TEAM F002

A Compact Cyclone Integrated Multiphase Separation Unit for Upstream Applications

Zainab Al Tarouti , Shahad Al Salman, Hadeel Suleiman, Heba Al Abbas , Rabab Al Dawood, Arwa Al Hayek
Coach: Dr. Tabassam Yasmeen

ME CHE 3 EE

Problem Statement

Compact oil–water–gas separators often suffer from poor phase separation and limited monitoring. This project integrates a cyclone separator with an RF antenna system to improve separation efficiency and enable real-time monitoring in upstream applications.

Constraints

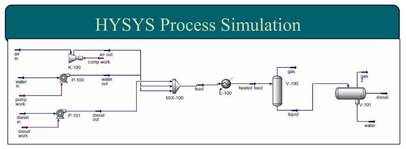
Maximum allowable pressure ≤3 bar	corrosion allowance of 3mm
pressure drop ≤ 30-40 mbar	operate at low voltage (≤12 V DC)
No electromagnetic interference	Cyclone inlet velocity 1.7–2.0 m/s
(L/D) of 4 and a liquid fill fraction of 0.60	

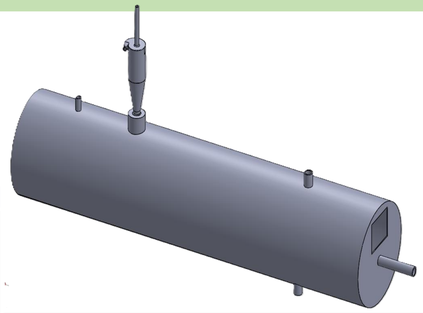
Specifications

residence time < 25	Spiral vanes helical geometry
Gas flow: 0.02 m³/h; Liquid flow: 0.5	reflection coefficient |S11| sensitivity of ±3 dB
operate within the 900MHz–3 GHz	5 V DC regulated power supply.
Oil outlet purity <20 vol% water-in-oil	

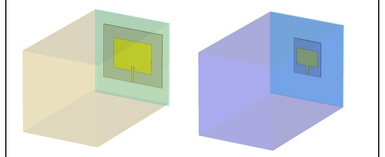
Prototype Design

HYSYS Process Simulation

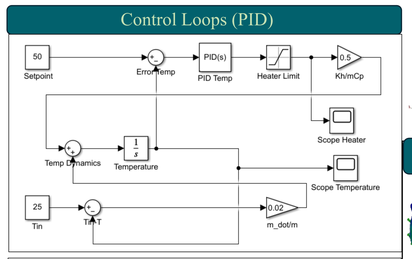




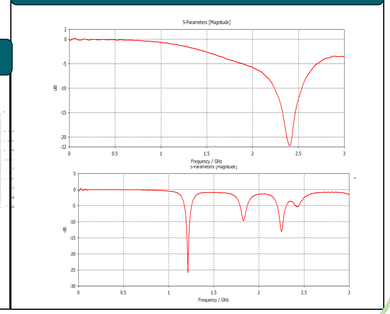
Antenna Design Configurations



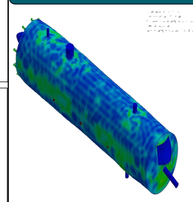
Control Loops (PID)



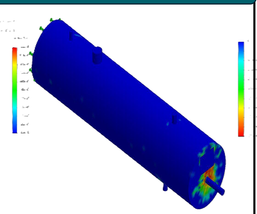
Reflection Coefficient Diagram



Stress Analysis

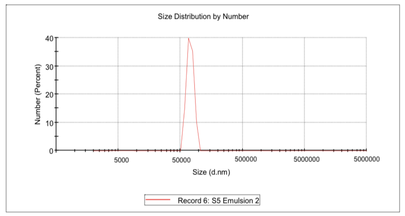


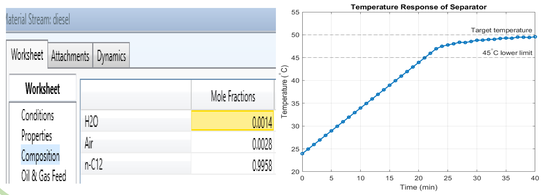
Factor of Safety



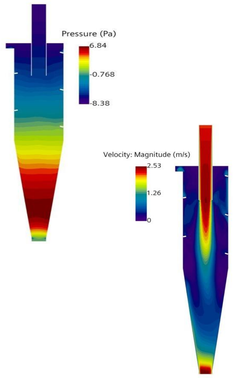
Testing & Validation

Process & Thermal Validation



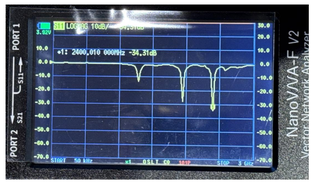


Cyclone CFD Analysis



RF Antenna Testing

Diesel Antenna



Water Antenna

Performance Metrics

40%
Smaller Size
Compact cyclone design reduces separator footprint.

30%
Faster Separation
Reduced residence time with improved phase disengagement.

Real-Time
RF Monitoring
Continuous monitoring using RF antenna sensing.

Conclusion

The proposed system met the project targets by improving multiphase separation using the cyclone and enabling real-time monitoring through the RF antenna, while maintaining a compact and efficient design.