

Seth Burns

Biogas & Electric, LLC
4225 Executive Square, Suite 430
San Diego, CA 92037-8412

NOxRx[®]

Emissions Control for
Biogas Engines



**biogas &
electric[®]**

Tuesday, October 28, 2014

seth@biogasandelectric.com

www.biogasandelectric.com



NIFA



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

NOxRx[®] Origins

Inventor:



Mike Matelich, Ph.D. (Chief Scientific Officer)

- Ph.D. in Chemistry from Stanford University
- Postdoctoral fellow at Harvard University
- 20 years experience in catalysis and optimization of chemical reactivity

R&D Funded by:



NIFA



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

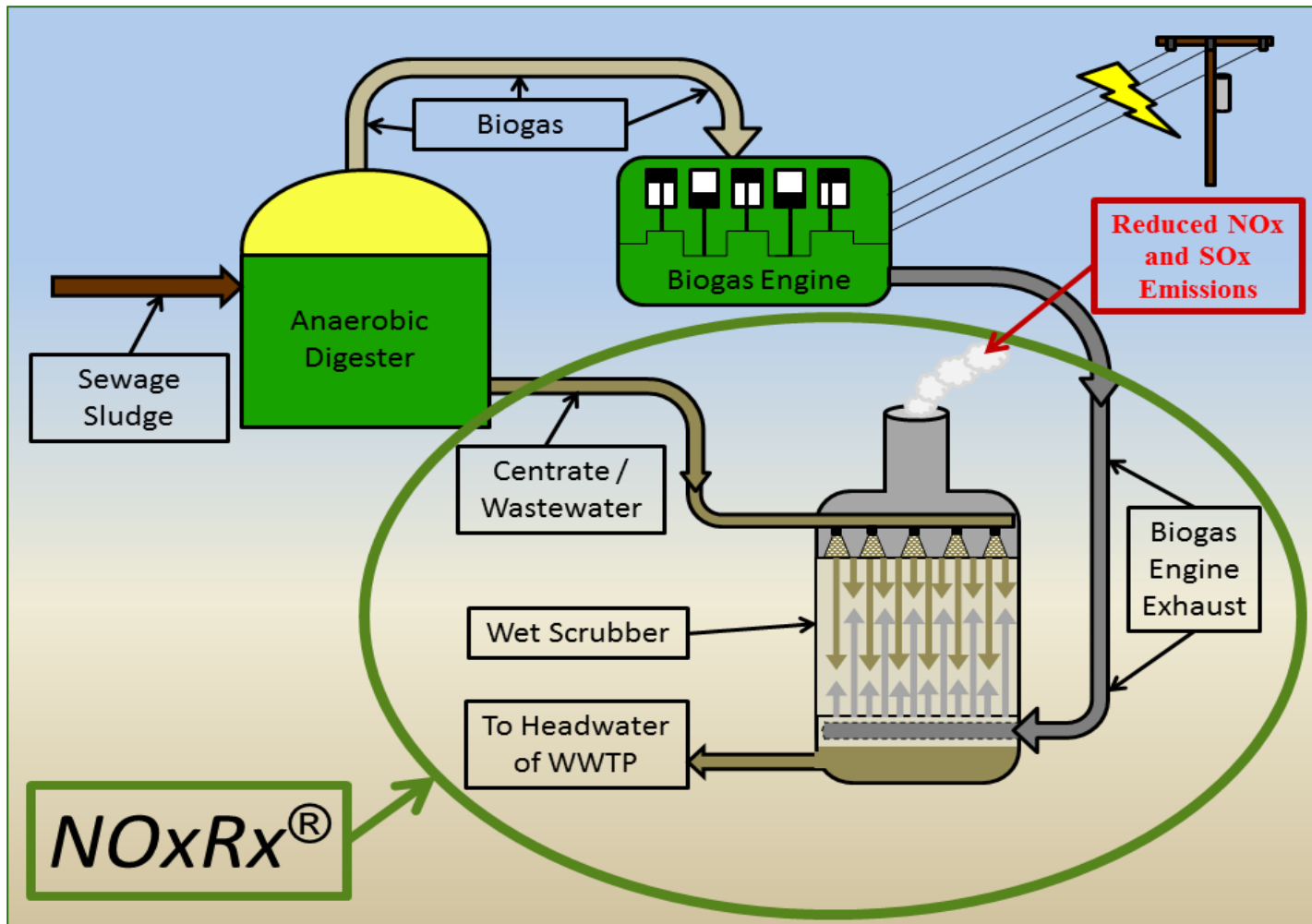


Stationary Biogas Engine



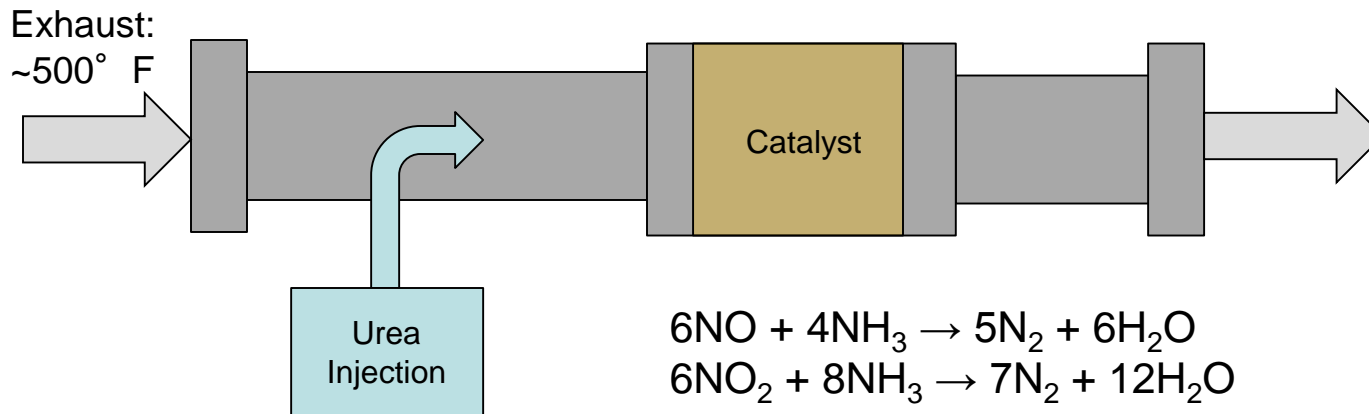
- SCAQMD rule 1110.2: NOx 11ppm
- SJVAPCD rule 4702: NOx 9-11ppm
- 2007 CARB standard: NOx 2-3ppm

NOxRx[®]: Emissions Reduction Solution



US Patent #8,012,746 and other patents pending.

SCR – Selective Catalytic Reduction



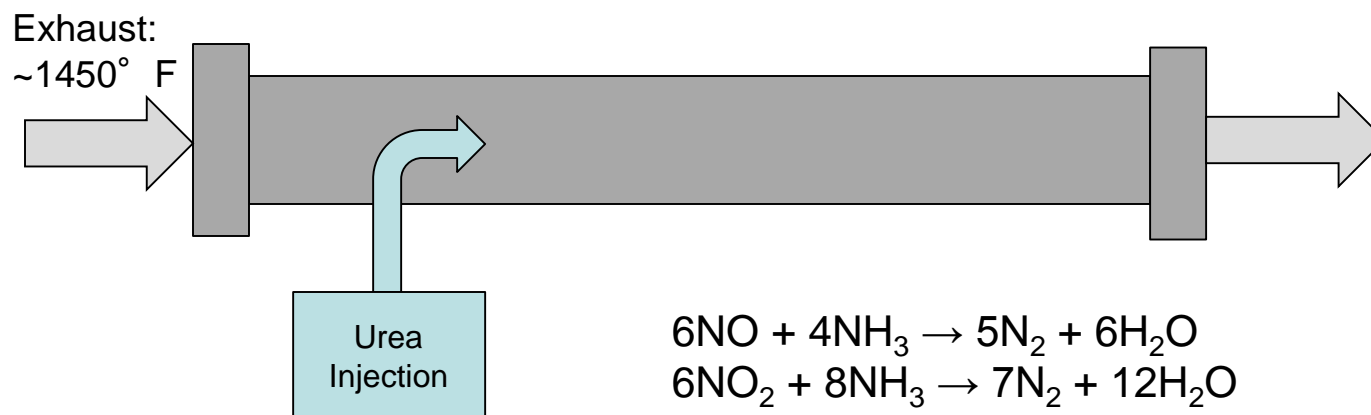
Pros:

- Good NO_x reduction (to 9 – 11 ppm)

Cons:

- Requires H₂S reduction prior to combustion
- Continual urea purchases and catalyst replacement
- Not CARB compliant (2 – 3 ppm)
- N₂O production (GHG approximately 300 times more potent than CO₂)

SNCR – Selective Non-Catalytic Reduction



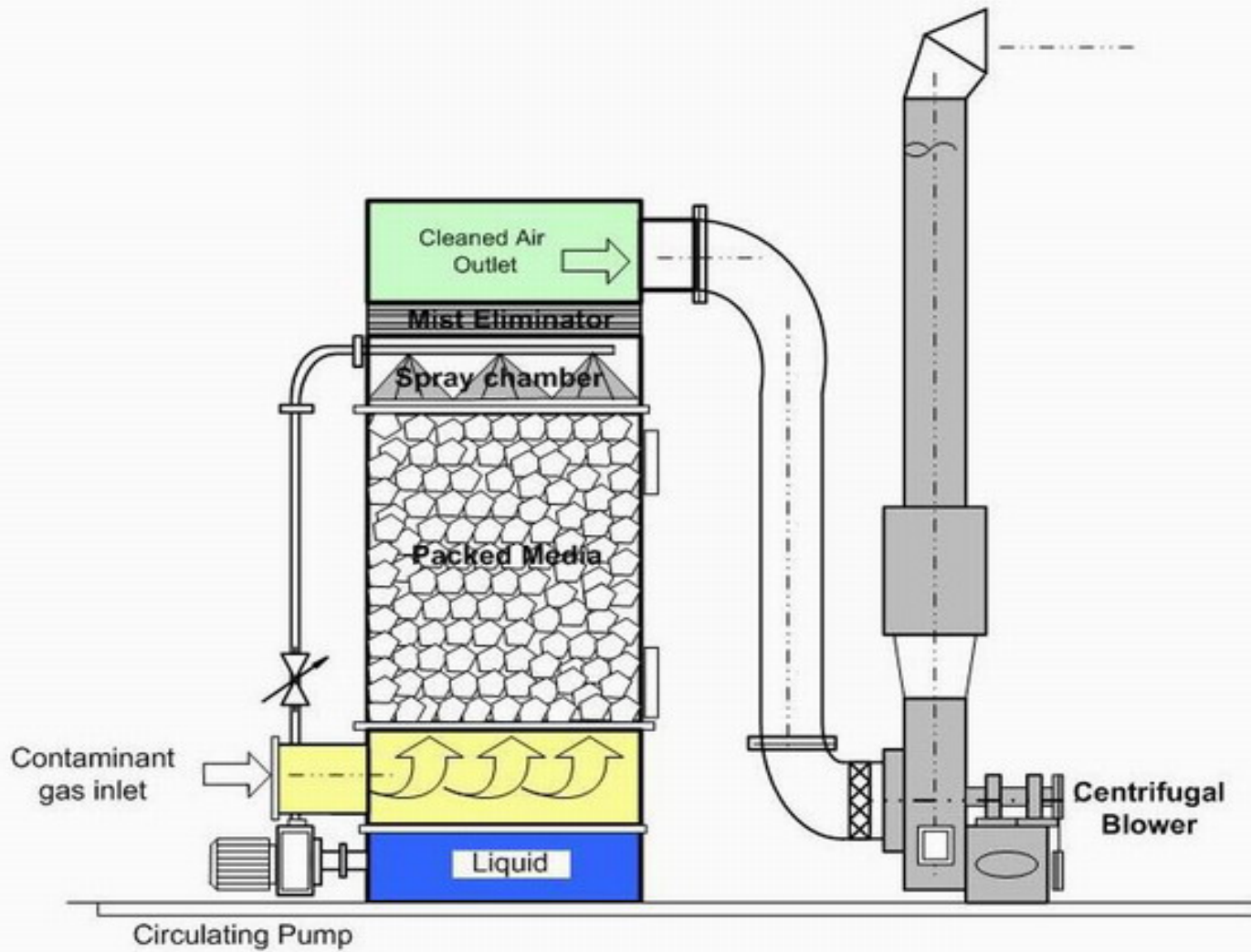
Pros:

- Up to 70% NO_x reduction

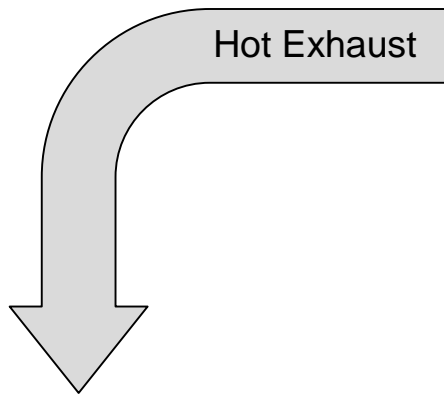
Cons:

- Not CARB compliant
- Continual urea purchases
- Must heat exhaust stream to 1450° F

Wet Scrubbing - Overview



NOxRx[®]: Emissions Reduction Solution



Quench

- Increase humidity
- Reclaimed water

Cool

- Exhaust temperature reduced to <math><120^{\circ}</math> F

Oxidize

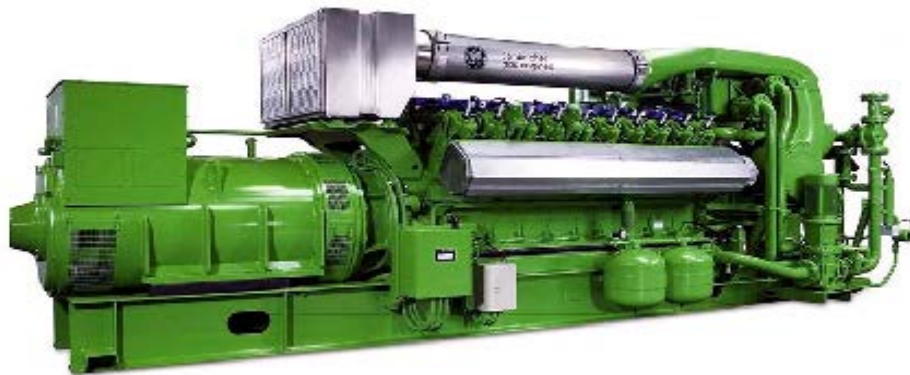
- Non-catalytic or catalytic method(s)

Absorb
& React

- 50-70% reduction at each stage

Combined Heat and Power (CHP) is the Solution

	CHP with NOxRx [®]	Fuel Cell	Condition for Pipeline	Plasma Arc Gasification	Micro Turbine
Efficiency	A	A+	B	C	C
Emissions	A-	A	A-	B	A-
CAPEX	A	F	D	D	C
OPEX	A	C	C	C	B
Sustainability	A	C	B	C	B



NOxRx[®]: Emissions Reduction Solution



Demonstration:

	Before	After
NOx	37 ppm	2 ppm
SOx	585 ppm	< 0.1 ppm

- CARB Compliant
- No H₂S reduction required
- Low cost
- Robust
- Scalable

US Patent #8,012,746 and other patents pending

Bakersfield Wastewater Treatment Plant #3

NOxRx[®] installation underway:



seth@biogasandelectric.com



Proposal

City of Palm Springs Wastewater Treatment Plant



Questions?

Thank you to:



Biogas & Electric, LLC
4225 Executive Square, Suite 430
San Diego, CA 92037-8412

T: 619-251-3849
seth@biogasandelectric.com