VELKOMMEN
TIL
WORKSHOP
TØRKING AV MARIN BIOMASSE

OLA WEEN/ANNE LISE CHAPMAN/PIERRICK STÈVANT

MØREFORSKING

TAFJORD®

VRI
Møre og Romsdal
Virkemidler for regional FoU og innovasjon

TØRKING - FELLES UTFORDRING FOR MARINT RÅSTOFF

MÅL FOR DAGEN - KARTLEGGING

«20-25 % av energibruk i industri (Tyskland, Danmark) brukes til tørking»

BEHOV - OVERLAPP/SYNERGI?

Dryer Selection versus Feedstock Form

	Liquids			Cakes		Free-Flowing Solids					Formed
Nature of Feed	**Solution**	**Slurry**	**Pastes**	**Centrifuge**	**Filter**	**Powder**	**Granule**	**Fragile Crystal**	**Pellet**	**Fiber**	**Solids**
Convection dryers											
Belt conveyer dryer							×	×	×	×	×
Flash dryer				×	×	×	×			×	
Fluid bed dryer	×	×		×	×	×	×		×		
Rotary dryer				×	×	×	×		×	×	
Spray dryer	×	×	×								
Tray dryer (batch)				×	×	×	×	×	×	×	×
Tray dryer (continuous)				×	×	×	×	×	×	×	
Conduction dryers											
Drum dryer	×	×	×								
Steam jacket rotary dryer				×	×	×	×		×	×	
Steam tube rotary dryer				×	×	×	×		×	×	
Tray dryer (batch)				×	×	×	×	×	×	×	×
Tray dryer (continuous)				×	×	×	×	×	×	×	

MØREFORSKING

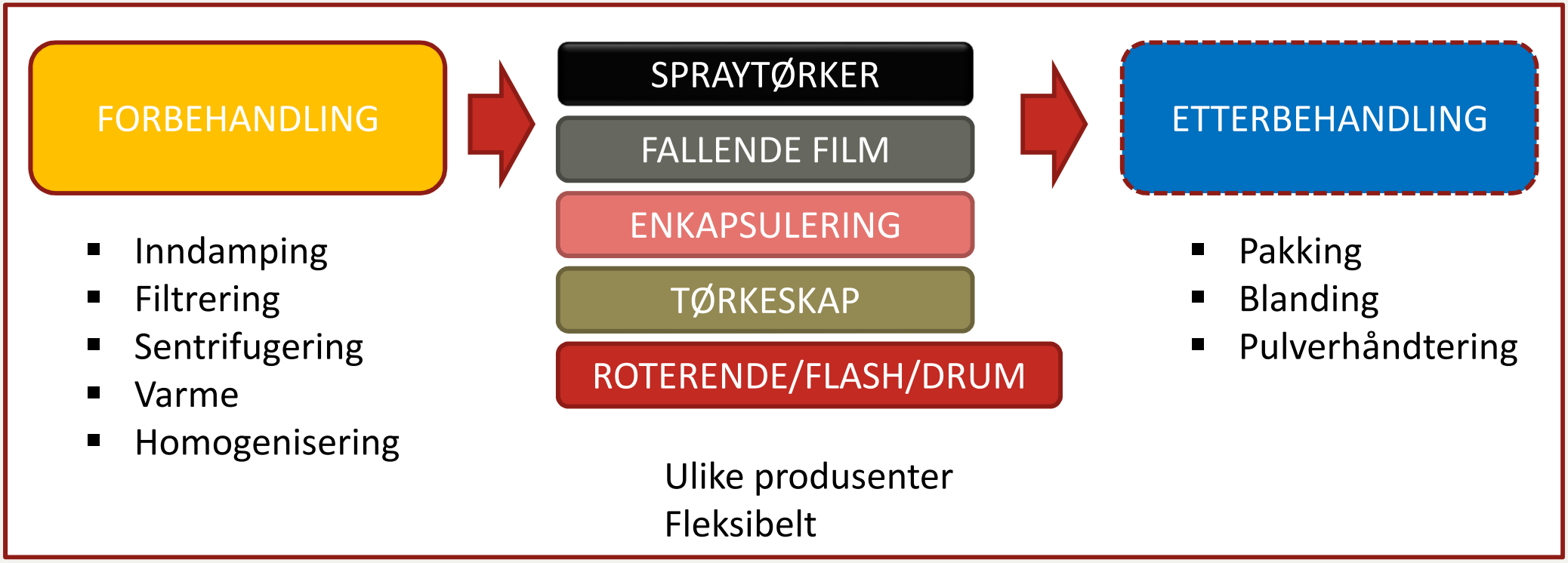
BEHOV – NY TEKNOLOGI?

Conventional *vs.* Innovative Drying Techniques

Feed Type	Dryer Type	New Techniques
Liquid suspension	• Drum	• Fluid/spouted beds of inert particles
	• Spray	• Spray/fluid bed combination
		• Vacuum belt dryer
		• Pulse combustion dryers
Paste/sludge	• Spray	• Spouted bed of inerts
	• Drum	• Fluid bed (with solid backmixing)
	• Paddle	• Superheated steam dryers
Particles	• Rotary	• Superheated steam FBD
	• Flash	• Vibrated bed
	• Fluidized bed (hot air or combustion gas)	• Ring dryer
		• Pulsated fluid bed
		• Jet-zone dryer
		• Yamato rotary dryer

«250 patenter i året (USA), 80 patenter i året (EU)»

INNHOLD - STRUKTUR



Energi + Gass + Vann (steam)

FOU – MANGE AKTUELLE TEMA

KVALITET

- Fordøyelighet
- Sensoriske parameter
- Farge
- Tekstur
- Bevare ernæringsverdi

HELSEEFFEKTER

- Bevare effekt
- Konsentrere effekt
- Matsikkerhet

LØNNSOMHET

- Tid
- Energibruk
- Effektivitet

EKSEMPEL 1 - MAKROALGER

40°C

70°C

EKSEMPEL 2- LIMVANN

FRYSETØRKING
(kontrollert, skånsomt)

VARMESKAP
(lav kontroll, lite skånsomt)

EKSEMPEL 3 - FISKEMEL

Soyamel FM1 FM2 FM3

MÅL FOR DAGEN – KARTLEGGING/GRUPPEARBEID

- 4 grupper (1,2,3,4)
  - Kl 13.00 -13.50 Gr 1+ 2: Tema 1
  - Kl 13.00 - 13.50 Gr 3+ 4: Tema 2
  - Kl 14.00 - 15.00 Gr 1+ 2: Tema 2
  - Kl 14.00 - 15.00 Gr 3+ 4: Tema 1
- MF har sekretærrolle (noterer)
- Fasiliteringsfunksjon:
  - Oddmund Otterhals
  - Tom Ståle Nordvedt
  - Ola Ween
  - Gudmund Skjåk-Bræk

TEMA 1

- TEKNOLOGI
  - Forbehandling?
  - Tørketeknologi?
- LOGISTIKK
  - Transport
  - Råstoffgrunnlag (volum…)

TEMA 2

- KOMPETANSEBEHOV
  - Hente kompetanse (Norge, EU, USA)?
- MULIGHETER/BEGRENSINGER
  - Energibehov
  - Plassbehov
  - Felles problemstillinger
- FoU OPPGAVER
  - Prosjektmuligheter
  - Virkemidler

FOOD GRADE PILOT PLANT – (NEDERLAND)





Food grade laboratory scale drying equipment	• Büchi B-290 mini spray dryer (0.5 L/h) • Glatt GPCG 1.1 dryer/granulator/agglomerator (0.3-1 kg batch size)
Food grade pilot scale drying equipment	• NIRO 25 L/h single stage spray dryer • NIRO 250 L/h multi stage spray dryer • GMF 40 L/h double drum dryer • GMF 110 L/h single drum dryer
Food grade film evaporators	• Experimental 1-stage falling film evaporator (40 L/h) • 4-stage falling film evaporator (300 – 2000 L/h) • Scraped surface evaporator for high viscous products (100-200 L/h)
Food grade laboratory scale encapsulation equipment	• Glatt GPCG 1.1 fluid bed with Wurster and hot-melt (0.3-1 kg) • Glatt Procell 3 spouted bed (0.3 – 2 kg) • Experimental laboratory spray cooling equipment (0.5 kg product)
Pretreatment	• Laboratory heat treatment systems (2 L/h – 20 L/h) • Pilot heat treatment systems (50 – 10 000 L/h) • Homogenizers (3 L/h - 1000 L/h, up to 1500 bar) • Membrane separation (ranging from microfiltration to reverse osmosis)
Product handling	• Packaging in cans, bags and big bags • Lindor dry blending (200 kg)
Powder analysis	• Sorption isotherms • Bulk and particle density • Solubility, wettability, dispersability & particle size distribution • Stickiness & flowability • Emission • Smouldering properties

TID

Solids' Exposures to Heat Conditions

	Typical Residence Time within Dryer				
Dryers	**0–10 (s)**	**10–30 (s)**	**5–10 (min)**	**10–60 (min)**	**1–6 (h)**
Convection					
Belt conveyor dryer				×	
Flash dryer	×				
Fluid bed dryer				×	
Rotary dryer				×	
Spray dryer		×			
Tray dryer (batch)					×
Tray dryer (continuous)				×	
Conduction					
Drum dryer		×			
Steam jacket rotary dryer				×	
Steam tube rotary dryer				×	
Tray dryer (batch)					×
Tray dryer (continuous)				×	

ULIKE PARAMETERE

Typical Checklist for Selection of Industrial Dryers

Physical form of feed	• Granular, particulate, sludge, crystalline, liquid, pasty, suspension, solution, continuous sheets, planks, odd-shapes (small/large)
	• Sticky, lumpy
Average throughput	• kg/h (dry/wet); continuous
	• kg per batch (dry/wet)
Expected variation in throughput (turndown ratio)	
Fuel choice	• Oil
	• Gas
	• Electricity
Pre- and postdrying operations (if any)	
For particulate feed products	• Mean particle size
	• Size distribution
	• Particle density
	• Bulk density
	• Rehydration properties
Inlet–outlet moisture content	• Dry basis
	• Wet basis
Chemical/biochemical/microbiological activity	
Heat sensitivity	• Melting point
	• Glass transition temperature
Sorption isotherms (equilibrium moisture content)	
Drying time	• Drying curves
	• Effect of process variables
Special requirements	• Material of construction
	• Corrosion
	• Toxicity
	• Nonaqueous solution
	• Flammability limits
	• Fire hazard
	• Color/texture/aroma requirements (if any)
Footprint of drying system	• Space availability for dryer and ancillaries

MATRISER

		Før tørkeprosessen / behandling		Foredling utover tørking	Etter tørkeprosessen			
Råstoff	**Teknologi**	*Hvilket produkt skal tørkes?*	*% DW*	*Evt. kverning, sentrifugering*	*Væskeprodukt*	*% DW*	*Masseprodukt*	*% DW*
Laks	Skap / tunnel	Hoder	75 %	Nei	Nei	Nei	Tørket hoder	90,00 %
NVG Sild	Vet ikke	Filetavskjær	70 %	Koking, pressing og sentrifugering	Limvann	12 %	Grovt mel	92,00 %
					Olje	100 %	Limvann protein	92,00 %
Makroalger	Spray / fluid bed combo	Rå *S. Latissima*	18 %	Kverning og pressing	Press-ekstrakt	10 %	Tare mel	92,00 %