تحت رعاية فخامة الرئيس عبد الفتاح السيسي رئيس جمهورية مصر العربية

HELD UNDER THE PATRONAGE OF HIS EXCELLENCY ABDEL FATTAH EL SISI, PRESIDENT OF THE ARAB REPUBLIC OF EGYPT

EGYPS TECHNICAL CONFERENCE

SUPPORTED BY

وزارة البترول والثروة المعدنية
Ministry of Petroleum & Mineral Resources

13 – 15 FEBRUARY 2023 | EGYPT INTERNATIONAL EXHIBITION CENTER

SESSION: 16 REFINING DEVELOPMENTS AND ADVANCEMENTS

AET technology reduces greenhouse gas emissions, decreases costs, improves safety, reduces sulfur in fuels

Sumit Agarwal BD Director GE3S – AET

SUPPORTED BY

EGPC EGAS Ganoub Echem EGYPTIAN PETROCHEMICALS HOLDING COMPANY

ORGANISED BY

dmg events

About Alt Enviro Tech and GE3S

ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

Alternative Environmental Technologies (AET) is staffed by experts in analytical chemistry, mechanical engineering, combustion processes and regulatory affairs

AET has developed technologies and protocols for the manufacture of highly stable and cost-effective fuel emulsions this includes proprietary chemical additive packages, mechanical blending processes and "know-how" creating fuel emulsions that are robust and stable and able to tolerate the heat and pressure to which fuels are subjected prior to combustion in a diesel engine, furnace, gas turbine, or boiler.

AET has also developed a unique method of removing sulfur from distillates

GE3S Putting Sustainability Into Practice

GE3S ***brings the right blend*** *of expertise,* proven experience in sustainability and Carbon Consultancy Services and providing sustainable solutions *for Regulatory Authorities, Leading Real Estate Developers, Architect Firms, Contractors, Industries and Facility Management since 2009. Below are the key features of our experience:*

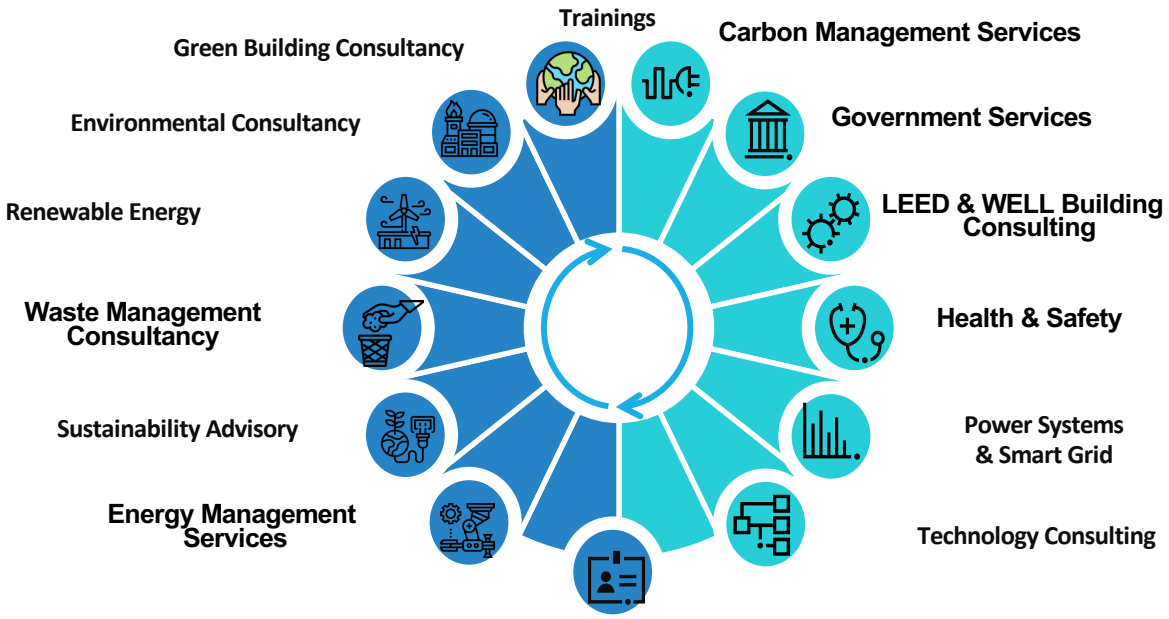
- Understanding and ***extensive experience*** in ***Carbon Advisory, Green Building & Sustainable Infrastructure, Energy Efficiency, Sustainability Strategy, Waste Management Design Engineering for Real Estate Projects, MRF & RDF Plants, Waste to Energy Plant, Waste Reduction Action Plans.***

About Global Environment and Energy Engineering Services - GE3S

GE3S Putting Sustainability Into Practice

Proven Value-Added Solutions

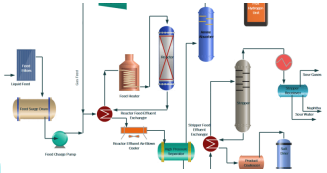
Deep Competency



Strategy | Plan | Design | Deploy | Post-Implementation

Think Sustainability Think GE3S

About Alternative Environment Technologies



Sulfex

DOE

ROE

FOE

Bio-DOE

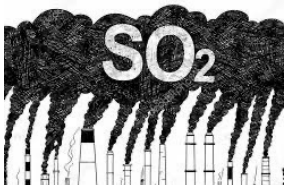
BioDiesel

ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

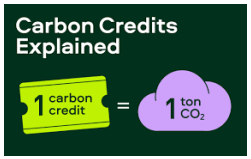
S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

Environmental Edge

➢Fuel as we know will remain for Decades .Transition could still be slower in developing economies



- Making Liquid Hydro carbons more efficient – Diesel, Fuel oil
- Reduce the Carbon Emissions
- Reduce the NOx Emissions
- Increase the Equipment Life
- Reduce the Energy Footprint during Production of HFO
- Reduce the Energy Footprint during desulphurization
- Help in the pyrolysis process (Rubber Tyre Disposal)



ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

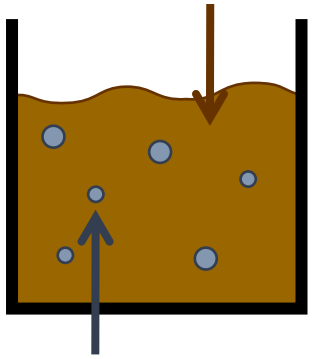
S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

GE3S Putting Sustainability Into Practice

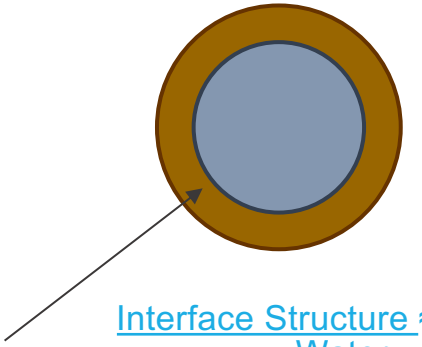
Emulsion Technology Expertise

➢AET uses W/O emulsion technology to improve the energy/environmental performance of petroleum products

External phase = Oil/Fat



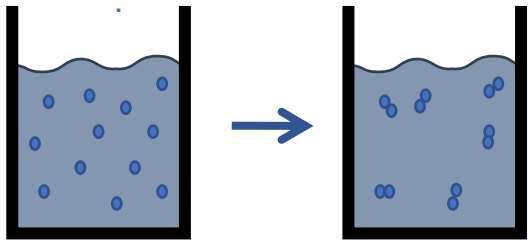
Internal phase = Water droplets



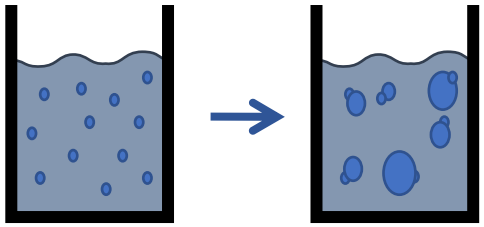
Interface Structure ≈ 80 A^0

- Water
- Components of Oil
- Chemical Stabilizers

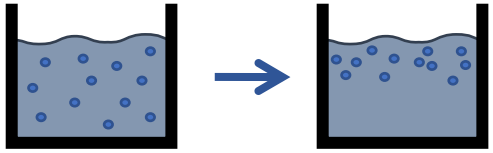
- Emulsion stability degrades with time, pressure and temperature
- A unstable Emulsion may look like,
  - Flocculation.
  - Coalescence.
  - Sedimentation/Creaming.
  - Ostwald Ripening.
  - Phase-inversion.



Flocculation



Coalescence



Creaming

ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

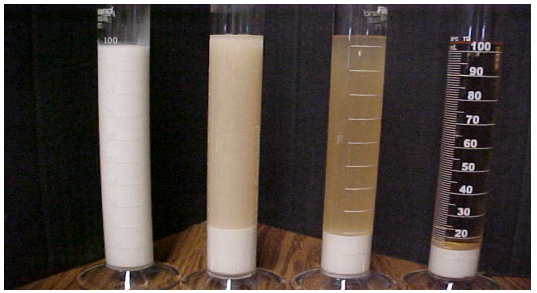
S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

GE3S Putting Sustainability Into Practice

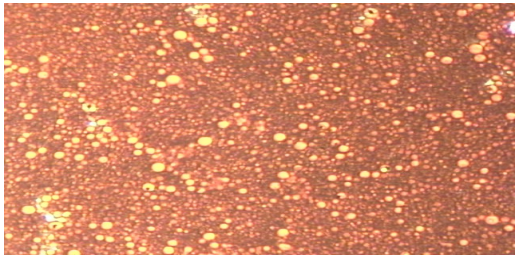
Emulsion Technology Expertise

- **The production of these emulsions involves the use of proprietary chemical additive packages, mechanical blending processes and "know-how**

- Proper chemical additives and a knowledge of their interaction with oil components.
- Chemical components to use as the emulsion surfactants
- The amount of energy to use in the emulsification process.
- The precise combination and application of these components produces fuel emulsions that are robust and stable and able to tolerate the heat and pressure to which fuels are subjected



Example of Emulsion, Flocculation, Coalescence and Sedimentation.



Microscopic slide of O/W Emulsion of Residual Oil.

Traditional Fuel Combustion

Reactants

$CH_4 + 2O_2$

Products

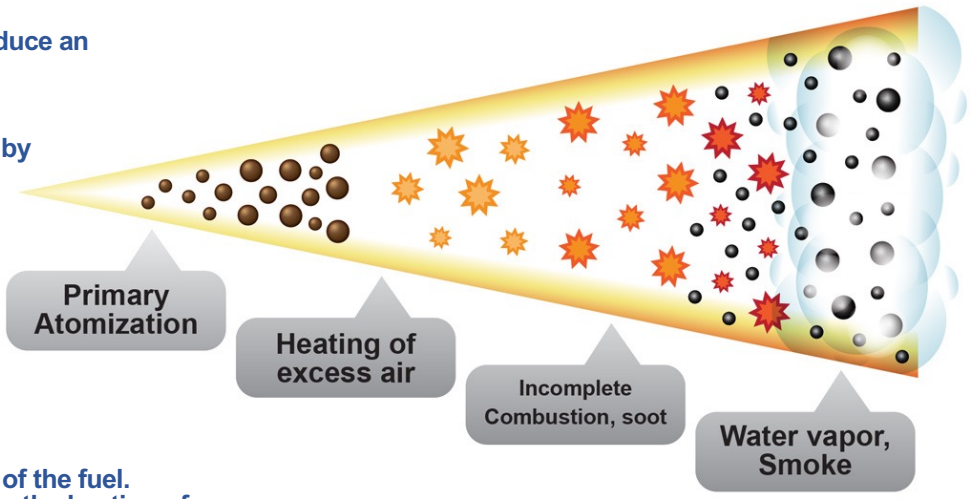
$CO_2 + 2H_2O$

- Fuel component derived emissions:
  - Carbon atoms (C) → Carbon Dioxide (CO_2).
  - Hydrogen atoms (H) → Water Vapor (H_2O).
  - Sulfur atoms (S) → Sulfur Dioxide (SO_2).
  - Oxygen atoms (O) decrease the amount of air required.

- Combustion conditions contribute to the following emissions:
  - Nitrogen Oxides (NO, NO_2, N_2O).
    - Thermal NO_X formation (outside combustion zone)
    - Prompt NO_X formation (inside combustion zone)
    - NO_X formation (from fuel N_2 content)
    - combustion re-burning.
  - Soot and Particulates (Ash).

- Practical combustion of liquid fuels is a two-step process:
  - The atomization of the fuel into a fine vapor to produce an intimate mixing with air.
  - Air/fuel mixture to a source of ignition.

- Issues with efficiency and emissions are primarily caused by ineffective atomization.

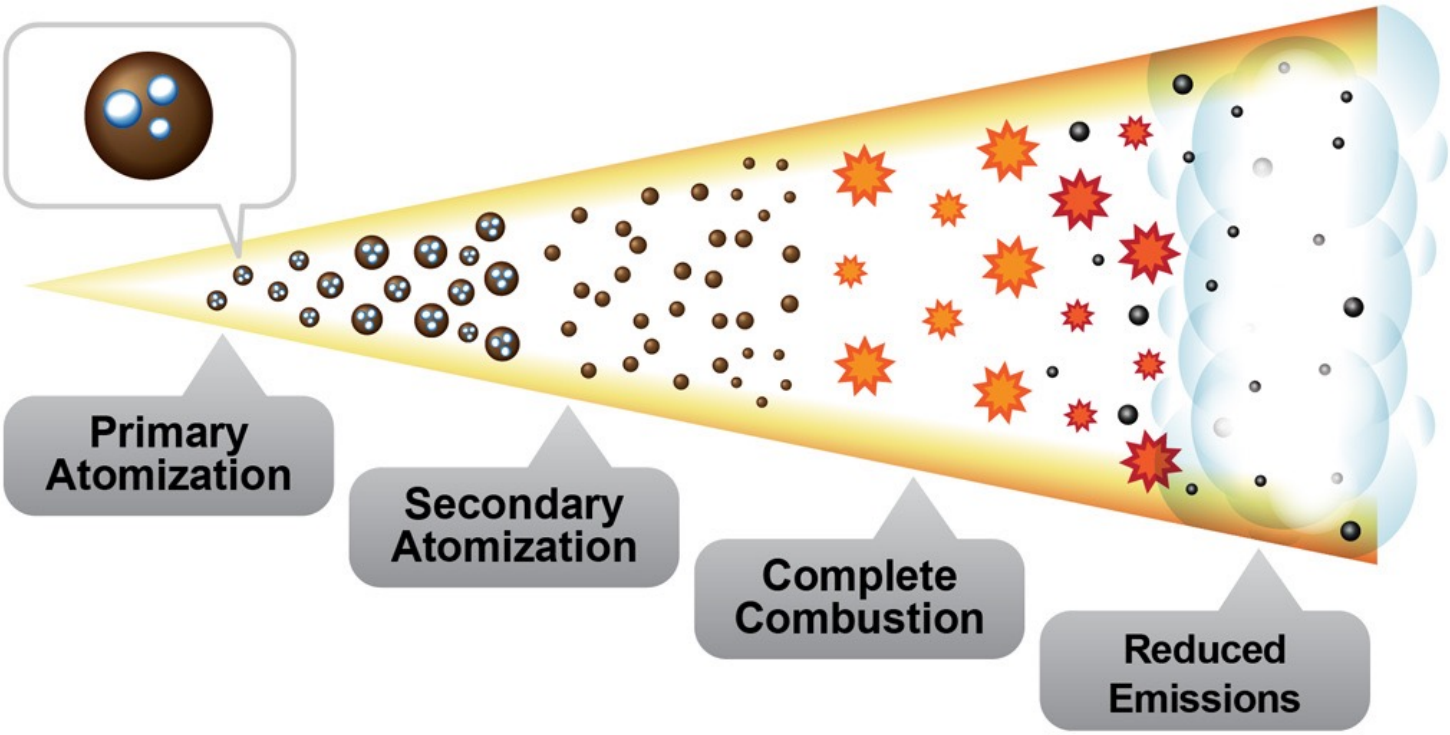


- Traditional atomisation Methods
  - Steam - Most widely used – Efficiency + Energy
  - Air
  - Mechanical Atomisers

- Process Insights
  - Droplet Size Minimizing
  - Sufficient air is needed for complete combustion of the fuel.
  - Excess Air leads to heat loss related to dry gas (or the heating of the Nitrogen in the air).
  - Minimal excess air generally leads to higher overall heat generation (and therefore increase in NOX) while excessive excess air leads to lower overall heat generation.

Emulsified Fuel Combustion

- The effects of emulsified fuels allows for the reduction of excess air and thus improvements in thermal efficiency and better environmental performance. DOE – FOE – Bio DOE



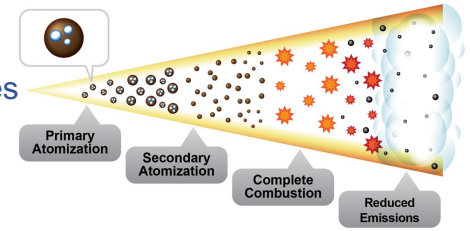
Emulsified Fuel performs better in open flame as well as internal combustion

Fuel Oil Emulsion – FOE

➢ FOE improves the combustion process hence less emissions and better efficiency in fuel oils.

Boilers	Engines
Atomization	Fuel Delivery system
Excess Air	Fuel Temperatures
Moisture in Fuel	Viscosity
Water vapor from hydrogen in fuel	Carbon Fouling
Slagging and carbon build up	
Heat Recovery	

- Applications
  - Furnaces
  - Slow speed engines
  - Boilers



Water

- Water content 8% and 16%.
- FOE can be tailored to meet preferred boiler operating outcomes.
- Water allows for the introduction of inexpensive water-soluble combustion additives.
- Hydrocarbon contaminated water (Brown Water) can be used to produce FOE.

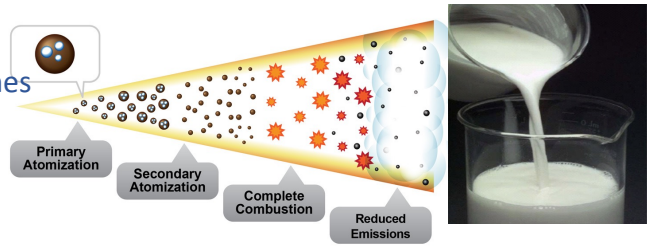
- Operational
  - Reduce fuel storage temperatures.
  - Reduce steam atomization.
  - Reduce excess air.
  - Increase heat transfer.
  - Reduce cleaning and maintenance.
- Environmental
  - Reduces the opacity (smoke) and particulate matter from the stack.
  - Reduction nitrogen in combustion.
  - Reducing thermal NOX.
  - Boiler efficiencies reduce carbon and sulfur-based emissions.
- Economics
  - Reduced steam atomization = $
  - Reduced excess air = $
  - Increased heat transfer = $
  - Reduced cleaning and maintenance= $

Diesel Oil Emulsion – DOE

➢ DOE improves the combustion process hence less emissions and better efficiency in Diesel.

Engines	Boilers	Turbines
Fuel Delivery system	Atomization	Compressed Air
Fuel Temperatures	Excess Air	Vibration
Viscosity	Moisture in Fuel	Blade Deposit
Carbon Fouling	Water vapor from hydrogen in fuel	Heat Recovery
	Slagging and carbon build up	
	Heat Recovery	

- Application
  - Transportation
  - Large Stationary Engines
  - Locomotives
  - Combustion Turbines
  - Boilers/Burners`



- Water
  - Water content can range between 7% and 13%. DOE fuel can be tailored to meet various operating requirements.
  - Fuel tailoring is mostly achieved through varying the water content and is based on end user requirements.
  - Water for diesel engine combustion must meet strict criteria for dissolved solids and chlorine

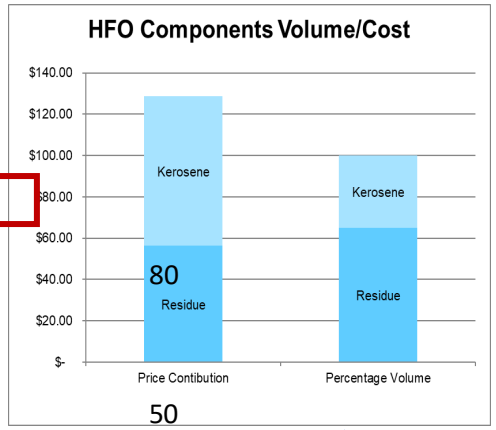
- Blending unit locations
  - Refinery
  - Terminal
  - Customer Site
  - Direct Interface with Combustion Equipment

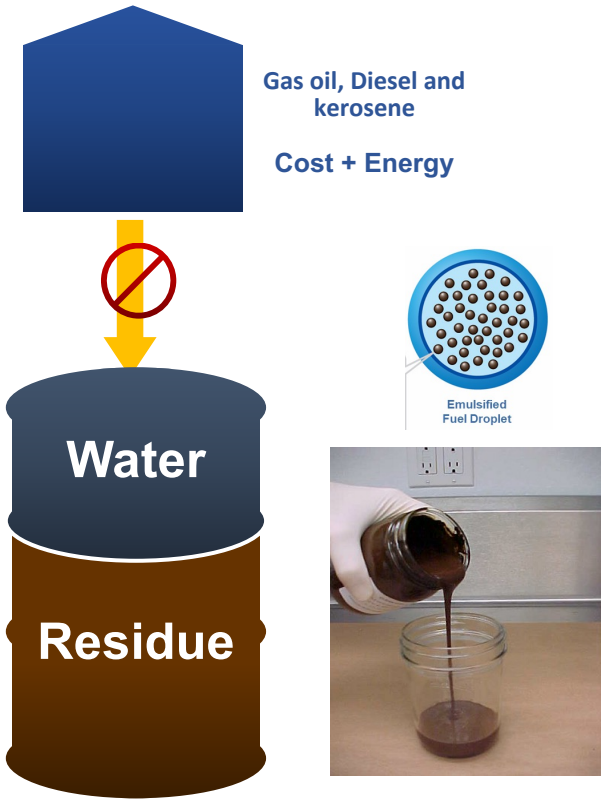
- Increased Efficiency
- Reduced Wear and Tear

Residual Oil Emulsion

➢ ROE replaces the cutter in HFO with water & AET Additive, allowing the calorific content of the fuel to exist only of low-cost residue. It also helps in the combustion process

	HFO	ROE
Density	1.01	1.03
Water %	0.5	32.8
Viscosity @ 50º CST	390	120
Viscosity @ 15º CST	10,000	140
HHV Kcal/Kg	10,300	6,855
LHV Kcal/Kg	9,800	6,201
Sulfur %	3.0	2.08
Carbon %	89.94	55.74
Hydrogen%	11.1	7.46
Nitrogen %	1.03	0.69
Oxygen %	1.65	1.11
Ash %	0.19	0.13





- ❑ Water can be Sour Water or Produced Water
- ❑ Applications Furnaces – slow speed engines - Boilers

ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

GE3S Putting Sustainability Into Practice

Residual Oil Emulsion

ROE continued

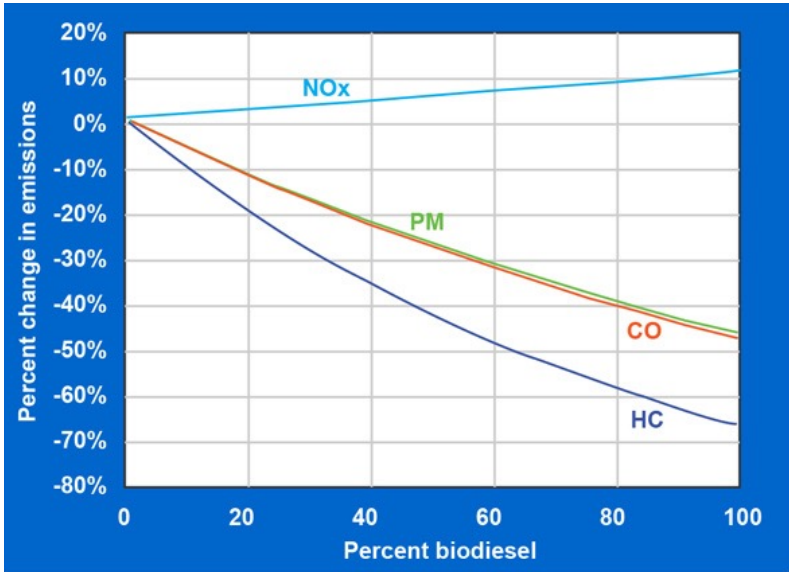
	ASTM	Bitumen	Duri	Flash	Combo	VFCR
Analysis	Test Method	Italy	Indonesia	Denmark	Denmark	Switzerland
Density kg/cu.m	D-1298	1.05	0.96	1.02	1.02	1.00
Viscosity cSt @ 50 C.	D-445	80000	55029	24450	7,777	6,036
Nitrogen wt %	D-4629	0.59	0.47	0.53	0.54	0.45
Sulfur wt %	D-4294	4.5	0.3	0.56	0.55	0.73

Raschig GmbH Industrial ROE
Ludwigshafen, Germany

- Positive Economics
  - Benefits consistent with DOE and FOE in terms of efficiency.
  - The biggest savings is based on substitution of water for cutter stock.
- Positive Environmental
  - Depends on feed stock and nature of assessment.

Bio Diesel Emulsion

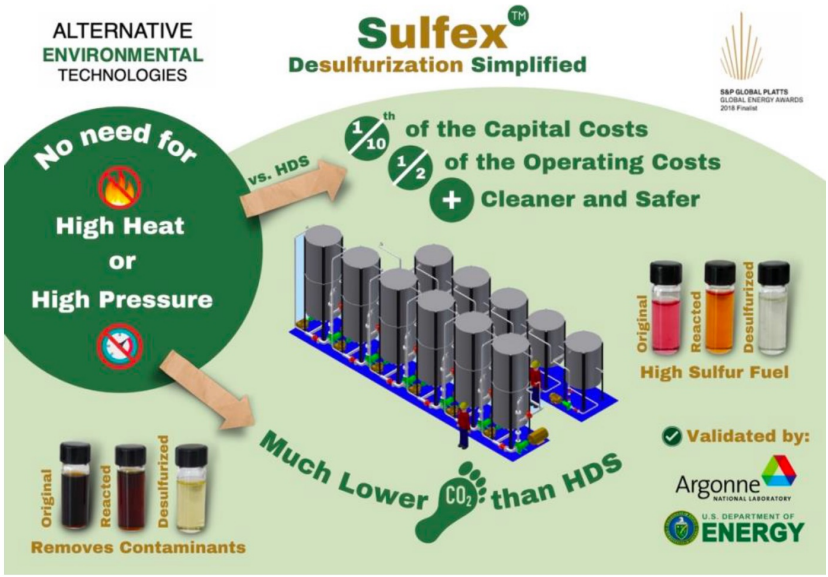
- Emulsions can solve the problem of elevated NO_X emissions from biodiesel, exemplified in this EPA graph showing NO_X increasing with the concentration of biofuel



- The biodiesel market is well-established in Europe and is growing exponentially in the U.S
- Biofuels are more oxygenated (higher oxygen to carbon ratio at combustion), resulting in increased NOX emissions when combined with nitrogen in intake air at high combustion temperatures; the water in an emulsion produces cooler combustion, neutralizing the effects of higher oxidation
- AET emulsion help in further reducing PM
- Emulsions deliver a carbon efficiency because of their better combustion

- Biodiesel degrades certain types of elastomers and rubber components in engine fuel systems over time. APT is developing additive packages aimed at improving compatibility of biodiesel with fuel system components.
- Biodiesel has greater viscosity than regular diesel fuel, resulting in higher cloud points, pour points and cold-filter plugging points. Emulsions improve the flow characteristics of higher-density fuels.
- Biodiesel blend stocks vary. APT is identifying specific biodiesel blend stocks with properties lending themselves to high-quality emulsions more compatible with engines.
- Emulsions and associated additive packages can help address issues with ethanol: low lubricity, low cetane number, separation with diesel and inferior atomization.

➢ Sulfex removal of sulfur compounds from distillates that is more economic (Capex and Opex) and with lesser carbon footprint than traditional methods



- ❑ This technology can be performed both at a refinery and separately from a refinery (suchas at a bunkering facility).
- ❑ Can be used to replace aging Hydrodesulfurization (HDS) systems or add capacity to existing HDS or improve distillates &fuels quality.
- ❑ Based on published data the cost for HDS to reduce 1500 ppm material to 10 ppm is $0.10 per gallon processed, while that for AET's Sulfex™ is $0.05.
- ❑ The basic principle of AET's Sulfex™ is water-based reagent (Oxidizer) + Fuel + Catalyst → Oxidised Sulpher is removed from fuel

- ❑ Hydro-desulfurization
  - ❑ Requires high temperature (>300 Celsius) and high pressure (>200 PSI)
  - ❑ Requires Hydrogen gas (expensive and hazardous to handle)
  - ❑ Very high capital cost
  - ❑ Established technology at refineries
  - ❑ Mainly limited to desulfurizing distillates

AET's Process, Sulfex™

- ***Low capital cost – does not require high temperatures and high pressures***
- ***Requires less space***
- ***Mixing/Extraction-based process that utilizes proven industrial processes in a unique and patentable fashion***
- ***Base processes desulfurize distillates at operational costs equivalent or lower than HDS.***
- ***Due to the above advantages, Sulfex™ plants can be sized and placed in locations such as smaller refineries, fuel distributors and pipeline terminals***

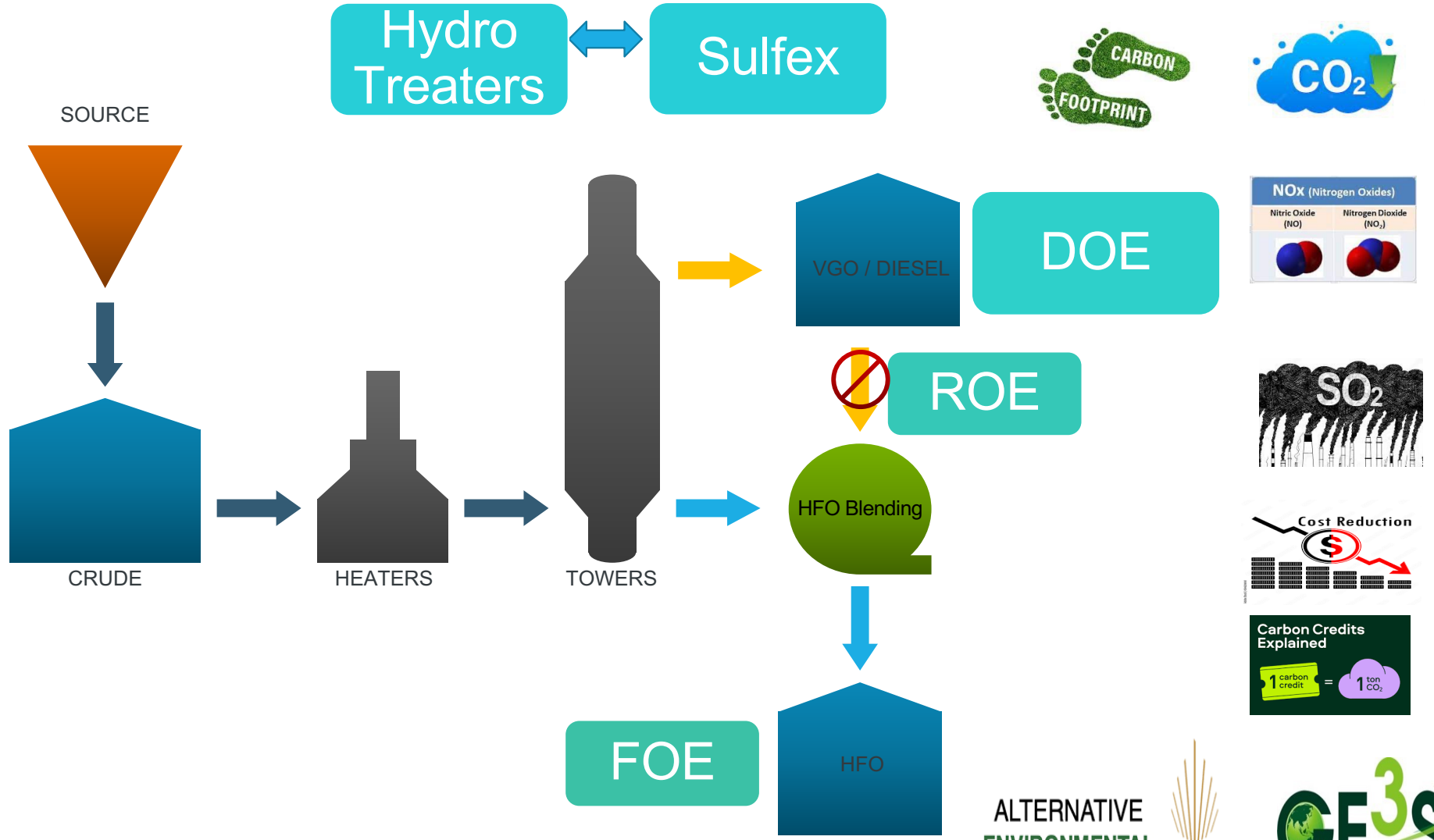
ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

GE3S Putting Sustainability Into Practice

Summary

- Range of patented products and technologies improving fuel efficiency, reducing pollution and bringing cost efficiencies



ALTERNATIVE ENVIRONMENTAL TECHNOLOGIES

S&P GLOBAL PLATTS GLOBAL ENERGY AWARDS 2018 Finalist

GE3S Putting Sustainability Into Practice

تحت رعاية فخامة الرئيس عبد الفتاح السيسي رئيس جمهورية مصر العربية

HELD UNDER THE PATRONAGE OF HIS EXCELLENCY ABDEL FATTAH EL SISI, PRESIDENT OF THE ARAB REPUBLIC OF EGYPT

EGYPS TECHNICAL CONFERENCE

SUPPORTED BY

وزارة البترول والثروة المعدنية
Ministry of Petroleum & Mineral Resources

13 – 15 FEBRUARY 2023 | EGYPT INTERNATIONAL EXHIBITION CENTER

INSERT: Sumit Agarwal , GE3S – AET

sumit@ge3s.me ; 00971588285373

THANK YOU

SUPPORTED BY

EGPC EGAS Ganoub Echem EGYPTIAN PETROCHEMICALS HOLDING COMPANY

ORGANISED BY

dmg events