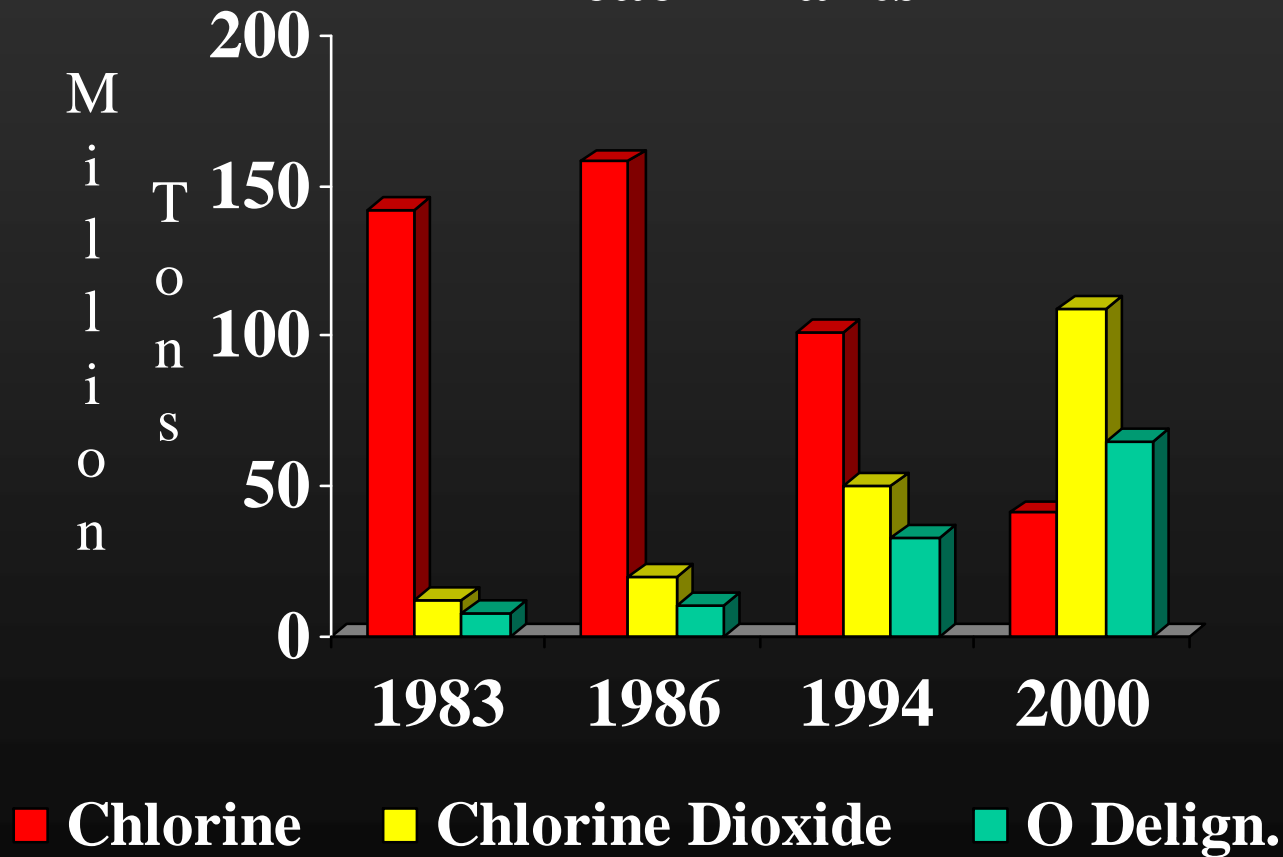


Optimizing ECF Bleaching Technologies with a Mini-O

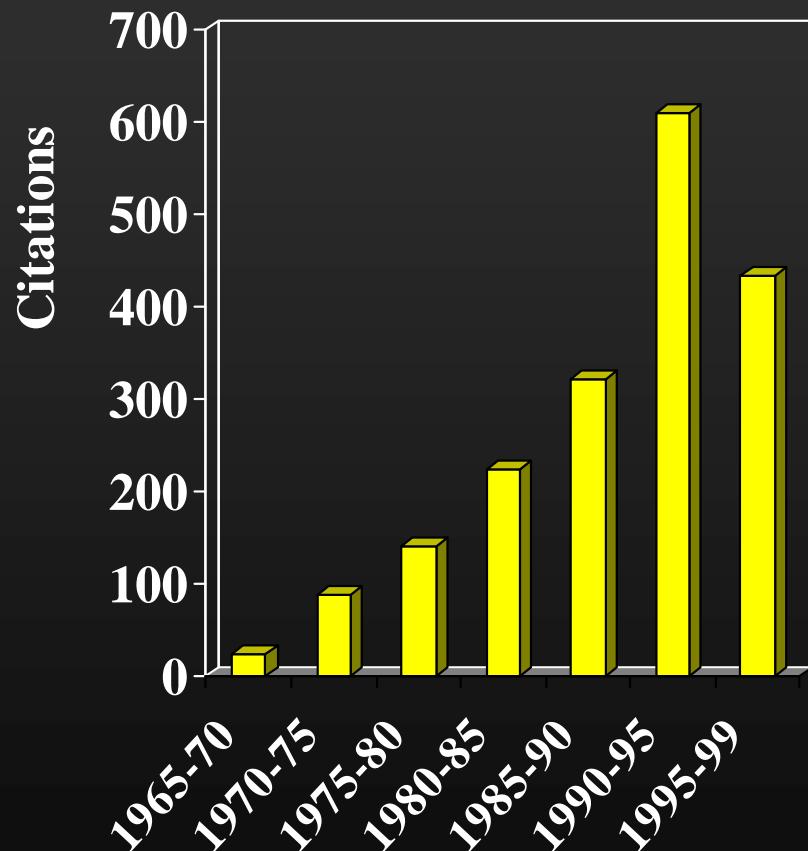
Oxygen Delignification

Chemical Usage of North American Bleach Plants



Improved environmental and operating cost performance

O Delignification: Background

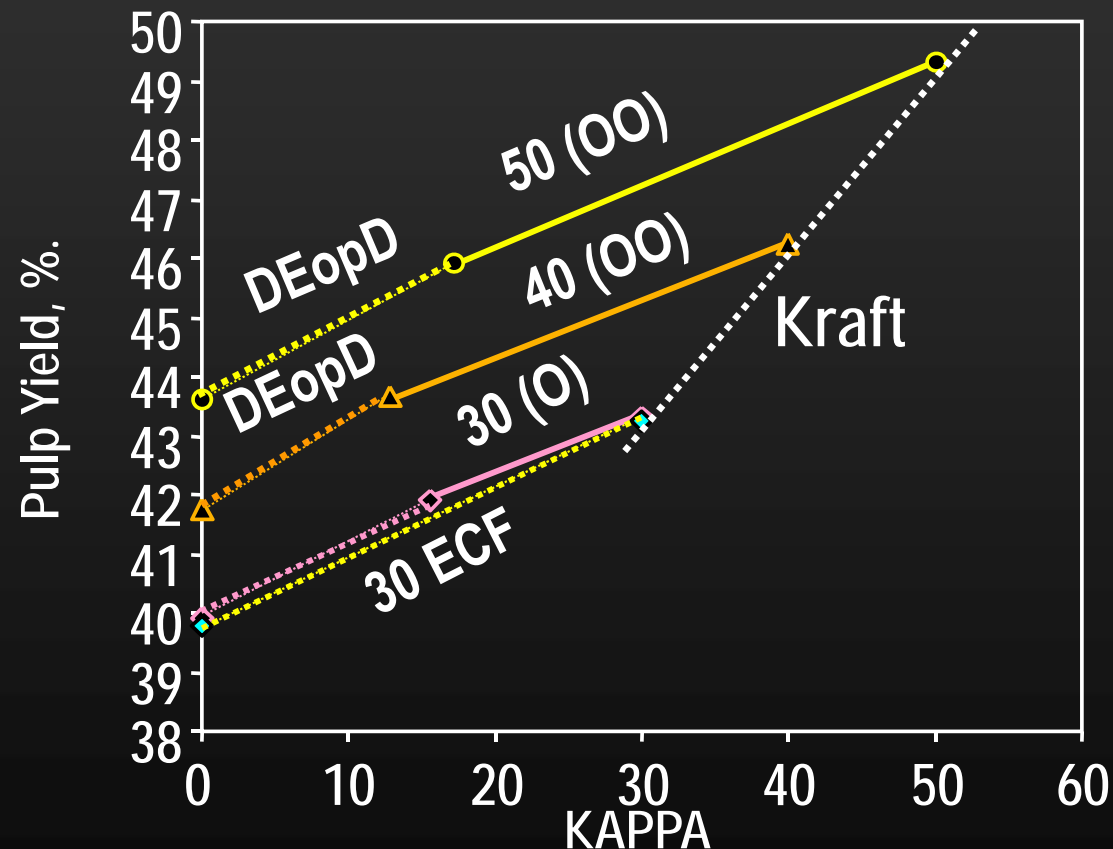


Literature

- 1960/70s
 - basic engineering & chemistry
- 1980/early 90s
 - process parameters, energy, environmental, pretreatments, fundamental chemistry, pulp properties
- Late 1990's
 - yield, selectivity, process parameters, lignin/carbohydrate chemistry, catalysts

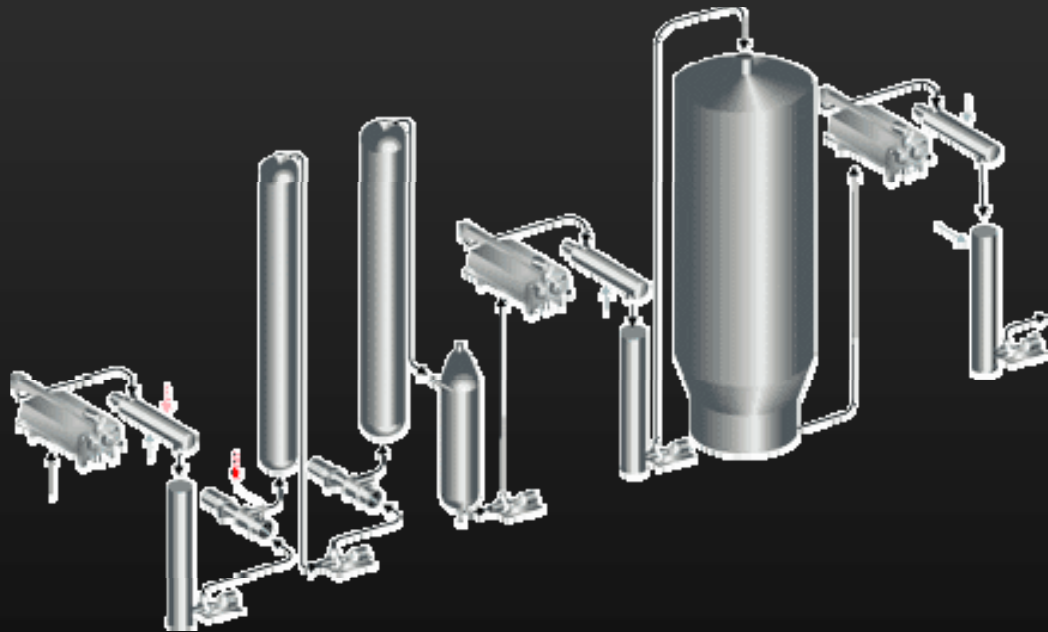
Oxygen Delignification

Increased interest in one and two-stage oxygen delignification



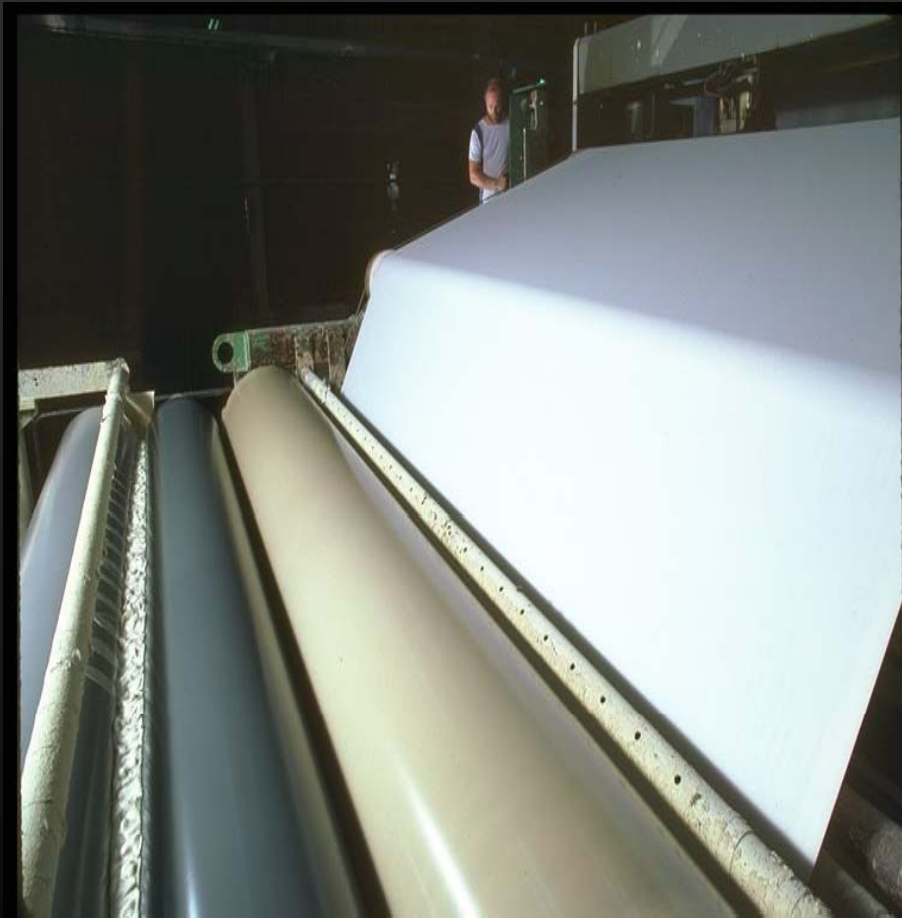
Yield and Operating Benefits

An Alternative Approach



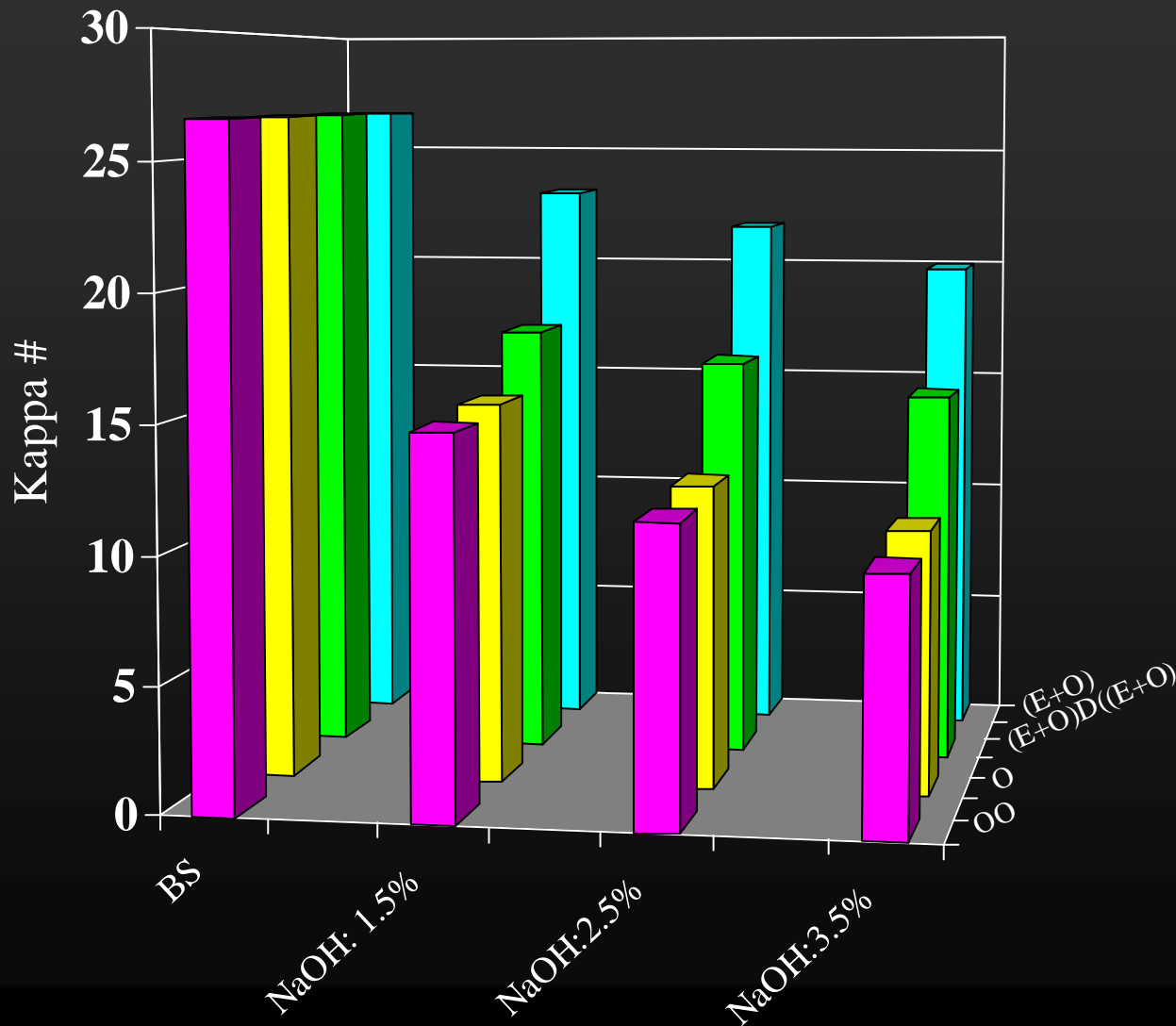
- Mini-O
 - Removes less lignin
 - Less capital
 - Easily retrofitted
- Enhanced Mini-O
 - Greater lignin removal
 - Multiple stages
 - H_2O_2 and/or ClO_2

Mill Application



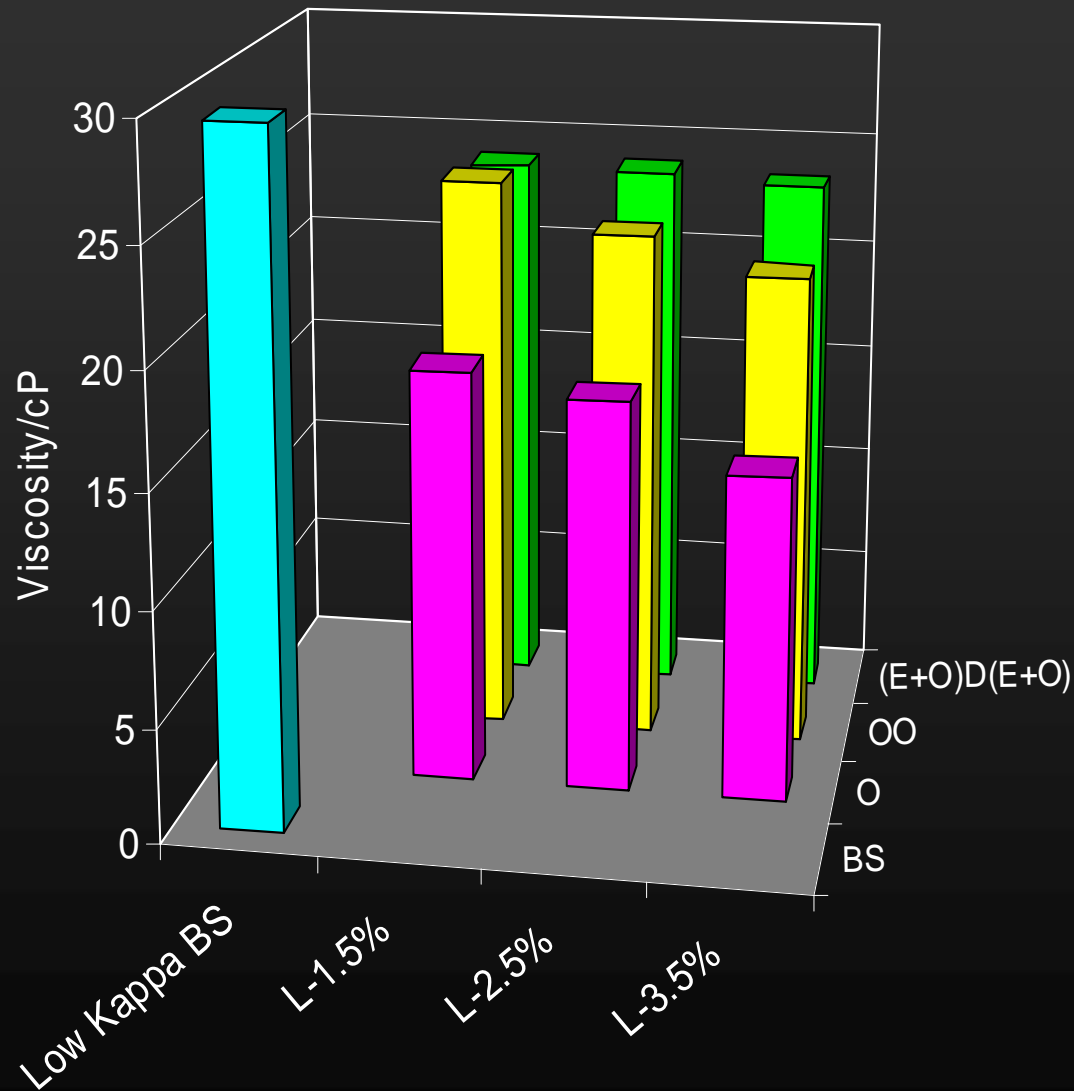
- McKenzie
 - Cook to normal target
 - Reduce lignin with O_2
 - Sodium hydroxide instead of oxidized white liquor
- Low AOX pulps
 - No production loss
 - No recovery bottleneck
 - 25% delignification

Recent Studies



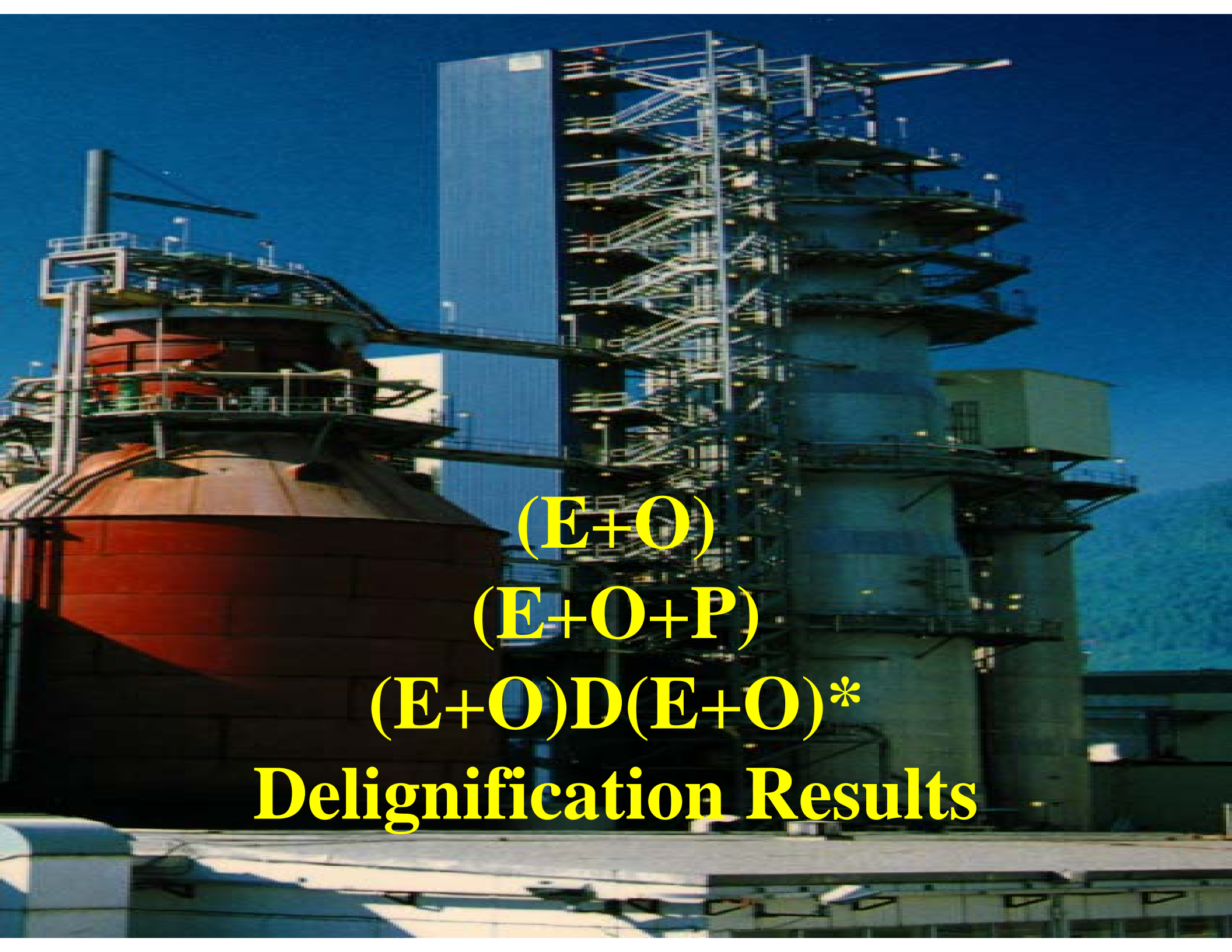
- Compared O systems
 - O, OO, mini-O
- Split the caustic charge in a (E+O)D(E+O)
- Delignification
 - Lowest for mini-O
 - 13-25%, depending on caustic addition

Recent Studies



– Viscosities

- O vs. (E+O)D(E+O)
 - Same delignification at 3.5% as O at 1.5%
- Improved viscosity



(E+O)

(E+O+P)

(E+O)D(E+O)*

Delignification Results

Mini-O Delignification Studies

Research Objective

- Examine impact of carryover
- 26.3 Kappa SW kraft
- Determine
 - Physical properties
 - Selectivity

- Contribute to future mini O-delignification road map to improve performance



Mini-O Delignification: Experimental Design

Bleaching Sequences

- (E+O)(E+O)
- D(E+O)
- (E+O)D(E+O)
- D(E+O)(E+O)

BL Carryover

- No carryover
- 2 kg/ton
- 10 kg/ton

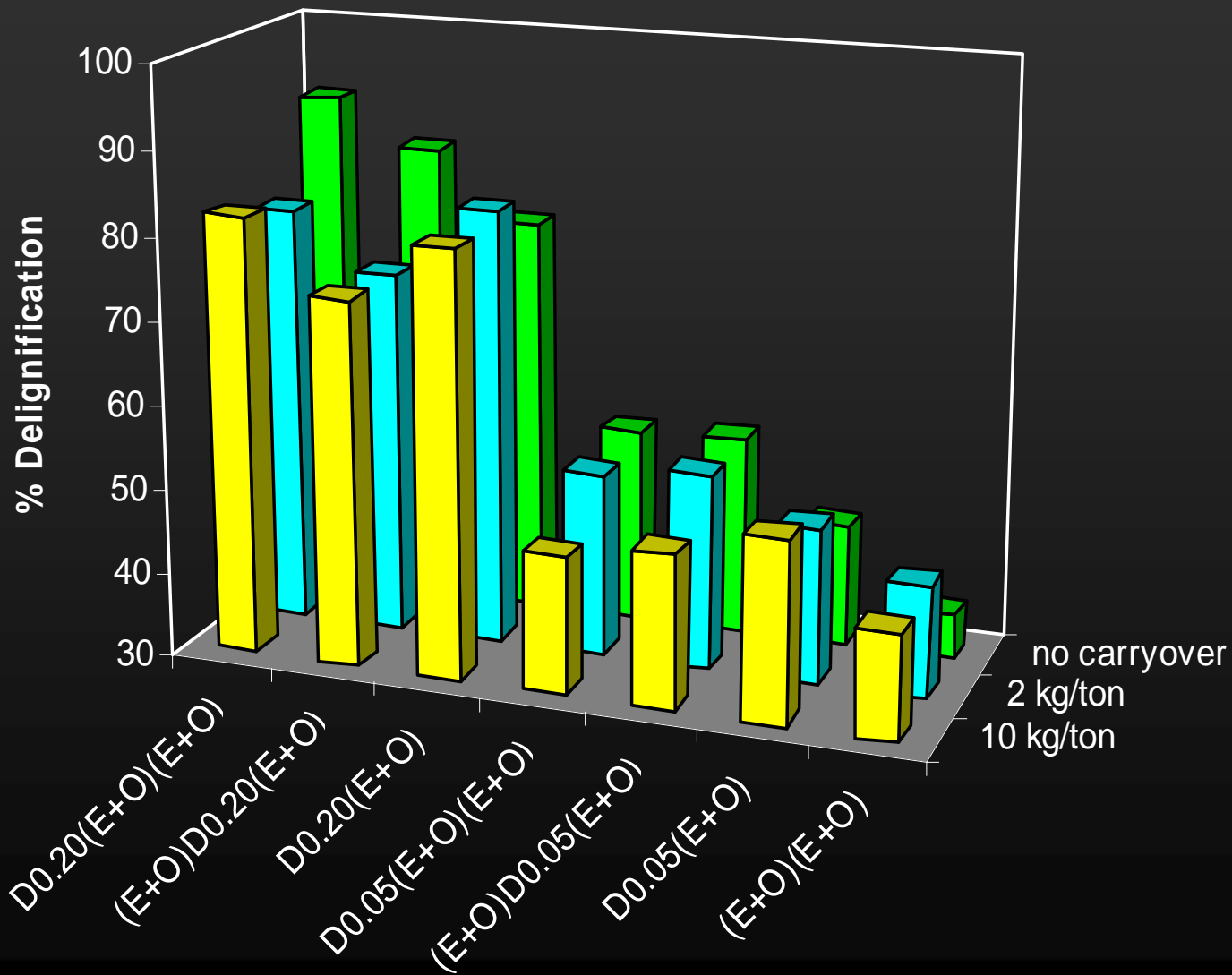
Experimental Conditions

Stage	O-Press./psi	% NaOH	Temp./°C	Time/min.
(E+O)	90	1.25	80	20
D _{0.05, 0.20}	-	-	70	30
(E+O)D(E+O)	90/0/90	1.25/0/1.25	80/70/80	70

10% consistency

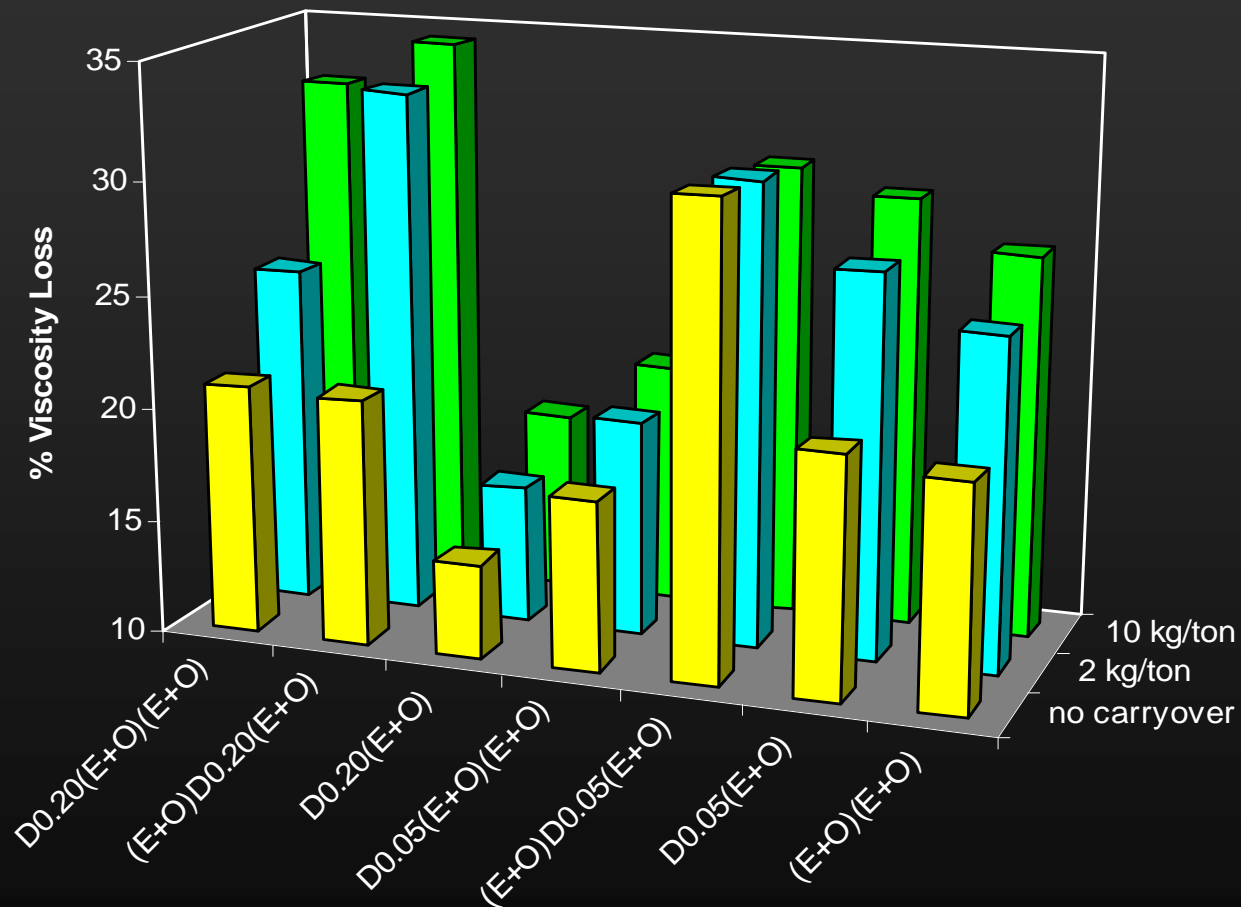
MgSO₄: 0.10%

Impact of Carryover



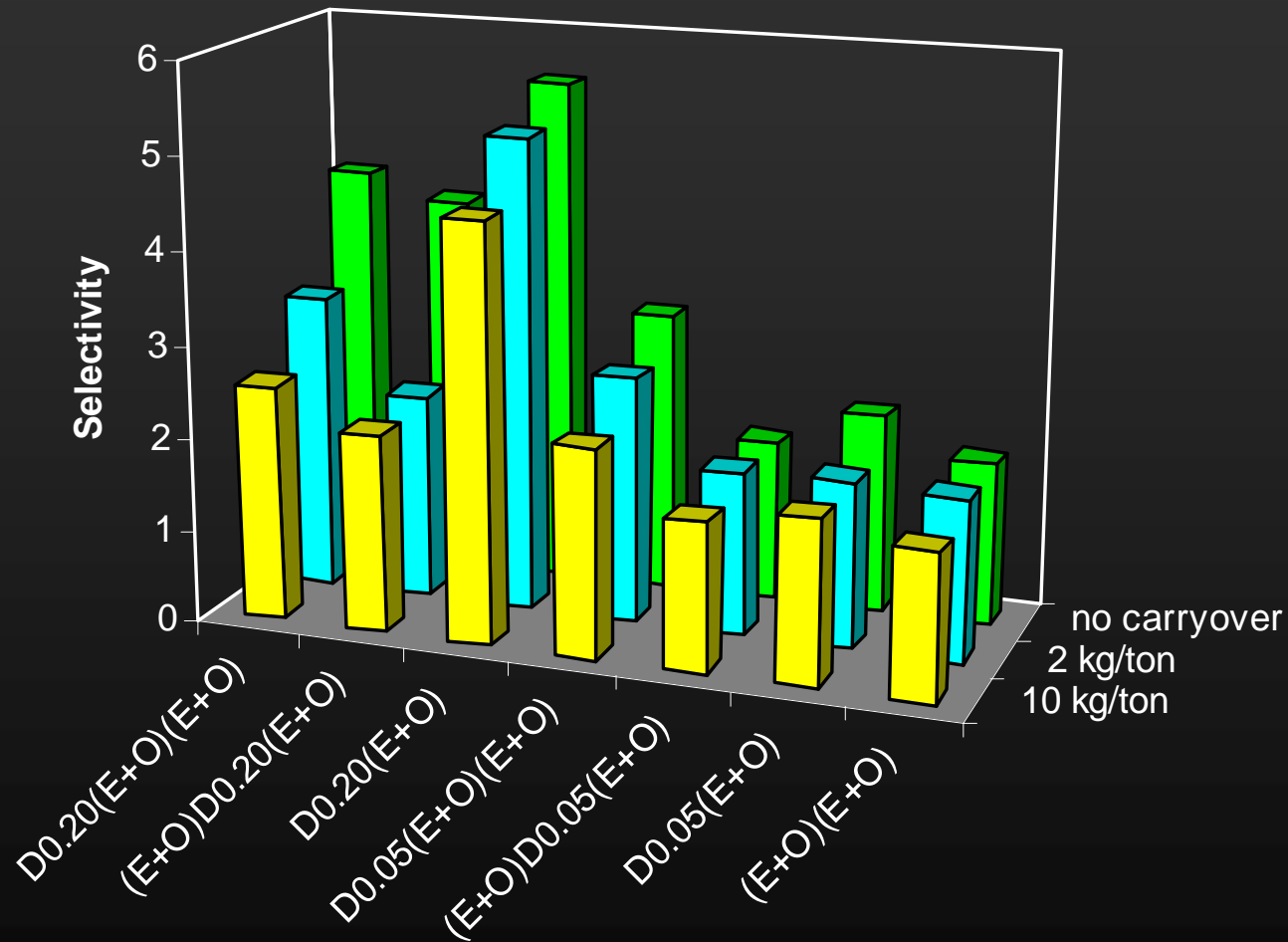
- Carryover decreases delignification
- Increased levels
 - Decreased response
- Splitting (E+O)
 - Improved response

Impact of Carryover



- Viscosity loss
 - Increases as function of carryover
- Carryover
 - May introduce transition metals
- Placement of (E+O)
 - Affects viscosity loss

Impact of Carryover



- Selectivity
 - Decreases as function of carryover
- Carryover
 - May introduce transition metals
- Placement of (E+O)
 - Affects selectivity

Mini-O with H₂O₂ Studies

Research Objective

- Examine impact of carryover
- Three SW kraft pulps
 - 26.3 Kappa pre-O₂
 - 24.3 Kappa pre-O₂
 - 8.9 Kappa post-O₂
- Determine
 - Physical properties
 - Selectivity
- Contribute to future mini O-delignification road map to minimize capital and enhance performance



Mini-O with H₂O₂ Delignification: Experimental Design

Bleaching Sequences

- O
- D(E+O)
- D(E+O+P)
- (E+O)*D(E+O)*
- D(E+O)*(E+O)*

Pulps

- Pre-Oxygen
– 26.3 kappa
- Pre-Oxygen
– 24.2 kappa
- Post-Oxygen
– 8.9 kappa

Experimental Conditions

Stage	O-Press./psi	% NaOH	Temp./°C	Time/min.
(E+O)	90	1.25	80	20
(E+O+P)	90	1.25	80	20
D _{0.05, 0.20}	-	-	70	30
(E+O)*D(E+O)*	90/0/90	1.25/0/1.25	80/70/80	70

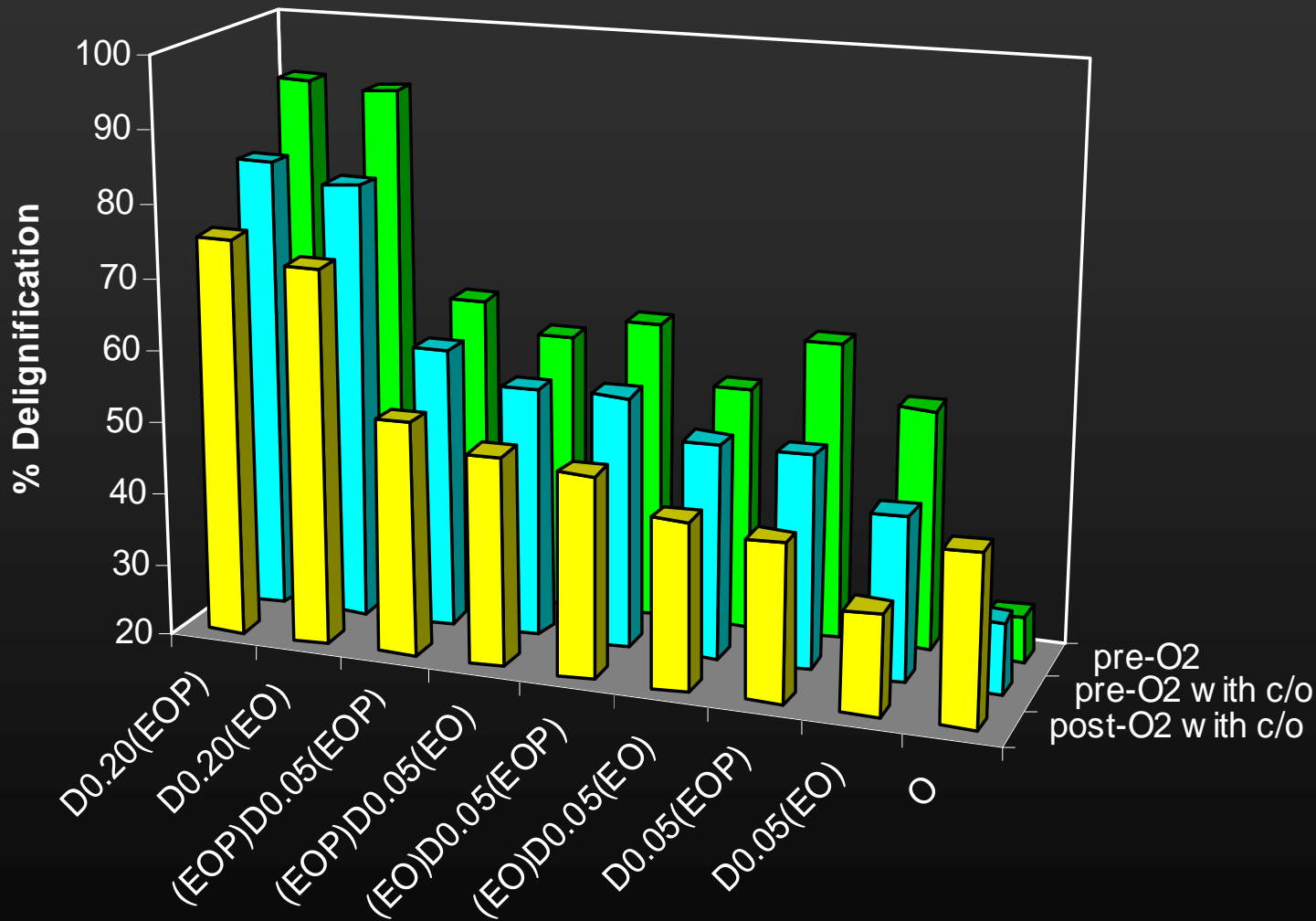
10% consistency

BL carryover: 10 kg/ton

H₂O₂ : 0.5%

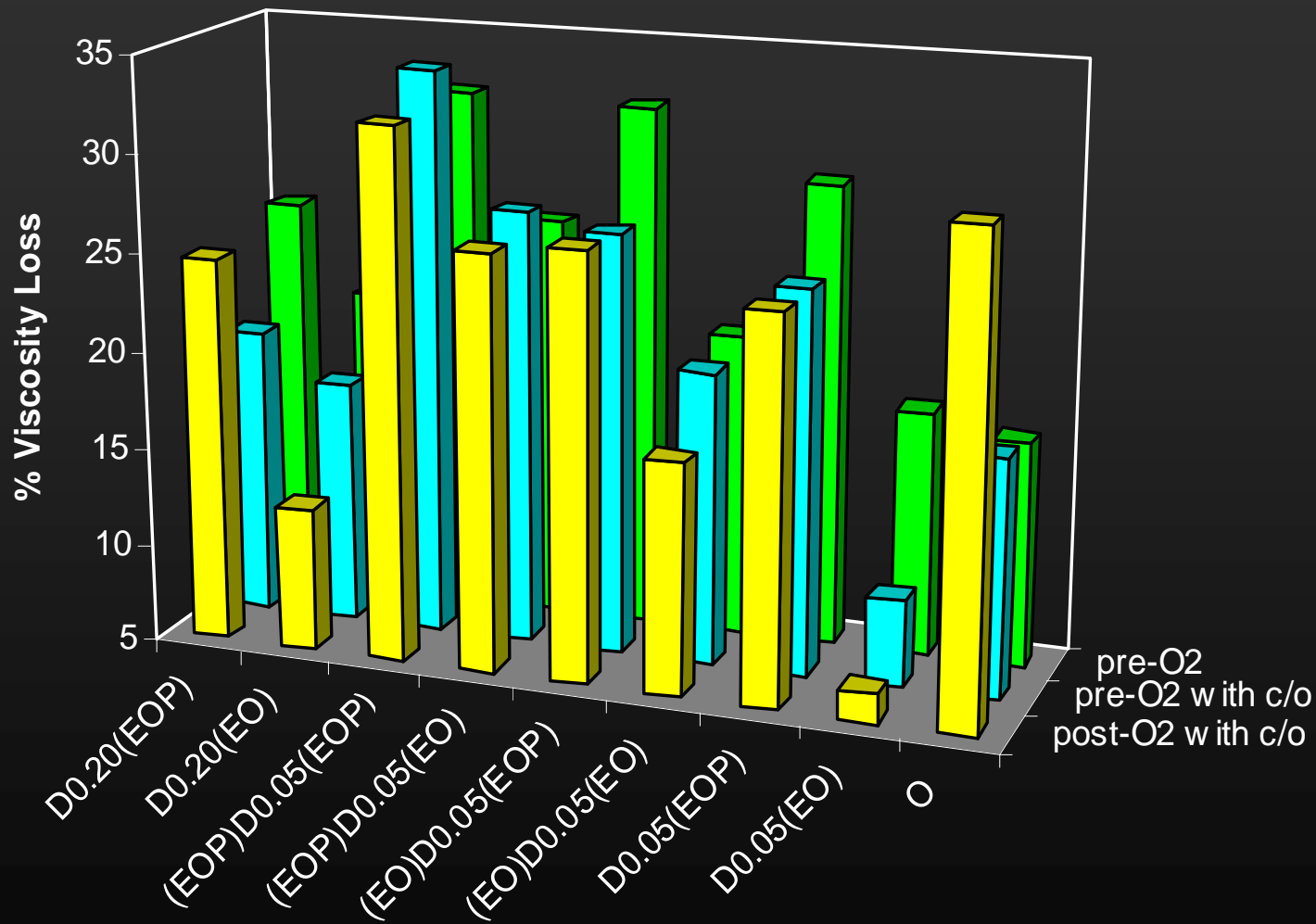
MgSO₄: 0.10%

Mini-O Reinforced with H₂O₂



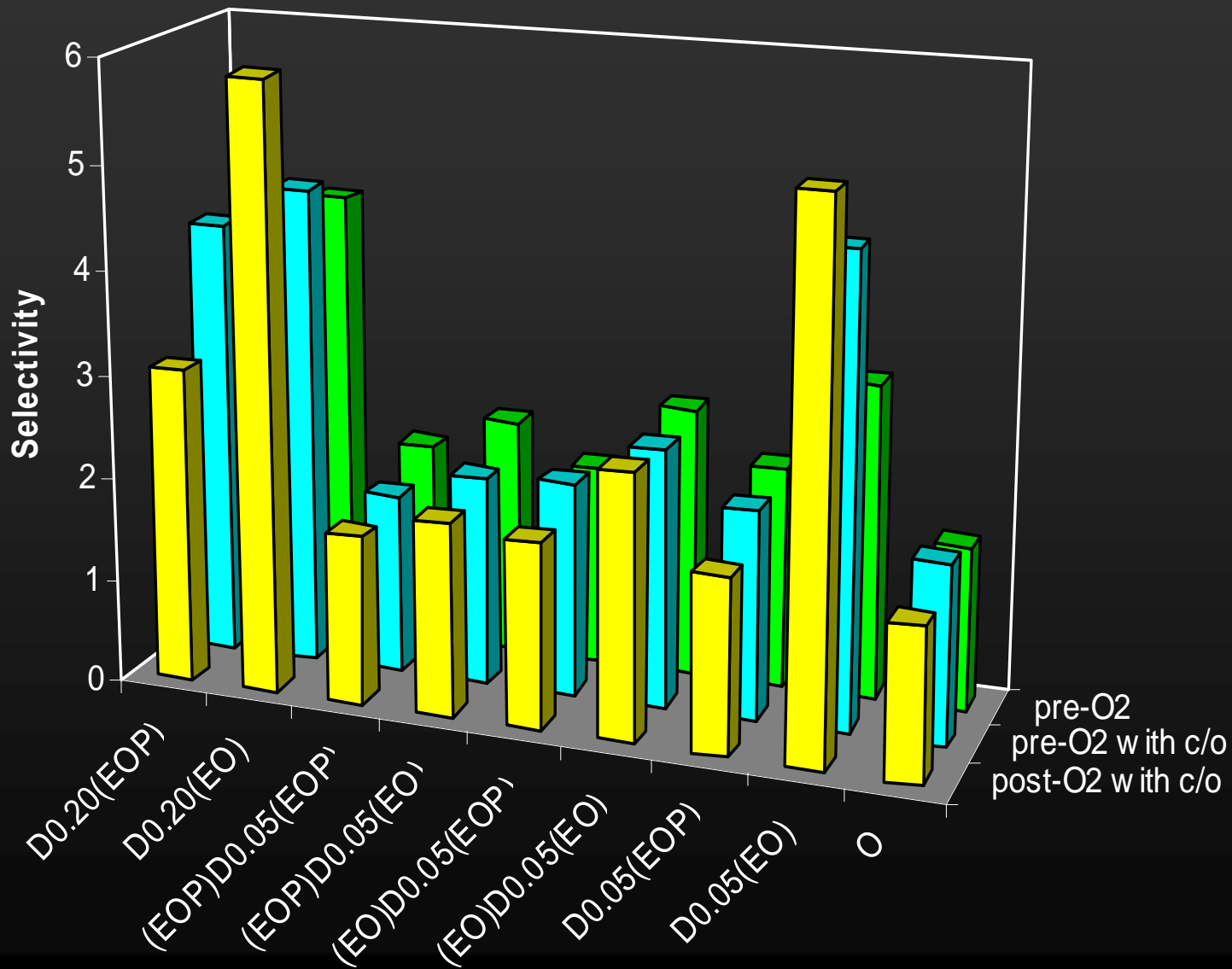
- Carryover at 10 kg/ton
 - Decreased response
- Pre-O₂ vs. Post-O₂
 - Decreased response in post-O₂
- Delig. Response
 - Proportional to H₂O₂
- (EO)*D_{0.05}(EO)*

Mini-O Reinforced with H₂O₂



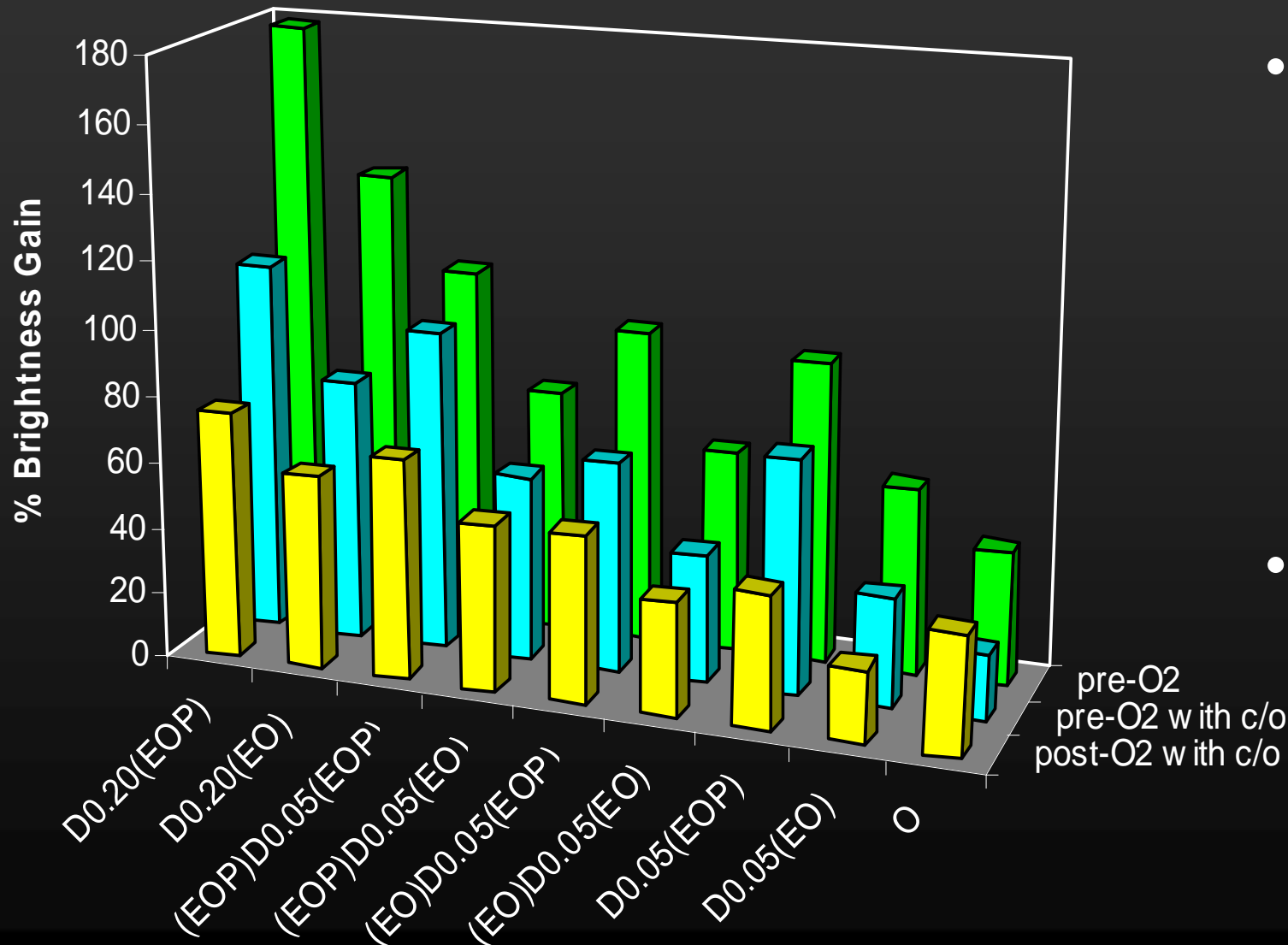
- Carryover at 10 kg/ton
 - Generally decreases viscosity loss
- Pre-O₂ vs. Post-O₂
 - Greater loss for pre-O₂ pulp
- Increased H₂O₂
 - Increased viscosity loss

Mini-O Reinforced with H₂O₂



- Carryover at 10 kg/ton
 - Generally decreases selectivity
- Pre-O₂ vs. Post-O₂
 - Greater selectivity for pre-O₂ pulp

Mini-O Reinforced with H₂O₂



- Carryover at 10 kg/ton
 - Generally decreases brightness response
- (EO) vs. (EOP)
 - Exiting bleaching stage



Conclusions

Mini-O Delignification: Implications

- Promising technology
- Superior performance with pre-O₂ pulps when compared to post-O₂ pulps
- Benefits of enhanced poor man's O
- H₂O₂ in last stage of (EO)*D(EO)*
 - Increased bleaching performance