MicGAS™ Clean Coal HUMAXX Biorefinery
A Step Change Clean Tech

Must Have:

Cleaner Air, Water, Food, Energy, Shelter

Desire:

Health, Environment

Wants:

Comfort, Entertainment, Communication, Information, Transportation

Must Maintain:

Productive Soils, Cleaner Water & Air

Desire :

Sustainability

Wants:

Sustain Other Inhabitants

ARCTECH, Inc.
14100 Park Meadow Drive
Chantilly, VA 20151
Tel. (703) 222-0280
www.arctech.com

Technology and Proven Solutions for the Musts

March 2014

ARCTECH
Offering "Balanced Sustainable Solutions"

ARCTECH Corporate Profile

- Established in 1988 as Spin-Off Company
  - From a Major US Aerospace Company
- Corporate Headquarters & Technical Research Center
  - Chantilly, Virginia
- Manufacturing Plant
  - South Boston, Virginia
- Market Profile: Develop Innovative Solutions from Concept to Implementation for the Energy, Environmental, and Agricultural markets
- Commercial Products Applications in the US, Egypt, Gulf Countries, & South Korea
- Creating Biotechnology Solutions since Mid 70's
- Selected as One of the Top Six Bio-Processing Firms in the United States
  - By Ernst & Young in 1989
- Founding Member of *Humic Products Trade Association (HPTA)* in 2011

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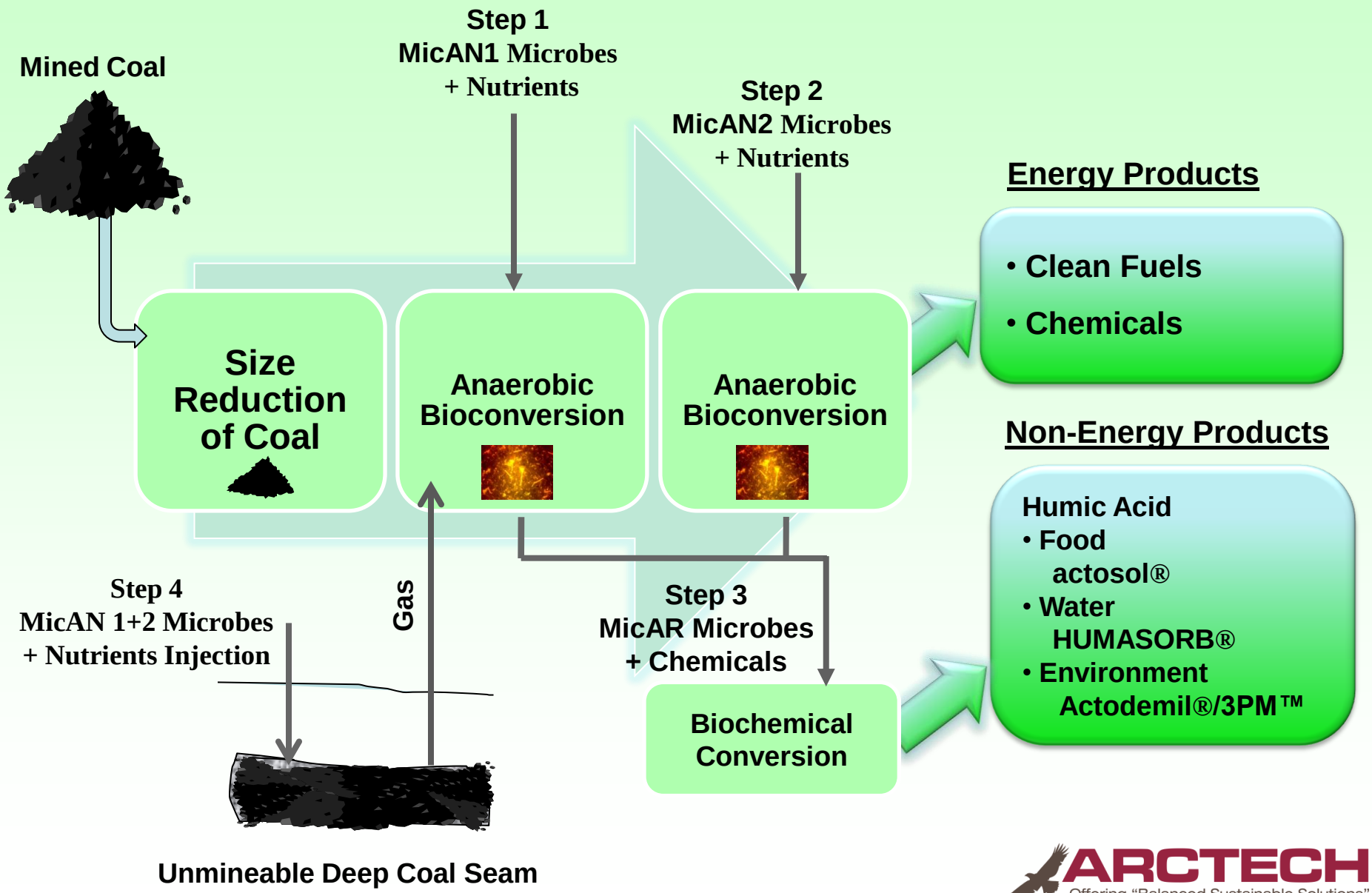
An Integrated MicGAS™ Biotechnology Process Flow Scheme



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Coal is the Most Abundant and Lowest Cost Source of Carbon for Fuels and Chemicals

Source	$1 Ton	% Carbon	$/Ton Carbon
Waste Biomass	-5 + 40	25	-20 + 160
Cultivated Biomass	60	25	240
Corn Grain	120	30	400
Coal	**5-40**	**60**	**12.5-100**

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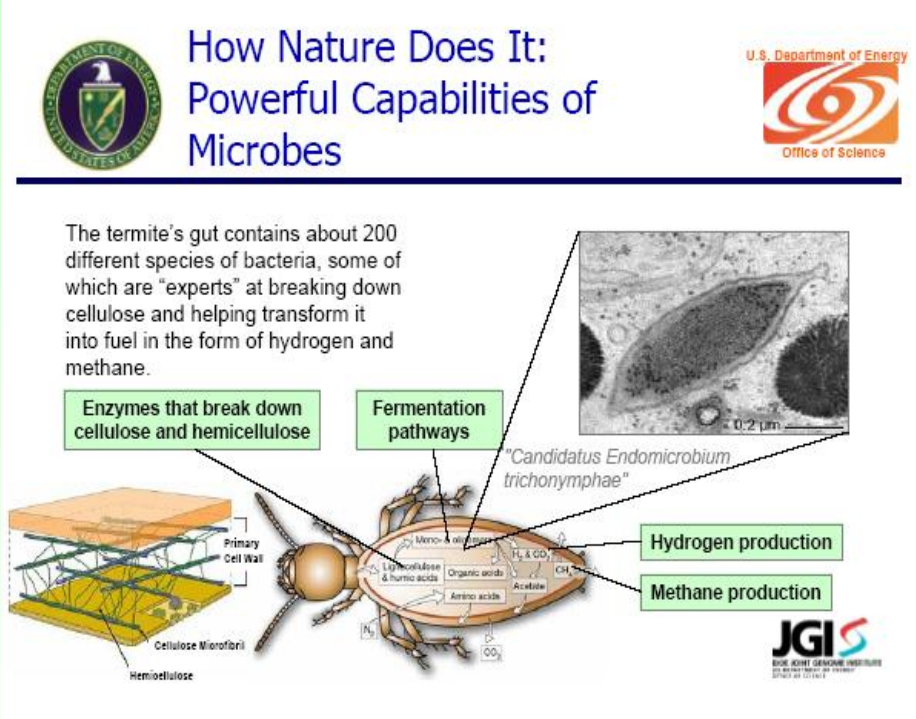
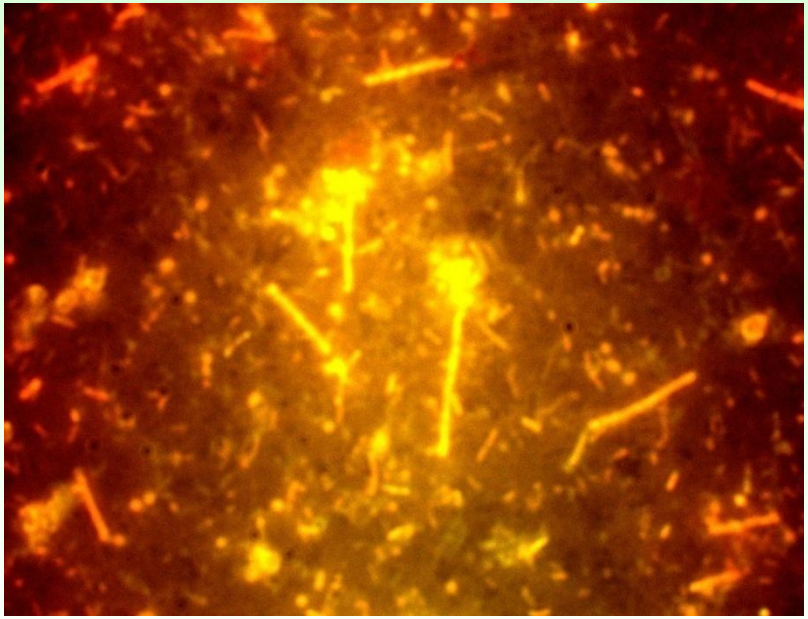
MicGAS™ Coal Biotechnology Among U.S. Department of Energy 14 Transformation Technologies



US Department of Energy *2007*



Mic1 Biotechnology Microbes from Termite Guts

Dr. Steven Chu sees an America free from foreign oil, powered by home-grown genetically engineered and eco-friendly fuel.
The Nobel laureate gets his inspiration from the guts of termites. The processes that allow insects to turn the hard fabric of plant material - cellulose - into an ethanol-like fuel is the key to cheap, clean-burning and virtually limitless fuel.

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LIST OF PATENTS AND TRADEMARKS

Patent # 5, 538, 530-July 23, 1996
Method for Safely Disposing of Propellant and Explosive Materials and for Preparing Fertilizer Compositions-Actodemil®.

Patent # 5, 670, 345-September 23, 1997
Biological Production of Humic Acid and Clean Fuels From Coal-MicGAS™ & Humic Acid.

Patent # 5, 854, 032-December 29, 1998
Biological Production of Humic Acid and Clean Fuels From Coal-MicGAS™ & actosol®

Patent # 5, 906, 960-May 25, 1999
Absorbent-HUMASORB®- CS (solid).

Patent # 6, 143, 692-November 7, 2000
Absorbent-HUMASORB®- L (liquid)
(valid for 20 years from date of issuance)

ARCTECH TRADEMARKS:

actosol® -January 2, 1992 Registered No.: 1,672,298
HUMASORB® - July 17, 2001 Registered No.: 76/074428
Actodemil® -July 24, 2001 Registered No.: 76/074429

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FETC SUCCESS

U.S. Department of Energy
Federal Energy Technology Center

CLEAN AFFORDABLE FUELS

- [x] fossil energy
- [ ] environmental
- [ ] energy efficiency
- [ ] other

M990000471 P8.5

ACTOSOL®

States Impacted:
All states

Benefit Areas:
Environmental Quality Improved

Participants:
ARCTECH, Inc.

FETC Contact:
Madhav Ghate**
Office: (304) 285-4135
E-Mail:ghate@fetc.doe.gov

MAIL ADDRESS:
* U.S. Department of Energy
P.O. Box 10940
626 Cochrans Mill Road
Pittsburgh, PA 15236-0940

**U.S. Department of Energy
P.O. Box 880
3610 Collins Ferry Road
Morgantown, WV 26507-0880

WEBSITE:
www.fetc.doe.gov

Description

Supported by the U.S. Energy Department's Federal Energy Technology Center, ARCTECH, Inc., of Chantilly, Virginia, developed and patented a technology called MicGAS™ that uses a biological conversion process to produce a hydrogen-rich clean fuel gas. While developing MicGAS™, the company produced a highly successfully spinoff, a carbon-rich humic acid fertilizer product now being commercially marketed throughout the U.S. and international markets. ARCTECH based the MicGAS™ technology on the biological conversion of coal as a way to produce a clean fuel gas, as well as the humic acid by-product, while reducing carbon dioxide. The technology uses naturally occurring microorganisms that are adapted to the conversion process. The bioconversion occurs in three steps. The first step uses chemical processes called hydrolysis and fermentation in which microbes convert coal into volatile organic liquids. These first-step liquids and gases are contacted with methane-producing microbes that hydrogenate the acetate and carbon dioxide to methane. When the methane is separated, it undergoes a biochemical conversion in step three, where the coal residue is converted into the humic acid by-product called actosol®.

Goals

To facilitate the efficient use of the nation's abundant coal resources for the production of energy, while sequestering carbon as the actosol® by-product and mitigating greenhouse carbon dioxide gas emissions.

Tangible Benefits

National: Because it sequesters carbon, the technology has shown the potential to mitigate greenhouse CO_2 gas emissions by 50 to 75 percent in comparison with the conventional power generation Rankine Cycle approach. In addition, the technology can be easily integrated into newer, high efficiency power plants. Also, ARCTECH recently scaled up a pilot product facility to produce humic acid and formulate it into the actosol® fertilizer product. The fertilizer is being marketed throughout the U.S. for use on golf courses, landscaping projects, erosion control, agriculture production, and many others. Oversees, the product is used in the Middle East to help propagate alfalfa, palm trees, and greenhouse crops, as well as in South Korean for golf courses and greenhouses.

Regional/Local: A primary benefit of the actosol® fertilizer is an increase of crop and plant yields by 20 to 100 percent, resulting in a net value gain of about $100 per acre. The fertilizer would be particularly attractive to those regional or local areas needing a boost in productivity.

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MicGAS™ Coal Biotechnology Demo Unit In Turkey

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Methane Gas Flame From MicGAS™ Clean Coal Bioreactor

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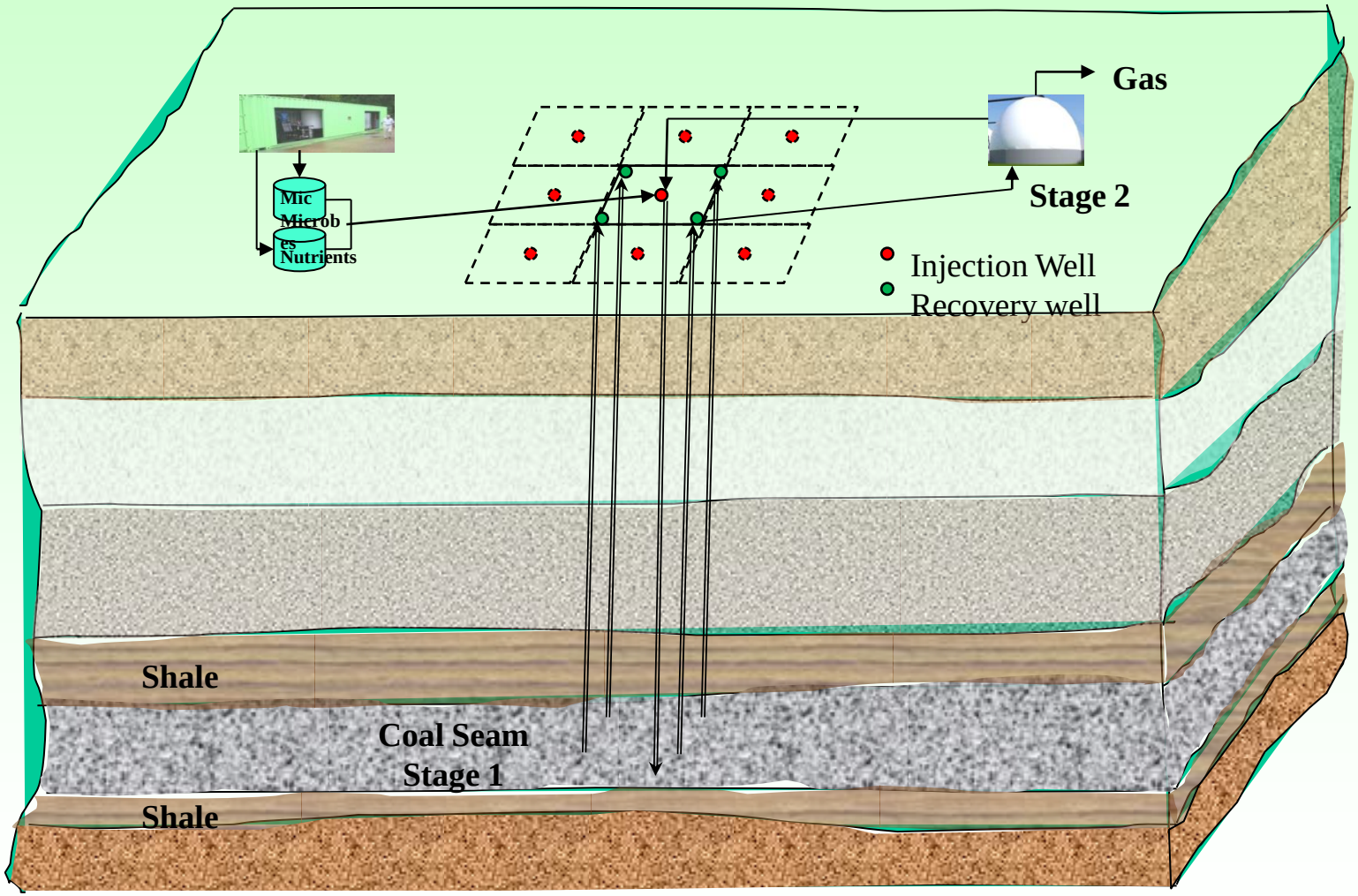
MicGAS™ In Situ Facility Layout



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Total Value Chain of HUMAXX MicGAS™ Coal Biorefinery for Turkish Lignite

100,000 Metric Tons of Bursa Lignite per Year Cost $4,000,000

MicGAS™ Biorefinery

$267 Million Cost

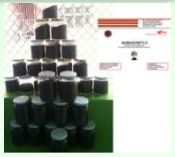
MicMicrobes + Nutrients Injection $18.4Million Cost

15 meters thick seam, 20 Million MT of Coal on 240 acres

Gas 206,000,000 m3

$61.8 Million

HUMASORB®-CS 9,400,000 kg



$28.5 Million

HUMASORB®-L 40,300,000 L

$43 Million

actosol® 300,240,000 L

$423.4 Million

a-HAX™ 30,440,000 L

$51.5 Million

Total Revenues: $608 Million Net Income after Tax $324 Million

APPLICATION USE

Electricity	780 x 10^6 kWh
Industrial & Thermal	1.8 Trillion kcal
Transportation	55 Million gallons of gasoline
Chemicals & Fertilizers	200,000 Tons of Urea
Hydrogen	500 Million m^3

Industrial Wastewater	28 Million m^3
Soil Remediation	Site Specific
Gas Treatment	Site Specific

Agricultures	10 Million Hectares
Forests	15 Million Hectares

Explosives Recycling	30,000 Tons
Manure Recycling	30,000 Tons
Municipal Sewage Water Recycling	28 Million m^3

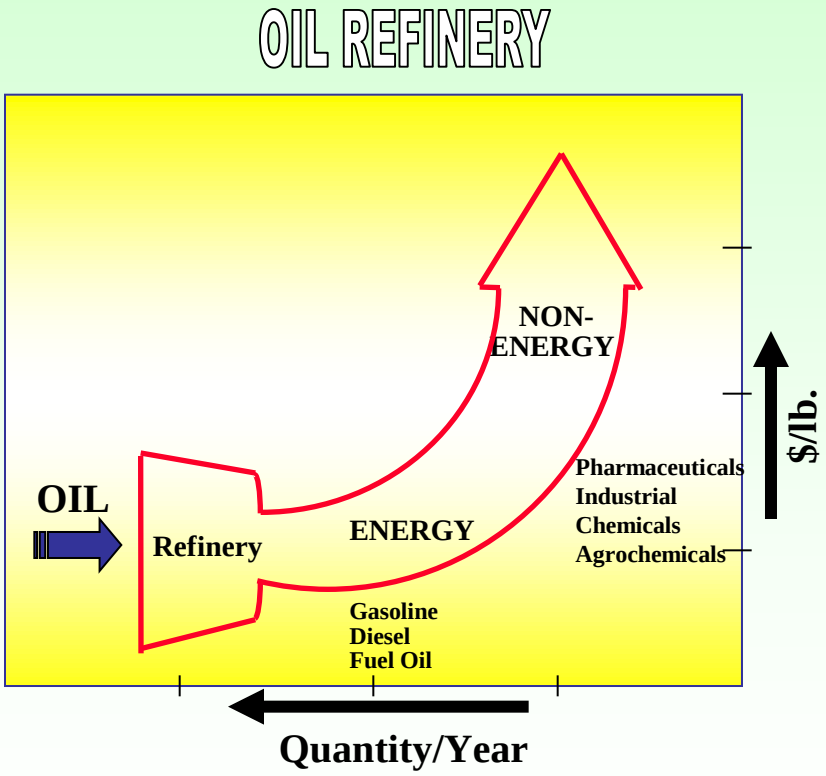
Assumption: Each product goes to 100% of each application use

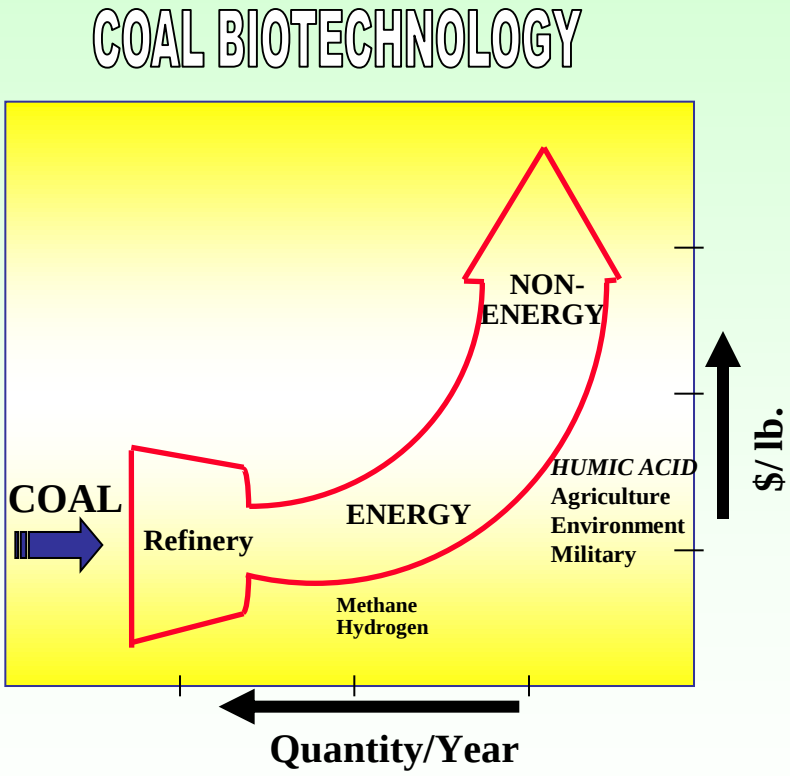
Note:

1 m^3 of gas = 3 kWh
1000 m^3 of gas = 1 Ton of Urea, (wiki.answers.com)
1 m^3 of gas = 1.5 m^3 H_2, (DOE-NREL)
Wastewater: L / m^3 of HUMASORB®-CS
Gas: L of HUMASORB®-L/ m3
Agriculture: 30 L of actosol®/ hectare
Forests: 20 L of actosol®/hectare
Wastes: 1000 L of a-HAX™ / 1 MT

Coal Biotechnology Follows Rockefeller Oil Strategy of Creating Low Cost Energy Fuels

High Value Non-Energy Products Support Production of Economical Energy Fuels





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Natural Gas Produces the Lowest Hazardous Air Pollutants of Concern

HAP	Coal		Oil		Natural gas	
	1990	2010	1990	2010	1990	2010
Arsenic	61	71	5	3	0.15	0.25
Chromium	73	87	4.7	2.4	–	–
Mercury	46	60	0.25	0.13	0.0015	0.024
Nickel	58	69	390	200	2.2	3.5
Hydrogen chloride	143,000	155,000	2,900	1,500	NM	NM
Hydrogen fluoride	20,000	26,000	140	73	NM	NM

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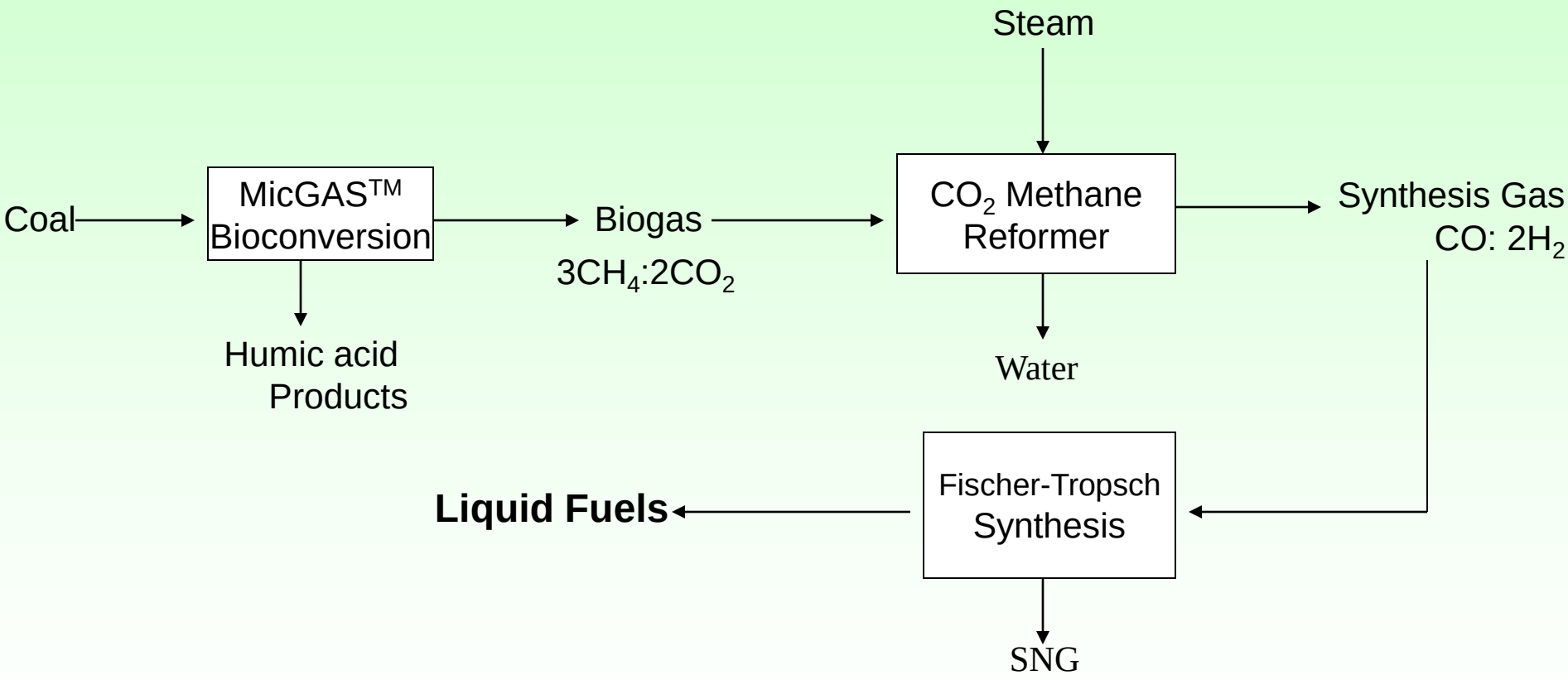
Integrated Flow Scheme of MicGAS™ Coal Biotechnology With Fischer-Tropsch Liquids Production



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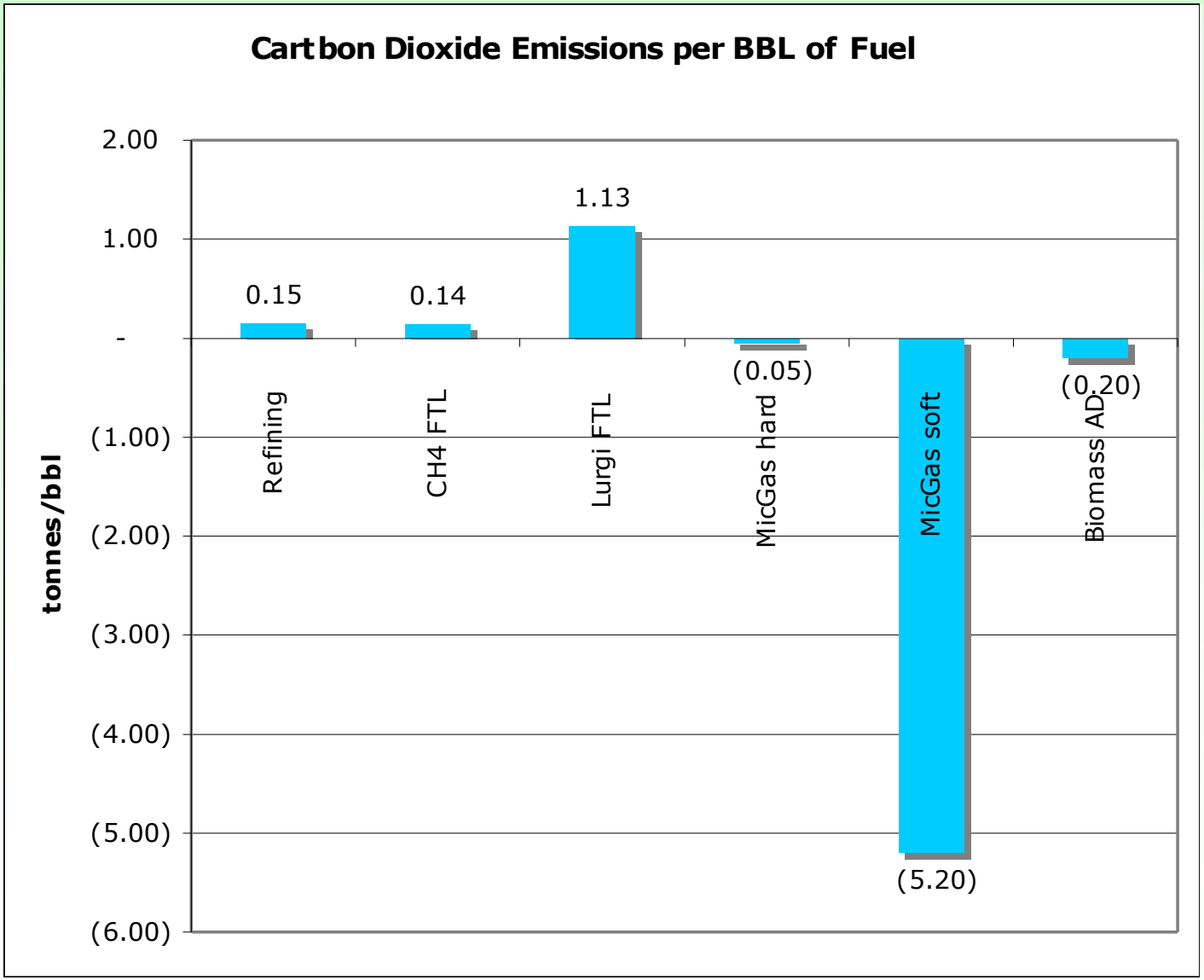
MicGAS™-FTL Eliminates Carbon Foot Print



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Why Methane Gas from MicGAS™ for Energy and Chemicals?

Issues of Today

- Oil reached as high as $146/bbl or $20+/million Btu Natural Methane gas $10+/ million Btu. Prices fluctuate as low as about $4/million Btu
- Worldwide demand for oil and natural gas is increasing because of high economic growth especially large economics of China and India. US supplies dwindling and increasing imports of high cost oil and gas
- Coal use decreasing for power generation because of pollution concerns and global warming
- Increased demand for cleaner transportation fuels

Methane Gas *Solutions*

- Methane produced at less than $2 per million Btu and shall remain competitive even at lower costs of oil and gas
- Demand for methane gas increasing in US
- Clean Methane gas can be easily retrofitted to existing coal plants
- Methane can be converted to liquid fuels and chemicals with existing commercial technology

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Soils are Fourth Largest Storehouse for Carbon

Table 1. Estimated Size of Major Pools of Carbon in the World Carbon Budget

	Trillion kilograms of carbon
Atmosphere (as CO_2)	700
Land	
Biomass	480
Humic substances (expressed as 50% of soil organic matter)	1500-2500
Waters	
Freshwater	250
Marine dissolved and suspended	4150
Sediments	2,000,000
Fossil fuels	10,000

Sources: B. Bolin Science, **196**, 613 (1977); B. Bolin and R. B. Cook, Eds. *The Major Biogeochemical Cycles and Their Interactions*, Wiley, New York, 1983.

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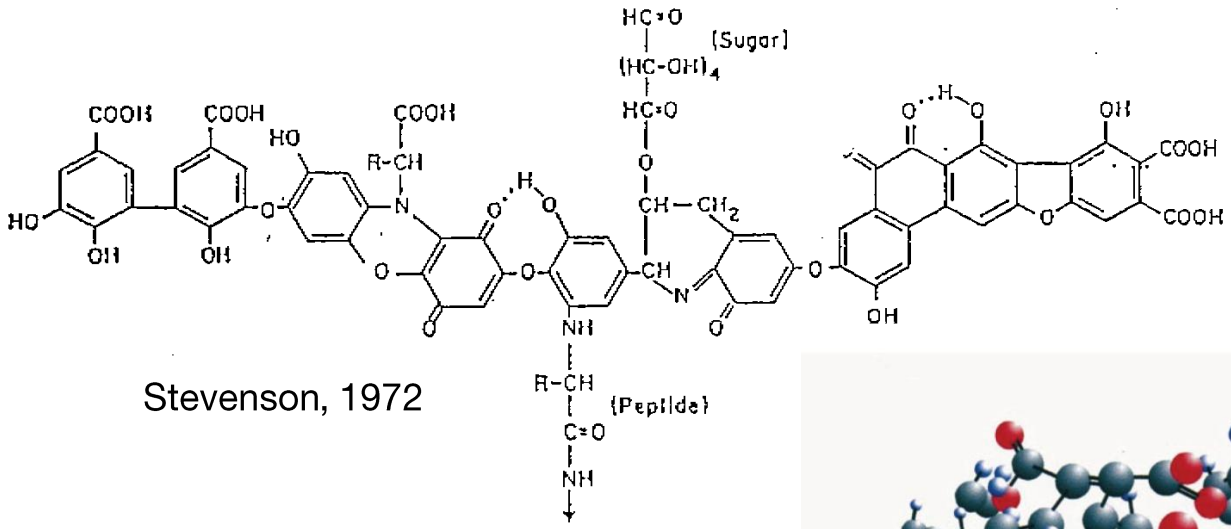
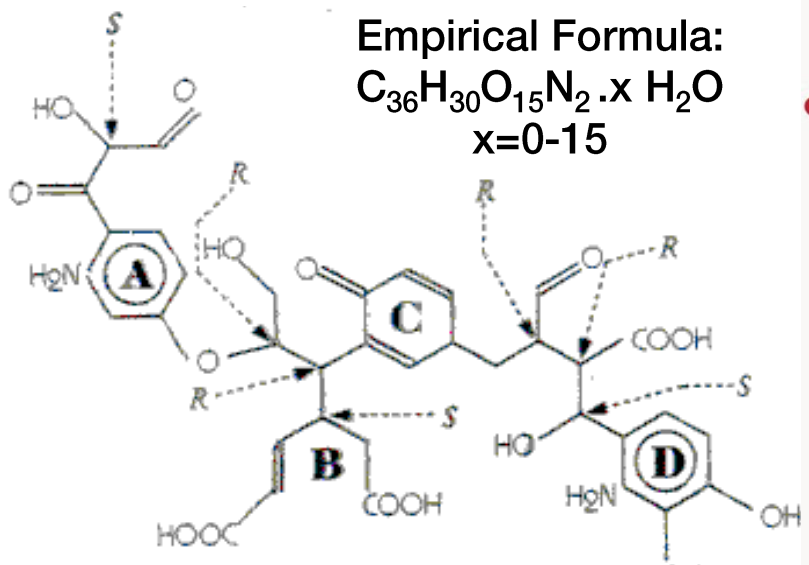
Model of Humic Acid Molecule

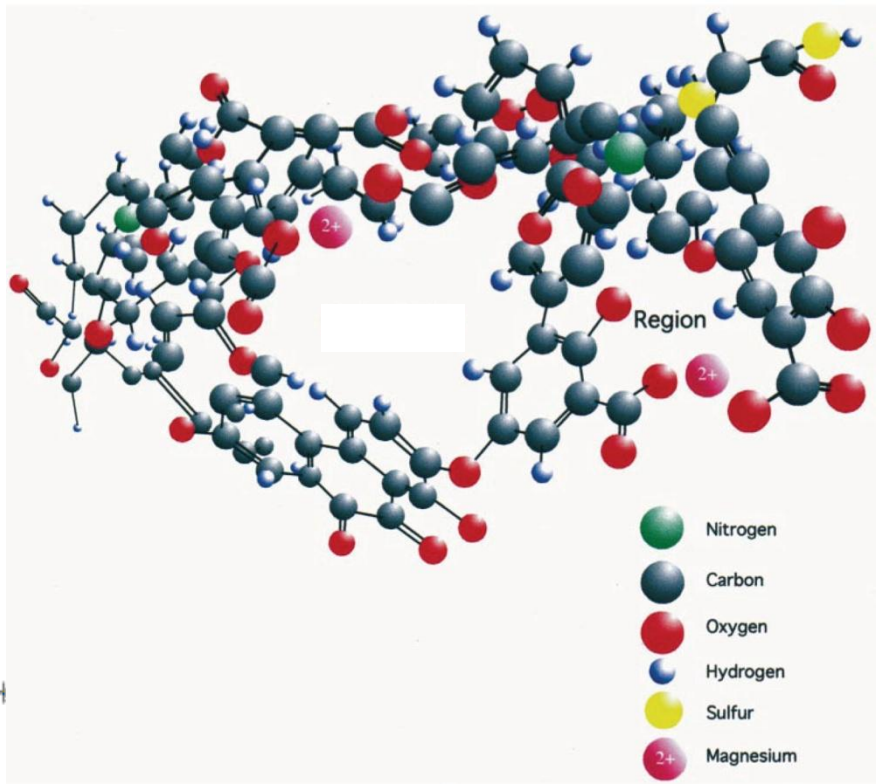


Stevenson, 1972

Empirical Formula:
$C_{36}H_{30}O_{15}N_2 .x\ H_2O$
x=0-15



TNB, 1998 (Temple, Northeastern and Birmingham)



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ORGANIC HUMIC PRODUCTS PRODUCTION PLANT
South Boston, Virginia

PRODUCTS

HUMASORB® ; Multipurpose Pollution Filter

actosol® ; Organic Humic Bio-stimulant/Fertilizer

Actodemil®; a-HAX™ for Safe Destruction and Recycling of Explosive s and Wastes

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HUMASORB®

Solution To Pollution

Low Cost for Simultaneous Cleanup of Heavy Metals, Radionuclides and Organics

Metals, Radionuclides, Organics

Multi-Purpose Adsorber

High Cation-Exchange Capacity

Can Be Regenerated

Cost-Effective

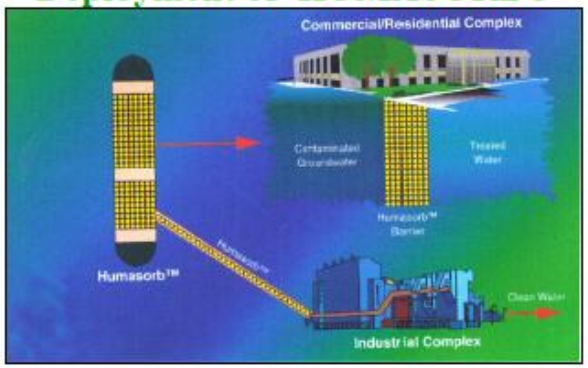
Environmentally Friendly

ARCTECH

Preserving tomorrow's world... today

HUMASORB® is based on the natural properties of humic acid and incorporates high ion-exchange capacity, the ability to chelate metals, adsorb organics, and also reduce toxic forms of contaminants such as Cr (VI) and chlorinated organics into non-toxic components.

Deployment of HUMASORB®



as an in-situ barrier

in pump and treat mode

HUMASORB® EFFECTIVE ON:

Metals:

Barium, Lead, Cadmium, Chromium, Nickel, Mercury, Arsenic, Copper, Zinc, Aluminum, Cobalt, Beryllium, Iron, Zirconium, Gold, Manganese, Magnesium, Vanadium, Boron

Radionuclides:

Uranium, Strontium, Cesium, Cerium (Plutonium Surrogate), Rhenium (Technetium Surrogate)

Organic Contaminants:

TCE, PCE, PCB, Chloroform, Carbon Tetrachloride

Additional contaminants under evaluation

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Successes of HUMASORB® Technology

HUMASORB® Treatment Unit For Removal of Toxic Metals from Wastewaters at U.S. Army - Johnston Island

Demonstration for resource recovery and treatment of acid mine water of Berkeley Pit Butte, Montana

- Successful treatment to recover metals such as copper and iron, and remove toxic metals such as cadmium to regulatory limits
- Fertilizer product recovered from the process successfully evaluated in field tests for growth of crops
- Demonstration established profitable approach

Treatment of waste brines at U.S. Army Chemical Weapons Destruction Facility at Johnston Island in Pacific

- Treated waste brines to remove arsenic, mercury and lead
- Successful treatment to meet EPA TCLP requirements
- Provided solution to a problem for which no solution existed

Treatability tests for removal of radio nuclides contaminants at DOE - Idaho Weapons Complex

- Effective for removal of cesium-137 and strontium-85 from Idaho Chemical Processing Plant (ICPP) Groundwater
- High affinity for radioactive strontium and cesium compared to background metals such as calcium
- Significant cost advantages compared to other media

Our HUMASORB® Process Mobile Unit is Available for Specific Technology Applications.

For More Information Contact:

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14100 Park Meadow Drive
Chantilly, VA 20151

Phone: (703) 222-0280 Fax: (703) 222-0299
E-Mail: dwalia@arctech.com
Or visit our website: www.arctech.com

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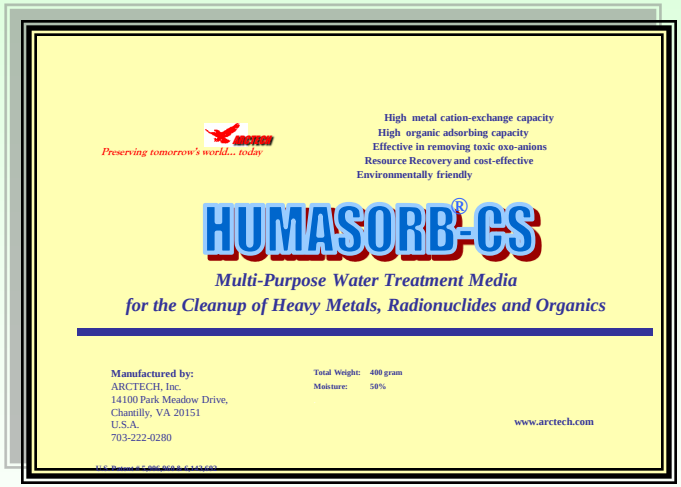
HUMASORB®-Multipurpose Water Filter Proven for Commercial Applications and Now Ready for Retail Market

Commercial



Retail

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Why HUMASORB® for Water Application?

Issues of Today

- 122 Trillion Gallons of Wastewater Per Year Need to be Treated
- Large Undergrounds Watersheds Remain Contaminated Because of High Costs
- Safe Drinking Water Becoming Scarce and Costly
- Impaired Irrigation Water Supply

HUMASORB® Solutions

- HUMASORB® can Cost-Effectively Treat Toxic Organic, Metals, Radionuclides and Pathogens
- HUMASORB® for Cost- Effective Subsurface Barrier Treatment
- HUMASORB® Effective for Removing Toxic Contaminants from Drinking Water
- HUMASORB® can Recycle Wastewaters into Organic Fertilizers.

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Pollution Prevention Market Potential
Totals 13 Trillion Gallons Per Year

SIC Code	Industry	Annual Disch Trillion gal/year	Treatment %	Market Trillion gal/year
4911	Electric Services	101	5	5.1
4952	Sewage Systems	7	5	0.4
3312	Steel Works	3	50	1.7
2911	Petro Refining	3	50	1.5
3353	Aluminum Sheet	3	50	1.3
1021	Copper Ores	1.5	40	0.6
2611	Pulp Mills	1	40	0.4
2621	Paper Mills	1	30	0.3
2869	Organic Chemicals	1	30	0.3
2873	Nitorgenous Fert.	1	30	0.3
		122		11.8

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HUMASORB® Product and Technology Applications Proven in Multiple Markets

Nuclear Wastes Applications	
HUMASORB® -- FOR REMOVAL OF RADIONUCLIDES AND ORGANIC CONTAMINANTS FROM MIXED WASTES AT DOE WEAPONS COMPLEX USDOE, Federal Energy Technology Center, Morgantown, WV	• The goal of this project was to develop HUMASORB®-CS and to remove metals, radionuclides and organic contaminants from aqueous waste streams in a single processing step. • Highly effective in removing multiple classes of contaminants such as metals, oxy-anions, organics and radionuclides from contaminated streams. • HUMASORB® is effective for application as a Permeable Reactive Barrier (PRB) material for in-situ treatment of groundwater. • Organic contaminants are adsorbed and removed from contaminated water. Chlorinated compounds are adsorbed and potentially reduced to less toxic compounds. • The isotherms for adsorption of some of the contaminants (such as copper, nickel, cerium and uranium) were represented well by either Freundlich or Langmuir isotherm models.
A NOVEL HUMASORB®-CS ADSORBENT REMOVES HOT Cs AND Sr Global Environment & Technology Foundation, Annandale, VA	• This project was conducted to establish the technically feasibility of HUMASORB®-CS to remove the hot contaminants such as radioactive cesium and strontium from contaminated groundwaters at Idaho National Engineering & Environmental Laboratory (INEEL). • The column was saturated with ^{137}Cs after nearly 600-700 bed volumes. • The column was only 25% saturated with ^{85}Sr after nearly 700 bed volumes. • The results show that HUMASORB®-CS can effectively remove both ^{137}Cs and ^{85}Sr.
TREATMENT OF DU CONTAMINATED PROPELLANT AND EXPLOSIVES WITH HUMASORB® TECHNOLOGY Iowa Army Ammunition Plant; Mason and Hanger Silas Mason Co., Inc.	• HUMASORB® technology can be successfully adapted to provide a solution to Mason & Hanger at the Iowa Army Ammunition Plant for the simultaneous destruction of M30 propellant and recovery of Depleted Uranium (DU) contamination. • $U_2O_3 \bullet 12H_2O$ admixed onto M30 Propellant grains was successfully removed from the propellant using the ARCTECE process and recovered for disposal. In these experiments all of the propellant was solubilized and denitrated.

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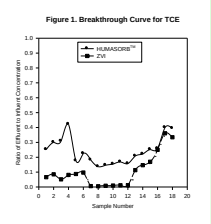
HUMASORB® Product and Technology Applications Proven in Multiple Markets

Nuclear Wastes Applications

HUMASORB® FOR REMOVAL OF Tc-99 AND TCE AT THE PADUCAH GASEOUS DIFFUSION PLANT FOR INSTALLATION OF PERMEABLE REACTIVE BARRIER

Sandia National Laboratory

- The breakthrough curves TCE show that both HUMASORB® and ZVI columns are approximately 40% saturated at the end of the tests. No daughter products detected in the effluent from the HUMASORB® column. The effluent concentration of dichloroethylene (DCE), a daughter product of TCE degradation, in the ZVI column was higher than the influent, indicating formation of daughter products.



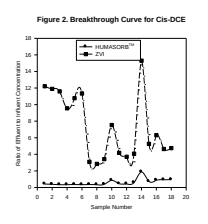


Table 1. Estimated Residence Time and Thickness for a Potential Barrier at Paducah, Kentucky

Residence Time* hours	Groundwater Flow, inches/day	Barrier Thickness, inches	
		Minimum	With 100% Safety Margin
10	12	5	10
8	12	6	12

* Residence time estimated using the results from the tests conducted at Paducah and with the assumption that 11 half-lives are required to remove TCE to below 5 ppb limit

- The amount of TCE removed was 0.575 mg/gram HUMASORB® and approximately 0.194 mg/gram of ZVI.
- The residence time required in permeable reactive barrier was estimated (with a 50% safety factor built in) to be about 10 hours for HUMASORB®. The residence time was then used to determine the thickness (10-12 inches) of a potential barrier as shown in Table 1.

HUMASORB® Capture and Remove Mercury from Contaminated Soil at DOE Oak Ridge Site

USDOE, Federal Energy Technology Center, Morgantown, WV

- To capture and remove mercury from contaminated soils in the Y-12 Plant soil at Oak Ridge National Laboratory (ORNL). The mercury concentration in the Y-12 Plant soil ranges from 0 to 1000 ppm. The results of the test are summarized in the following table.

Column Test	Spiked Hg(II), ppm	Output, ppm
#1	800	0.5
#2	800	0.2
#3	800	339

Column #1: HUMASORB®-CS (10 g) and contaminated sand (100 g) were mixed and then slurry packed.
Column #2: HUMASORB®-CS (10 g) was slurry packed in the bottom of the column, and contaminated sand (100 g) above it.
Column #3: only contaminated sand (100 g) was packed as a control.

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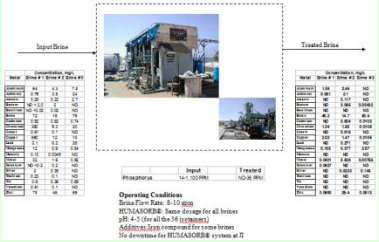
HUMASORB® Product and Technology Applications Proven in Multiple Markets

Military Wastes Applications	
HUMASORB®TREATED AND DISPOSED SPENT DECONTAMINATION SOLUTION FROM US ARMY CHEMICAL WEAPONS DEMIL FACILITY AT JOHNSTON ATOLL US ARMY	 • Successfully completed treatment of approximately 24,000 gallons of Spent Decontamination Solution (SDS) that contained RCRA hazardous levels of arsenic, lead and mercury.
DESTRUCTION OF LEWISITE IN TON CONTAINER SLUDGE AND ONSITE SECONDARY WASTE MANAGEMENT AT PINE BLUFF ARSENAL WITH HUMASORB TECHNOLOGY US Army Chemical Material Agency and EAI Corporation	• Pine Bluff Arsenal (PBA) has approximately 4,400-Ton Containers (TCs) requiring final disposal. The ton containers were originally used to store variety of chemical agents since almost World War I. • The micro-scale destruction experiments were conducted by EAI Corporation in 15-mL glass vials with TFE/silicone lined phenolic caps. A total of 24 decontamination reagents were evaluated by EAI, including five (5) HUMASORB decontamination reagents. Only HUMASORB reagents included hydrolysis, oxidation and adsorption mechanisms. • HUMASORB decontamination reagents were effective even at 100°F compared to other reagents, which required higher temperatures (150 or 180°F). • The results from the secondary waste minimization tests show that after the HUMASORB treatment, arsenic levels are reduced to non-detect levels (Detection Limit: 0.6 ppm). The Resource Conservation and Recovery Act (RCRA) limit for arsenic is 5 ppm.
HUMASORB® and Advanced Actodemil® Neutralization Technology for Safe Destruction of Picric Acid and Arsenic KOBE STEEL, LTD	**Table 1. Results of Analyses for Contaminants in the Treated Sample** Compound / Concentration / Regulatory Limit Arsenic / ND / 5.0 mg/L TCLP Barium / 1.3 mg/L TCLP / 100 mg/L TCLP Cadmium / ND / 1.0 mg/L TCLP Chromium / 1.3 mg/L TCLP / 5.0 mg/L TCLP Lead / ND / 5.0 mg/L TCLP Mercury / ND / 0.2 mg/L TCLP Selenium / ND / 1.0 mg/L TCLP Silver / ND / 5.0 mg/L TCLP Semivolatile Organic Compounds – None Detected Volatile Organic Compounds – None Detected • Using the Actodemil® technology for destruction of the explosive material picric acid from aqueous solution and the HUMASORB® technology for the removal of As (V) from an aqueous solution. • initial concentration of picric acid of 6,600 mg/L. However, picric acid was not detected after treatment with the a-HAX reactant. A summary of the results from the TCLP analyses are presented in Table 1. No organic compounds were detected.

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HUMASORB® Product and Technology Applications Proven in Multiple Markets

Industrial Wastes Applications

HUMASORB® REMOVING MERCURY <5 ppt AND PCB NON-DETECT FROM STORM WATER AT A SCRAP METAL YARD IN MICHIGAN

- To date over 3 million gallons of wastewater has been treated without requiring HUMASORB® replacing.

HUMASORB® TECHNOLOGY DEMONSTRATED FOR REMEDIATION OF METAL-CONTAMINATED TANNERY AND ELECTROPLATING WASTE STREAMS IN INDIA

National Association of State Development Agencies, Washington, D.C.

- For treatment of waste streams containing multiple metals in India. The results with the streams from the tannery showed chromium removal of more than 93-99% and with electroplating streams containing multiple toxic metals, the removal of metals was more than 95%.

Technical Feasibility of Polychlorinated Biphenyls (PCBs) Removal from Liquids by HUMASORB®-CS

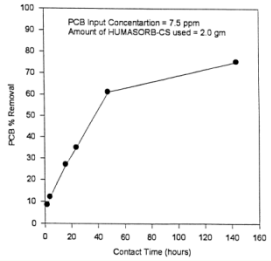

Table 1. PCBs Removal with HUMASORB®-CS

Contact Time, hours	Input concentration, ppm	Output concentration, ppm	Removal %
24	7.511	4.9	35
48	7.511	2.95	61
144	7.511	1.87	75
168	7.511	2.03	73

Table 2. Extraction of PCBs from Spent HUMASORB®-CS

Contact Time, hours	PCBs concentration, ppm	Recovery %
1	5.81	52
24	8.22	73
48	8.76	78
72	8.81	78

- HUMASORB® technology successfully adapted to provide a solution to Mason & Hanger at the Iowa Army Ammunition Plant for the simultaneous destruction of M30 propellant and recovery of Depleted Uranium (DU) contamination.

Feasibility Tests with HUMASORB® for Removal of Ba and Sr from Frac Wastewater

Sample ID		Sample C F'Sure only*		Frac Water NY	
Contaminants		Ba, ppm	Sr, ppm	Ba, ppm	Sr, ppm
Provided Data		1520	3120	13.7	50.8
HUMASORB®-CS	Untreated	1313.2	2762.4	5.7	44.0
	Treated	797.7	2177.5	0.318	7.0
	Reduction %	39.26	21.17	94.39	84.06

HUMASORB®-CS Treated and Untreated Frac Wastewater

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HUMASORB® Product and Technology Applications Proven in Multiple Markets

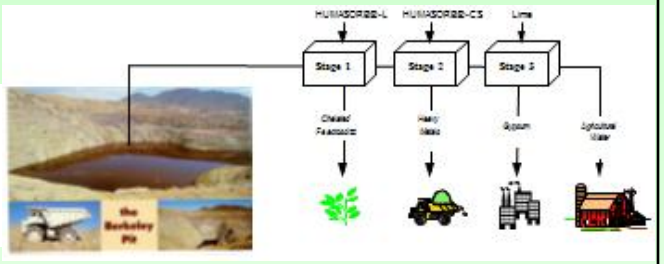
Mining Industry Wastes Applications

HUMASORB® TECHNOLOGY DEMONSTRATED FOR RESOURCE RECOVERY FROM BERKELEY PIT ACID WATERS IN BUTTE, MONTANA

U.S. Department of Energy/MSE Technology Applications, Inc.

- PILOT TESTING RESULTS

METALS	DEMONSTRATION OBJECTIVES	PROCESS PERFORMANCE
Arsenic	< 0.5 ppm in product	0.294-0.481 ppm in product
Cadmium	< 0.5 ppm in product	0.280-0.360 ppm in product
Cadmium	> 70% Removal in Stage 2	67.56-98.93 % Removal in Stage 2
Copper	> 70% Removal in Stage 2	85.44-99.96 % Removal in Stage 2
Iron	> 70% Removal in Stage 2	73.15-99.97 % Removal in Stage 2
Zinc	> 70% Removal in Stage 2	48.02-99.90 % Removal in Stage 2

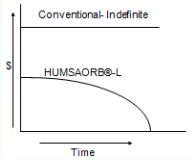


- ARCTECH's HUMASORB® process is an effective approach for economically viable treatment of acid mine waters such as Berkeley Pit water.

Demonstration of HUMASORB® Technology for In-situ Treatment of Acid Mine Drainage in the Abandoned Tide Mine Site, Indiana County, PA

Pennsylvania Department of Environmental Protection (PA DEP) and Blacklick Creek Watershed Association, Inc.

- HUMASORB®-L treatment meets the success criteria for removing metals to > 90% and raising the pH to more than two units, criteria set forth for this project by the PA DEP.
- The HUMASORB®-L treated acid mine water enhances growth of SRB which can lead to improving the operation of the passive treatment system.
- HUMASORB®-L system can be easily deployed at mine sites.
- HUMASORB®-L can be utilized as active treatment for metal recovery as a micronutrient fertilizers.
- HUMASORB®-L Offers Lower Life Cycle Costs for AMD Treatment



HUMASORB®-CS Feasibility Test for Selenium and Other Toxic Chemicals from the Runoff Water from Coal Waste Pile at Mammoth Coal Co., Montgomery, WV

- Selenium and Other Toxic Chemicals are Removed from the Runoff Water from Coal Waste Pile.

Toxic Metal	Untreated, ppb	HUMASORB Treated, ppb	NPDES Permit Limit
As	24	n.d.	n.a.
Cd	n.d.	n.d.	n.a.
Cr	n.d.	n.d.	n.a.
Hg	n.d.	n.d.	n.a.
Pb	n.d.	n.d.	n.a.
Se	13	n.d.	8 ppb

n.d.: not detected
n.a.: not available
Sample Submitted by SNF Flomin, Inc.

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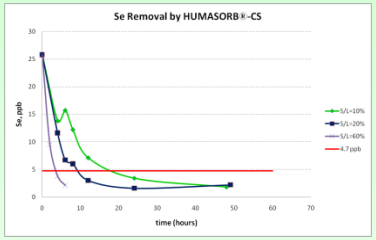
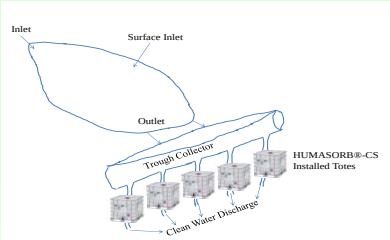
HUMASORB® Product and Technology Applications Proven in Multiple Markets

Mining Industry Wastes Applications

HUMASORB® Treatment for Selenium Removal from Coal Mine Discharge Water in West Virginia

- HUMASORB®-CS had good capability to remove Se in the WV Coal Mine Discharge water that can meet the more stringent NPDES regulation. About three hours contact time with 60% of S/L loading, selenium went down less than 4.7 ppb.



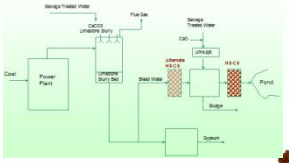


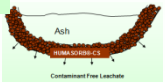
HUMASORB®-CS Implementation Approach for Removal of Selenium from Coal Mine Discharge Wastewater.

Power Plant Wastes Applications

HUMASORB®-CS Feasibility Test Showed that Toxic Metals are Removed from Spent Scrubber Wastewaters at Dominion Resources Chesterfield Power Plant-Virginia

Dominion Resources





Toxic Metals (mg/L)	Chesterfield Units Bleed Slurry (2/25/2010)		Chesterfield WWTP Effluent (2/25/2010)		Regulatory Limit	HUMASORB® Compliance
	Initial	HUMASORB Treated	Initial	HUMASORB Treated		
As	0.598	nd	0.696	nd	0.20	Yes
Be	0.427	0.33	0.416	0.303	3.00	Yes
Cd	0.108	nd	0.119	nd	0.05	Yes
Cr	0.175	nd	0.150	nd	0.60	Yes
Hg	0.785	nd	0.674	nd	0.05	Yes
Pb	6.966	nd	5.832	nd	0.10	Yes
Se	1.030	0.133	1.070	0.103	2.00	Yes
Ag	nd	nd	nd	nd	0.10	Yes
Cu	nd	nd	nd	nd	0.10	Yes
Fe	nd	nd	0.155	nd	1.00	Yes
Ni	1.084	nd	0.143	nd	0.50	Yes
Tl	0.87	nd	0.799	0.011	0.50	Yes
Zn	1.801	nd	0.067	nd	0.10	Yes

nd. not detected

scrubber waste water

Toxic Metals (mg/L)	Ash Pond Leachate (mg/L)			HUMASORB Treated (mg/L)			TCLP Hazardous Waste Limit, mg/L
	pH3	pH5	pH6.5	pH3	pH5	pH6.5	
As	1.163	1.135	1.580	nd	nd	nd	5.0
Be	1.220	0.608	0.680	0.011	0.006	0.003	100.0
Cd	0.193	0.183	0.183	nd	nd	nd	1.0
Cr	0.090	0.090	0.095	nd	nd	0.006	5.0
Hg	nd	nd	nd	nd	nd	nd	0.2
Pb	1.055	1.118	1.028	nd	0.052	0.037	5.0
Se	1.165	1.215	1.585	nd	nd	nd	1.0
Ag	nd	nd	nd	nd	nd	nd	5.0
Cu	9.023	nd	nd	nd	nd	nd	
Fe	0.683	nd	nd	nd	nd	nd	
Ni	2.315	1.258	0.193	0.045	0.072	0.011	
Tl	1.345	1.208	1.288	nd	nd	0.045	
Zn	1.003	0.143	nd	nd	nd	nd	

nd. not detected
TCLP: Toxicity Characteristic Leaching Procedure

ash pond leachate

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HUMASORB® Product and Technology Applications Proven in Multiple Markets

Municipal Wastes Applications

HUMASORB®-CS Amended Smart Sponge® Feasibility Proven For Removal of Toxic Metals, PCB and Oils

AbTech Industries Inc.

- All RCRA heavy metal mix (As, Ba, Cd, Cr, Pb, Hg, Se and Ag) and Cu are removed completely to 100% by HUMASORB®-CS amended Smart Sponge® except As. Removal % of As was 95.7%.
- The result of TCLP test shows that heavy metal leaching complies with the TCLP Regulatory Level.

Metal	Leachate, ppm	TCLP Regulatory Level, ppm	Compliance
Ag	ND	5	Yes
As	0.074	5	
Ba	0.034	100	
Cd	ND	1	
Cr	ND	5	
Cu	ND	Not Listed	
Hg	0.006	0.2	
Pb	0.92	5	
Se	ND	1	

- PCB removal was 43.75%.
- Phosphorus was removed 97.56 % by HUMASORB®-CS Amended Smart Sponge®.

Drinking Water Applications

HUMASORB® MATKA UNIT FOR SAFE DRINKING WATER

- MATKAs, a common word from the Hindi language and Kolshi in Bangladesh, are in common use in rural and poor households on the Indian subcontinent.

Tests conducted in Prototype HUMASORB® Matka System

Contaminant	Untreated Water, ppm	Treated Water, ppm	WHO Guideline for Drinking Water System, ppm
Lead	5-20	ND	0.01
Arsenic	5-20	ND	0.01
Chromium	5-20	ND	0.05
Fluoride	5-20	ND	1.50
Hardness	451	19.75	NE
Nitrate	95.54	ND	50

ND: Not Detected, NE: Not Established

ECO

- Total System under 300-500 Rupees for a 3-gallon (11 litres) MATKA
- Provide 300-360 gallons (1,130-1,360 litres of drinking water
- HUMASORB ® recharge cost : less than 500 Rupees

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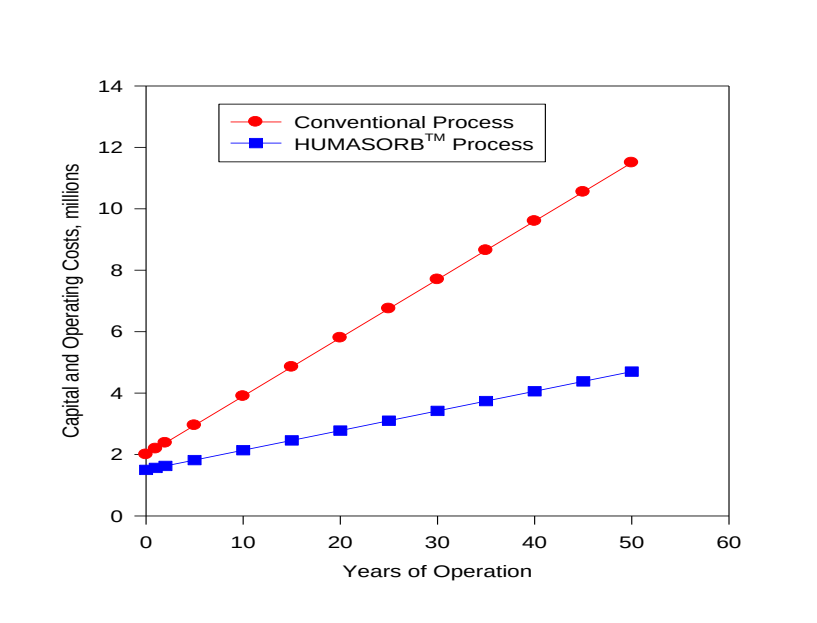
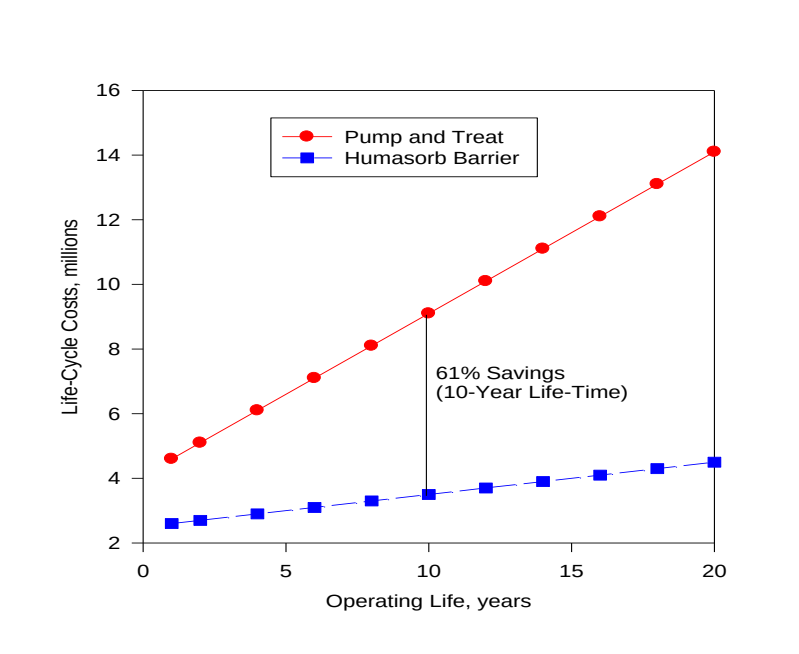
HUMASORB® HAS LOWER LIFE-CYCLE COST

Pump and Treat : 30 million gallons per year



Passive Treatment



Conventional Process: Electrochemical treatment, filtration and clarification. Costs based on EPA Report 542-R-99-006
HUMASORB™ Process: Estimated Costs for water contaminated with multiple metals and organic compounds

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actosol®

Humate Fertilizer

- Increases yields of crops, vegetables and fruits
- Produces superior turf and deep roots
- Enhances uptake of fertilizers
- Replenishes depleted soils
- Promotes ecological balance

OMRI Listed

USDA approved

HUMATE

Humates are naturally occurring deposits in soil. They are the key ingredient in all actosol® products.

HOW DOES actosol® CREATE BENEFITS?

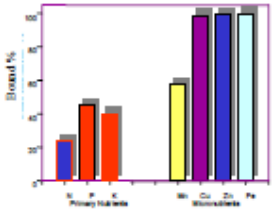
- By enhancing soil structure and fertility;
- By efficient transfer of fertilizer nutrients and micronutrients because of the high chelation and cation exchange properties of the active humate components of actosol®;
- By increasing moisture holding capacity of soil;
- By increasing microbial activity in the soil; and
- By enhancing plant cell biomass.

LIQUID
now with QUICK & SUSTAINED RESULTS

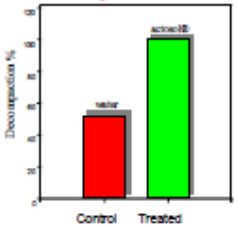
APPLICATION OF actosol®

- Agriculture
- Floriculture
- Mine/Landfill reclamation
- Road/Highway erosion control
- Horticulture
- Turf Management/Maintenance
- Dune stabilization
- Hydroseeding

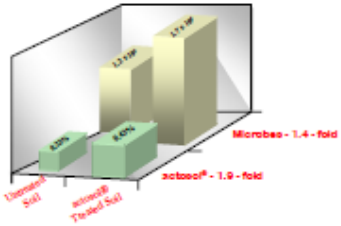
Primary and micronutrients are bound to actosol®



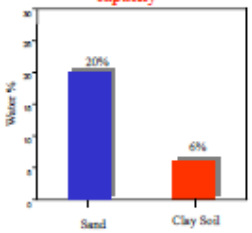
actosol® improves soil structure



Microbial counts are higher in actosol® treated soils



actosol® increases water holding capacity



Magic of actosol®

Turf

actosol® creates vegetation in sand dunes

Ocean City, MD

hydroseed mix

hydroseed mix plus actosol®

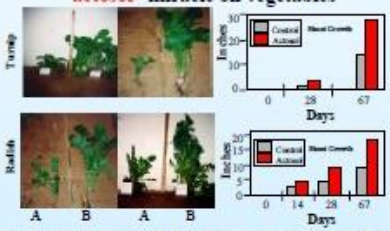
6 weeks growth, Virginia Tech., testing

Floriculture

actosol® brightens flowers

Horticulture

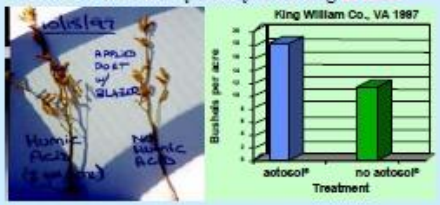
actosol® miracle on vegetables



A - Standard Garden (20-20-20) B - Garden actosol® (10-10-10)

Agriculture

60% increase in soybean yield using actosol®



effect of actosol® on corn plants

actosol® Commercial Products

Bio-activated Base actosol®	-	Humate
Calcium actosol®	-	plus Ca (2%)
Horticulture actosol®	-	plus K(10%)
Potash actosol®	-	plus K (6%)
Garden actosol ®	-	plus NPK (10%-10%-10%)
Turf Booster actosol®	-	plus NPK (20%-5%-5%)
Micronutrient actosol®	-	plus Fe, Mn, Zn, Cu, (total 2%)

Worldwide actosol® Applications

UNITED STATES
- Landscaping
- Erosion Control
- Landfill Closure
- Golf Courses
- Sod Farms
- Nurseries-Tomatoes
- Sand Dunes
- Floriculture
- Agriculture
- Horticulture

GULF COUNTRIES
- Rhodes Grass
- Water Melons
- Cucumbers
- Alfalfa
- Orange Groves
- Grapes
- Onions
- Date Trees

MAURITIUS
- Sugar Cane
- Horticulture

S. KOREA
- Golf Courses
- Greenhouses

For additional information:
visit our web site at www.arctech.com
or contact

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14100 Park Meadow Drive
Chantilly, VA 20151

(703) 222-0280 (p) - (703) 222-0299 (f)
(800) 471-8494

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Preserving tomorrow's world…today!

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ACTION OF HUMIC SUBSTANCES ON PLANT GROWTH

Physical

- Increases water holding capacity
- Increases aeration of soils
- Improves soil workability
- Helps resist drought
- Improves seed bed
- Makes soil more friable or crumbly
- Reduces soil erosion.

Chemical

- Chelates nutrients for uptake by plants
- Possesses high ion-exchange capacity.
- Increases buffering properties of soils
- Increases percentage of total Nitrogen in soils.

Biological

- Accelerates plant cell division and promotes growth
- Increases germination of seeds and viability
- Increases root respiration and formation
- Stimulates growth & proliferation of soil microorganisms.
- Aids in photosynthesis.

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actosol® Organic Humic Fertilizer Products Proven in Commercial Applications-Now Ready for Retail Market

Commercial

Retail

Proven by Pros! Now Available to Homeowners!

actosol®

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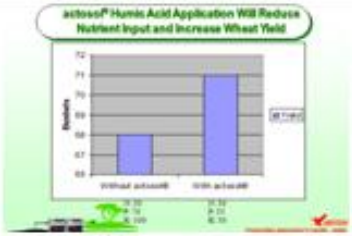
Examples of the Use of actosol® Organic Humic Acid on Agriculture Crops

Agriculture	Description	Results on agricultural crops
Wheat Experiment conducted by Paul Bodenstein, Crop agronomist, Ag. Systems, Virginia Crop Consulting firm	Plot 1: 3 gal actosol® + 30 N: 70 P: 100 K Plot 2: 3 gal actosol® + 30 N: 35 P: 50 K	 Addition of actosol® humic acid reduced phosphorous & potassium application by 50% and increased yield by 4%
Wheat (Southern States 8308 variety), Woodlief Farms in Rolesville, North Carolina	Application rate @ 1.5 gal/40 gal water/ acre were applied overhead. Plot size: 1 acre/ treatment. Both treatments received the identical amount of fertilizer and same growing conditions. Data collected consisted of 10 replication for each treatment.	 actosol® control actosol® control *actosol®* Improved root development, Plant Height. Results showed that the use of *actosol* averaged 44 seeds per head vs. 21 for the control and weight of seeds per head averaged three times as great 2.2 grams vs. 0.8 grams for the control.
Wheat North Delta, Egypt	applied at 2 gal/acre before seeding	actosol® application increased germination of wheat in Kafr El Sheik, Egypt (3 weeks after treatment) Untreated Treated Yield (Grain & Straw, Tons/acre) Treated 5.51 Untreated 4.92 % Yield Increase 12.0 Increased germinations, yield of grain & straw by 12%

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Examples of the Use of actosol® Organic Humic Acid on Agriculture Crops

Agriculture	Description	Results on agricultural crops continue
Soybean At a 44,000 acre farm located in Beaufort, North Carolina. Experiment conducted by Paul Bodenstein, Crop agronomist, Ag. Systems, Virginia Crop Consulting firm	Foliar application at 550 mg actosol®/liter water (or 1.1 lb./acre) with a post-emergence application of blazer herbicide, surfactant and manganese. Applications on soybeans were during the fourth trifoliate.	 actosol® + Blazer Blazer Fourteen days after treatment, test plots treated with actosol® and Blazer had progressed to the eighth trifoliate while soybeans treated with Blazer alone were just beginning their fifth trifoliate. Addition of actosol® to the Blazer significantly reduced phytoxicity and enhanced growth resulting in an increase of 6.8 bushels /acre.
Clover North Delta, Egypt	applied at 2 gal/acre before seeding	actosol® application increased number of harvests and color of clover in Kafr El Sheik, Egypt Yield (Tons/fed for total of 5 Fresh Cuts) Treated 78.7 Untreated 67.2 % Yield Increase 12.65 Increased chlorophyll, # harvest & yield by ~13%
Tobacco Plants Hope Farm, Clinton, North Carolina	Green house: Seedlings: 288cells/tray applied *actosol®* @12.5 gal /500 gal. water Field: Seedlings transferred to field & received 2 gal actosol®/ 80 gal. water /acre	actosol® improved root development in tobacco plants Increased root mass, nutrient uptake, plant height by 10% & improved chlorophyll content

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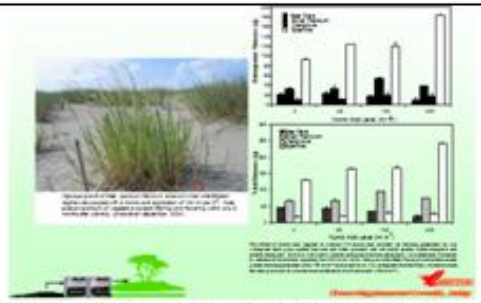
Examples of the Use of actosol® Organic Humic Acid on Turf

Turf	Description	Results on turf
Grass in Sand dunes, Ocean City, Maryland	Application rate @5 gal/ acre. actosol® was applied as part of the hydro-seed mix (recycled wood fiber mulch, biodegradable tack, seed mix of 1/3 perennial rye,1/3 grain rye and 1/3 K-31 fescue at 10 lbs/1000 square feet)	Increased root mass, chlorophyll, established robust cover
On produced water resulted from J.M. HUBER Inc. , a coal bed methane producer in Wyoming. Work was conducted by Robert Downey of Energy Ingenuity of Colorado	A field unit consisting of a chemical pulse pump and a turbine flow meter mounted on a small skid for automated metering in actosol® into the high salinity produced water prior to irrigation of the adjoining land area. actosol® was metered in to add only 50 ppm into the water during the 30 days of the 45 days of test period. The control area received only produced water without any addition of actosol®.	The test area showed lush green vegetative growth without any bare spots compare to the control
On 4 varieties of sea grasses in Marsh Land, Louisiana, Prof. Mark Hester at Univ. Louisiana	actosol® was applied at four dosage rates.	 Application of actosol® resulted in enhanced growth of both root biomass and top growth.

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Examples of the Use of actosol® Organic Humic Acid on Turf

Turf	Description	Results on turf continued
On tall fescue in central sod farm in Maryland (Billarpinski)	2.5 gal/acre +100% STD fertilizer, 2.5 gal/acre + 80% STD fertilizer, Grower STD fertilizer.	 Reduction in fertilizer, improved root development & turf growth
On Turf in Virginia Beach Area (Symsi Manuel)	Application rate @ 3 gal. per 60 gallons of water was used to cover the turf area. The first application was made with a hand held power sprayer and then the second application was applied with a bloom sprayer.	Control actosol® *Calcium actosol®* on Root and Turf Growth Under High Salinity Conditions

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Examples of the Use of actosol® Organic Humic Acid on Horticulture

Horticulture	Description	Results in horticulture/ornamentals
On Ornamentals at Country Joe's Nursery, at Boynton, Beach, FL (David Englert)	Application rate @ 4 oz/ 2 gallon water (1:30 ratio) or 4oz/4 gallon water (1:60 ratio)	(Begonia) (Montera) Control actosol© Control actosol© Improved Roots and Foliage Growth on Variety of Ornamentals & Reduced the Production Time for Marketability of Container Ornamentals

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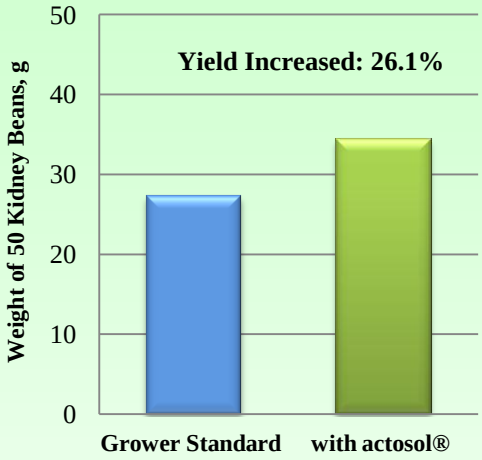
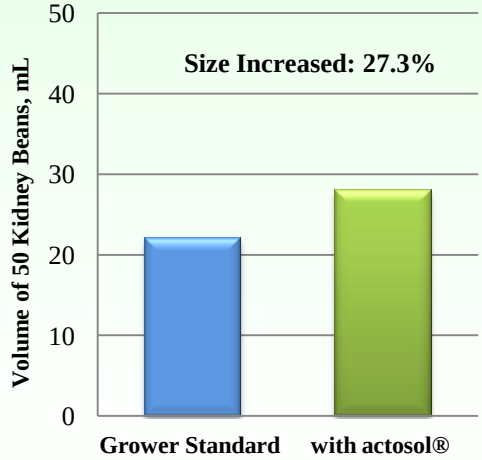
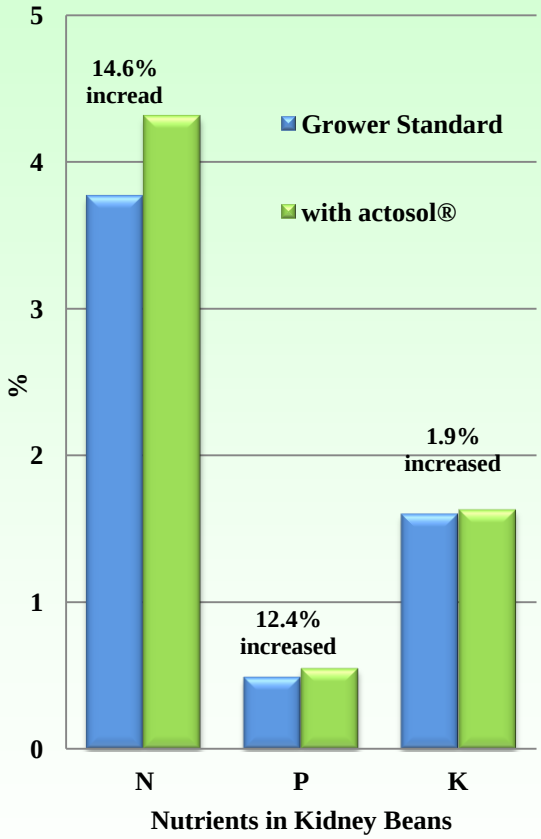
Kidney Beans Grown with actosol® by Carson Farm, MN Showed Increased Yield and Size







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actosol® in Peoples Republic of China

腐殖酸液体肥 ACTOSOL®

生物试验报告

研究单位：西南农业大学资源环境学院

研究人员：王正银　徐卫红　叶学见

李光耀　廖琼仙

资助单位：香港民生实业有限公司

中国·重庆

一九九九年三月～一九九九年五月

Did use our fertilizer

Did use our fertilizer

Mango

untreated

Soil

Soil & Foliar

Offering "Balanced Sustainable Solutions"

Rice

ARCTECH
Offering "Balanced Sustainable Solutions"

Pears

Treated

Untreated

ARCTECH
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Peach

ARCTECH
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actosol® Application Enhances Growth of Strawberry Plants in West Tahrer, Egypt

Untreated

Treated

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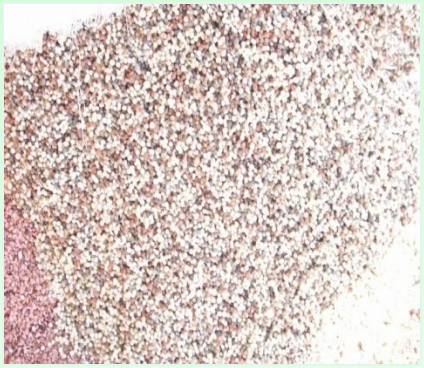
Preserving Tomorrow's World...Today

Nutrient ENHANCER™ Improves Efficiency of Granular Fertilizers



Southern Sates Commercial Facility, Nutrient-ENHANCER™ Impregnated NPK and Its Application on the Farm.

Nutrient-ENHANCER™ NPK Increased Height of the Rye Plant

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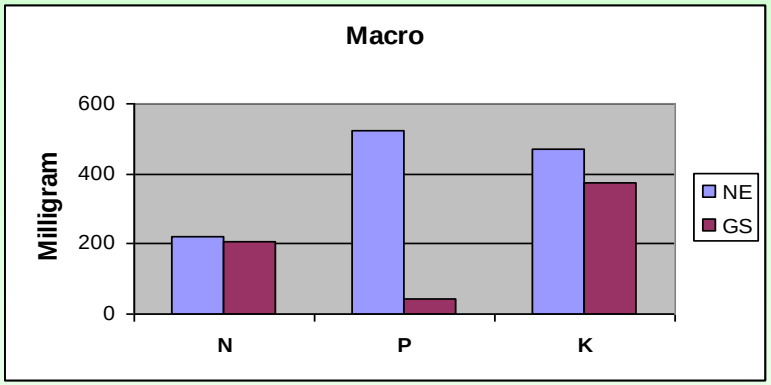
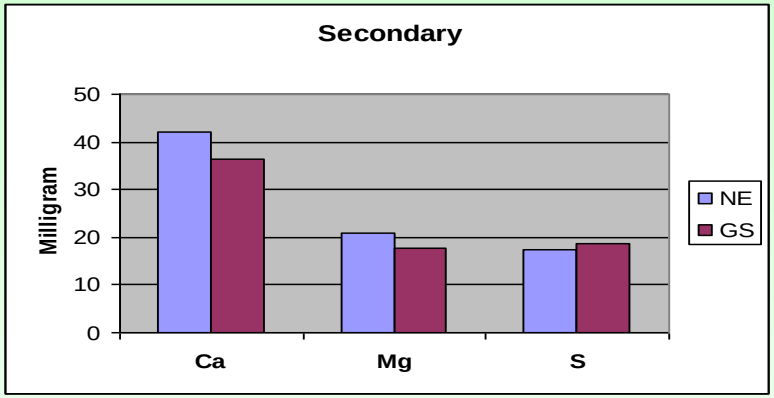
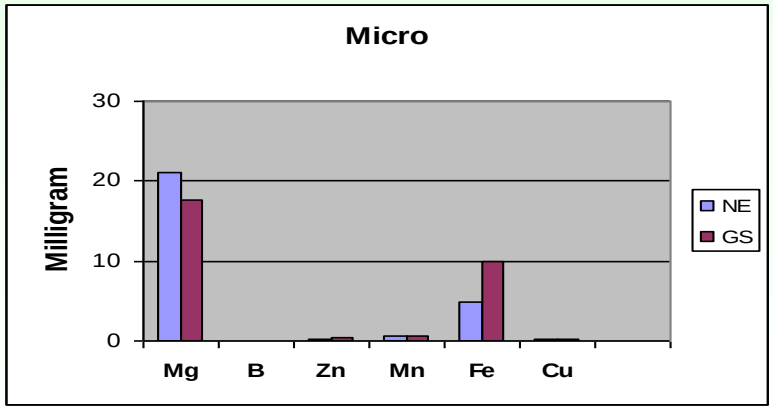
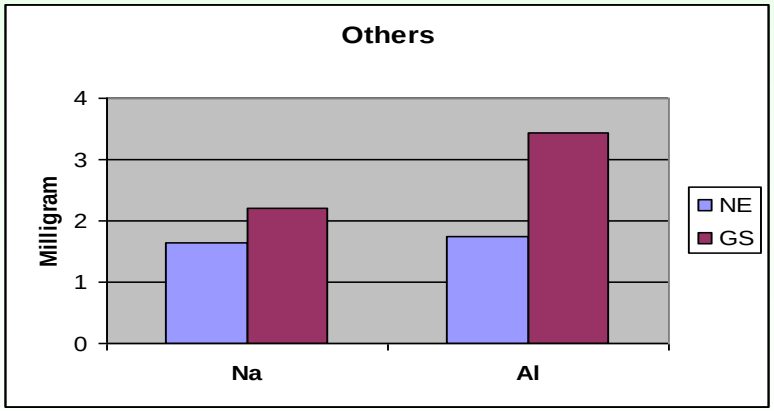
Nutrient ENHANCER™ Increase Uptake of Macro, Secondary, and Micro Nutrients









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Astonishing Synergistic Benefits when Combined with Agrochemicals (Tests by Virginia Tech)

US Environmental Protection Agency
June 13, 2003

Approves *actosol*® Humic Acid as Environmentally Safe and Exempts from Tolerance Requirement when Used as an Ingredient (adjuvant, UV protectant) in Pesticide Formulations

Additional Info : www.epa.gov/fedregstr

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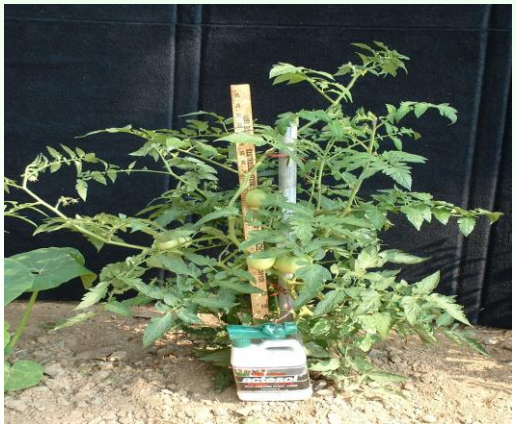
actosol® vs. Miracle-Gro



AUGUST 2003

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Why *actosol*® Organic Humic Acid for Agriculture?

Issues of Today	***actosol® Solutions***
❖ Increasing Public Demand for Safer Organic Foods	❖ Allowed Under 2004 USDA National Organic Certification Program
❖ States Requiring Decrease Inputs of Chemicals and Fertilizers to Reduce Damage to Local Watersheds, Whereas Farmers Need to Increase Yield to Remain Competitive	❖ Increase Update of Fertilizers and Increase Crop Yields. EPA Approved in 2003 Use of ***actosol***® as Adjuvant and UV Protectant and Reduce Application Rates of Chemicals
❖ Increasing Droughts and Limited Irrigation Waters	❖ Increases Moisture Retention Capacity of Soils
❖ Increasing Impaired Lands Due to High Salts Build Up	❖ Improves Soil Tilth

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Approval of actosol® Humic Acid

A. USDA National Organic Food Production Program
October 21, 2002
Allows use of Humic Acid for Growing Organic Foods
Additional Info : www.ams.usda.gov/nop

B. US Environmental Protection Agency
June 13, 2003
Approves Humic Acid as Environmentally Safe
and Exempts from Tolerance Requirement
when Used as an Ingredient (adjuvant, UV protectant)
in Pesticide Formulations
Additional Info : www.epa.gov/fedregstr

C. OMRI Listed (Organic Materials Review Institute)
February 18, 2005
Additional Info : www.omri.org

D. South Carolina, DOT
March, 2012
Approves as Biological Stimulant

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Potential U.S. Markets For *actosol*® -Humic Acid

Application	Total Land (Acres)
Agriculture	393 million
Floriculture	0.035 million
Pasture Land	73 million
Grassland Pasture	590 million
National Forest and Parks	231 million
Commercial Landscaping/Turf Management	12.5
Golf Courses	2 million
Other (Highway Management, Horticulture, etc.)	25 million
Total	1.326 billion

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Land Degradation and Water Shortages Threaten Global Food Production – UN FAO, November 28, 2011

- **Global food production is being undermined by land degradation and shortages of farmland and water resources, making feeding the world's rising population – projected to reach nine billion by 2050 – a daunting challenge.**

- **A quarter of the land is highly degraded, while another eight per cent has moderate degradation, 36 per cent is classed as stable or slightly degraded and 10 per cent ranked as "improving."**

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Use of specialty Organic Fertilizers in U.S.A. Rapidly Increasing Due to Environmental Consensus and Demand for Organic Foods

	1990	1995	2000	2005
A. Chemical(1000MT)				
Multinutrient (NPK)	18,367	18,637	18,755	19,884
Single Nutrient	25,943	29,501	37,719	32,038
Secondary and Micro	2, 395	2,604	3,066	3,388
Total	47,705	50,744	53,540	55,330
B. Organic (MT)				
Compost	30,715	46,782	88,124	96,220
Dried Manure	146,420	164,564	160,680	144,157
Sewage Sludge	58,672	91,641	152,740	117,134
Specialty Organics	57,762	204,960	234,227	281,254
Total	235,805	507,947	1,037,385	638,765

Chemical fertilizers are: anhydrous ammonia, nitrogen solution (30%), urea nitrogen (46%), ammonium nitrate, sulfate of ammonia, super phosphate 20%, super phosphate 44-46%, diammonium phosphate (18-46-0) and potassium chloride 60% K_20.

Source: ERS.USDA.GOV

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actosol® Humic Acid Being Applied Successfully In Various Applications

UNITED STATES

- Landscaping
- Erosion Control
- Landfill Closure
- Golf Courses
- Sod Farms
- Nurseries-Tomatoes
- Sand Dunes
- Floriculture
- Agriculture
- Horticulture

GULF COUNTRIES

- Rhodes Grass
- Water Melon
- Cucumber
- Alfalfa
- Orange Groves
- Grapes
- Onion
- Date Trees

MAURITIUS

- Sugar Cane
- Horticulture

S. KOREA

- Golf Courses
- Greenhouses

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Actodemil

The Solution to Munitions Waste Disposition

Energetics - Chemical Agents - Biological Agents

SAFE:
Permanently Destroys Energetics, Chemical and Biological Agents

ENVIRONMENTALLY SOUND:
Non Polluting and Non Hazardous Product

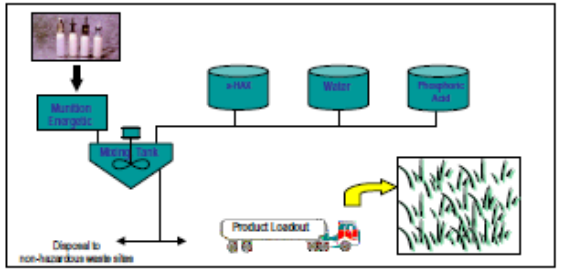
COST EFFECTIVE:
Lower Cost Than Thermal Destruction Methods
Recycles Energetic Into Saleable Fertilizer

A CLEAR CUT ALTERNATIVE TO INCINERATION AND OB/OD.

Actodemil® technology - Description and Applicability

Actodemil® technology is based on naturally occurring coal-derived humic acid for accomplishing a series of useful reactions to decompose highly toxic and hazardous chemicals. Humic acid is a water soluble colloidal solution. It is a reducing agent and thus it promotes reductive hydrolysis. In addition, it has a strong affinity for organic molecules and metal ions, and is thus effective for absorption of reaction products. The key reactant material in the reaction is the ARCTECH proprietary a-HAX reagent. The reaction is carried out in a reaction vessel operating at atmospheric pressure and at a temperature of 160 to 180ºF. Following completion of reaction (between 2 to 4 hours), the product is neutralized and is then ready for application as a fertilizer or safe disposal.

Actodemil® Technology Flow Sheet



Actodemil® TECHNOLOGY SUCCESSFULLY TESTED ON:

Energetics	Chemical Agents	Biological Agents
Large-Bore Gun Propellants	*Nerve Agents*	*E. coli*
- 3"/50, 6"/47, M6 (NC based)	GB, VX	
- 105 MM (NC/NG based)	*Blistering Agents*	
- 106 MM - M30, M30A1(NC/NG/NQ)	HD, HT, H	
Rocket Propellant		
- 2.75" AA (NC/NG based)		
Other Explosives - HMX, RDX, TNT,		
DNT, Lead Azide, PETN, and AP		

In addition, a variety of energetic wastes treated such as: Rags, Turnings, Dust, Overcast, Off Spec, Rejected Propellants, Explosives, Filters contaminated with Explosives, Unstable, Out of Date Materials, Floor Sweepings, Expended Samples from Lab, Manufacturing Wastes, etc.

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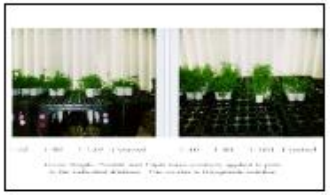
Actodemil® TECHNOLOGY TREATED PRODUCT:

- Complies with EPA Toxicity Characteristic Leaching Procedure (TCLP) Requirements
- Is Not Reactive (as defined by RCRA Requirements)
- Complies with EPA Universal Treatment Standards
- Is Not Mutagenic as Determined by Ames Assay Test
- Showed no Energetic Response (friction and impact tests)
- Is Not Phytotoxic to Plants

Fertilizer Product Enhances Alfalfa Growth



REGULATORY ACCEPTANCE

- Compliance with 1997 EPA Munitions Rule Permits Recycling of Energetics to Fertilizer as Non-RCRA Activity
- Nevada EPA in 1999 Approved Use of Recycled Fertilizer and Commended Actodemil® Approach.

INDUSTRY IMPLEMENTATION

- Disposal of Energetic Manufacturing Waste
- Recycling of Nitrocellulose Fines and
- Recycling of Scrap Propellant into Fertilizer.

Actodemil® Mobile Production Unit

Our Bench-Scale Unit is Available for Specific Technology Application Studies

In Addition, Pre-Designed Units are Available:

- 100 Pounds per Batch - 50 gallon unit
- 200 Pounds per Batch -100 gallon unit
- 1,000 Pounds per Batch - 500 gallon unit

ARCTECH, Inc. is a diversified company that provides technologies, services and products to meet growing needs of clean energy and for preserving the environment. Formed as a spin-off company from the Environmental Science and Technology division of the Atlantic Research Corporation, the ARCTECH group through 25 years of experience in energy, energetics, environment and agriculture, has created holistic solutions in these interrelated market sectors. The entrepreneurial scientists and engineers at ARCTECH have pioneered the use of vast resources of coal and coal-derived humic acid products such as actosol® fertilizer; HUMASORB®, a multipurpose contaminant adsorber; ACTODEMIL®, described herein for cost effective disposal of munition; and an overall encompassing MicGAS™ technology for production of clean energy while reducing the build up of greenhouse CO_2 emissions. For additional information about our outside the box solutions, please visit our Web Site: **www.arctech.com**.

ARCTECH

Preserving tomorrow's world... today

For Your Specific Munitions Application Needs, Please Contact:

Mr. Nand Kaushik

ARCTECH, Inc.
14100 Park Meadow Drive
Chantilly, VA 20151-2217

Phone: (703) 222-0280 Fax: (703) 222-0299
E-mail: nkaushik@arctech.com • Website: www.arctech.com

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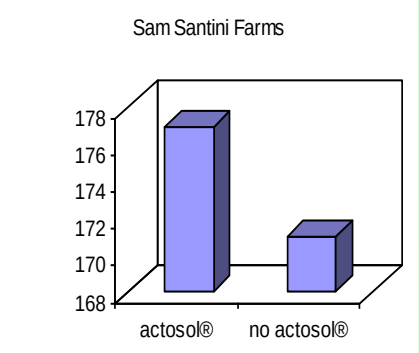
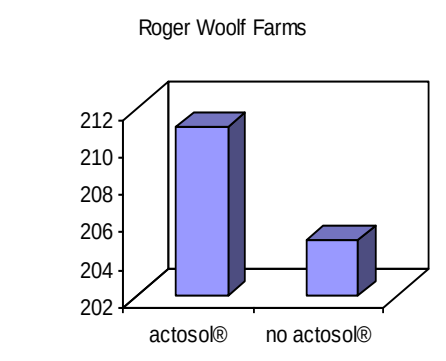
Actodemil® MOBILE TEST UNIT AT McAlester ARMY AMMO PLANT IN OKLAHOMA





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Actodemil® Technology Supported by EPA regulators and the Public

.....the Agency has determined the recycling of propellants or explosives into fertilizer may be a permissible activity under RCRA.....the use of an unused explosive or propellant as an ingredient to produce commercial fertilizer would be exempt from regulation under RCRA.....

Excerpts from U.S. EPA Military Munitions Rule

40CFR Section 266.202.
April 1997

GOING GREEN AT THE DOD. Defense Department Scientists Agree Army Depot uses obsolete Demil Technology. Actodemil® Technology fulfills the biblical prophecy of tuning swords into plowshares

- Reno News
May 29, 2001

STATE OF NEVADA
KENNY C. GUINN
Governor

DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES
DIVISION OF ENVIRONMENTAL PROTECTION
333 W. Nye Lane, Room 138
Carson City, Nevada 89706-0851

February 25, 1999

Dear Mr. Kaushik:

The Division first became aware of the ARCTECH study during an inspection at HWAD in March/April 1997. The Division later learned in July 1997 that fertilizer produced during the study was ultimately applied to the land as a fertilizer at the Gomes property in Fallon, Nevada. In response to concerns regarding the suitability of the product as fertilizer and adequate treatment of the waste munitions, the Division reviewed data provided by ARCTECH, as well as soil samples taken by the Division, and determined that the **"Actosol" product did not exhibit any of the characteristics of a 'hazardous waste."** However, because the waste munitions were being recycled in "a manner constituting disposal" (i.e., placed on the land), the Division was concerned that the laboratory data did not adequately demonstrate compliance with the applicable treatment standards of 40 CFR 268 Subpart D (see 40 CFR 266 Subpart C). ARCTECH later provided data indicating that the presence of the underlying constituent(s), specifically Barium, could be adequately addressed during the fertilizer manufacturing process.

Because waste munitions do share many of the same components of common fertilizers, the Division **commends ARCTECH's efforts** to develop fertilizers from this otherwise discarded material. Notwithstanding the potential merits of your process, the Division wishes to reiterate the importance of demonstrating compliance with 40 CFR 266 Subpart C and the applicable state requirements as conveyed in my letter to HWAD (dated November 18, 1998).

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Why *Actodemil® for Safe Disposition of Munition?*

Issues of Today

- 500,000 tons of Obsolete Conventional Munitions
  - UN Disallowed Ocean Dumping in 1950's
  - OB/OD Permitting Becoming Difficult
  - Metals parts being Recycled But Need Cost-Effective Solution for Safe Disposition of Unstable Energetics
  - Incineration Costly and Polluting
  - Get Explosives for Industry Result in Polluting Mining Areas

- 80,000 Obsolete Missile
  - Contain 96 million lbs. of Ammonium Perchlorate

- 25,000 Tons of Obsolete Chemical Munitions

Actodemil® Solutions

- 1997 EPA Munitions Rule Allows Recycling into Fertilizer and Exempt from RCRA

CURRENT PROJECTS:

- Crane Army Ammo-INDIANA
- Toole Army Ammo Plant-UTAH
- McAlester Army Ammo-OKLAHOM
- Radford-VIRGINIA
- ROK-Army-KOREA
- Egypt-Army/HAIKSTEP

- Feasibility of Actodemil® Proven for Safe Destruction of Ammonium Perchlorate for the US Army

- Feasibility of Actodemil Proven Safe Destruction of Nerve & Blistering Agents for the US Army

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3PM™ PROCESS

Pollution Prevention and Profit from Manure Process

Produces humic rich fertilizer

Eliminates odor, pathogens and viruses from manures;

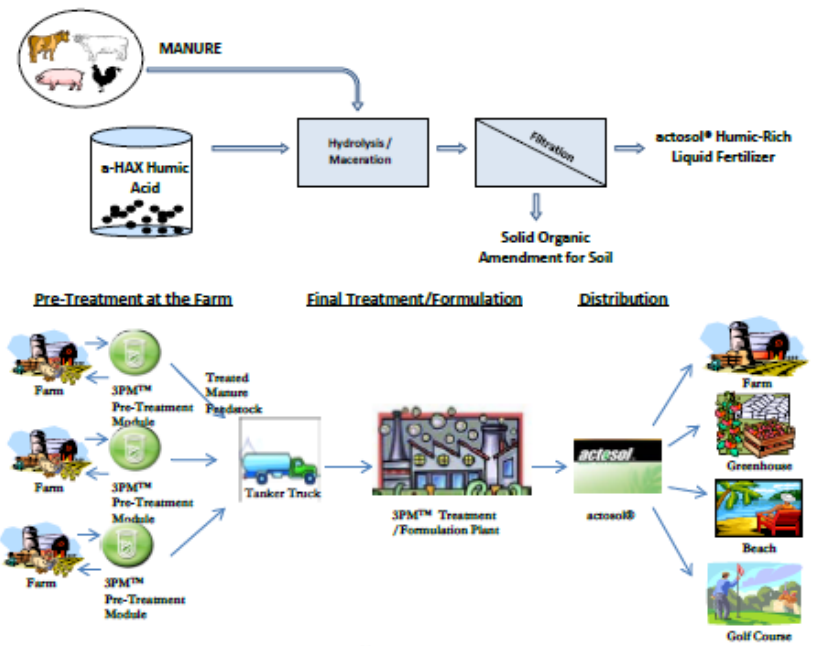
Modular design, applicable for small to large scale operations

Converts Problem into economic opportunity

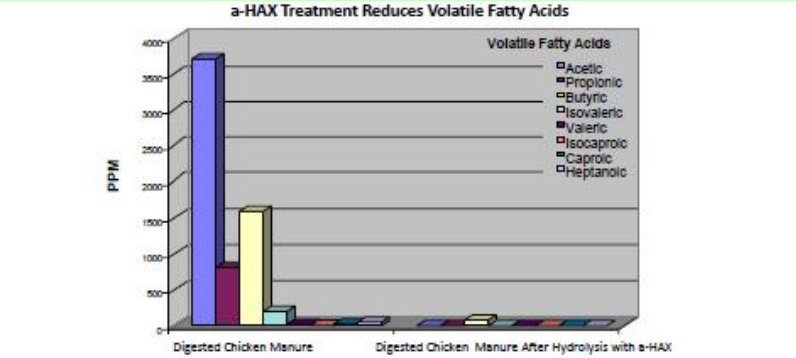
ARCTECH

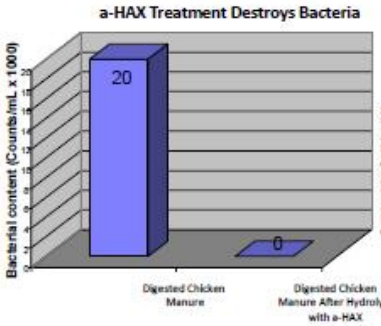
Preserving tomorrow's world... today

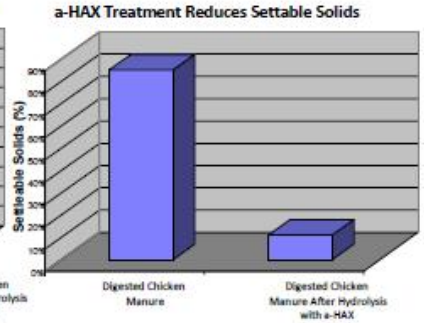
3PM™ is an "outside the box", innovative process that simultaneously de-odorizes, and macerates particulates, and completely converts animal wastes (e.g., chicken manure) into humic rich fertilizer. **The use of natural organic matter derived a-HAX™ humic acid in this Process is the unique innovation that sets 3PM™ apart from any other process that also produces fertilizer from animal wastes.** Preliminary economic analysis even for a small 0.25 to 0.5 ton per day processing plant, shows the process to be economical due to effective, high value humic acid fertilizer. A generalized flow scheme of the 3PM™ process is as follows:



FOR LARGER MANURE PRODUCTION FARMS A FULLY INTEGRATED 3PM™ FACILITY CAN BE INSTALLED AT THE FARM





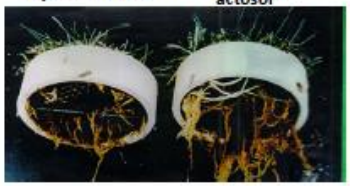


actosol® creates vegetation in sand dunes

Ocean City, MD

hydroseed mix

hydroseed mix plus actosol®



6 weeks growth, Virginia Tech., testing

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For Your Specific Application needs, please contact:

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Chantilly, Virginia 20151
Phone: (703) 222-0280 Fax: (703) 222-0299

Website: www.arctech.com

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Panelists Confirmed Removal of Offensive Odor from Swine Manure with a-HAX™

Treatment (mL of a-HAX)	Panel Ratings*				
	Panel 1	Panel 2	Panel 3	Panel 4	Panel 5
None	5	5	5	5	5
0.5	4	3	4	4	3
1.0	1	2	2	2	2
2.0	3	4	**1**	**1**	**1**
5.0	2	4	3	3	4

*1: best smelling, 5: worst smelling.

Test data performed by Penn State University.

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Typical Expected Mass Balance

1 Ton of Manure
(2000 lbs with
25-50% moisture)

+

250 gallons of a-HAX™

→

800 gallons of
Organic Humic Fertilizers

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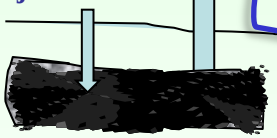
Total Value Chain of MicGAS™ Coal Biorefinery Plant

100,000 Tons of Wyoming Sub-bituminous Coal

MicGAS™ Biorefinery

MicMicrobes + Nutrients Injection



50 ft thick seam, 20 Million Tons of Coal on 240 acres

Liquid Fuel 30 Million gallons

actosol® 40 Million gallons

HUMASORB®-CS 112 Million lbs

HUMASORB®-L 28 Million gallons

a-HAX™ 28 Million gallons

$45 Million

$60 Million

$168 Million

$63 Million

$63 Million

Total Operating Revenues $399 Million
Net Operating Revenue $206 Million

On 150 Million Capital Investment
NPV=$658 million
Rate of Return=42.5 percent

APPLICATION USE

Transportation	30 Million gallons of gasoline and/or jet fuels
Agricultures	4 Million Hectares
Non-Agricultures	2 Million Hectares
Industrial Wastewater	28 Billion gallons
Soil Remediation	Site Specific
Gas Treatment	Site Specific
Waste Recycling	56,000 Tons
Municipal Sewage Water Recycling	20 Billion gallons

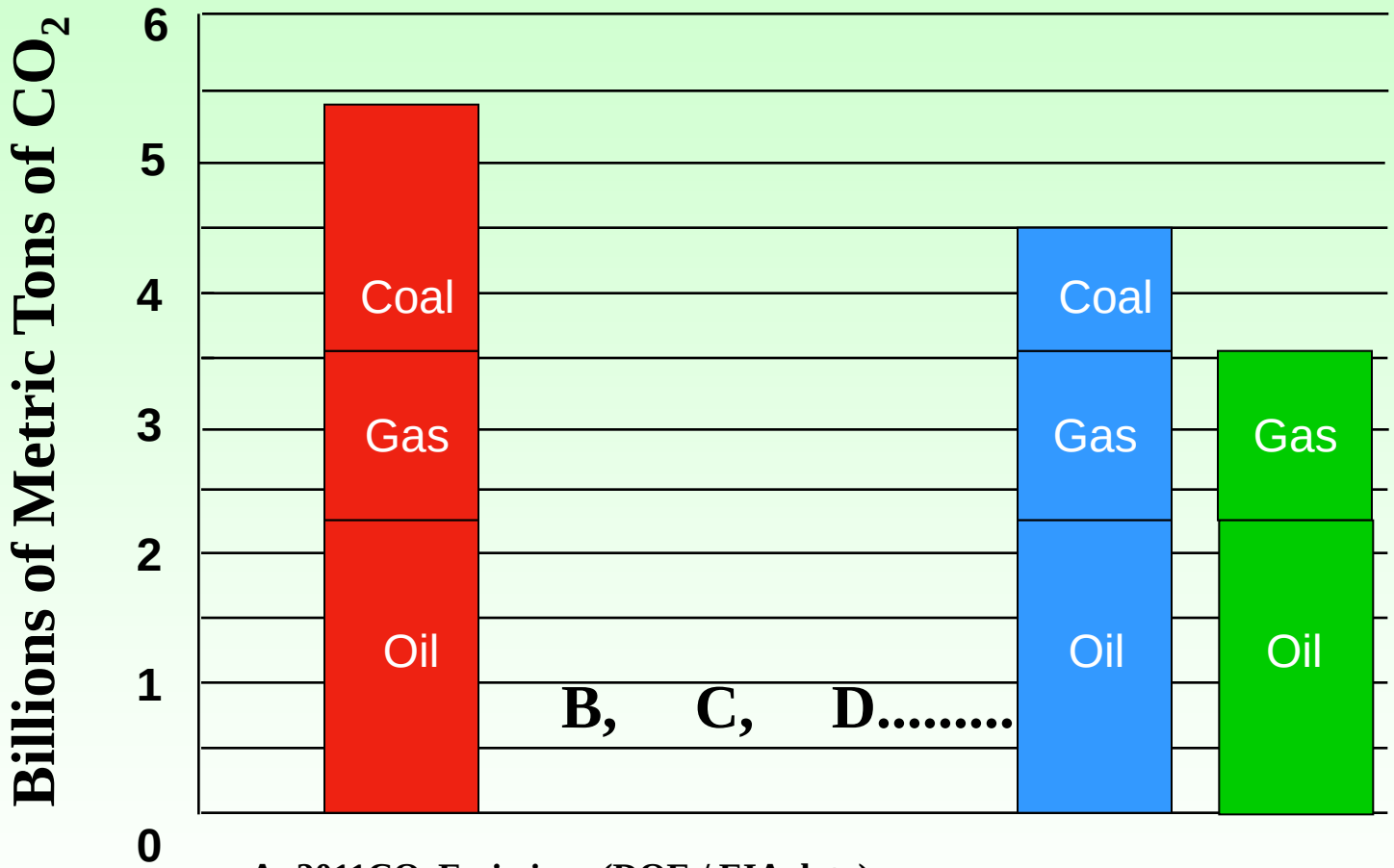
Assumption: actosol® and a-HAX™ go 50/50 to the each application.

Note:

Agriculture: 5 gallons of actosol®/ acre
Non-Agriculture: 10 gallons of actosol®/acre
Wastewater: 5 lbs of HUMASORB®-CS/1000 gallon
Wastewater: 5 gallons of HUMASORB®-L/1000 gallon
Wastes Recycling: 250 gallons of a-HAX™ / 1 Ton
Municipal Sewage: 0.67 gallons of a-HAX™ /1000 gallon

ARCTECH
Offering "Balanced Sustainable Solutions"

30% CO_2 Reduction of Overall U.S. Emissions Achievable by Only Using Coal with MicGAS™ Biotechnology Approach



A: 2011CO_2 Emissions (DOE / EIA data)
Y: CO_2 Reduction with the use of Coal-derived Methane Gas and Fuels
Z: CO_2 Reduction with Biomass Cultivated with Coal-derived actosol® Humic Acid Fertilizer

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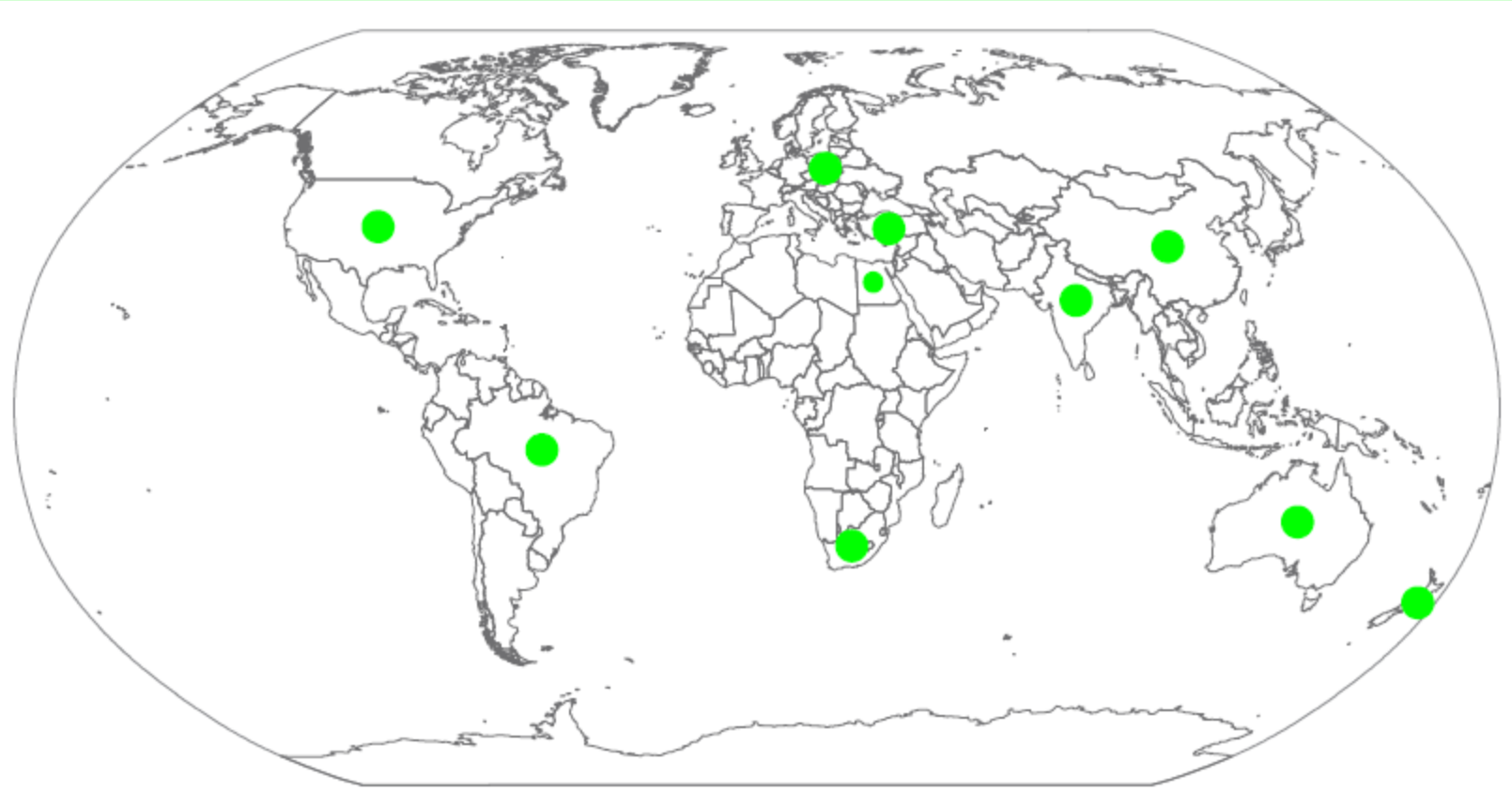
Worldwide HUMAXX™ Envisioned Plant Location



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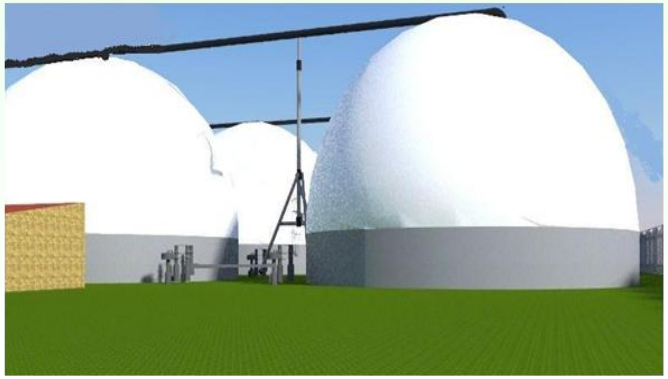
ARCTECH, Inc. USA Envisioned Commercial MicGAS™ Clean Coal Biotechnology Plant



ARCTECH
Offering "Balanced Sustainable Solutions"

Coal Biotechnology Solutions Offer an Economic Value Proposition & Complies with the Age Old Aspirations of The YIN YANG

Must Haves:

Cleaner Air

Water, Food,

Energy, Shelter

Desire:

Health

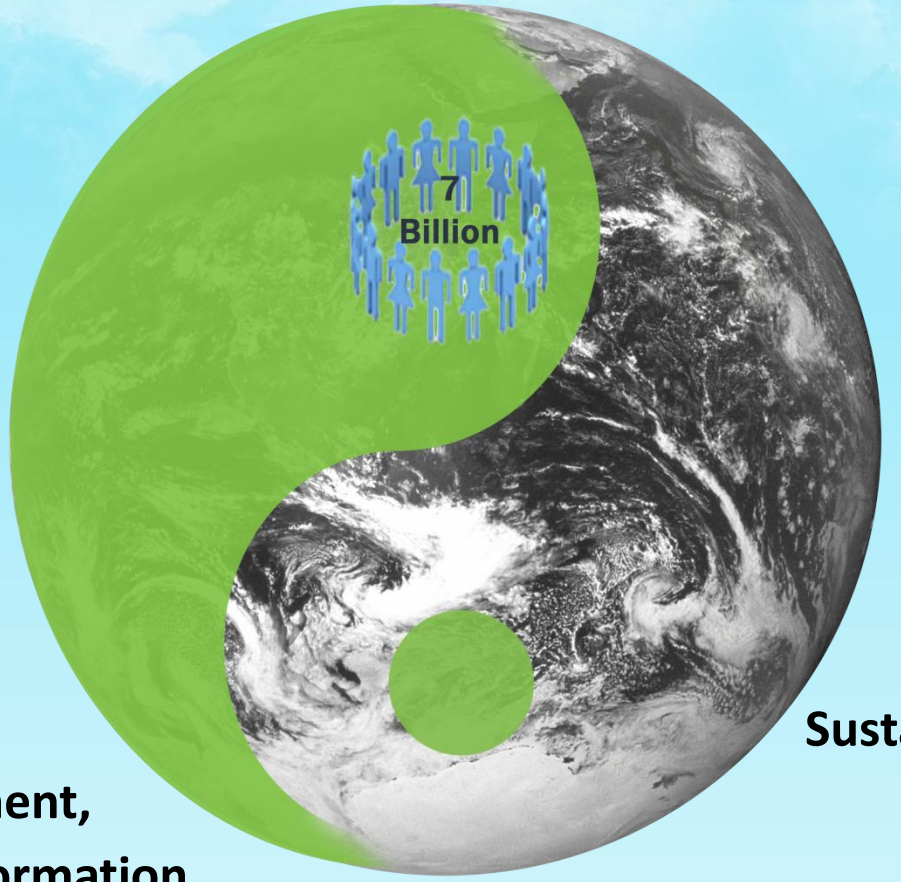
Environment

Wants:

Comfort, Entertainment,

Communication/Information,

Transportation



Must Maintain:

Productive Soils,

Cleaner Water & Air

Desire:

Sustainability

Wants:

Sustain Other Inhabitants

ARCTECH

Preserving Tomorrow's World...Today

Humic Science & Technology Ten

Structures, Properties and Uses

This Conference is dedicated with thanks for the work of

Dr. Daman S. Walia

President

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Born December 29, 1946 at Nabha, State of Punjab, India

B.S., Chemistry, Physics and Geology, Punjab University, Chandigarh, India, 1967
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Research Scientist, Illinois Institute of Technology Research Institute, Chicago, Illinois 1975-78
Fossil Energy Specialist, Oak Ridge National Laboratory, Oak Ridge, Tennessee 1978-81
Technical Director, R&D Division, United Coal Company, Bristol, Virginia 1981-84
Manager, Environmental Science and Technology Group, Atlantic Research Corporation, Alexandria, Virginia 1984-87

Founder and President, Arctech, Inc., Chantilly, Virginia 1988-to date

American Chemical Society
National Defense Industrial Association
Advisor, Humic Science & Technology Conferences, 1997- to date
Recipient of 7 US Patents

ARCTECH
Offering "Balanced Sustainable Solutions"

MicGAS™ Coal Biotechnology Creates Highest $ Value and Converts Coal into Environmental Compliant and Climate Control Solution

TECHNOLOGY	CURRENT		NEW			
	Thermal Combustion	Thermal Gasification	Thermal Gasification-IGCC	Thermal Gasification-CTL	Thermal Gasification-Gas	Non-Thermal MicGAS™
A. Capital Cost B. Economical Size	$800/kwh 150 MW	$3 Billion 6 M tons/yr	$2000+/kwh 5 M tons/yr	$4-6 billions 5 M tons/yr	$5 Billion 5 M tons/yr	$10 million 10,000 tons
C. Products &Revenues/Ton ENERGY Electricity,kwh Gas, SCF Liquid, BBL NON ENERGY Humic Acid S,NH_3 etc.	 2000 ($100) -- -- -- --	 -- 10,000($50) -- -- negligible	 2800 ($140) -- -- -- --	 -- -- 0.6 ($50) -- --	 -- 10,000($50) -- -- --	 -- 10,000($50) 1000gals+($4000) --
D. Carbon Dioxide Emissions/ton	4000 lbs	4000 lbs	4000 lbs	4000 lbs	4000 lbs	500lbs(-11,500 lbs)

Notes

Technologies in U.S.A.

Thermal Combustion: Coal Combustion with steam turbine for electricity generation e.g. 1500+existing plants

Thermal Gasification: Coal gasification and Fischer-Tropsch to methane e.g. Great Plains gasification Plant, N. Dakota (Blue gas planned by Great Point)

Thermal IGCC: Integrated Combined Cycle Gasification for electricity generation e.g. none on coal

Thermal CTL: Coal to liquid via thermal Gasification and Fischer-Tropsch synthesis of gas to liquids e.g. none un U.S.A. (only in S. Africa)

HUMAXX MicGAS™ bioconversion of coal into bio gas for electricity generation clean fuels, chemical productions and humic acid products for safer foods and environmental protection (actosol®, HUMASORB®, & Actodemil®).
e.g. prototype on coal in Virginia

Assumptions Based on Average Estimates:

1. Electricity price at $0.05/kwH FOB plant
2. Liquid fuel price estimated at $2.00 per gallon FOB plant
3. Humic acid products at $2.00 per gallon and $1.50 per lb.,FOB plant
4. Gas prices for 1000 SCF or one million Btu @ $5.00
5. Carbon dioxide Emissions from MicGAS™ for electricity production will result in net capture of CO2 . For example one acre of biomass captures 3 tons of carbon dioxide per year. With 1000 gallons of actosol® humic acid applied on 20 acres of land at 50 gallons/acre will increase biomass by 10%. Thus, additional six tons of carbon dioxide will be captured and resulting in net reduction of 6 tons x 2000 lbs/ton=12,000 lbs (Sequestered) - 500lbs (Combustion) =11,500 lbs.
6.Cost for Carbon Dioxide for capture transport and underground sequestration is projected to be $90 per 2000 lbs. from combustion, Thermal IGCC and Thermal CTL plants.

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