Helium Operators Familiarization Program

Upgrader Hysys simulation

Doha, January 2013 I PICHOT Delphine I Process Department

Summary

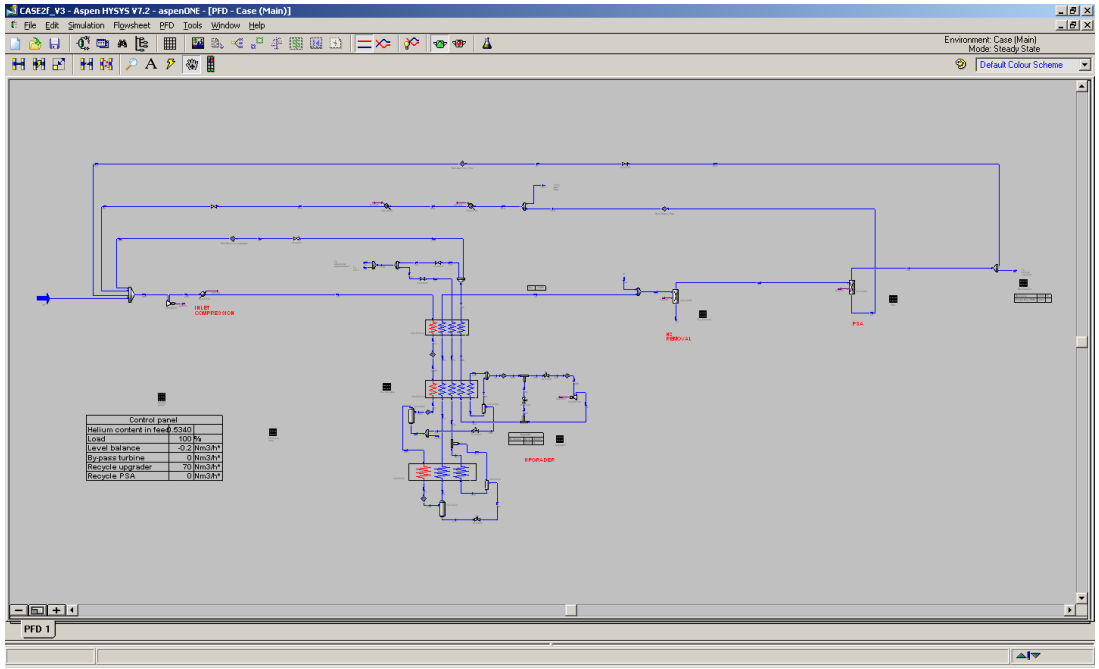
- Introduction
- Simulation construction
- Simulation optimization
- Cases study

Introduction

Introduction

- AspenHysys, a proprietary product of AspenTech, is a process simulation software

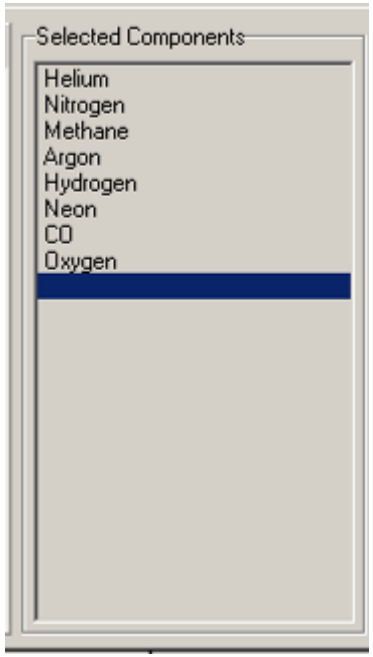
- For this project, it has been used to simulate and optimize:
  - **The upgrader unit**
  - The air separation unit
  - The helium liquefier



Introduction

- The simulation takes into account 8 components:

Helium	He	Hydrogen	H2
Nitrogen	N2	Neon	Ne
Methane	CH4	Carbon monoxyde	CO
Argon	Ar	Oxygen	O2



- Properties of components are based on an Equation of State (EOS) which is property of Air Liquide

- The simulation is used in steady state mode (plant design)

Simulation build-up

Simulated units

- Feed inlet

PFD Unit 321

- Upgrader

PFD Unit 322 - Upgrader

- H2 removal unit

PFD Unit 322 - H2 removal

- Pressure Swing Adsorption Unit

PFD Unit 322 - PSA

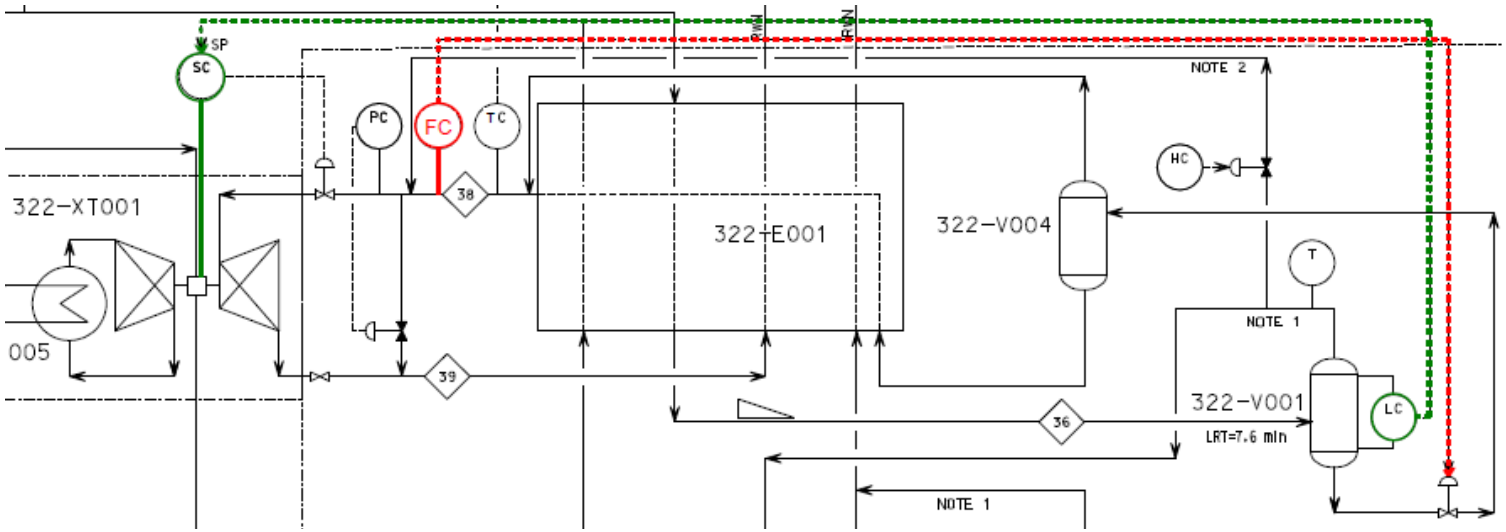
- Gas from gas bags

PFD Unit 322 - PSA Offgas Adsorbers

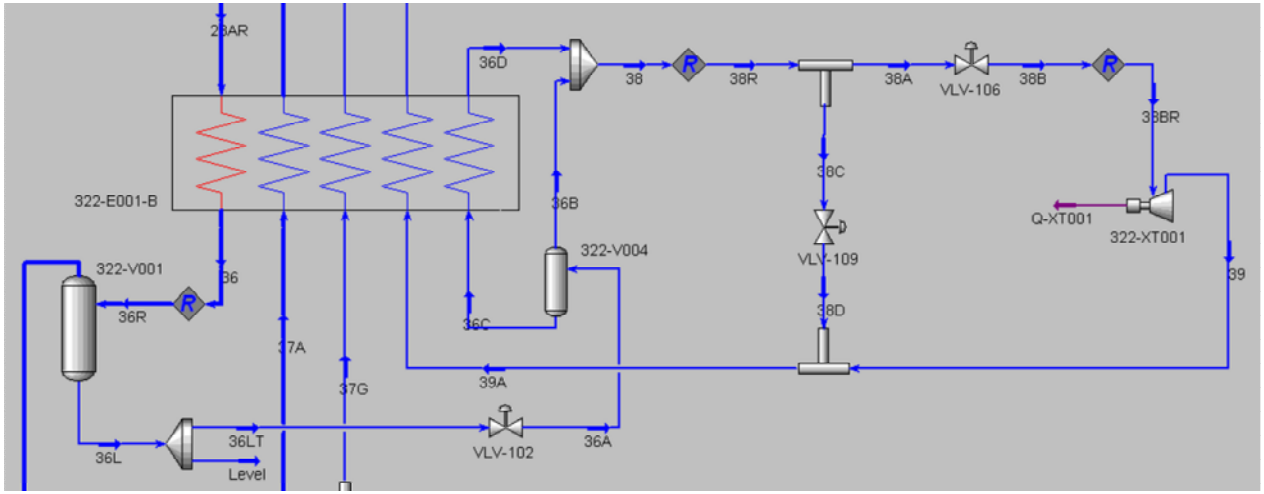
SIMULATION CASE

Parameters (1/3)

- Expander bypass flow -> acts on cold box frigorific balance
  - If level in first mixture separator increases, it means there is an excess of cold power => the flow to the expander needs to be decreased (or the expander bypass flow to be increased)



Cold balance

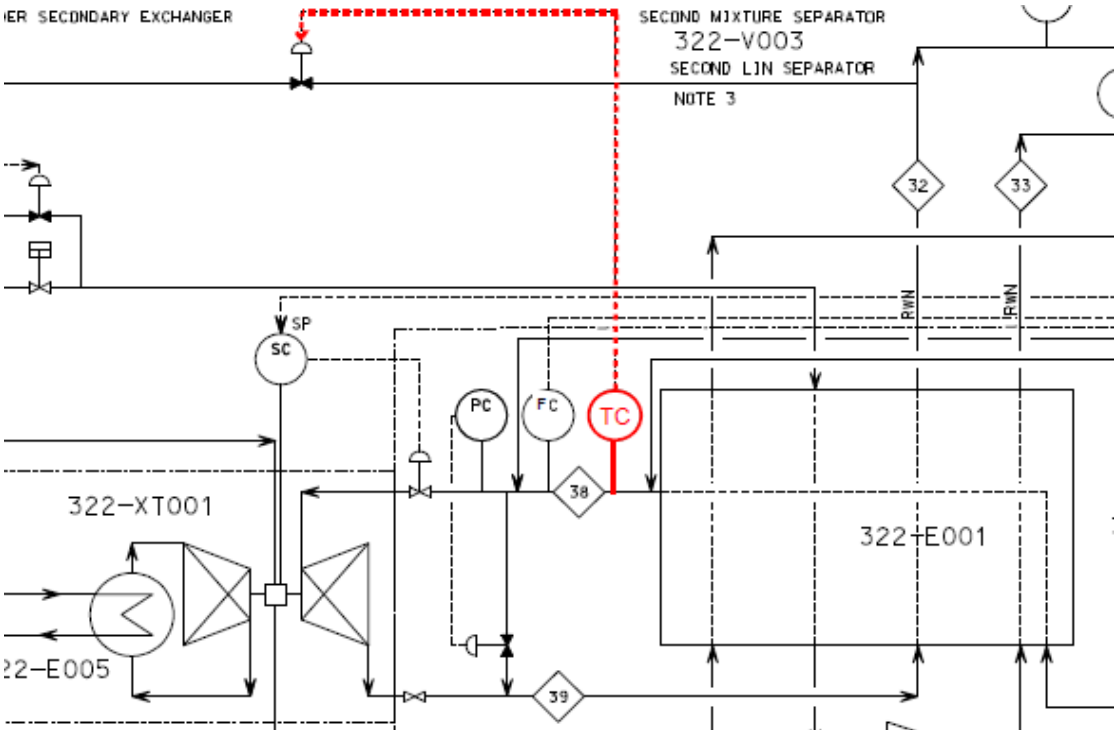


- Examples:
  - Steady level in first mixture separator — Simulation Case
  - Excess of cold production — Simulation Case
  - Deficit of cold production — Simulation Case

	Expander bypass flow	Level in 322-V001
Initial state	284 Nm3/h	0
Excess of cold production	100 Nm3/h	+25 Nm3/h
Deficit of cold production	400 Nm3/h	-15 Nm3/h

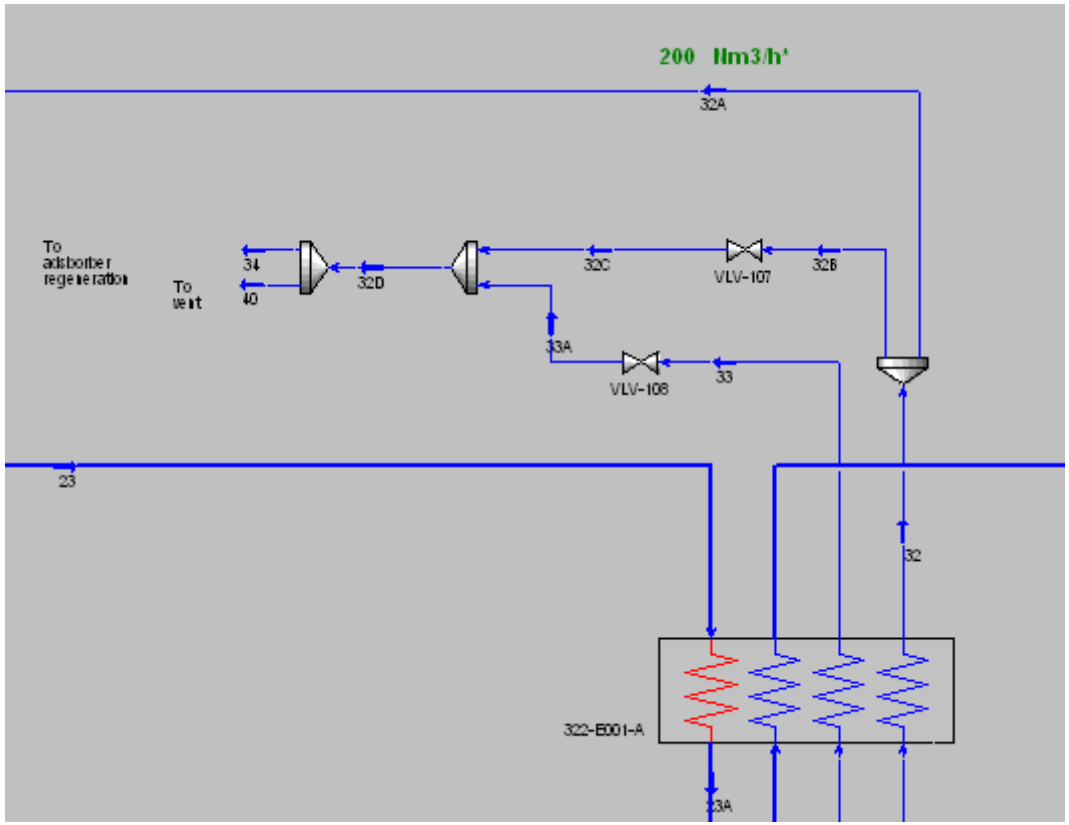
Parameters (2/3)

- Upgrader recycle flow -> acts on expander inlet temperature
  - If the feed is richer in helium, the exchanger gets colder. To avoid being too cold at the inlet of the expander (risk of liquid), the upgrader recycle needs to be open to increase the nitrogen content in the feed gas and to warm up the exchanger



Expander inlet temperature

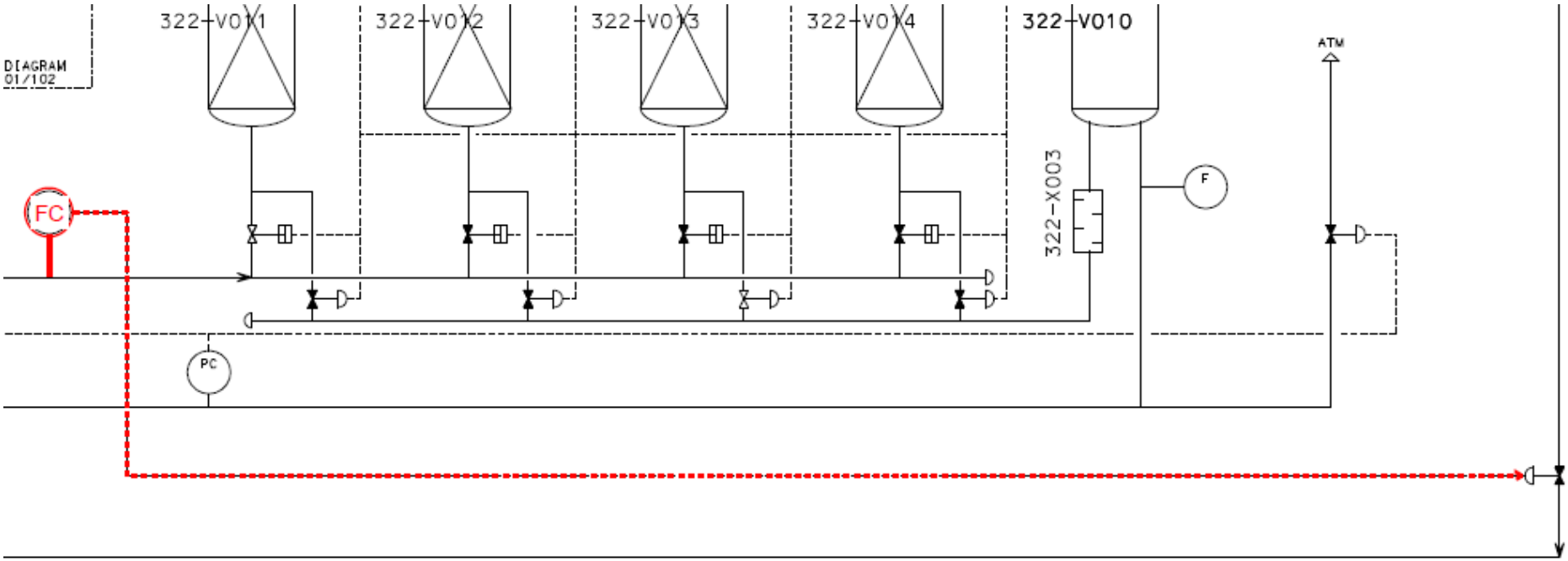
- Examples:
  - RWN recycle close
    Simulation Case
  - RWN recycle open
    Simulation Case



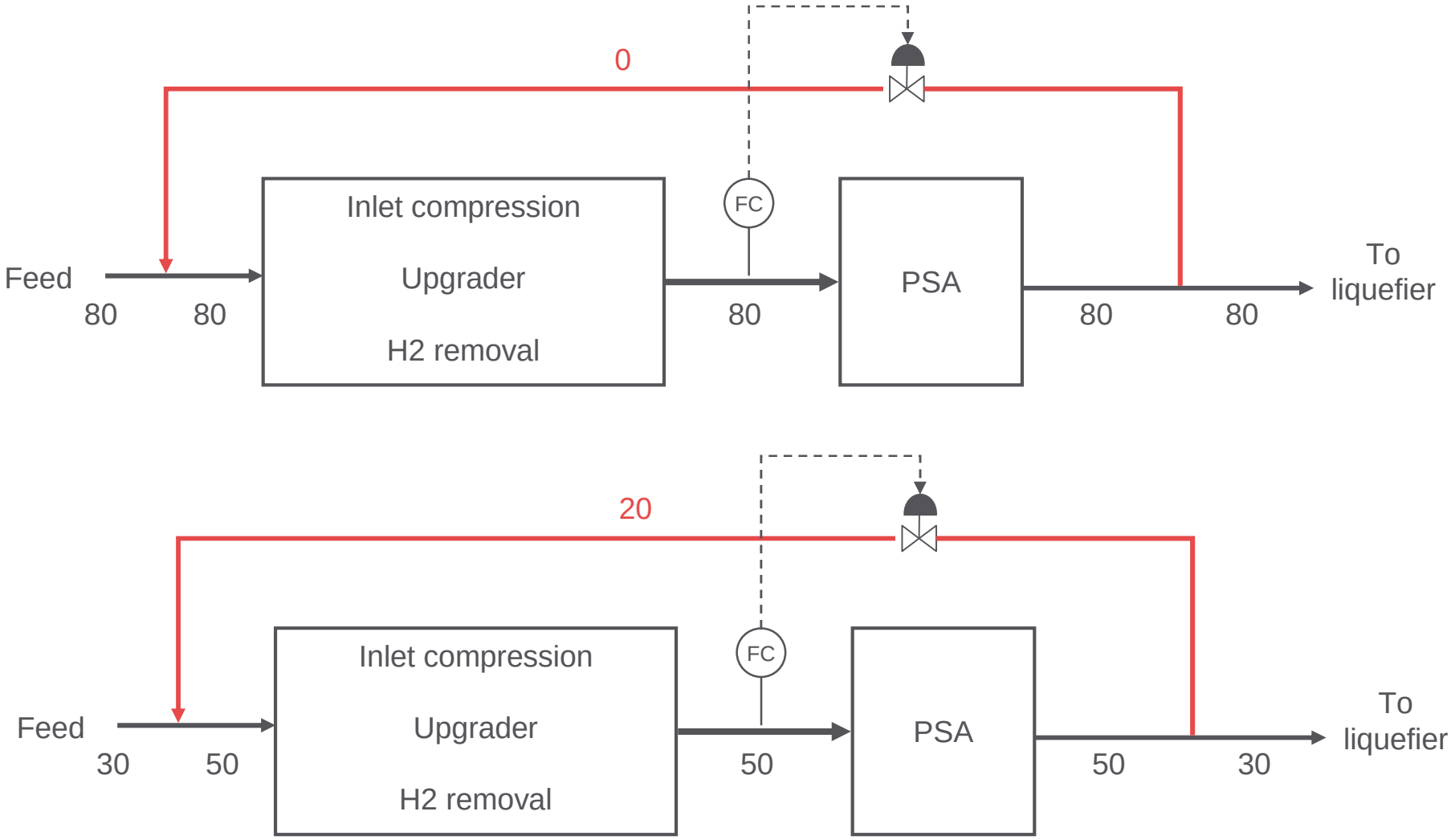
	RWN recycle flow	Expander inlet temperature
RWN recycle close	0 Nm3/h	-140°C
RWN recycle open	200 Nm3/h	-138°C

Parameters (3/3)

- PSA recycle flow -> acts on the load of the PSA unit
  - Stay above PSA turndown (load ≥ 50% or PSA inlet flow ≥ 3500 Nm3/h)

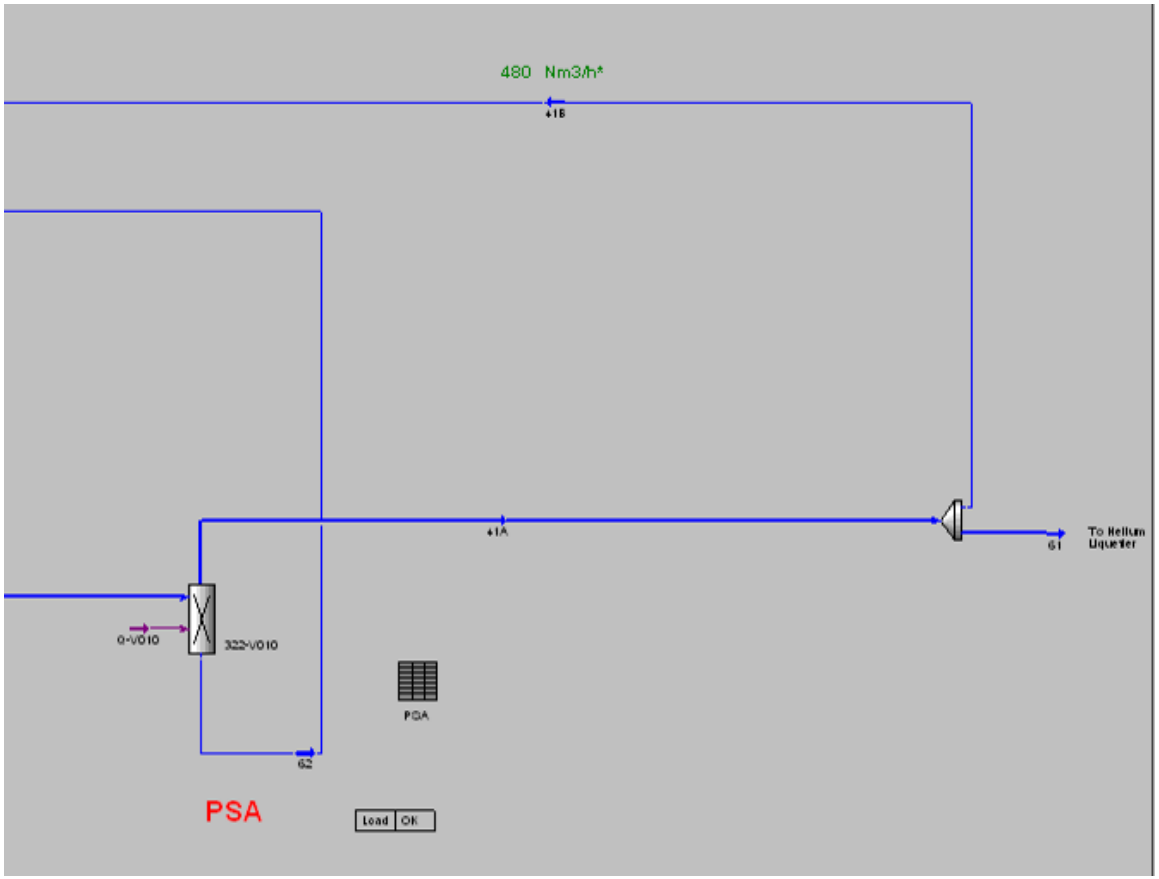


PSA turndown



PSA turndown

- Examples:
  - 100% load — Simulation case
  - 40% load — Simulation case i / Simulation case f



Cases study

Feed composition variation

- Nominal helium content in feed gas — Simulation case
- Less helium in feed gas — Simulation case i / Simulation case f
  - Less flow to the expander / More bypass flow
- More helium in feed gas — Simulation case i1 / i2 / Simulation case f
  - More flow to the expander / Less bypass flow
  - If exchanger too cold, RWN recycle open

Helium content in feed gas	Expander bypass flow	Expander inlet temperature	RWN recycle flow
44.2% (minimum)	397 Nm3/h	-130°C	0 Nm3/h
48.57% (nominal)	284 Nm3/h	-140°C	0 Nm3/h
53.4% (minimum)	0 Nm3/h	-159°C	70 Nm3/h

Load variation

- 100% load
- 70% load
  - Start to open RWN recycle
- 40% load
  - Start to open PSA recycle

Simulation Case

Simulation cases

Load	Expander bypass flow	Expander inlet temperature	RWN recycle flow	PSA recycle flow
100%	284 Nm3/h	-140°C	0 Nm3/h	0 Nm3/h
90%	366 Nm3/h	-144°C	0 Nm3/h	0 Nm3/h
80%	405 Nm3/h	-150°C	0 Nm3/h	0 Nm3/h
70%	380 Nm3/h	-161°C	55 Nm3/h	0 Nm3/h
50%	670 Nm3/h	-160°C	650 Nm3/h	0 Nm3/h
40%	670 Nm3/h	-160°C	1170 Nm3/h	480 Nm3/h
25%	670 Nm3/h	-160°C	1950 Nm3/h	1200 Nm3/h

Flow from gas bags

- Simulation case i / Simulation case f

End of presentation

Thank you for your attention