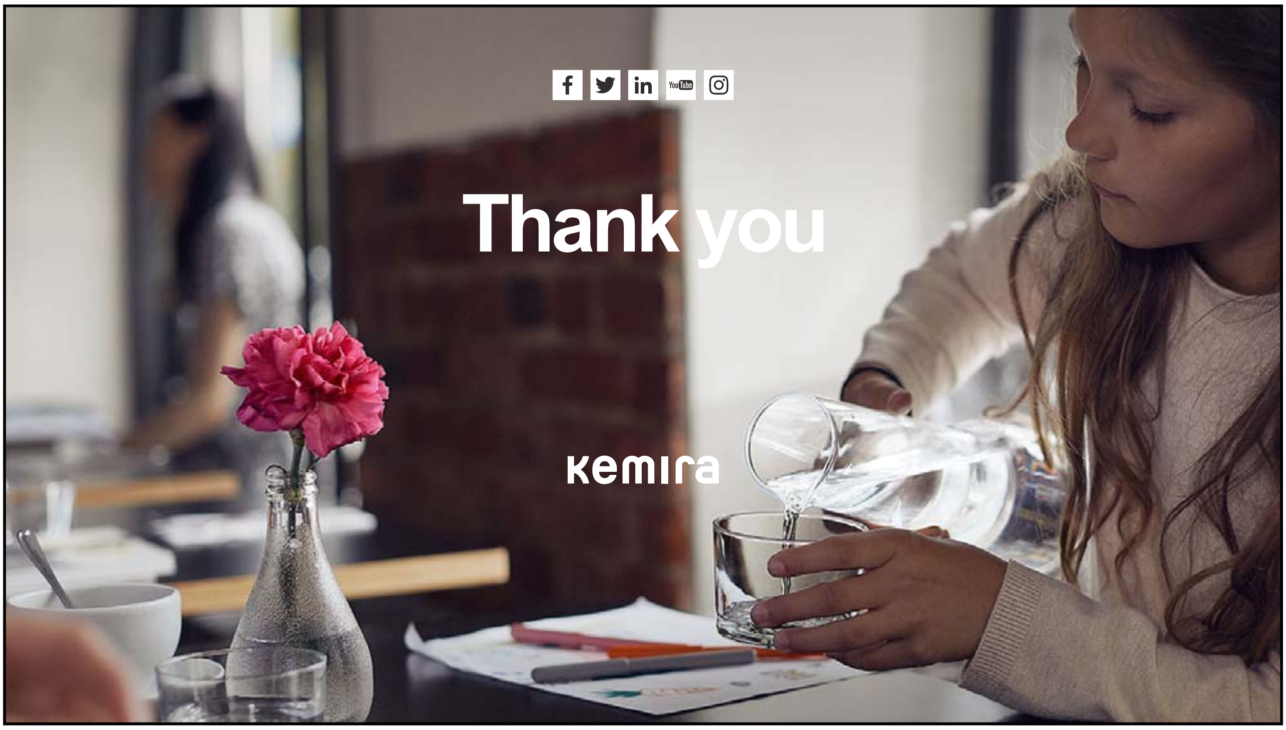
Thank you
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