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Zero Emissions Sulphur Recovery Production

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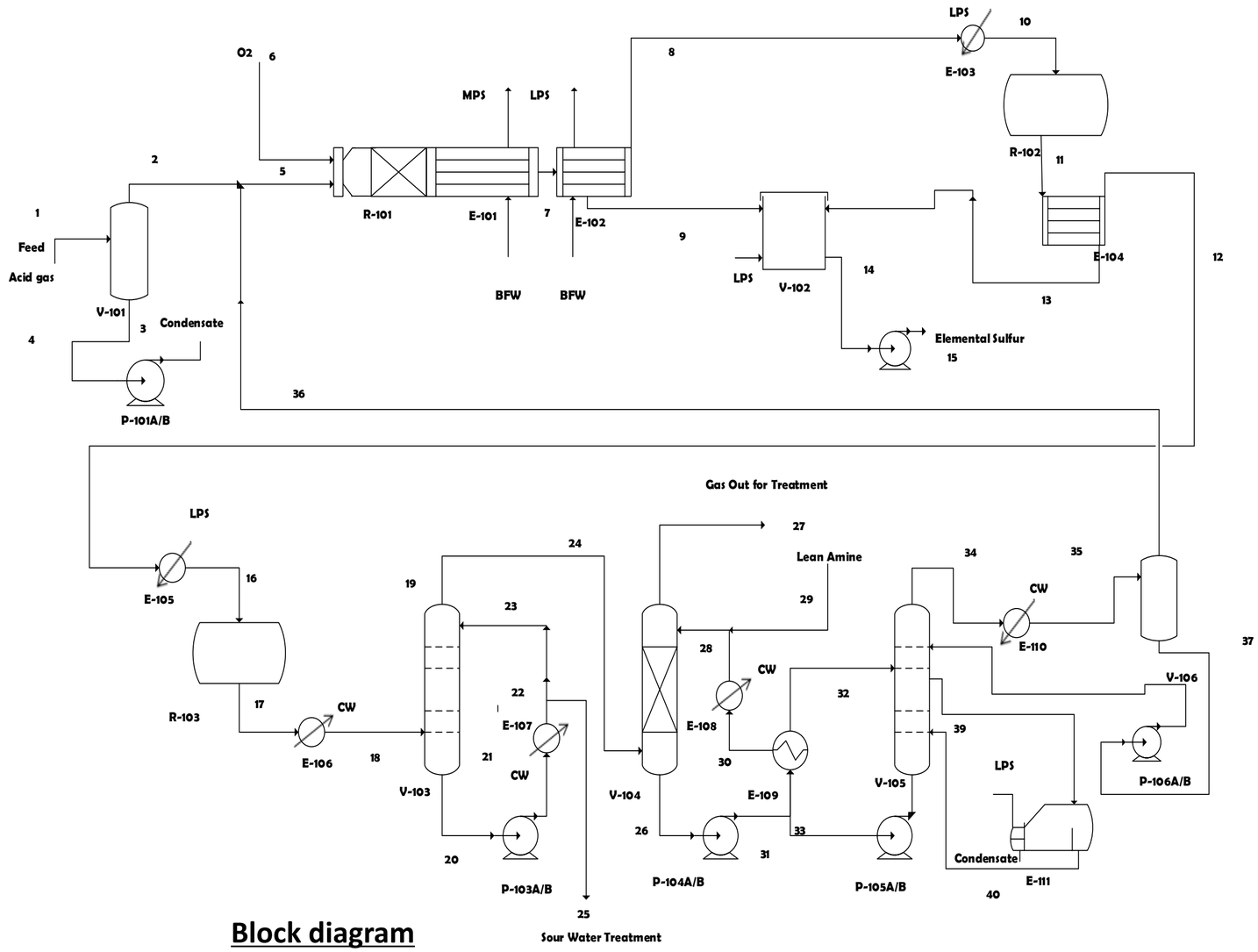
Abstract

A designed process for the concurrent production of hydrogen and Sulphur from a H_2S containing gas stream (acid gas) with zero emissions. The method uses catalytic oxidative cracking, COC, of H_2S to form H_2 and S_2. In addition, the process will have a Clause reactor to reduce the recycle rate of the H_2S to the COC reactor, and a Tail Gas Treatment, TGT, section to produce a rich stream of H_2. As a result, the novelty in the plant is to export H_2 without the necessity of an incinerator.

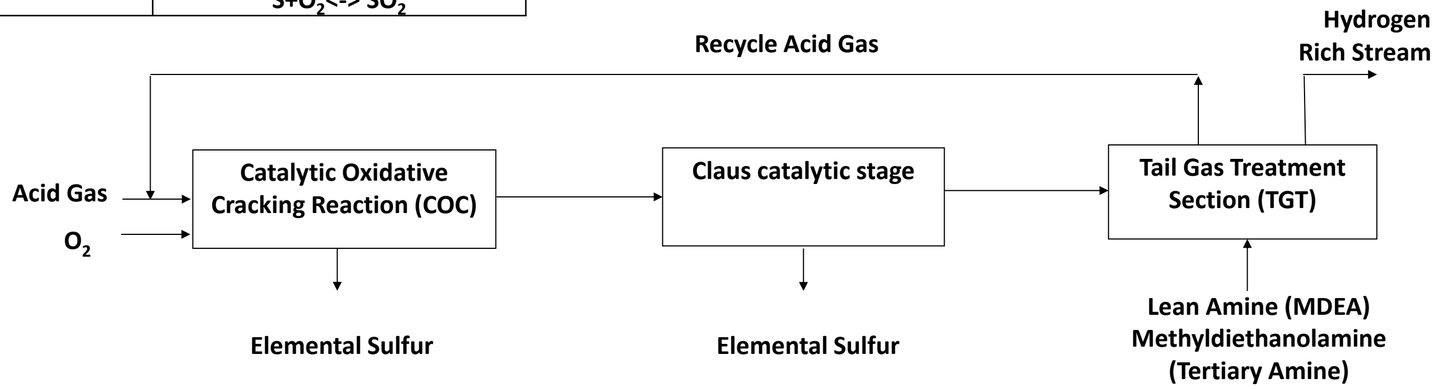
Reactions

Unit	Reaction
Catalytic Oxidative Cracking Reactor (COC)	$4\ H_2S + O_2 <-> 2\ H_2 + 2\ H_2O + 2\ S_2$
	$H_2S + 1.5\ O_2 <-> H_2O + SO_2$
	$CH_4 + 2\ O_2 <-> CO_2 + 2\ H_2O$
	$C_2H_6 + 3.5\ O_2 <-> 2\ CO_2 + 3\ H_2O$
	$C_3H_8 + 5\ O_2 <-> 3\ CO_2 + 4\ H_2O$
	$H_2S <-> H_2 + 0.5\ S_2$
Clause Catalytic Reactor	$CH_4 + 2\ S_2 <-> CS_2 + 2\ H_2S$
Hydrogenation reactor	$2\ H_2S + SO_2 <-> 1.5\ S_2 + 2\ H_2O$
	$COS + H_2O <-> H_2S + CO_2$
	$CS_2 + 2\ H_2O <-> 2\ H_2S + CO_2$
	$SO_2 + 3\ H_2 <-> H_2S + 2\ H_2O$
	$S + O_2 <-> SO_2$

Process Flow Diagram



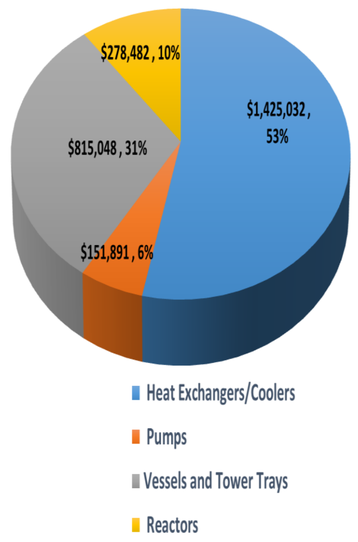
Block diagram



Design Goals

- Elemental Sulphur production rate of 510 ton/day from acid gas feed of 750 Kmol/hr and H_2S gas recycle to COC reactor of 512 kmol/hr.
- 309 kmol/hr H_2 rich gas stream of 0.79 mole fraction to be exported to end users.

Equipment Cost Summery



Equipment Used in The Project

Tag Number	Description	Tag Number	Description
V-101	Feed Acid Gas	R-103	Hydrogenation Reactor
V-102	Sulfur Tank	E-101	Waste Heat Boiler
V-103	Quench Tower	E-101	Waste Heat Boiler
V-104	H_2S Absorber	E-102	Sulfur Condenser
V-105	Amine Regenerator	E-103	Acid Gas Preheater
V-106	Acid gas Recycle from Amine Regenerator	E-104	Sulfur Condenser
P-101A/B	Condensate Pump	E-105	Gas Pre heater
P-102A/B	Sulfur Pump	E-106	Gas Cooler
P-103A/B	Quench water pump	E-107	Quench Water Cooler
P-104A/B	Rich Amine Pump	E-108	Lean Amine Cooler
P-105A/B	Lean Amine Pump	E-109	Lean and Rich Amine Heat Exchanger
P-106A/B	Acid Gas Recycle Pump	E-110	Gas Cooler
R-101	Air/Oxygen (COC) Reactor	E-111	Amine Reboiler
R-102	Claus Reactor		

NORTHROP GRUMMAN

Engineering & Science Student Design Showcase at Florida Institute of Technology