

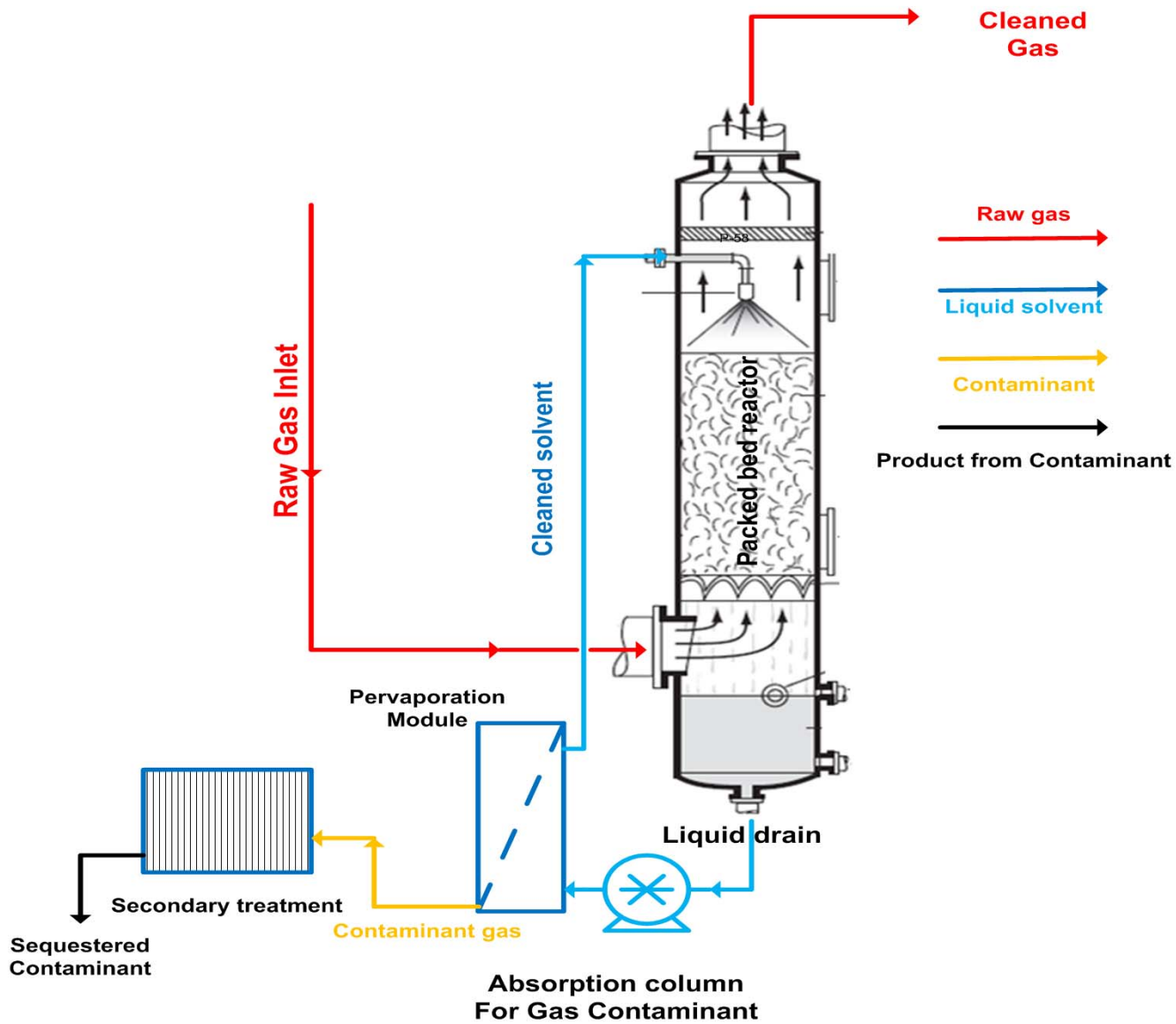
NRGTEK INC.

**Bio-gas, CO₂ Sequestration &
Associated Gas Treatment
Technologies**

Nrgtek Technology

- **Liquid solvent-based scrubbers, followed by pervaporation using organophilic membranes**
 - Stable solvents
 - High life-cycle membranes
 - Catalytic sequestration of contaminants
- **Heterogeneous system (solid catalyst-liquid media-gas treatment)**
- **Contaminant sequestered by chemical / electrochemical means – secondary treatment**
- **No hazardous by-products created**

Gas Separation Process



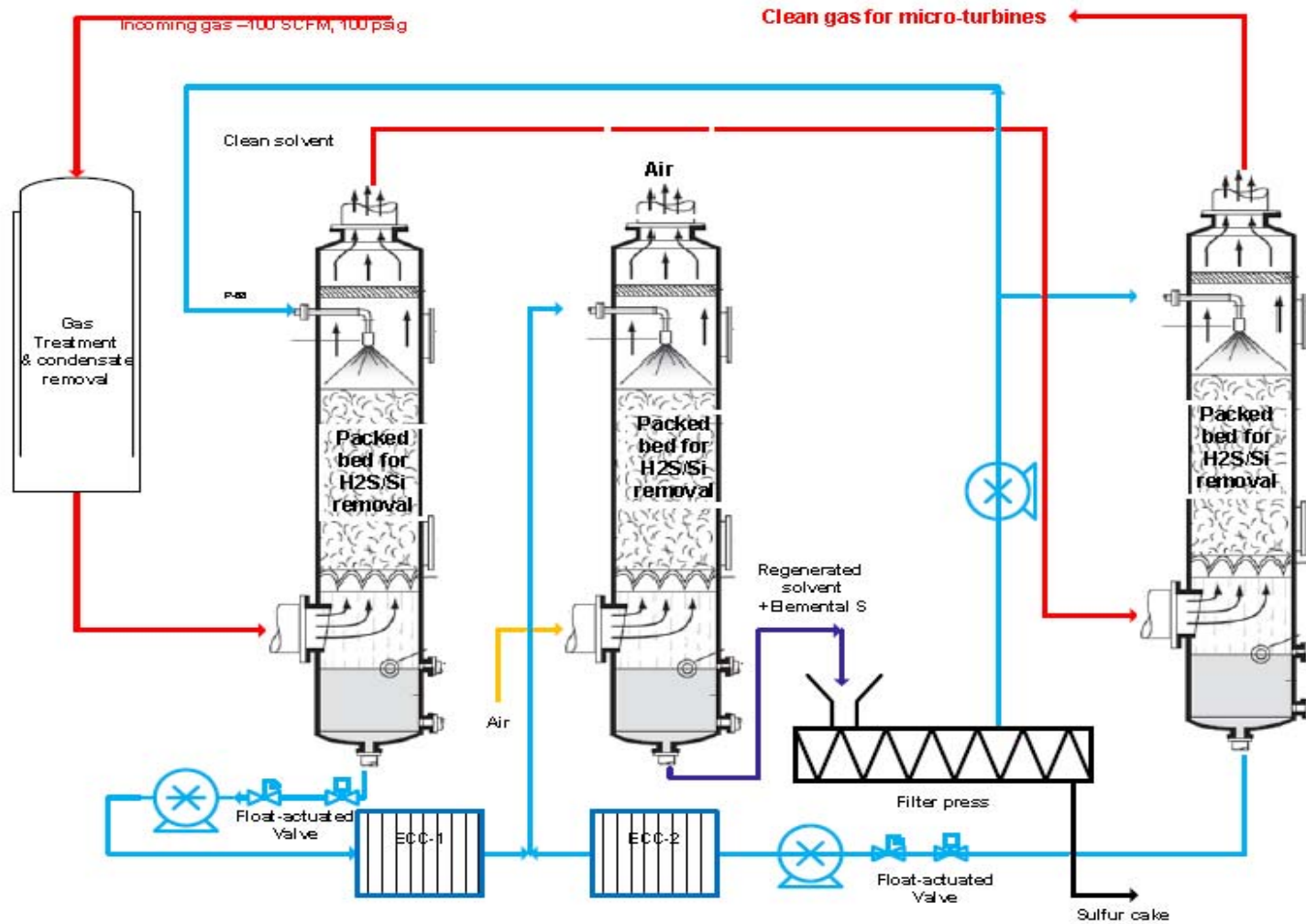
Landfill gas → energy: issues

- Contaminants, ranging from CO₂, organo-halides, H₂S, organo-sulfides and siloxanes.
- Siloxane removal key to successful power generation
- Micro-turbines especially susceptible to siloxane levels
- Common siloxane removal methods -
 - Absorbents: Activated carbon /alumina/ silica gel / SAG™
 - Liquid solvents – ‘Selexol’, polyethylene glycols
 - Condensation of siloxanes to liquids ($\leq -9^{\circ}\text{C}$): low temperatures & high pressures
 - Membrane separation/gas filtration (PPTek, UK)

Nrgtek Process

- **Meets specifications of power generation equipment for allowable Si**
 - Capstone: 0.03 mg/m³ (5 ppbv)
 - Caterpillar: 28 mg/m³
 - GE Waukesha: 25 mg/m³
 - GE Jenbacher: 10 mg/m³
 - Deutz: 5 mg/m³
 - Solar: 0.1 mg/m³
 - Flex Energy (I-R): 0.06 mg/m³ (10 ppbv)
 - SCR catalyst specifications (250 ppbv)
 - Fuel cell specifications (100 ppbv)
- **Heterogeneous system: high η Siloxane removal**
- **US Patent Application, EU Patent Application**
- **Independent system, or upstream of absorbent media**

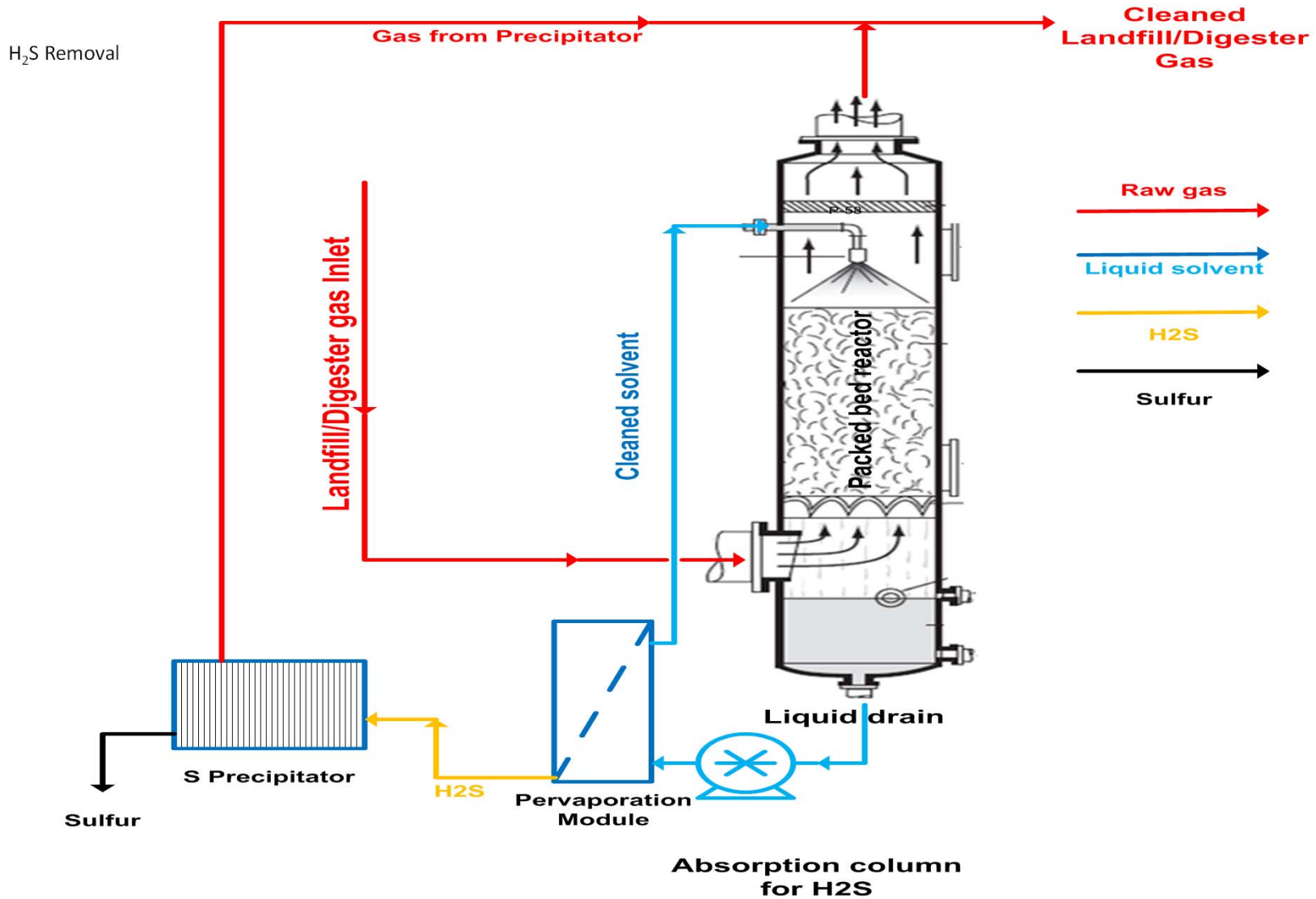
Siloxane/S Removal: Rutgers



H₂S removal -

- **Competition: Iron sponge/Sulfatreat**
 - Batch processing and regeneration
 - LO-CAT process (iron chelate system)
- **Nrgtek Process**
 - Continuous system
 - Liquid scrubbers, using special solvents
 - Organophilic pervaporation: gas-liquid separation
 - Clean solvent regenerated in a continuous loop
 - Sulfur removed in proprietary precipitators
 - Low energy consumption

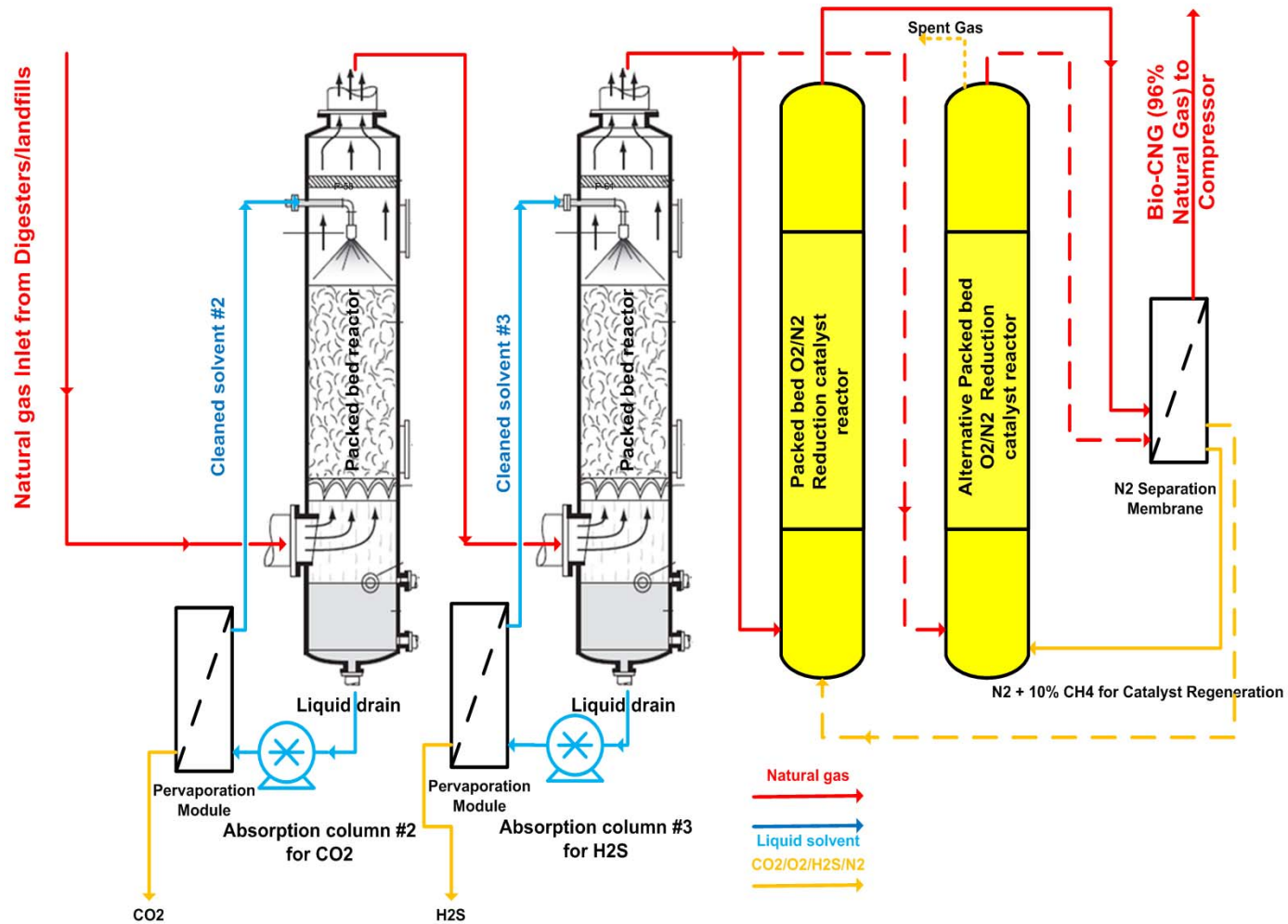
H₂S Removal from Gas Streams



Bio-CNG

- **Natural gas prices in Asia & EU: \$8-12/MMBTU, as compared to \$4/MMBTU in US**
- **Biogas: 45-65% methane from digesters/landfills**
- **Flared or used for power production in lean-burn engines, gas turbines**
- **Low BTU → value addition if converted to higher BTU or pipeline quality (> 96% methane)**
- **Bio-CNG: compressed to 3000 psi after clean-up**

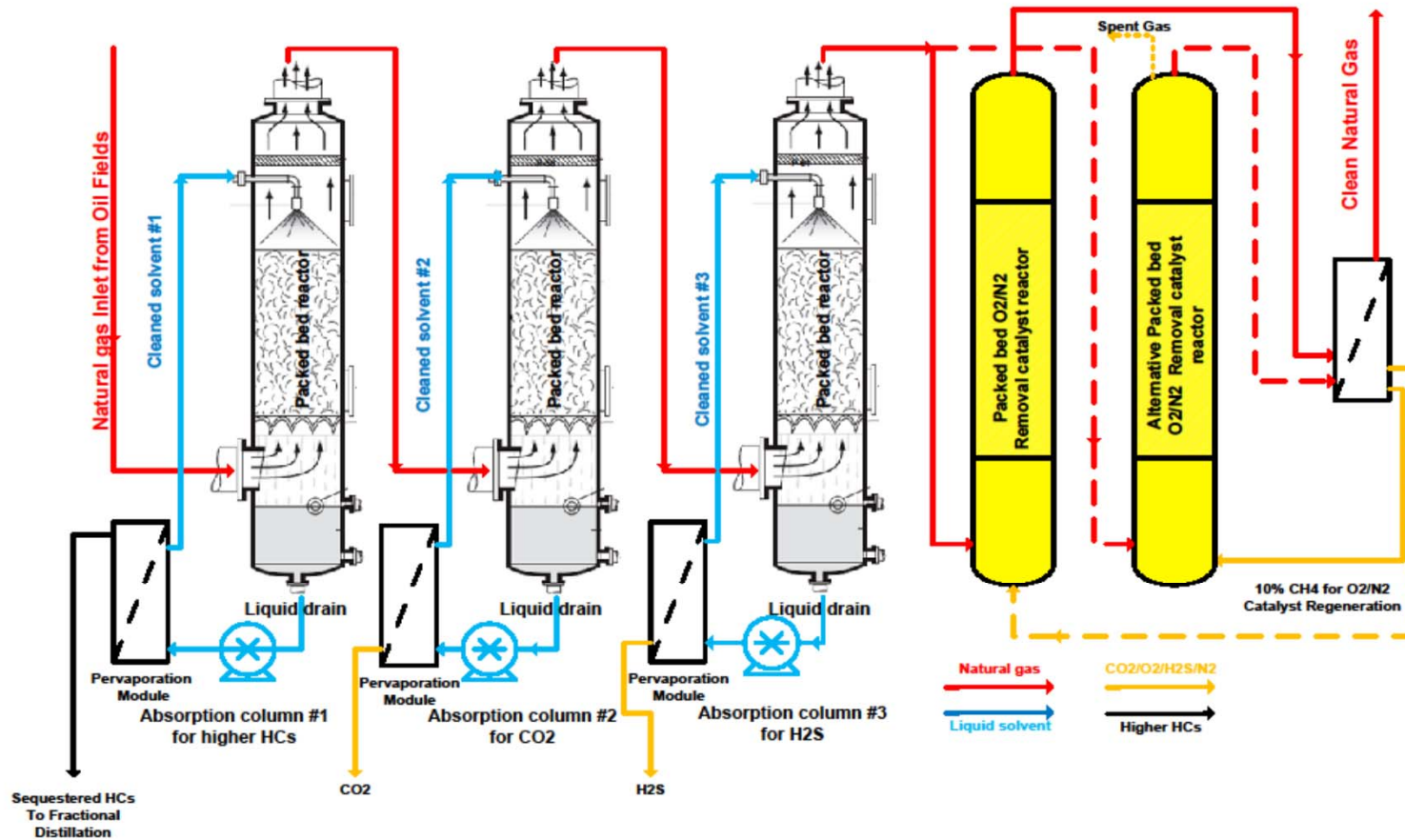
NRGTEK Bio-CNG process



Associated gas treatment: oil fields

- Flared gas from oil fields treated to pipeline quality gas (CA EPA requirements expected)
 - Ethane, propane, pentane, butane and other HC gases removed for fractional separation
 - H₂S, COS removal from gas streams
 - CO₂ removal and sequestration (similar to biogas treatment to bio-CNG)
 - O₂/N₂ removal by proprietary catalysts/membranes
 - Pipeline quality gas: > 96% methane

Associated Gas Treatment



CO₂ Capture & Sequestration

- **Many technologies available for CCS:**
 - Solvent-based separation: amines, Selexol (polyglycols)
 - Energy required to regenerate solvent
 - Gas hydrates/clathrates
 - mixed hydrate/clathrate
- **Nrgtek Process**
 - Solvent-based CO₂ absorption
 - Pervaporation using organophilic membranes
 - Easy CO₂ removal and solvent regeneration

CO₂ Sequestration

