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Advanced Combustion- Request for Information - Part 2 of 2

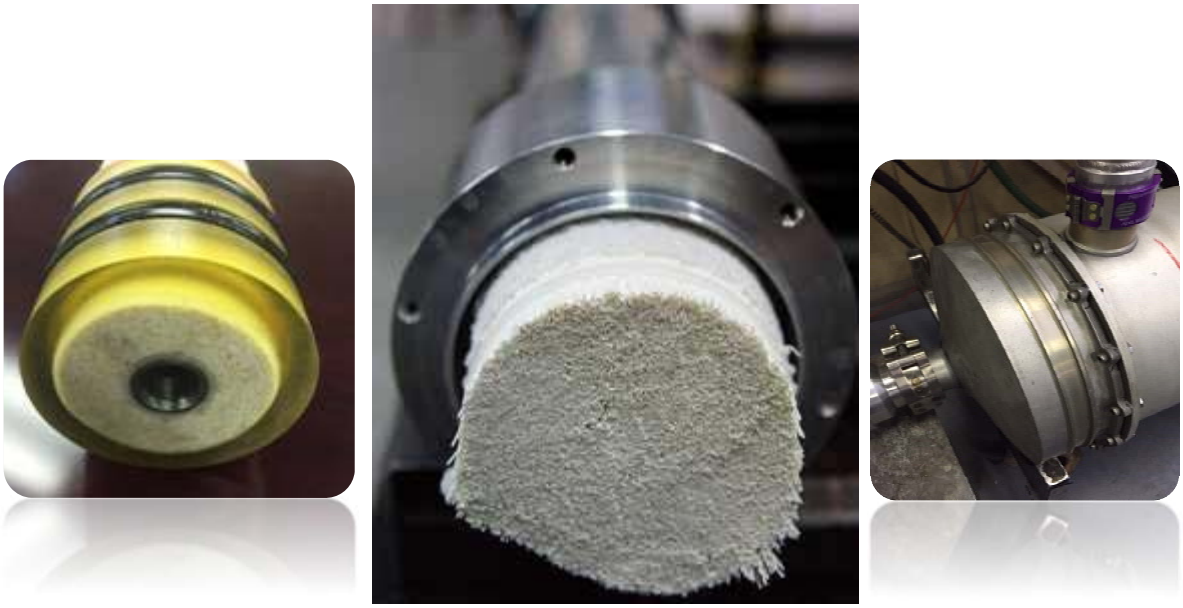
Additional submitted attachment is included below.

Black Swan, LLC

Marc Straub
General Manager – Membranes, Vice President – Technology
Generon IGS, Inc.
Arcy Lane 992, Building 992
Pittsburg, CA 94565

September, 24th 2020

Brian Kolodji, PE and President
Black Swan, LLC
5612 Segovia Way
Bakersfield, CA 93306



Ref.: **19-ERDD-01, Research Idea Exchange for "FUTURE SOLICITATION ON OXYGEN-ENRICHED COMBUSTION"**

Honorable Chair Hochschild:,

Generon IGS, is a manufacturer and employer of about 40 people in California and we are operating in the bay area for more than 40 years. Generon is a spin-off of Dow Chemical and was incorporated in 2001 and we are 100% privately owned. Generon manufactures air and gas separation membranes, and specifically the highest performance and lowest pressure/energy/ cost Black Swan Wig Membranes for

oxy-combustion. These membranes are hollow-fiber membranes that can be used in systems for power plants, industrial boilers, refinery, chemical and oil&gas industry and have been used mostly for oxygen production from air. Generon is one of four membrane manufactures in the gas processing industry located in California, and one of dozens of companies in the world that manufactures hollow-fiber membranes, but we are the only membrane company in California that spin their own commercial hollow-fibers here in California and the only membrane manufacturer that offers the patent pending highest performing/lowest capital/ operating cost membrane in the world, the Black Swan Wig Membrane..

Black Swan, LLC from Bakersfield, California has developed the patent pending Black Swan Wig membrane and the Black Swan Membrane Air Enrichment Process. Kolodji Corp is an engineering company with a common owner, Brian Kolodji, with both corporate entities being California based out of Kern County California, and have operations of pilot plants with Black Swan, LLC energy carbon management technology. Black Swan Membrane Air Enriched (MAE) oxy-combustion technology reduces fuel consumption, and associated greenhouse gas (CO2) emissions, both by up to 40% without reducing duty (steam or power generation) in power plants or any industrial plant that fires fuel and air Black Swan technology produces up to 43% enriched oxygen from air that replaces the combustion air going to the furnace with only a simple low cost modification to the burner of the power plant or boiler. Black Swan, LLC Waste Heat Recovery and Flue Gas Extraction and Biosequestration technologies add more value by producing even more returns on energy savings, making and reducing usage of potable water, and producing food from CO2 emissions. Additionally, the priority pollutant concentration of the flue gas is reduced, specifically for NOx and CO emissions. These emissions can be reduced by up to 70%. A case study showing reduction in natural gas usage without impacting duty is provided for a biogas fired power plant. Biogas is a 100% sustainable renewable fuel, but because of the low heating value, biogas requires over 10% fuel supplementation with natural gas, a non-renewable fuel. With oxygen enrichment to only 24%, biogas is able to sustain combustion without supplemental non-renewable natural gas. PROMAX (as licensed by Kolodji Corp) simulations below show elimination of the use of natural gas using oxygen enrichment and exclusively biogas, while retaining the same duty performance for the power plant.

	Energy Consumption		
	1 tpd [kWh/ ton O2]	**25 tpd** [kWh/ ton O2]	**100 tpd** [kWh/ ton O2]
Cryogenic ASU	n/a	n/a	**11.1**
O2-PSA	**52.5**	n/a	n/a
O2-VPSA	n/a	**14.6**	**12.6**
Traditional "NITROX" Membrane Process	**18.8**	**18.8**	**18.8**
Black Swan / Generon	**10.0**	**10.0**	**10.0**

GENERON

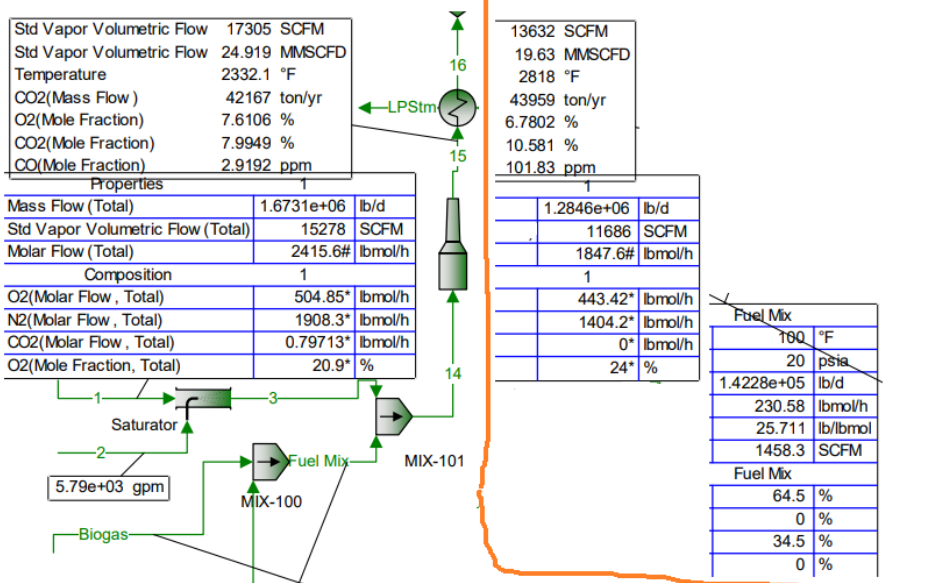
Black Swan, LLC

COMMENTS FOR RFI BY CEC 09242020

PROMAX BIOMASS POWER PLANT SIMULATIONS

CASE 1 DATA: BIOGAS WITH NATURAL GAS AND AIR >>>>>>>>>>>>

CASE 2 DATA: <<<<< BIOGAS ONLY WITH O2 ENRICH AIR



Std Vapor Volumetric Flow	17305	SCFM
Std Vapor Volumetric Flow	24.919	MMSCFD
Temperature	2332.1	°F
CO2(Mass Flow)	42167	ton/yr
O2(Mole Fraction)	7.6106	%
CO2(Mole Fraction)	7.9949	%
CO(Mole Fraction)	2.9192	ppm

	13632	SCFM
	19.63	MMSCFD
	2818	°F
	43959	ton/yr
	6.7802	%
	10.581	%
	101.83	ppm

Properties	1	
Mass Flow (Total)	1.6731e+06	lb/d
Std Vapor Volumetric Flow (Total)	15278	SCFM
Molar Flow (Total)	2415.6#	lbmol/h
Composition	1	
O2(Molar Flow , Total)	504.85*	lbmol/h
N2(Molar Flow , Total)	1908.3*	lbmol/h
CO2(Molar Flow , Total)	0.79713*	lbmol/h
O2(Mole Fraction, Total)	20.9*	%

	1.2846e+06	lb/d
	11686	SCFM
	1847.6#	lbmol/h
	1	
	443.42*	lbmol/h
	1404.2*	lbmol/h
	0*	lbmol/h
	24*	%

Fuel Mix	
100	°F
20	psia
1.4228e+05	lb/d
230.58	lbmol/h
25.711	lb/lbmol
1458.3	SCFM
Fuel Mix	
64.5	%
0	%
34.5	%
0	%

Std Vapor Volumetric Flow	1.83	MMSCFD
Water Content	7.6813	mg/L
CO2(Mole Fraction)	34.5	%
C1(Mole Fraction)	64.5	%
Water(Mole Fraction)	1	%

2.1 MMSCFD

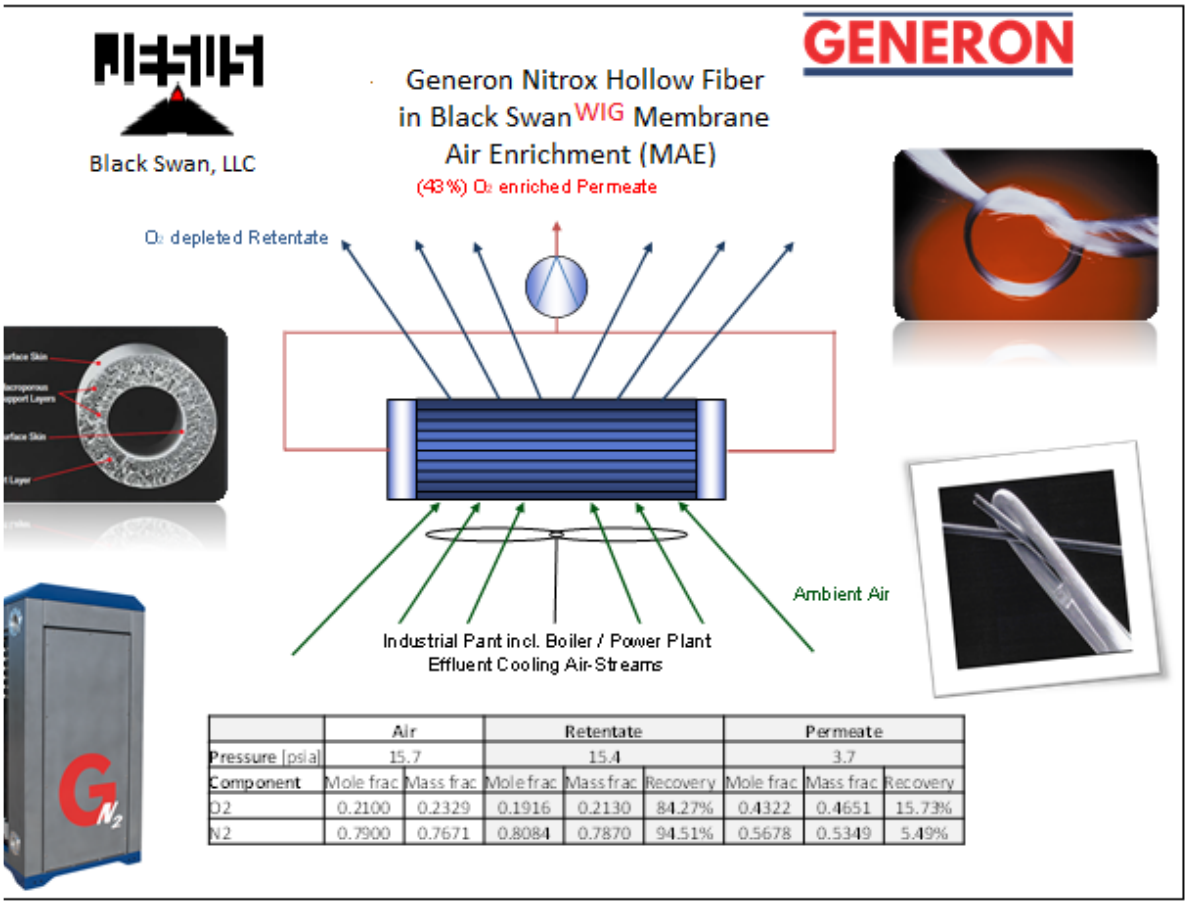
Properties	Fuel Mix	
Temperature(Total)	97.47	°F
Pressure(Total)	20	psia
Mass Flow (Total)	1.3154e+05	lb/d
Molar Flow (Total)	219.6	lbmol/h
Molecular Weight(Total)	24.959	lb/lbmol
Std Vapor Volumetric Flow (Total)	1388.9	SCFM
Composition	Fuel Mix	
C1(Mole Fraction, Total)	67.093	%
C2(Mole Fraction, Total)	0.255	%
CO2(Mole Fraction, Total)	31.653	%
N2(Mole Fraction, Total)	0.085	%

Std Vapor Volumetric Flow	0.17	MMSCFD
C1(Mole Fraction)	95	%
CO2(Mole Fraction)	1	%
C2(Mole Fraction)	3	%
N2(Mole Fraction)	1	%

0 MMSCFD

Names	Units	3	14	15	16	3	14	15	16
Temperature	°F	100	99.7	2.33e+03	350*	100	99.9	2.82e+03	350*
Pressure	psia	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
Mole Fraction Vapor	%	100	100	100	100	100	100	100	100
Mole Fraction Vapor	%	100	100	100	100	100	100	100	100
Mass Density	lb/ft^3	0.0696	0.0689	0.0138	0.0476	0.0698	0.0691	0.0118	0.0477
Molar Flow	lbmol/h	2.52e+03	2.74e+03	2.74e+03	2.74e+03	1.92e+03	2.16e+03	2.16e+03	2.16e+03
Mass Flow	lb/d	1.72e+06	1.85e+06	1.85e+06	1.85e+06	1.32e+06	1.46e+06	1.46e+06	1.46e+06
Molecular Weight	lb/lbmol	28.4	28.1	28.1	28.1	28.5	28.2	28.2	28.2
Std Vapor Volumetric Flow	SCFM	1.59e+04	1.73e+04	1.73e+04	1.73e+04	1.22e+04	1.36e+04	1.36e+04	1.36e+04
Vapor Volumetric Flow	ft^3/min	17133	18616	92984	26962	13104	14670	85993	21236
N2(Molar Flow)	lbmol/h	1908.3	1908.5	1908.5	1908.5	1404.2	1404.2	1404.2	1404.2
O2(Molar Flow)	lbmol/h	504.85	504.85	208.23	208.23	443.42	443.42	146.13	146.13
Water(Molar Flow)	lbmol/h	100.67	102.68	399.02	399.02	76.998	79.304	376.66	376.66
CO2(Molar Flow)	lbmol/h	0.79713	70.305	218.75	218.75	0	79.549	228.05	228.05
N2(Mole Fraction)	%	75.839	69.759	69.752	69.752	72.959	65.154	65.149	65.149
O2(Mole Fraction)	%	20.064	18.453	7.6106	7.6106	23.04	20.575	6.7802	6.7802
Water(Mole Fraction)	%	4.0007	3.7531	14.583	14.583	4.0007	3.6797	17.476	17.476
CO2(Mole Fraction)	%	0.03168	2.5698	7.9949	7.9949	0	3.6911	10.581	10.581
Mass Cp	Btu/(lb*°F)	0.24746	0.2549	0.3305	0.26705	0.2466	0.25588	0.34574	0.27055
Ideal Gas CpCv Ratio		1.3945	1.3839	1.2714	1.3596	1.3944	1.3803	1.2555	1.352
CpCv Ratio		1.3965	1.386	1.2714	1.3615	1.3964	1.3826	1.2555	1.354
Dynamic Viscosity	cP	0.018683	0.01821	0.055063	0.023372	0.018769	0.018149	0.061498	0.023186
Thermal Conductivity	Btu/(h*ft*°F)	0.0154	0.015534	0.057988	0.020368	0.015406	0.015565	0.0666	0.020272

Black Swan, LLC



	Air		Retentate			Permeate		
Pressure [psia]	15.7		15.4			3.7		
Component	Mole frac	Mass frac	Mole frac	Mass frac	Recovery	Mole frac	Mass frac	Recovery
O2	0.2100	0.2329	0.1916	0.2130	84.27%	0.4322	0.4651	15.73%
N2	0.7900	0.7671	0.8084	0.7870	94.51%	0.5678	0.5349	5.49%

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Due to the benefits of Black Swan, LLC/Generon Membrane Technology future green-field projects or re-vamped brown-field projects in California can benefit from technology made in California leading to reduced fuel consumption, reduced Green House Gas (CO2) emissions, reduced NOx emissions, and reduced water consumption, and increased agricultural production!. The technology can then be exported to the rest of the world to combat the Energy-Water-Food Nexus dilemma, Greenhouse gas accumulation in the atmosphere, and resolve climate change on a global level by 2030, sooner than California's mandate of 2045.