gasworld – Middle East Conference

USES & APPLICATIONS OF INDUSTRIAL GASES IN THE OFFSHORE OIL & GAS INDUSTRY

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Objective

Industrial gases, and in particular liquid nitrogen, are used for a variety of applications in the offshore oil & gas industry. This presentation will provide an overview of this market, discuss the potential growth areas, and review the support services necessary to support offshore work.

We shall focus on the equipment packaging, certification codes and standards, and transportation issues.

A particular focus will be on the use of nitrogen / helium to leak testing offshore facilities prior to commissioning - this service has become the industry standard for oil & gas facilities and can consume large quantities of liquid nitrogen and helium gas.

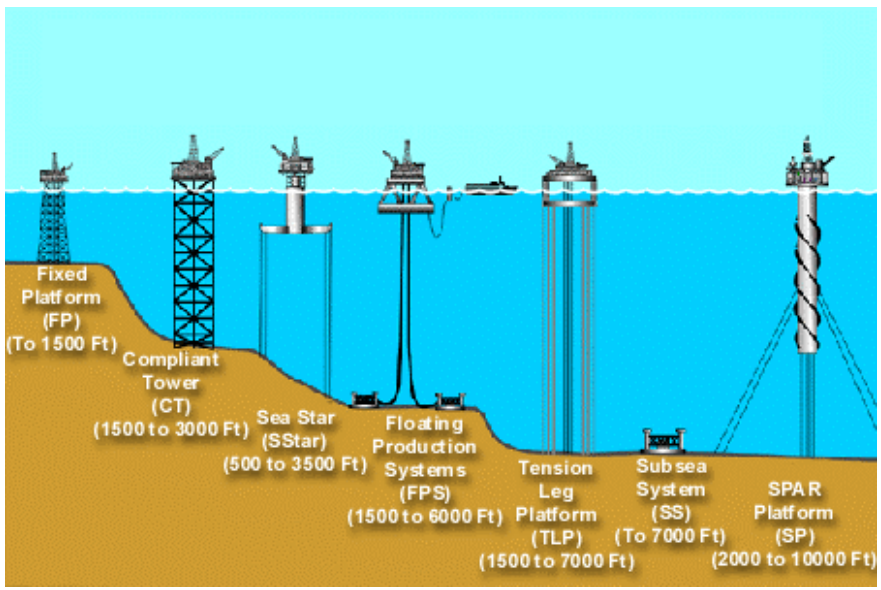
Contents

- What is offshore?
- Downhole applications for industrial gases
- Topside applications for industrial gases
- Nitrogen / helium leak testing
- Offshore equipment overview
  - › Transport of cryogenic liquids & gases
  - › Vaporisation & pumping of cryogenic LN2
- Typical gas consumption
- Membrane vs. LN2
- Growth opportunities

What is Offshore?

Initially N2 used on drilling & well completion on jack-up or semi-sub drilling rigs

Vessel based operations to support either pipeline commissioning or well stimulation

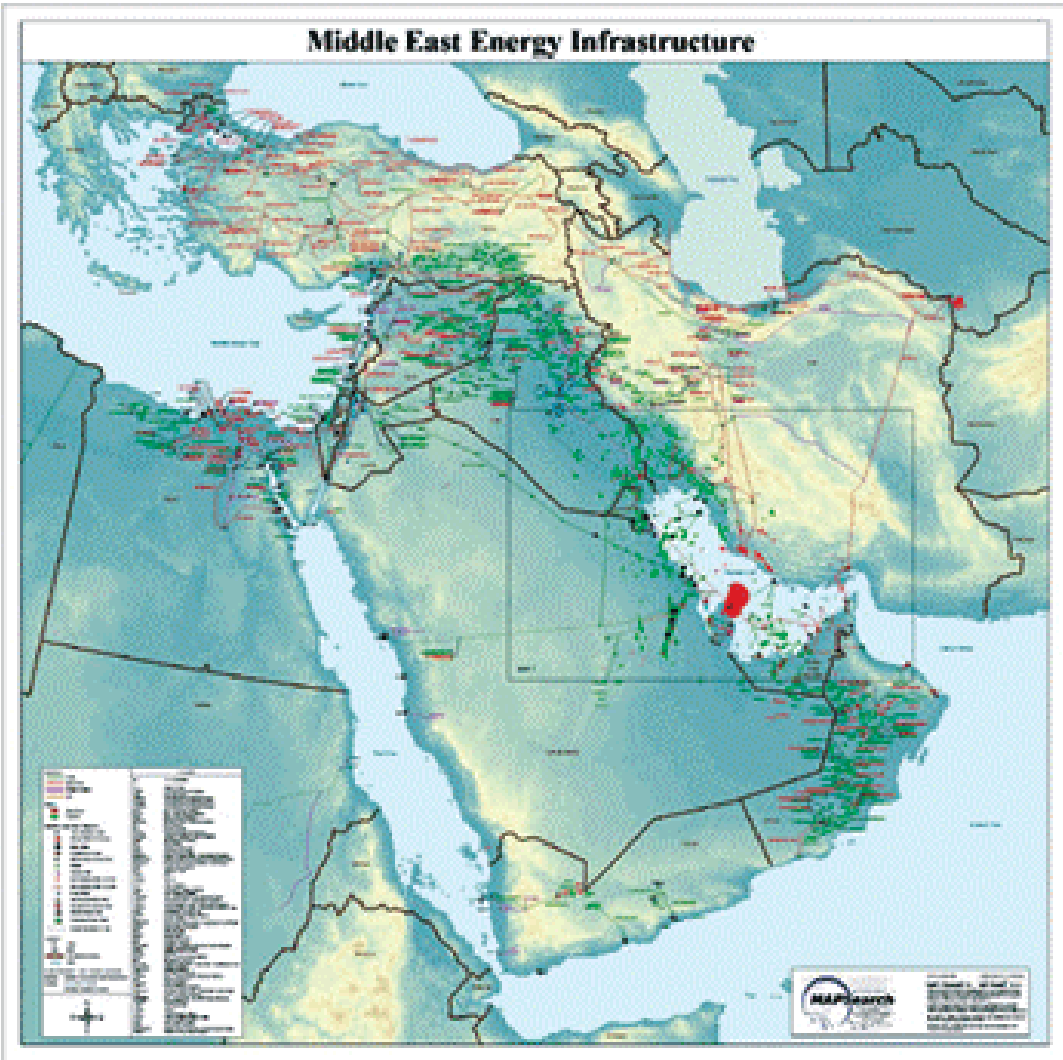


Main use of industrial gases is on permanent offshore platforms.

As fields being developed in ever deeper waters the complexity and cost increases

High oil prices make such projects economic

Offshore Middle East



UAE

- Adma Opco, Zadco, Total
- DP, Crescent, Atlantis
- New Umm Shaif & sour gas

KSA

- Saudi Aramco
- New “Maintain Potential”

QATAR

- Oxy, Maersk, QP – oil & gas
- RasGas / Qatargas feeding LNG
- Dolphin feeding UAE / Oman
- New “RG II, QG 3&4, Pearl GTL

IRAN

- South Pars

OMAN

- Some deepwater potential

CASPIAN & INDIA

- Many projects supported from UAE

Downhole Applications

Nitrogen gas can be injected in the well via coiled tubing. Normally the nitrogen equipment is supplied as part of the coil tubing package for:

- Gas lifting (reduce hydrostatic head)
- Sand-fill cleanout (after fracturing)

Nitrogen can also be pumped directly in to the well via the wellhead to displace the fluid column left in the well after completion via the downhole sliding sleeve. Other uses include:

- Foaming cement
- Nitrifying acid
- Packer equalisation

Customers for the sector will be major service co's (BJ, Halliburton, Schlumberger and local / regional service co's (NOWMCO, MB, Sapesco)

Topside Applications

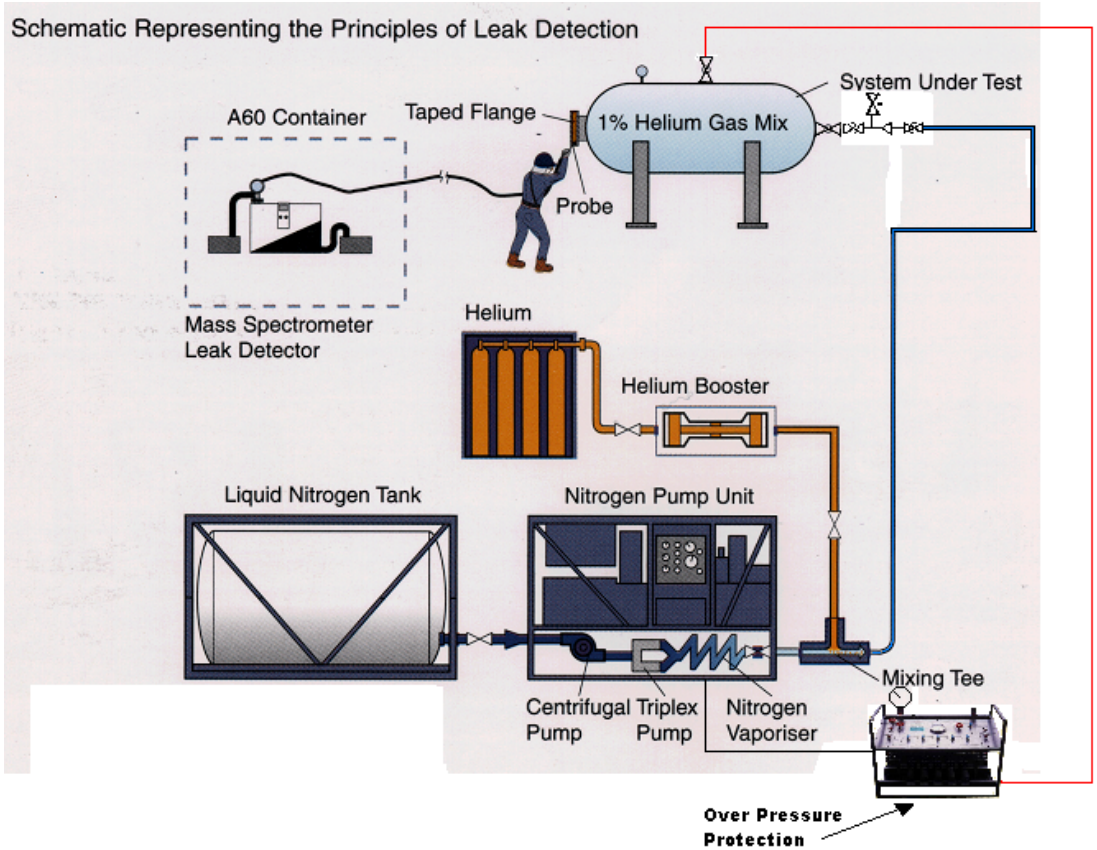
There are many uses for nitrogen in oil & gas platforms:

- Purging systems out of and in to service
- Drying moisture sensitive systems
- Pressure testing valves for seat leakage
- Deploying pipeline smart plugs
- Propelling pipeline pigs
- Blanketing systems for preservation
- Leak testing flanged connections
- Starting compressors

Whilst these services are used daily in the North Sea, there is a growing acceptance of such techniques in the Middle East

Customers for the sector will be major service co's (BJ, Halliburton, Weatherford and some local service companies.

Nitrogen / Helium Leak Testing



Using both LN2 & gaseous helium this is the largest market for offshore industrial gases

Service is also provided at onshore construction yards in Abu Dhabi and Dubai

It allows all hydrocarbon systems to be leak tested at their working pressures and all leaks quantified in standard cubic feet per year (scf/yr) using a mass spectrometer tuned to helium

Nitrogen / Helium Leak Testing

Offshore Cryogenic Tanks

LENGTH	16ft
WIDTH	8ft
HEIGHT	8ft
WEIGHT	12,000 KG full, 6,000 KG empty
MAWP	Up to 17 barg
CAPACITY	8,000 litres LN_2 = 5,250 Nm^3 GN_2

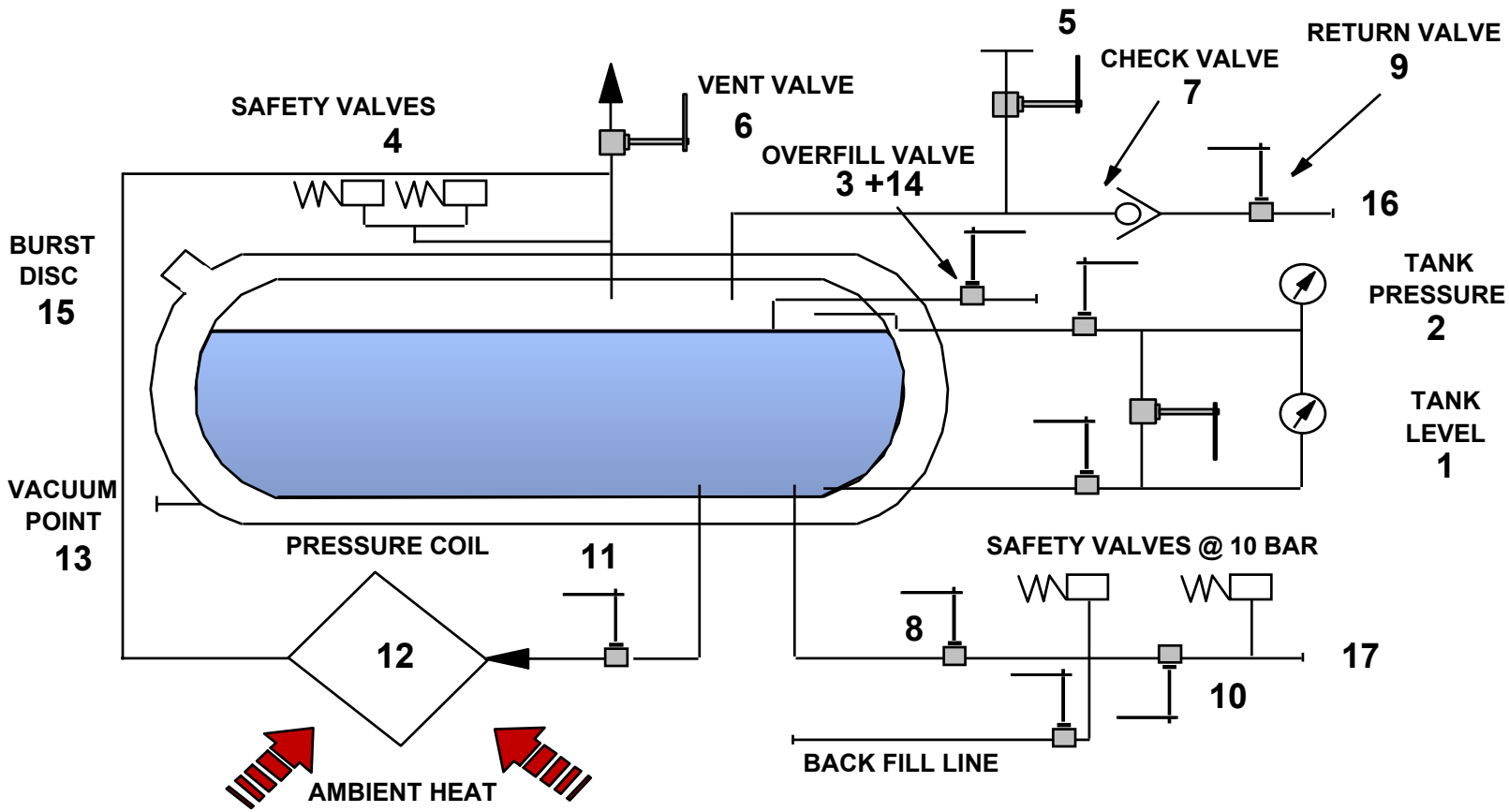
Note – at 12,000 KG full some platforms may be unable to lift full tanks

LENGTH	10ft
WIDTH	8ft
HEIGHT	8ft
WEIGHT	12,000 KG full
MAWP	Up to 17 barg
CAPACITY	7,220 litres LN_2 = 5,000 Nm^3 GN_2

Note – these 10' tanks can be linked to ship as 20' container

Offshore LN2 tanks are lifted using 5 leg slings. They are governed by lifting regulations as well as ADR and IMO codes

Offshore Cryogenic Tanks



Offshore Nitrogen Pumps / Vaporisers

NITROGEN PUMP NP 90

LENGTH	12ft
WIDTH	8ft
HEIGHT	8ft
WEIGHT	7,500 KG
CAPACITY	90,000 scfh / up to 10,000 psig

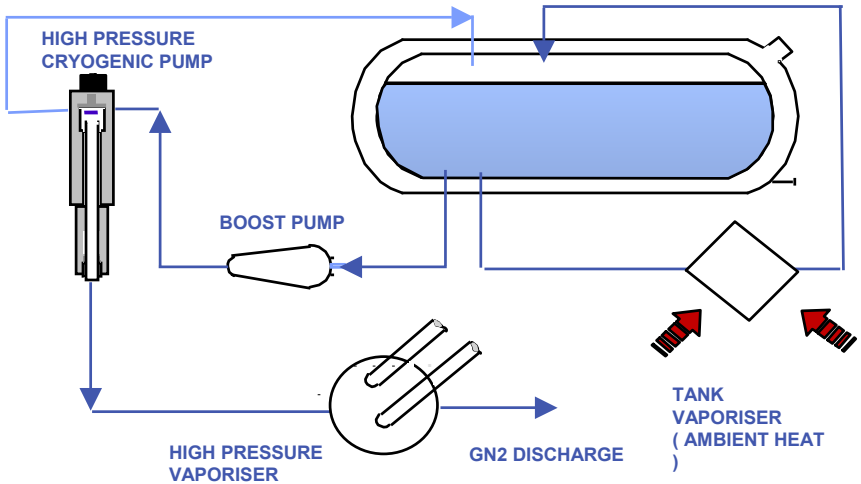
Note – at 7,500 KG unit suitable for older platforms with reduced crane capacity

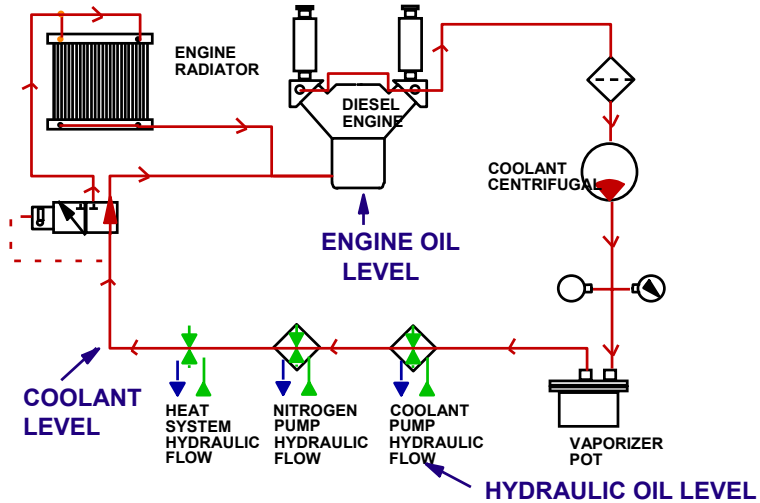
NITROGEN PUMP NP 180

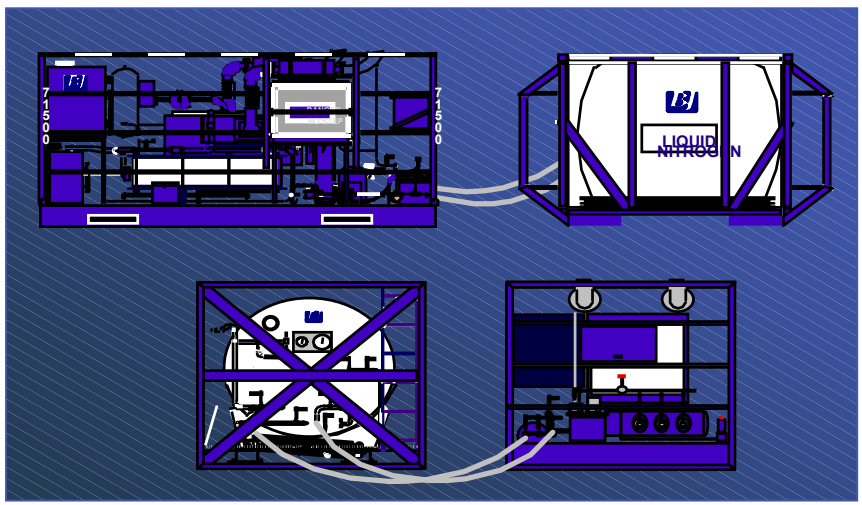
LENGTH	16ft
WIDTH	8ft
HEIGHT	8ft
WEIGHT	12,000 KG
CAPACITY	180,000 scfh / up to 15,000 psig

Lift frames governed by DNV 2.71 code. Engines for zone 2 operation

Offshore Nitrogen Pumps / Vaporisers







OPERNATIONAL OVERVIEW

- LN2 circulated back to tank via boost pump
- Once circuit cooled LN2 pumped via triplex
- All waste heat sources used from diesel engine
- Heat transfer medium is engine coolant
- Counter coil heat exchanger used to vaporise LN2
- LN2 to GN2 expansion = 696 times
- Total control on pressure and gas temp

Typical Gas Usage

OPERATION	LN2 USAGE (USG)	HELUM USAGE (M3)
Nitrogen well displacement	4,000	0
Nitrgoen foamed acid treatment	6,000	0
Nitrogen / CT gas lift	8,000	0
Wellhead platform purge	4,000	0
Compression platform purge	10,000	0
Central process platform purge	16,000	0
Wellhead platform N2/He leak test	6,000	200
Compression platform N2/He leak test	20,000	600
Central process platform N2/He leak test	30000	900
Position pipeline isolation plug	8000	0
Provide N2/He for compressor start up / tests	2000	4000
Purge & pack of new infield pipeline	12000	0
Purge & pack of new export tunkline	50000	0

Points to consider

- Nearest LN2 supply location, tanker fleet and storage capacity
- Boat availability & jetty LN2 storage
- Platform space, deck loading, crane capacity / availability

Membrane vs. LN2

MEMBRANE

Positive

- No LN2 supplies = reduced logistics
- Typically lower N2 supply cost
- Great for remote areas with limited LN2 supply

Negative

- Large equipment footprint, particularly for high flow
- 95% purity not suitable for all applications
- High capital cost (approx. 2 x LN2 for 90,000 scfh spread)
- Feed air not available in zone 2 rating

LN2

Positive

- Wide availability of equipment – smaller overall footprint
- Equipment built for DNV 2.71, zone 2, and ATEX
- Very flexible in terms of flow, pressure and gas temp
- High purity nitrogen suitable for all applications

Negative

- LN2 cost and supply issues
- Greater number of lifts c/w cryogenic spill risks
- Challenge in areas with poor LN2 supply
- May require storage tank farm to support

Growth Opportunities

1. ***Gas developments require far more offshore nitrogen services than oil developments*** – this means growth in Qatar, UAE, India, Iran, Egypt and the Caspian
2. ***LNG developments offer best growth opportunity as all feature significant infrastructure plus export pipelines*** – for Middle East the focus is Qatar and Egypt (plus Yemen onshore)
3. ***Dewatering deepwater pipelines after hydrotest can use up to 50,000 USG on LN2 per line*** – developments underway in India with future opportunities in Azerbaijan
4. ***Increased acceptance of "North Sea" techniques by National Oil Companies*** – there has been a strong increase in N2/He leak testing and N2 purging in Qatar, UAE and Azerbaijan, with some interest now in Saudi Arabia and Kuwait
5. ***Increased LN2 production capacity in developing areas*** – in Yemen, the Caspian, and particularly Kazakhstan there is a shortage of LN2 which hampers the growth of the associated service applications

END