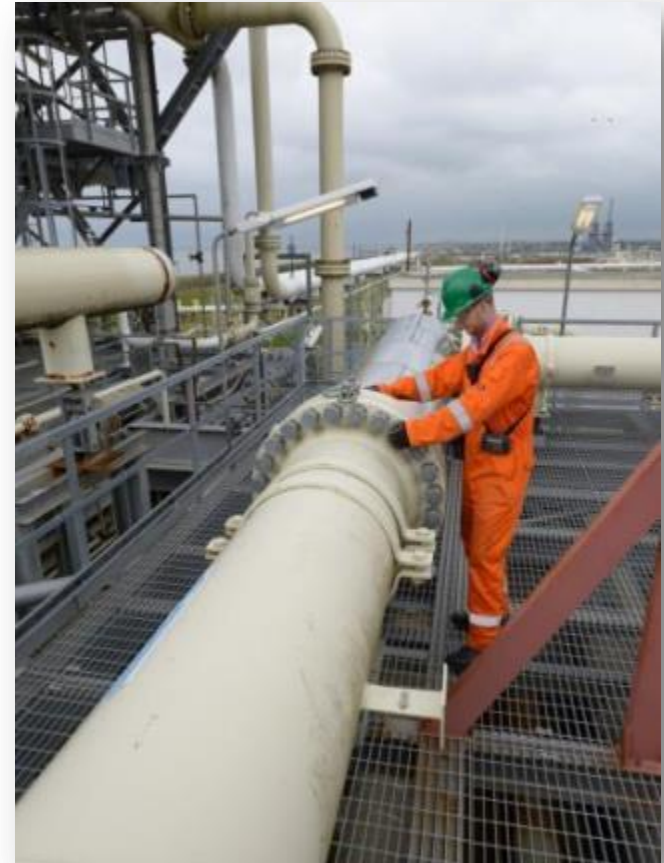






*Caltec brings simple passive technology that enables oil and gas operators to harness the kinetic energy of the production process to enhance their production, extending economic field life and reducing environmental impact...*

- The world leader in Surface Jet Pump (SJP) and compact separation systems for upstream oil and gas production enhancement
- Caltec offers application identification, design, optimisation and the provision of solutions based upon our proprietary SJP and compact separation technologies
- Extensive track record in adding value to major IOC and NOC clients worldwide
- Caltec is part of Petrofac Production Solutions
- Petrofac is a major international EPC service company. Worldwide offices.



## **SJP Based Production Enhancement systems:**

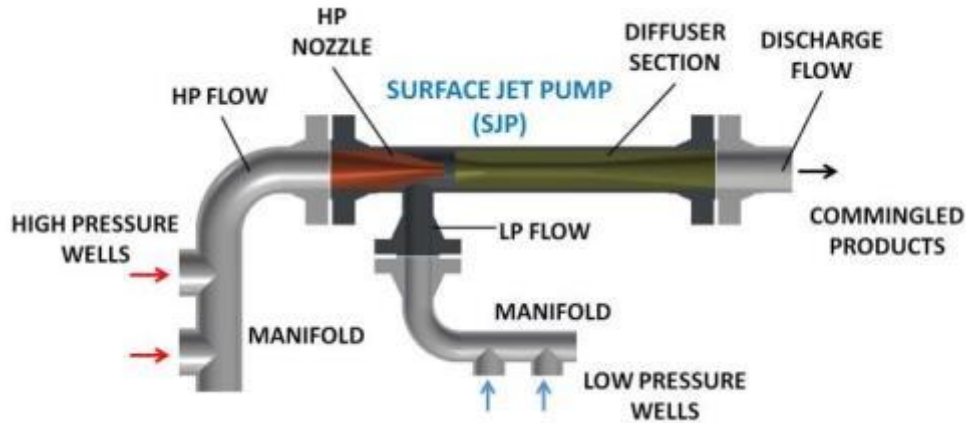
- Increase production from mature oil & gas fields and wells
- Boost the pressure of low pressure gas wells or fields
- Revive liquid loaded wells
- Eliminate or enhance intermediate compressors
- Debottleneck compressors
- Prevent gas flaring and venting
- Enhance artificially lifted wells (especially gas lift)

## **Compact Separation systems:**

- Phase splitting including gas - liquid separation
- Sand separation
- Oil - water separation
- Compact multiphase well testing using conventional meters

# Caltec's Surface Jet Pump (SJP)

(Otherwise known as an Educator or Ejector or Velocity Spool™)

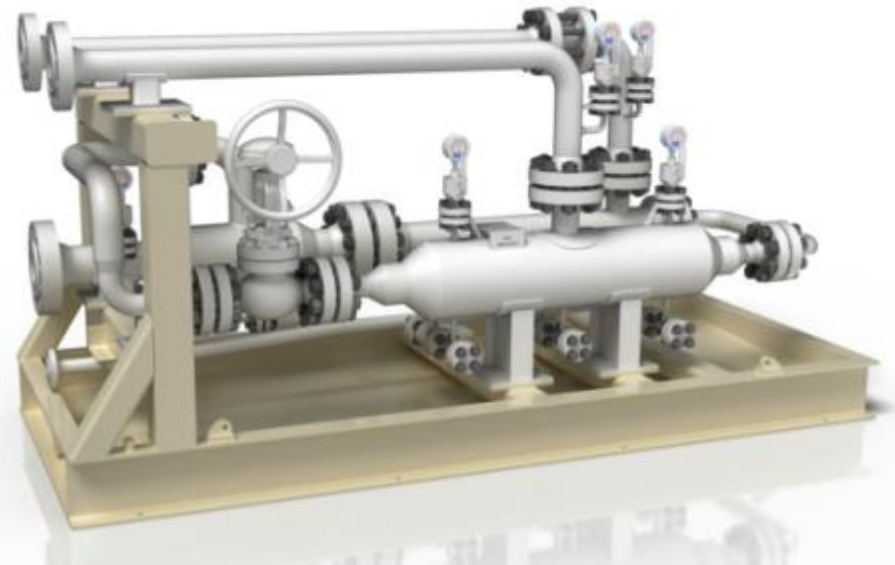


HP sources:

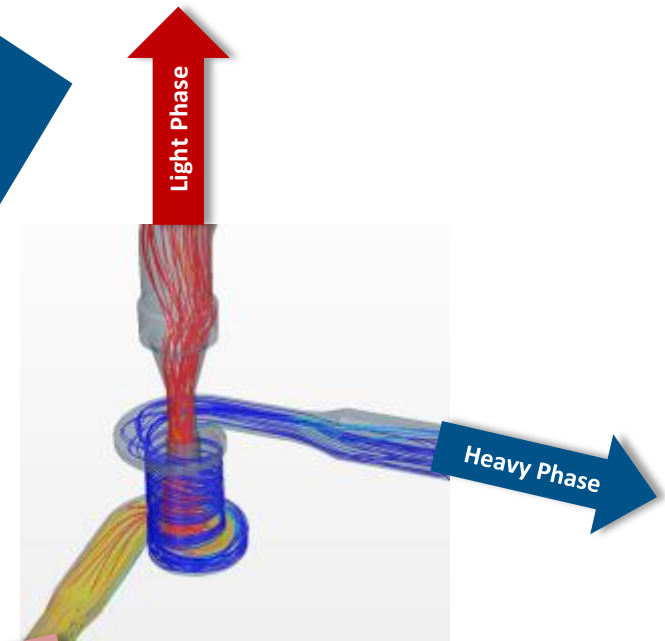
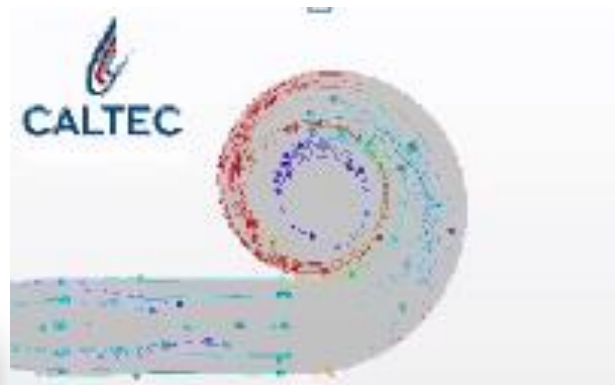
- HP wells
- HP gas from process system
- Compressor re-cycled gas
- HP oil / water (injection water)

# Features & Benefits of Caltec's SJP

- Passive
- Utilises energy otherwise wasted
- Designed to international codes and standards
- Low weight
- Minimal footprint
- No moving parts
- Low CAPEX, very low OPEX
- Minimal control and instrumentation
- Easy and quick to install
- Low risk
- Short payback period



Technology inspired by nature...



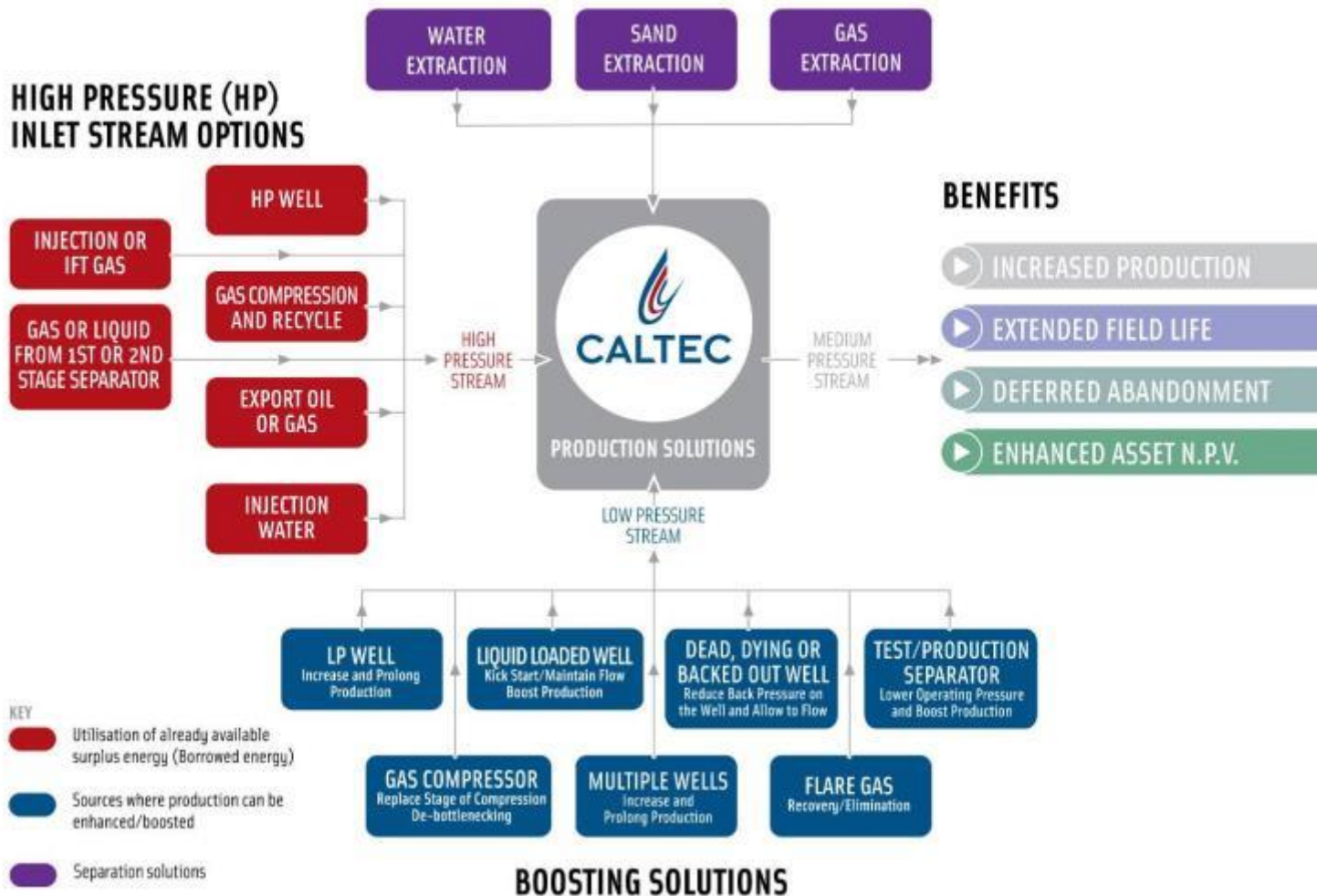
High 'g' forces are generated from the inlet flow stream's momentum by accelerating the flow through an involute to achieve rapid:

- Coalescence
- Phase separation

# Typical Applications

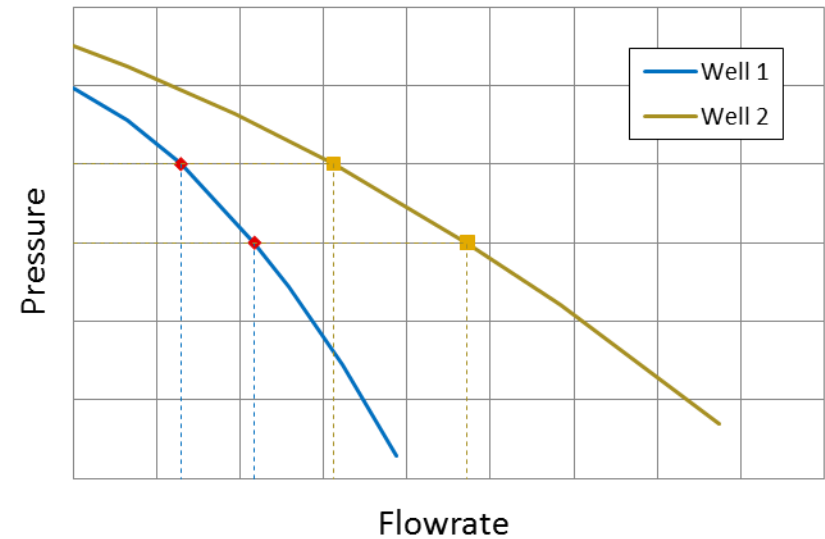
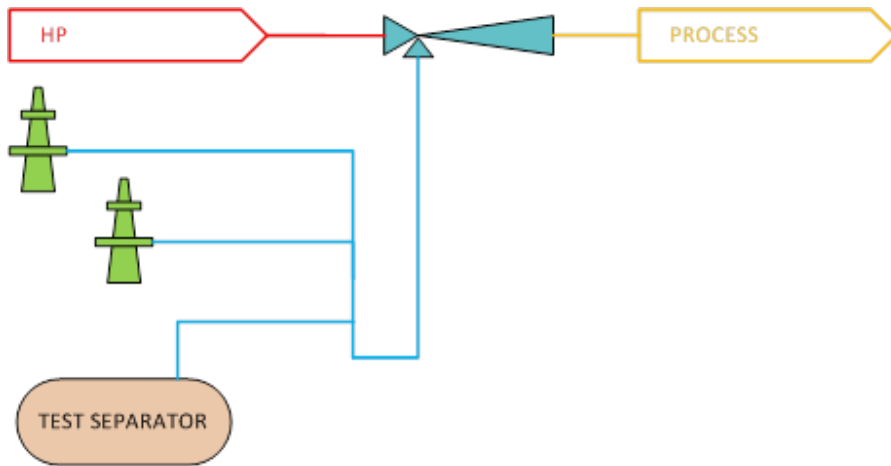


## SEPARATION SOLUTIONS

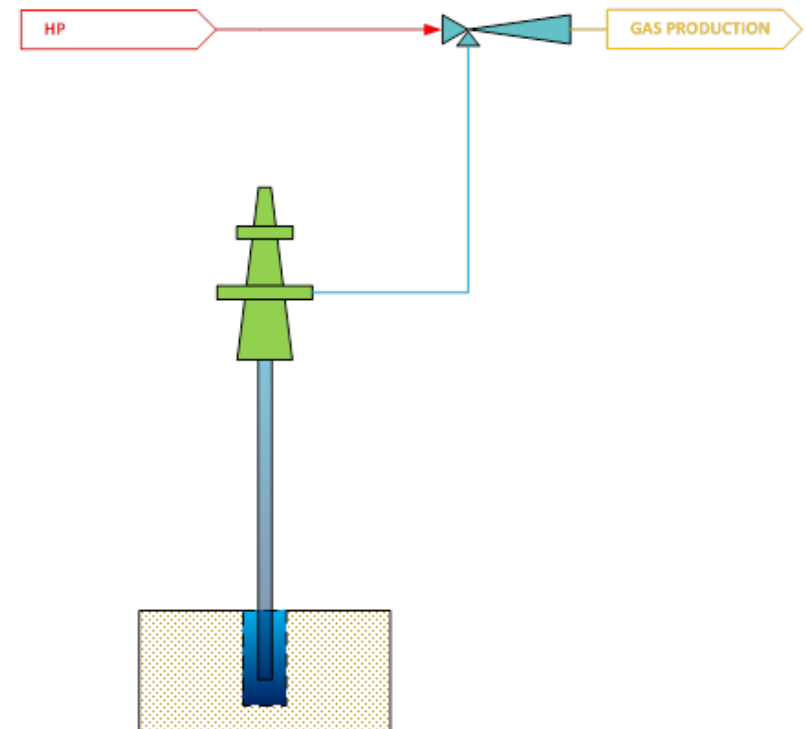


# Production Boosting

- Lowering the FWHP creates an increase in production determined by the PI curve
- SJP lowers the flowing pressure, delivering the fluids to production systems

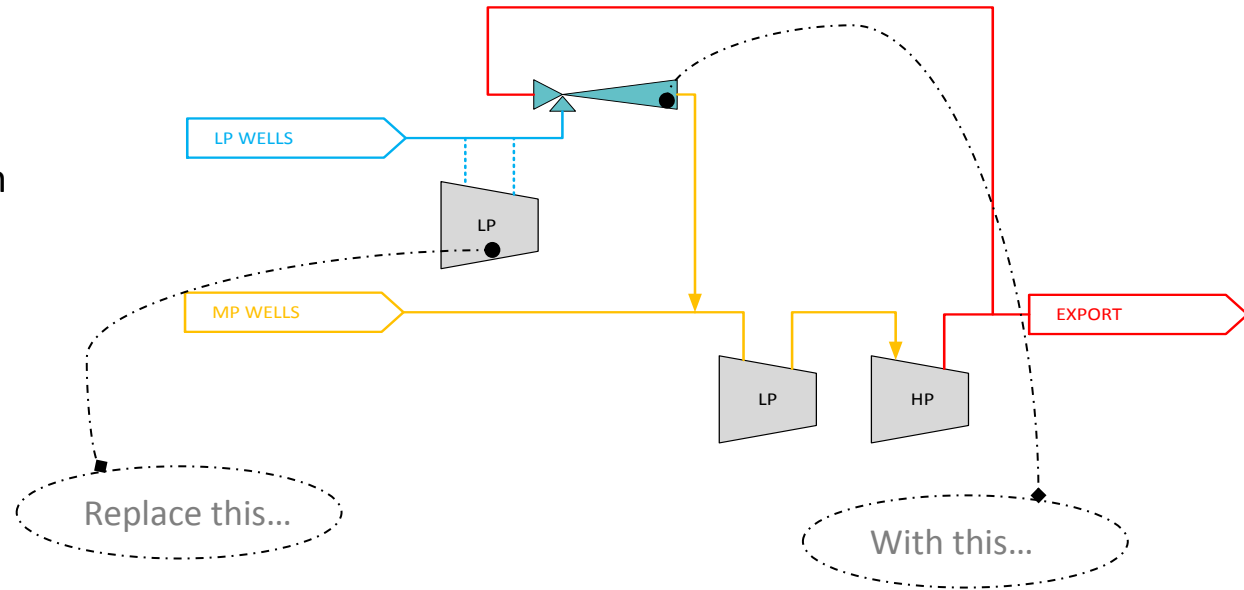


- SJP can be used to reduce the FWHP (and FBHP)
- Flashing leads to reduction in fluid density
  - Increased in-situ velocity sweeps liquids
- Can sometimes be a slow process, depending on length of riser, depth of well bore etc.



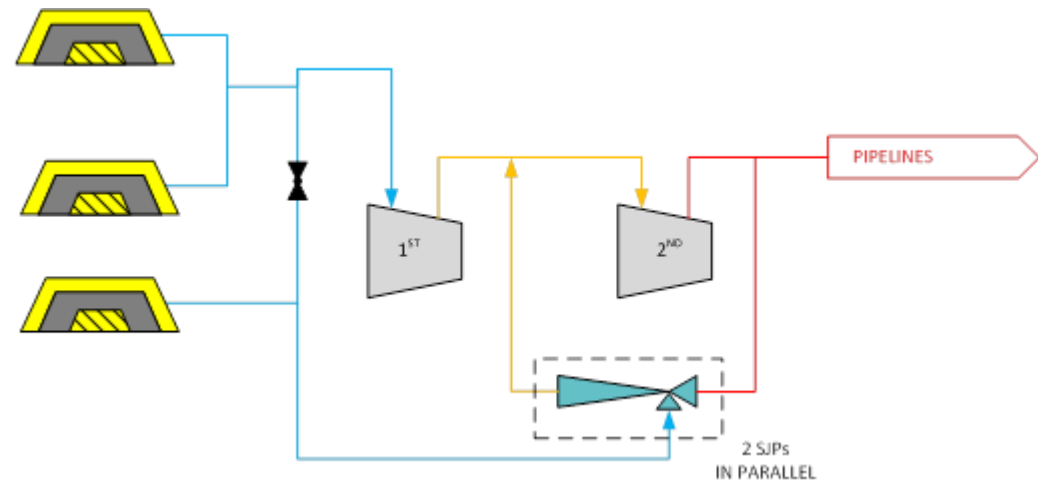
# Compressor Removal

- Remove a stage of compression
  - Save maintenance costs
  - Save on fuel gas
    - Export as sales gas instead
- Use later-stage compressor recycle to boost LP
- Rapid start-up / shutdown



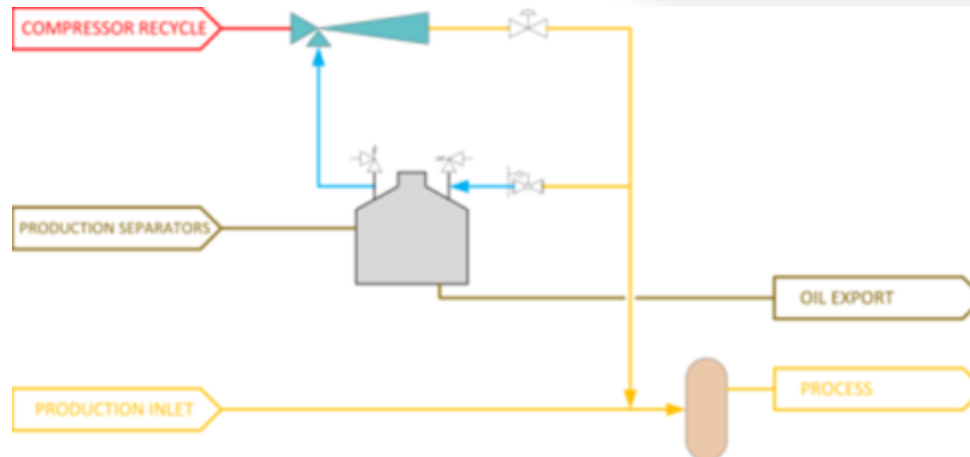
# Compressor Debottlenecking

- SJP to optimise compression
- Use HP gas from downstream compressors to boost LP
- Can be used to boost inlet pressure to compressor



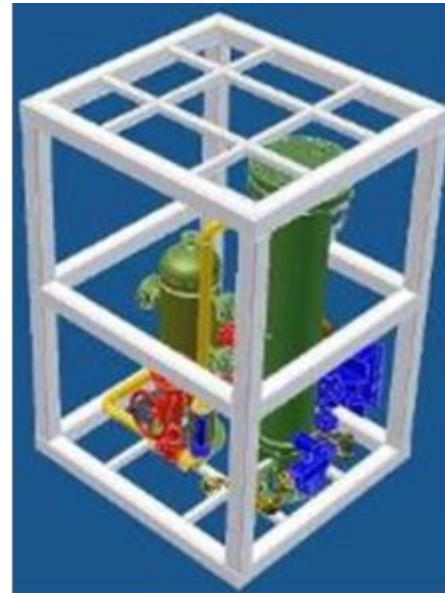
# Vent Gas Recovery

- Recover vent gas from crude oil storage tanks
  - Prevent hazardous emissions
  - Re-capture otherwise lost gas into the production process
- Maintain tank safety systems
  - Over-pressure protection
  - Vacuum protection



# Well Test/Multiphase Metering

- Multiphase well testing using conventional meters
- Separated flows can be recombined on the skid
- Low pressure drop (typically 1 bar)
- Compact size with low weight and small footprint. Highly mobile
- Can convert into a multiphase production boosting or well revival system with Caltec's patented Wellcom<sup>®</sup> SJP technology



Skid-mounted version



# Oil-Water Separation – Wx<sup>®</sup> Technology

- Consistent performance over a wide flow range
- Low sensitivity to inlet water cut above 50%
- Large turndown ratio, approx 10:1
- Operates inline at full wellhead or process pressure with low pressure drop across the system (generally 1-2 bar)
- No moving parts: very low maintenance, low inventory, minimal control required
- Very small footprint
- Inline modular design capable of flow rates of 1,000 – 50,000 bpd in a standard 36" pipe
- Tolerant to gas in the inlet stream – performance is maintained with gas present
- Ideal for high pressure/high temperature wellhead and subsea applications

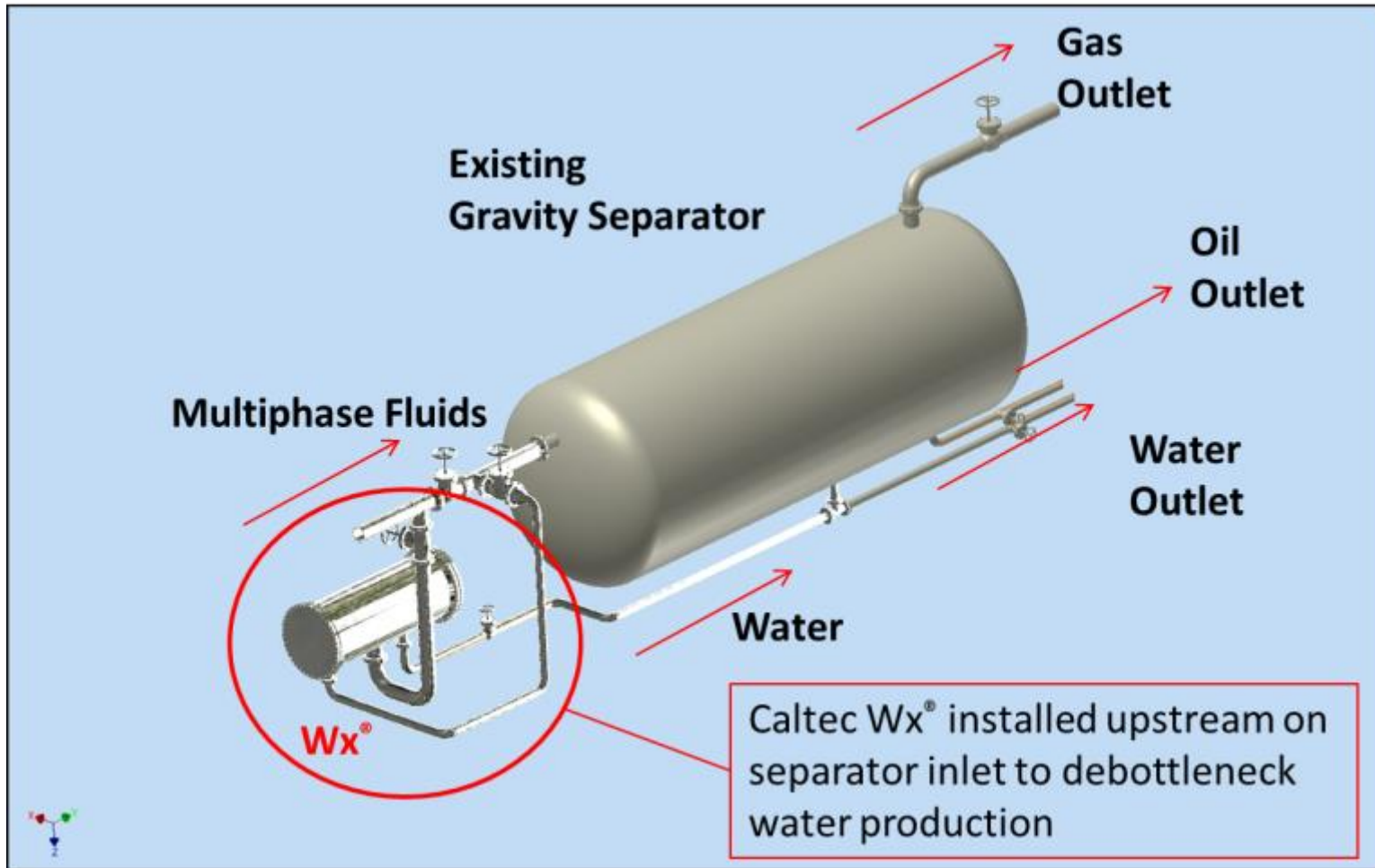


## Typical Performance:

- 60% - 70% water extraction
- Water quality; 2,000 to 500 ppm oil in water



# Wx<sup>®</sup> for Debottlenecking Water from Gravity Separator

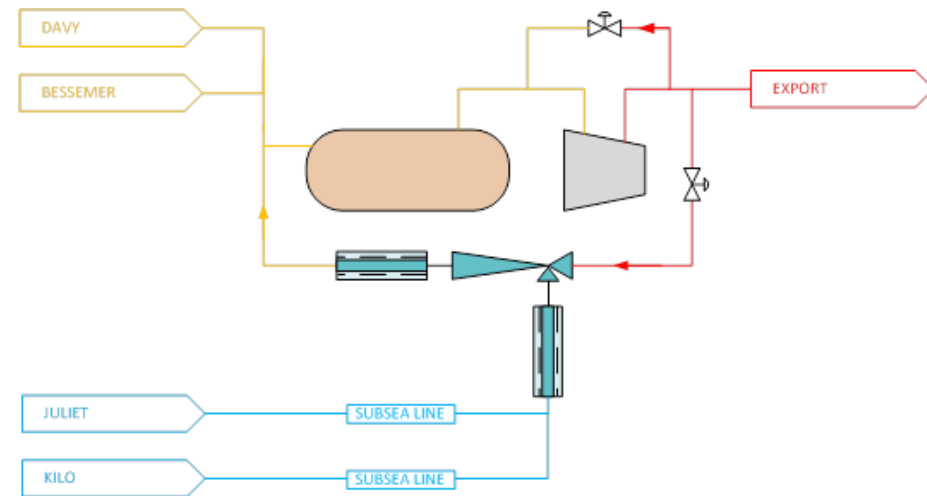


# Case Histories

# Production Boosting

## UKCS - Offshore

- **Issue**
  - Near-by low pressure wells could not be tied-in due to the capacity limitation of the existing compression facilities.
- **Solution**
  - Used SJP to draw in low pressure satellite wells (15km subsea tie-back)
  - HP gas mmscfd at 1000 psig
- **Benefits**
  - Recovered extra 68 mmscfd of gas from LP wells (increase of 25%)
  - Stabilised and unload liquid from LP wells
  - Tolerant to liquid slugs
  - Increased intake capacity of compressor

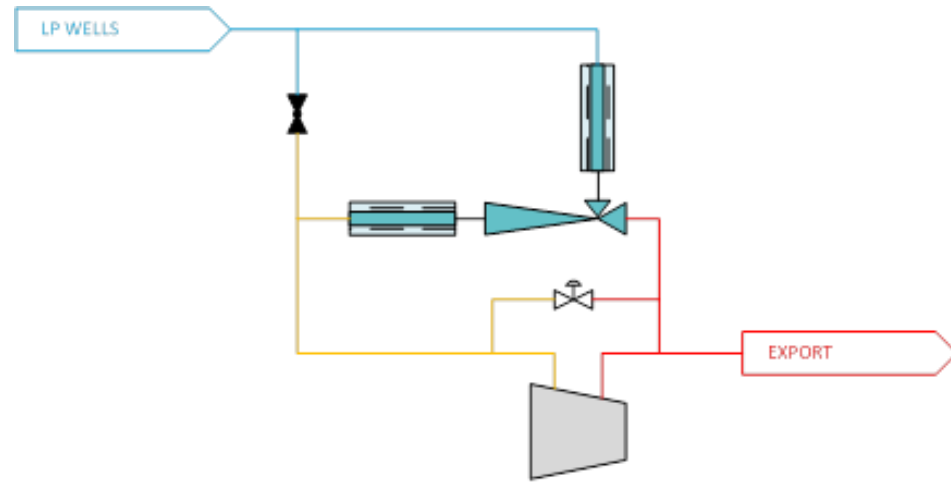


Award-winning solution

# Production Boosting

## Netherlands – Offshore

- **Issue**
  - Reducing gas production, compressor on constant recycle
  - New compressor or re-wheel required to increase production
- **Solution**
  - 16" SJP
  - SJP installed to use 92mmscfd HP gas at 84bara
  - LP flowrate of 94mmscfd at 20.5bara
- **Benefits**
  - LP gas from wells boosted by almost 6bar
  - Total gas production increased by 91mmscfd

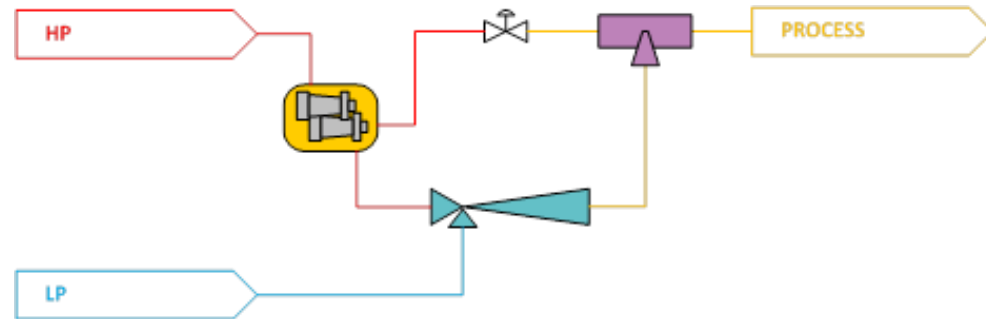
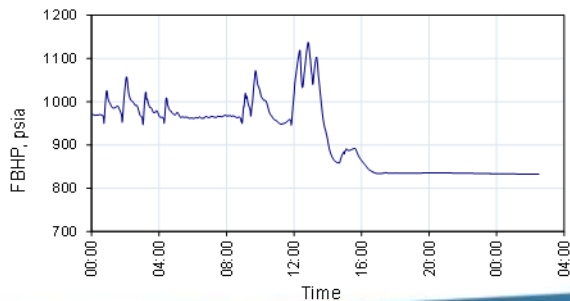


*“By installing an SJP in the recycle line of the existing compressor, we avoided a second stage compressor cum re-wheel (est. savings some €10M, first gas acceleration one year)”*

# Multiphase Boosting

## Malaysia - FPSO

- **Issue**
  - Shut-in LP wells
- **Solution**
  - Multiphase HP wells used to reduce back-pressure
- **Benefits**
  - Used energy otherwise lost in choke from HP well
  - 20% pressure boost for LP wells
  - Increased production by over 35% (150 bpd)
  - Improved flow regime in well bore, stabilising production



# Avoid LP Field Back-Out

UKCS - Offshore

- **Issue**

- New HP wells would have backed-out LP wells by increasing pipeline pressure

- **Solution**

- Using high pressure gas from the well to power the SJP enabled draw-in of the backed-out low pressure wells

- **Benefits**

- Backpressure on the LP wells reduced by 5 bar giving extra 22 mmscfd of gas (production increased by 110% )
- Better use of already available energy with minimum modification to the existing piping
- Increased the producing life and stability of the LP wells
- Delivered the combined flow at the required higher downstream pressure



## Malaysia - Offshore

- **Issue**
  - Multiple wells under-performing or shut-in
- **Solution**
  - Using HP gas from compressor to power the jet pump enabled production of 16 wells
  - Boost of ~25 mmscfd from 40 barg to 50 barg
  - HP gas ~60 mmscfd at 100 barg
- **Benefits**
  - Increased production of 14 mmscfd
  - Additional connection to test separator enabled liquid unloading at low pressures
  - Increased the producing life and stability of the LP wells



# Compressor Replacement

## UK - Onshore

- **Issue**
  - Operational costs with compressor and fuel gas consumption
- **Solution**
  - Removed 1<sup>st</sup> stage compressor by utilising the available energy from recycle gas from HP compressor
  - Boost of 19 mmscfd from 25 psig to 70 psig
  - HP gas 32 mmscfd at 1000 psig
- **Benefits**
  - Save 2 mmscfd fuel gas by removing LP compressor
  - Make use of available recycle gas
  - Saving a compressor for use elsewhere
  - Entire field being drawn in by SJP

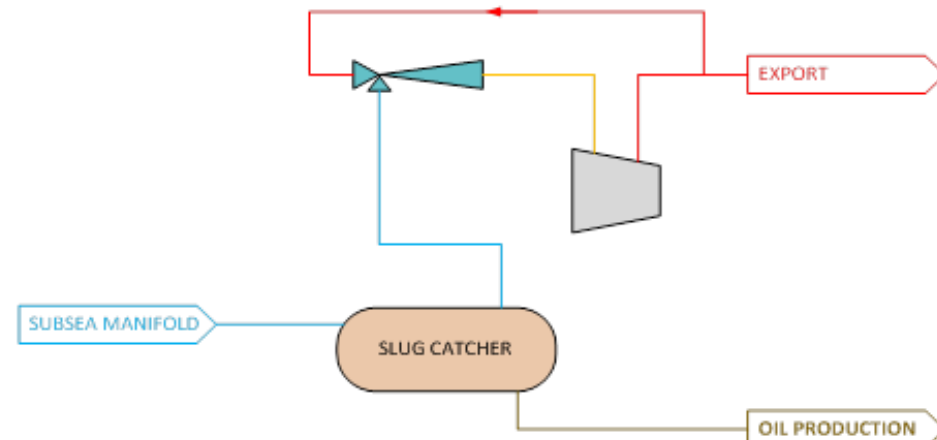
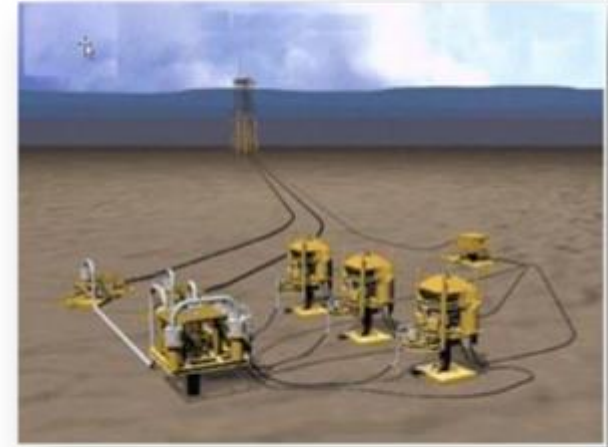




# Well Deliquification / Revival

## Gulf of Mexico - Offshore

- **Issue**
  - Wells shut-in and liquid loaded
- **Solution**
  - HP gas from the existing compressor on recycle used to power the Surface Jet Pump
- **Benefits**
  - Lowered arrival pressure at the platform by 200 psi
  - Reduction in liquids accumulated in the pipeline, causing a further 140 psi drop at the wellhead
  - Recovered 2.5 BSCF of otherwise lost reserves
  - Flow delivered at higher pressure to compressor suction increased compressor throughput



## Mexico - Onshore

- **Issues**
  - Gas venting from crude storage tank
    - Environmental emissions
    - Safety risk from electrical storms
- **Solution**
  - Used SJP to capture vent gas
  - LP capacity of 0.3 mmscfd
  - HP gas 1.8 mmscfd at 62 barg
  - Recycle to maintain tank pressure
  - Discharged into inlet rectifier
- **Benefits**
  - No further emissions
  - Made use of available recycled gas





# BOOSTING PRODUCTION AROUND THE WORLD

