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Hydrous Thermolysis of Biomass Production of Hodge' Carbonyls & Oligomeric Lignin

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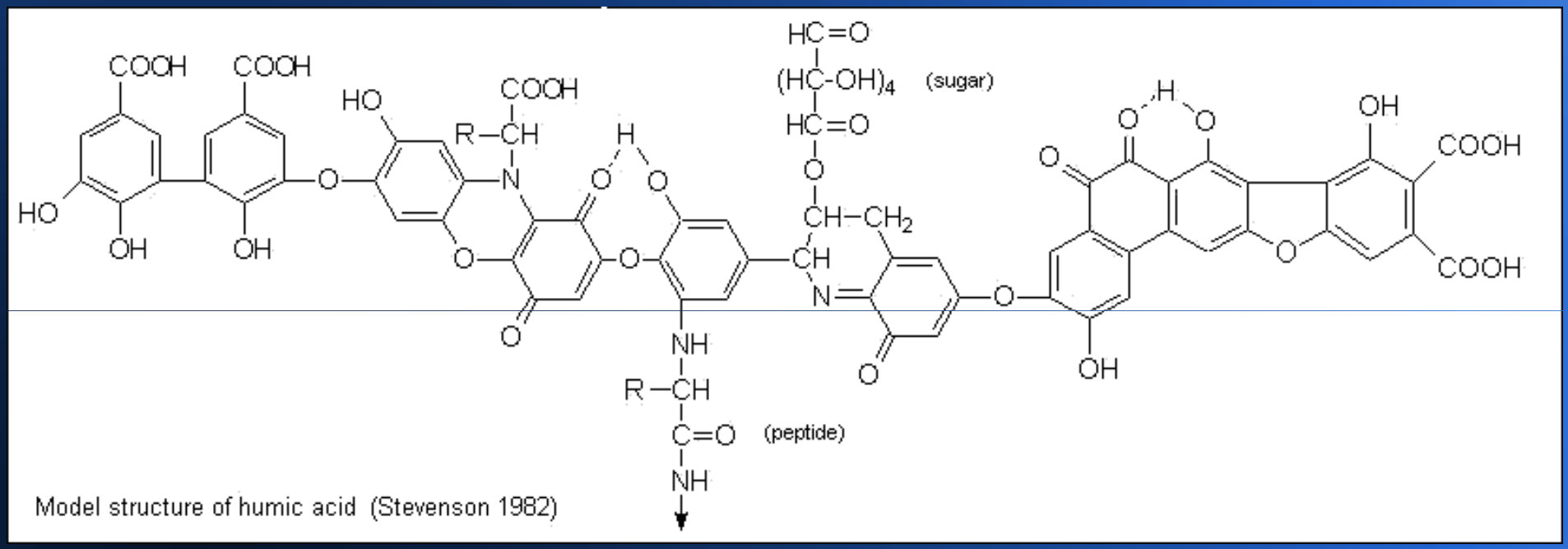
Hodge' Carbonyls

Yields wt% dry feed	Feed		
	Sucrose	*Glucose*	*Bleached pulp, Tembec Cellulosics*
Hydroxyacetaldehyde	34	57 - 62	18
Glyoxal	3.5	4.4	4.1
Methylglyoxal/glyceraldehyde	above 1	3.3	above 1
Acetol	2.5	2.3	2
Formaldehyde	11.5	8	5.1

Key Components of Wood Pyrolysis Condensates

Yields, wt% dry feed	*Softwood mix: - fir-spruce from British Columbia*	*Hardwood, beech from Eastern Europe*
Water soluble fraction:		
Hydroxyacetaldehyde	15	9.5
Glyoxal	1.4	2
Formaldehyde	2.4	2.5
Water insoluble fraction:		
Oligomeric lignin	22	22

Model Structure of Humic Acid



Other Typical Results

Biomass, feed	Corn Hulls	Sugar Cane Bagasse	Giant Reed	Willow Copice	Flax Straw	Oats Hulls	Switch Grass	Miscanthus	Corn Stover	Distiller's Grain	Flax Shives
Oligomeric Lignin	12	13.5	14	17	15	18	16	19	20	20	16
Char	11	12	14	12	15	13	14	13	15	17	16

Fast pyrolysis: - proposed, potential applications of main product streams

	Energy	Agriculture	Green Chemistry
Water soluble Hodge' carbonyls Typical yield: 35 - 45wt%	Hydrogen (S. Czernik, 2002)	Water-soluble polymeric fertilizers - melanoidins (after neutralization with ammonia, ureas...) Micro-nutrients carriers (Bio-Pirol, Brazil)	Chelating/complexing agents
	Synthesis gas (methane co-reforming)		Co-polymers based on hydroxyacetaldehyde dimer
	Gasoline Water-based catalysis (Huber, Dumesic, 2006)	Pesticides, anti-fungal and pathogen destruction agents (UWO)	Food aromas/browners
			Synthetic self-replicators
	Steam reforming towards synthesis gas (Arauzo, 2009)	Fumigation of tomato/strawberry pads	H_2S capture
			Cosmetics/embalmers
Oligomeric lignin Typical yield: 15 - 25wt%	Gasoline boosters Cyclo-paraffins (Piskorz, 1989) and UOP hydrogenation (2009)	SOC containing humus precursor	Resin modifiers/fillers
		N,P,K-C fertilizers	
		Germination accelerators	Anti-oxidants (ala pycnogenol, resveratrol, betulin...)
		Seed coating	
Bio-char Typical yield: 10 - 20wt%	Boilers, kilns,	Permanent fertilizer USDA ARS - reduced leaching of N and P (2008)	Absorbers
	metallurgy	Reduction of soil erosion. Loss of agrochemicals minimized (Laird, 2008)	Catalysts carriers

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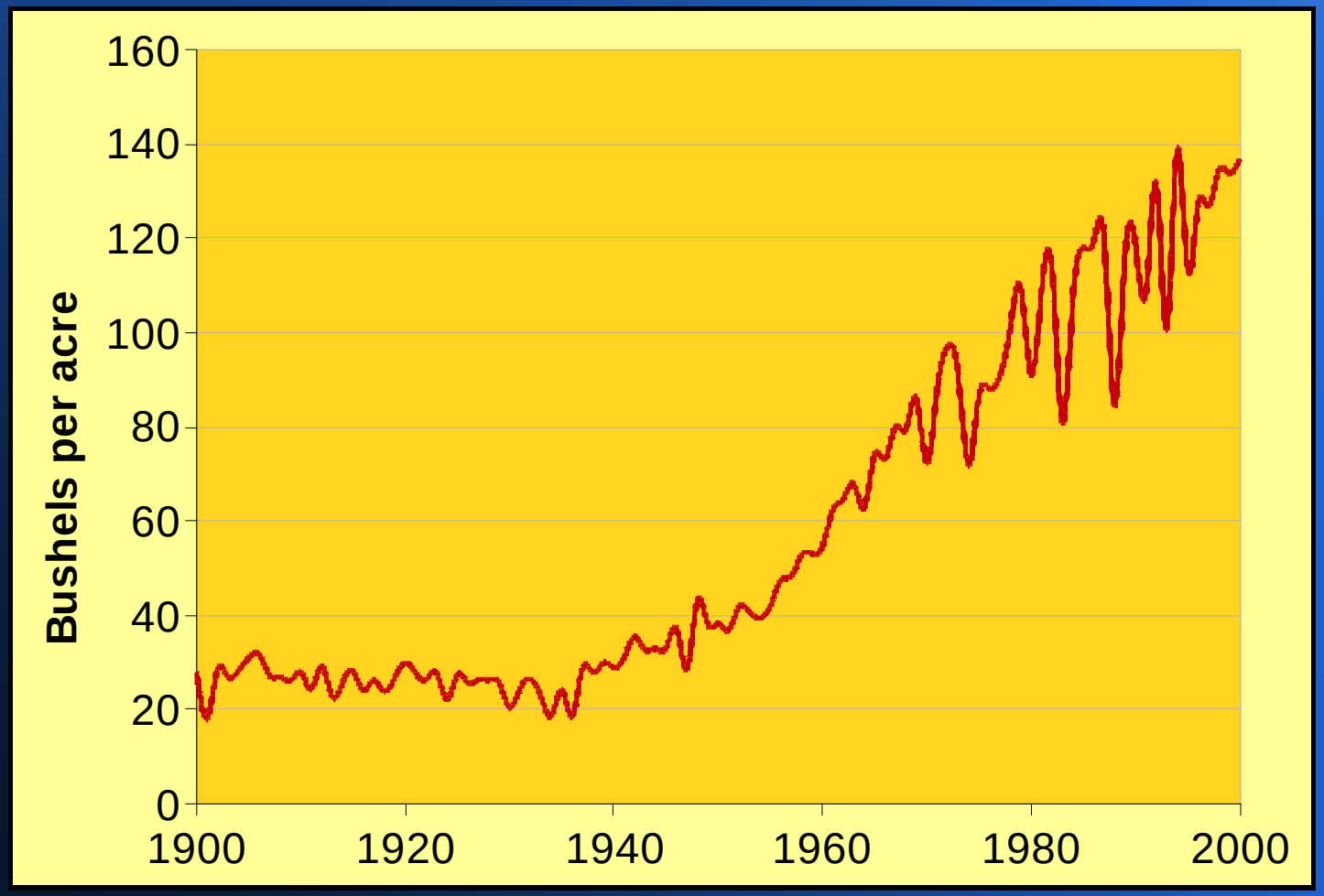
Semi Commercial Plant

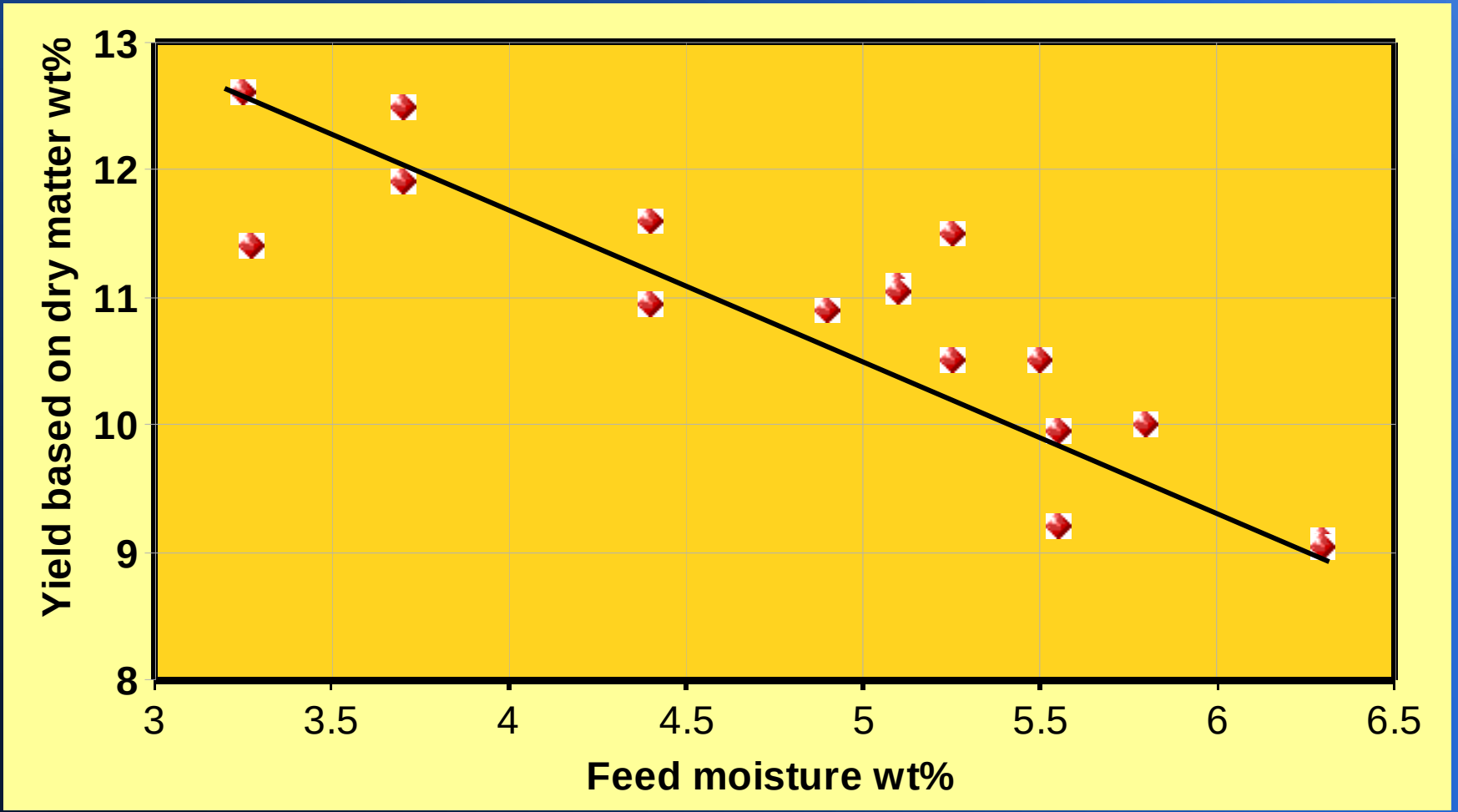
2kg/h Pyrolyzer

Average Corn Yields in USA, 1900-2000



Source: USDA-NASS

Yield of Pyrolysis Water

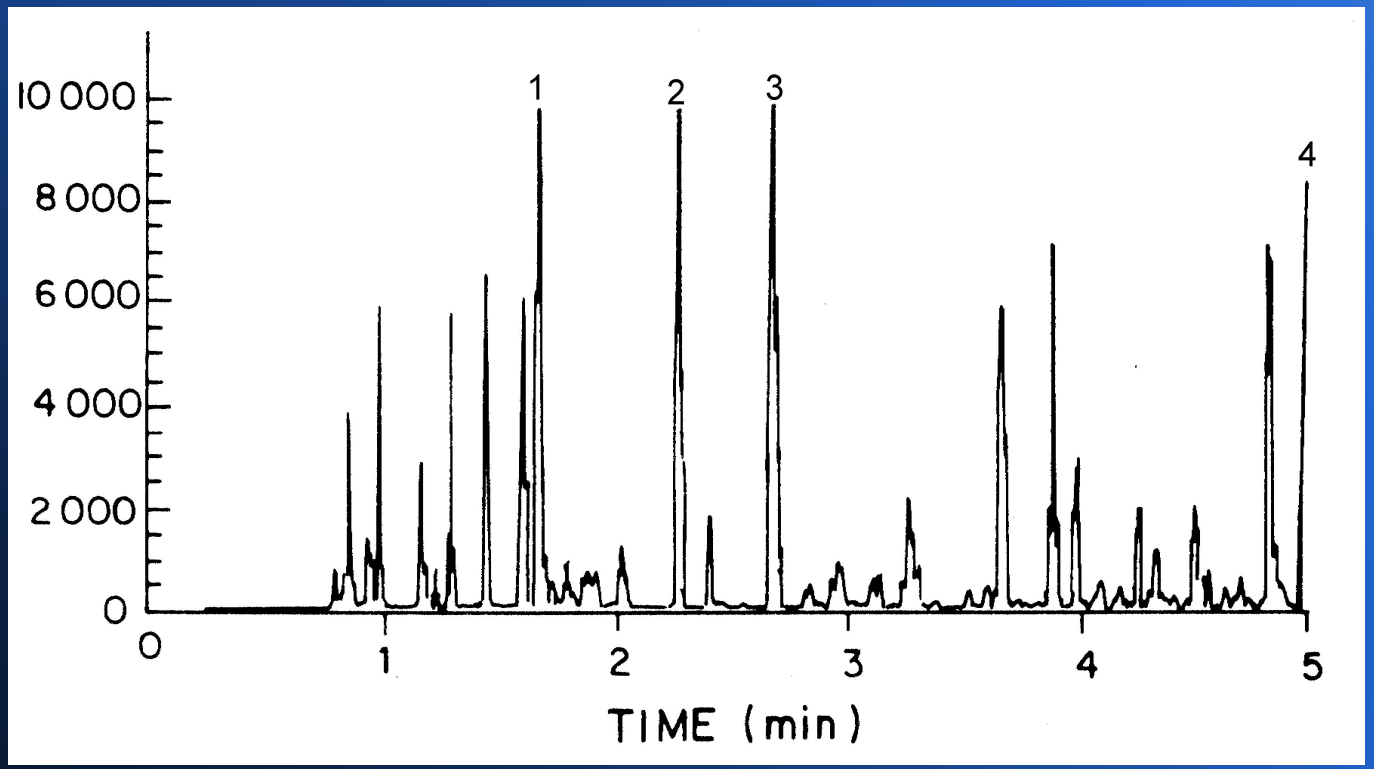


Source: Y. Solantausta

“Bio-oil” - liquid product (condensate) of fast pyrolysis - properties:

- Water content ~20 wt% or more
- Immiscible with petroleum hydrocarbons
- No ignition (at room conditions)
- Calorific value ~60% of bunker C
- Cetane number- less than 8
- Octane number – not applicable
- Ageing instability
- Thermal instability (char particulates effect)
- Non-distillable
- Contaminated by charcoal particulates of micron sizes
- Pungent odour
- Corrosive
- Acidic
- Storage disadvantages
- Combustion emission rich in CO and particulates
- Seldom homogeneous liquid – in form of micro-emulsion, micellar solution

Total ion chromatograph of light organic product from hydrotreating of oligomeric lignin



1. cyclohexane 2. methylcyclohexane 3. toluene 4.propylbenzene

J. Piskorz, P. Majerski, D. Radlein and D.S. Scott. Energy & Fuels, 1989, 3, 723