

# Minox Deoxygenation System – Lessons learned and upgrades

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## Why are we here today?

- Minox issues from papers presented by BP and Shell at this seminar last year
- Present the course of development of the Minox process over the last 10 years



## Agenda

- Presentation of Grenland Group
- Introduction to the technology
- Challenges and improvements made to the system
- Presentation of our latest deliveries
- Summary

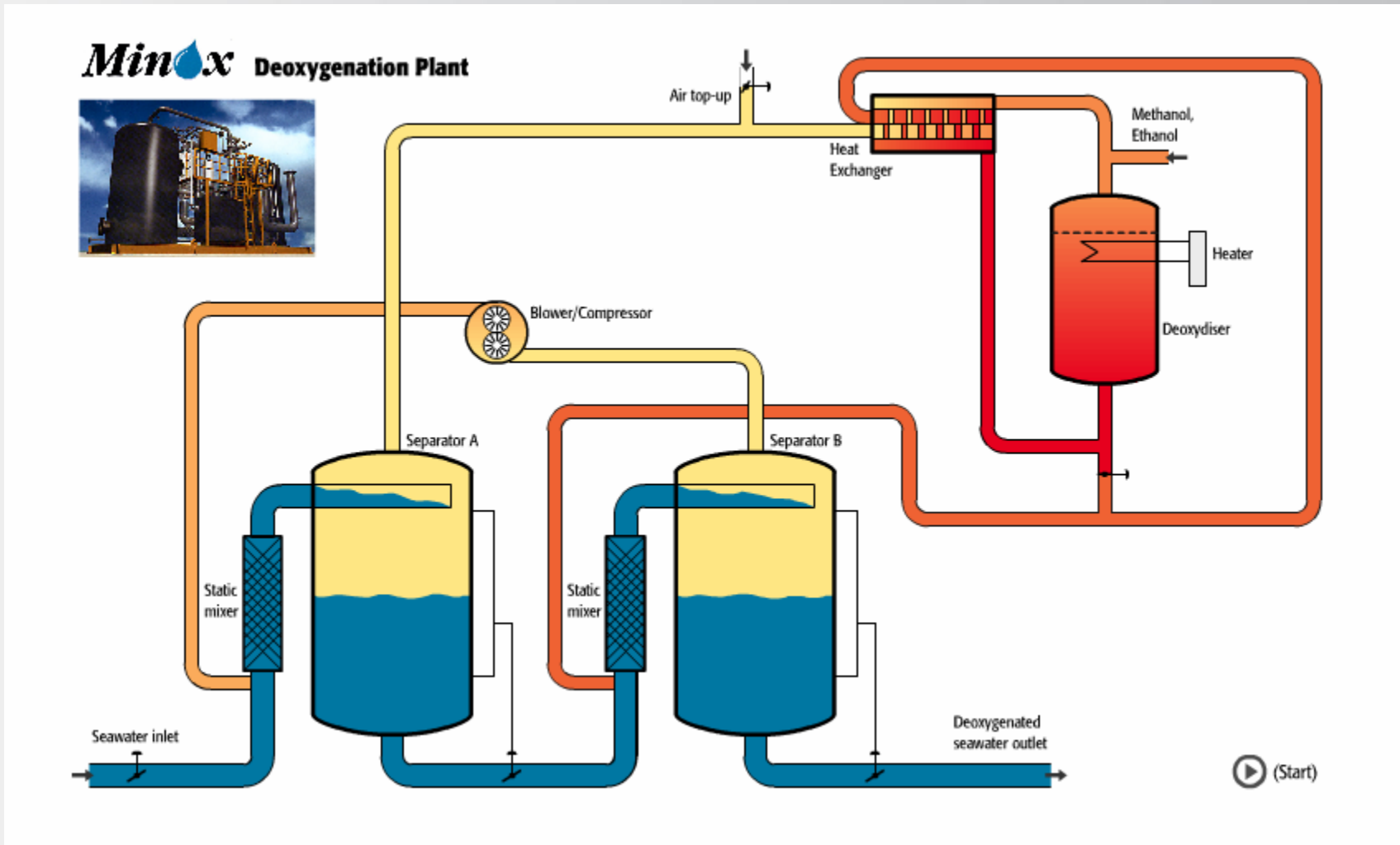
## Grenland Group



- Aprox. 1100 employees
- USD 300 mill revenue in 2006
- Listed on Stock exchange

# How the Minox DeOx Process Works

## Two stage Co-current System



## The Minox evolution

- 1991: First commercial Minox system delivered – Generation 1  
Serpentine piping, complex control system, large, heavy, expensive
- 1993: Single stage systems delivered by KPS
- 2001: Glitne, Valhall - Generation 2
- 2003: Heidrun - Generation 3
- 2006: Balam, Agbami - Generation 4
- 2007: Ursa - Antifoam free system
- 2007: Sumandak - Single stage system



## Licensing to Kvaerner Process Systems

- 4 two stage systems was delivered to BP from KPS
  - Clair (North Sea), Holstein, Thunder Horse and Atlantis
- BP contacted Grenland Group to review the systems and assist during commissioning
- Review findings
  - Double set of mixers (33% + 67%)
  - Too small blower (High dP – reduced flow rate)
  - Catalyst washing possibility missing
  - Poor control and instrumentation of system
  - Top-up air must be cleaned
  - Metallurgy problems

## Lessons Learned from the Minox systems delivered by GG

### ➤ Blower failure

- Water carry-over and Foaming led to salt and scale deposits



*Seal break down*

*Corrosion*



### Implemented improvements

- Inlet cyclone in separator
- Axial Demister cyclone in separator
- New type compressor / compressor upgrades
- Running intervals when 2x100% blowers are installed
- New operational and maintenance procedures



## Lessons Learned from the Minox systems delivered by GG

### ➤ Methanol distribution

- Methanol distribution prior to 3rd generation led to varying performance
  
- Picture

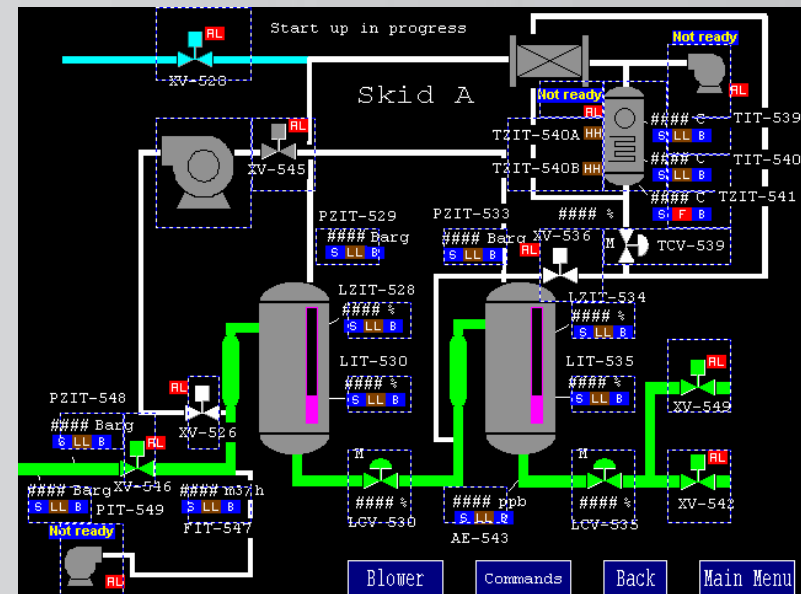
### ➤ Implemented improvements

- Methanol injection – Spray nozzles
- Static gas mixer (Batman disc)
- Improved gas distributor

## Lessons Learned from the Minox systems delivered by GG

### ➤ Control and Instrumentation

- Manual systems, not fully automated, labor intensive operation



### ➤ Implemented improvements

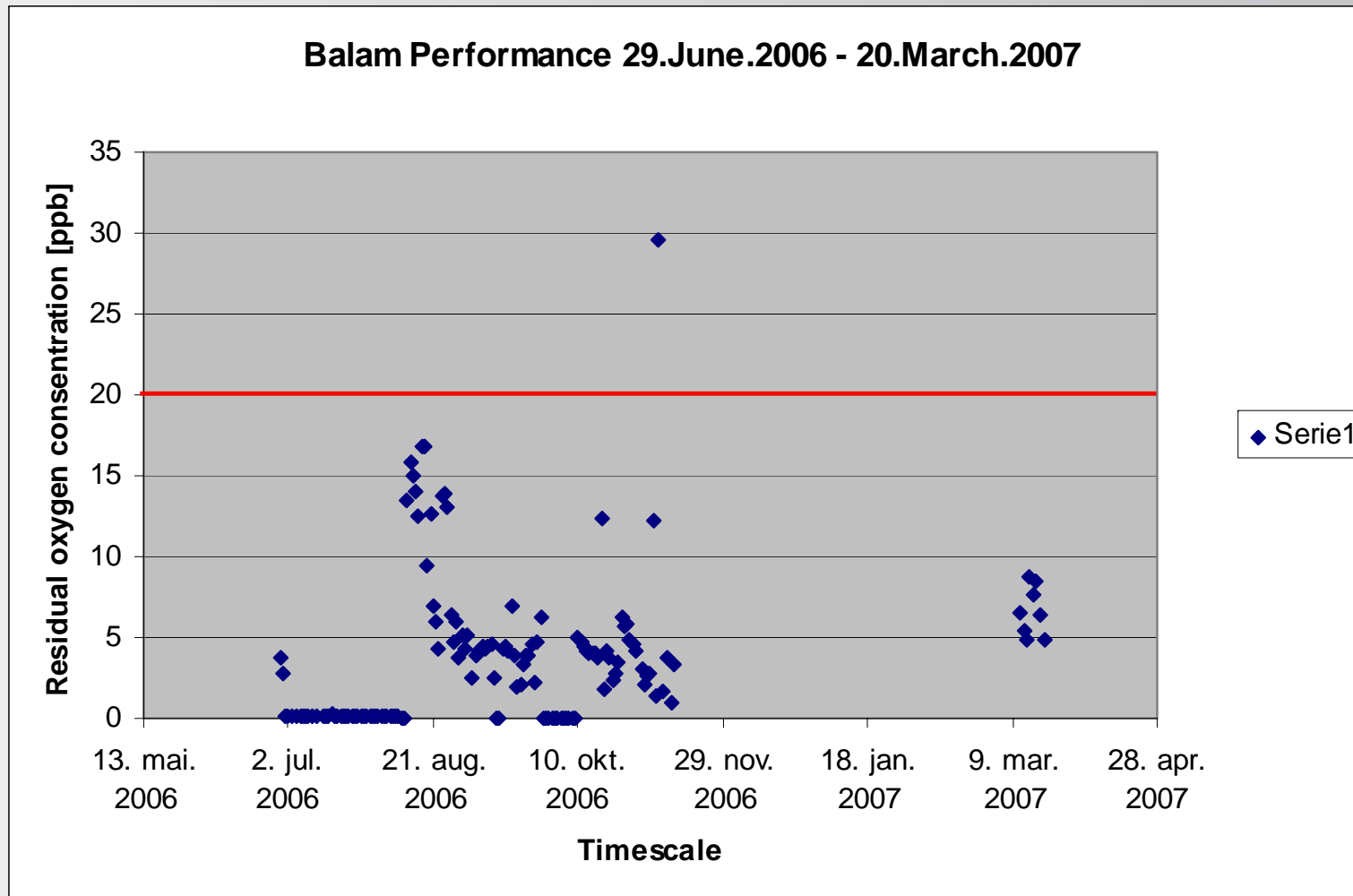
- Fully Automated systems
- 10 years operational experience – better control logic
- Online stripping gas sampling system
- Actuated pressure control

## The first 4th Generation system was delivered to Pemex (Balam)

- Project kick off March 2005
- Delivery October 2005
- Commissioning Spring 2006
- Operation early summer 2006
- Unmanned platform
- Good performance from day one
- Good performance since startup



## Balam performance June 29/06 – March 20/07



By the excellent performance of the Balam unit – we considered the operational and performance issues with Minox solved.....

.....but Shell Oil, New Orleans, gave us the challenge of making a Minox system able to operate without using Antifoam for use on their Ursa platform.....

.....and we took on the new challenge and entered into a cooperation agreement with Shell



*Pictures from the first tests.....*

## Why Antifoam free Minox System?

- 1 Minox System can be installed upstream of SRU (Sulphate Removal Unit)
- 2 Eliminate usage of antifoam agents – lower OPEX

## Shell Ursa – First Antifoam free System delivered

- Basis was a 4th Generation Minox system

Additional features:

- Enlarged Separators
  - Coalescing Filter Separators upstream heat exchanger
  - Coalescing Filter Separators upstream compressors
  - Elevated regeneration system
- 
- Commissioning planned summer 2008



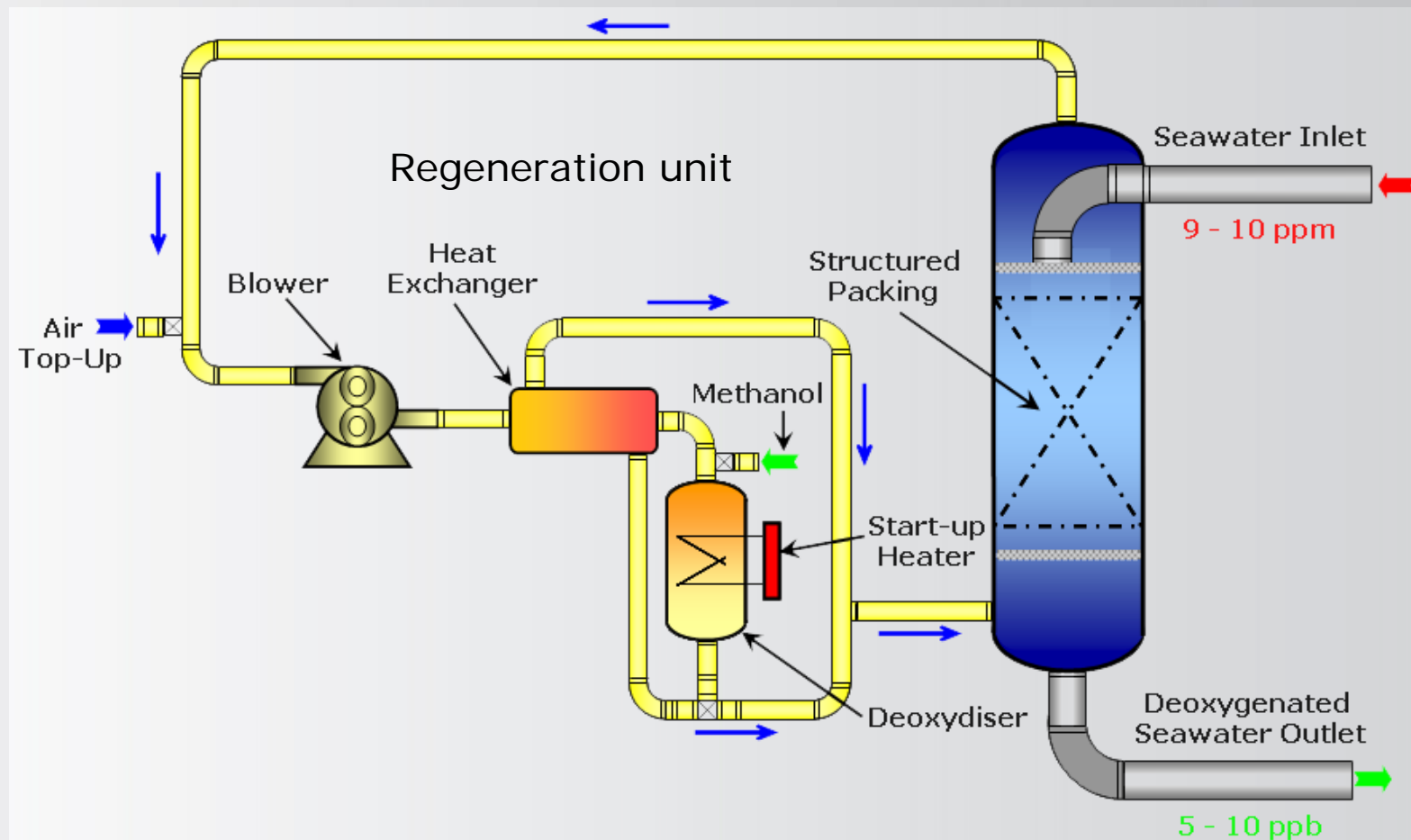
## Technical improvements summary

- Water carry-over minimized
- Compressor Fouling minimized – maintenance reduced
- Catalyst fouling reduced / Longer intervals between catalyst washing
- Methanol mixing improved – stable performance
- Foaming eliminated / reduced

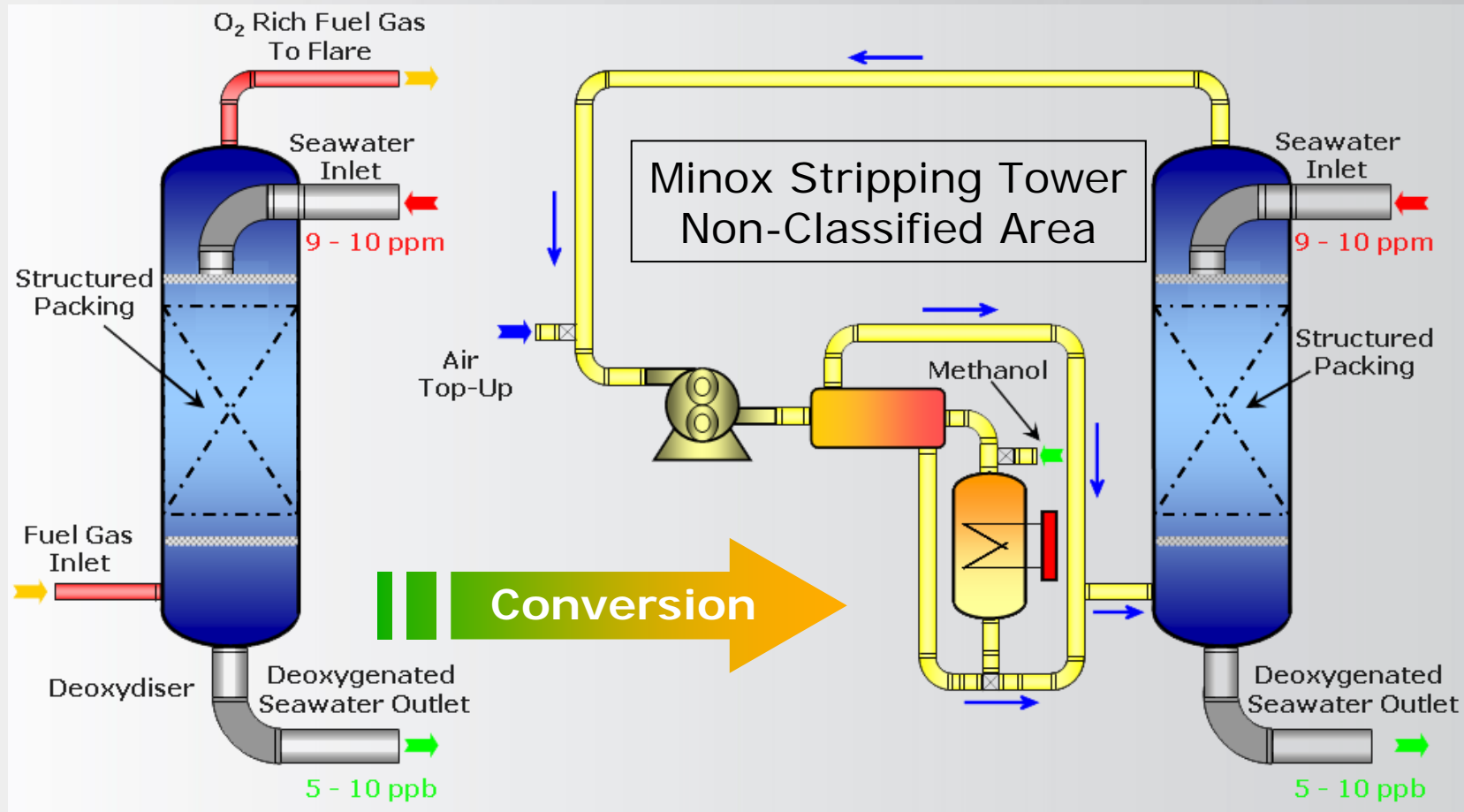




## How the Minox DeOx Process Works Single-Stage Counter-Current System



## Facility Upgrades & Conversions



Fuel Gas Stripping Tower  
Classified Area

## Summary

- Experience over a number years has given valuable input to the evolution
- Improvements and New features installed has proven increased reliability, quality and robustness of the process
- Can be delivered as:
  - Single Stage System
  - Conversion of Fuelgas systems
  - Two Stage System
  - Antifoam free system
- Minox is today a well proven Deoxygenation System

Thank you very much for your attention!

