Twin Screw Technology

General Overview and Multiphase Boosting

11/2013

Axel Jäschke
Technical Director - ITT Bornemann USA
Office: +1 832 320 2500
Mobile: +49 170 576 4115
+1 832 293 7935

Bio Axel Jäschke

Axel Jäschke, currently the technical director of ITT Bornemann USA, has been involved with twin-screw pumps for various applications in the oil/gas industries during the past 15 years.

His technical experience in multi-phase boosting technologies had brought him to various projects in Columbia, Venezuela, Russia, Abu Dhabi and Thailand. As head of the R&D department for Subsea Boosting he was involved in several new developments and patents regarding multiphase boosting during the last years.

Based out of Houston, he is responsible for the development of new, US based multiphase boosting solutions.

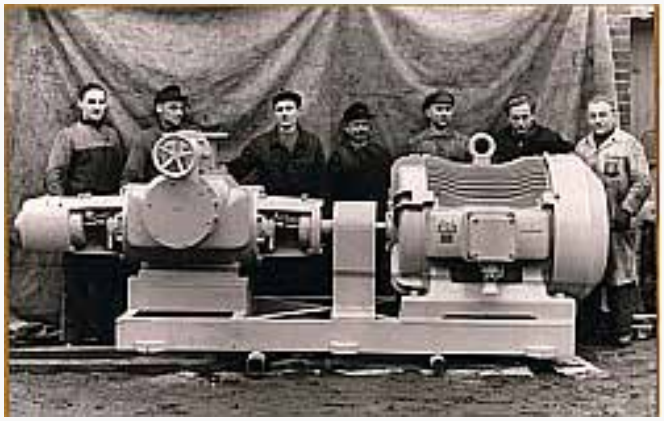
A Graduate Mechanical Engineer from University of Hanover, Germany, Axel was also involved in the design and management of various tank farm projects in Europe prior to starting with Bornemann in 1998.

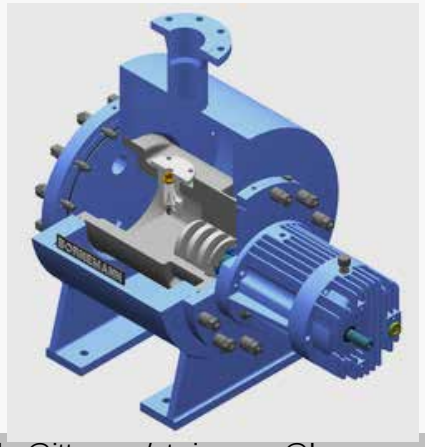
Content

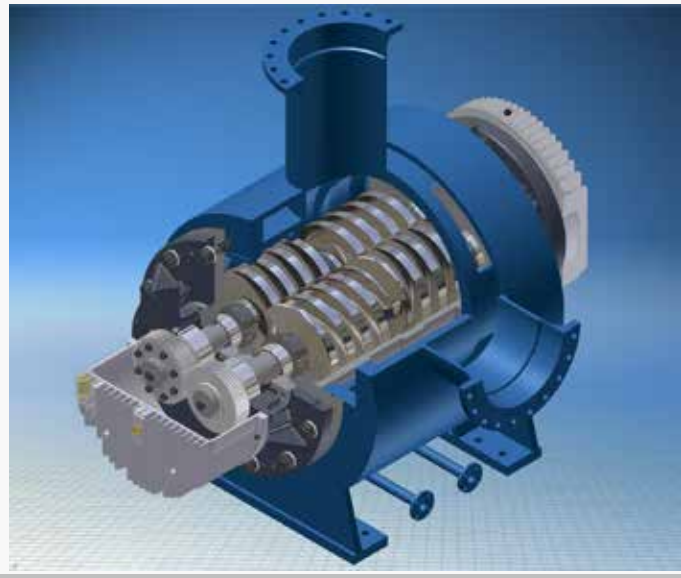
- Pumping Principles: Centrifugal Pumps (CFP) and TSP
- Why Twins Screw Pumps
- TSP Performance and NPSH
- TSP Applications and Operating Range
- Multiphase Boosting – Considerations and Solution
- Typical Installations

A Pump is a Pump ….

but some pumps are different.







axel.jaeschke@itt.com / twinscrew@bornemann-USA.com

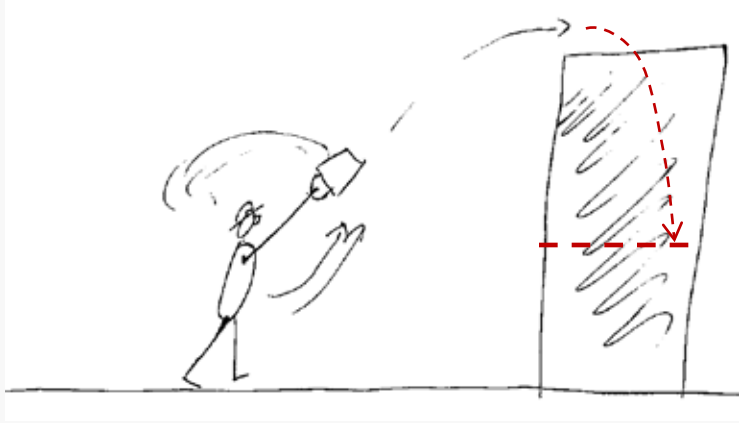
TSP Multiphase Systems

Basic pumping principles ...

Centrifugal Pumps (CFP)
and Twin Screw Pumps (TSP).

Hydrodynamic Pumps = Centrifugal Pumps (CFP)

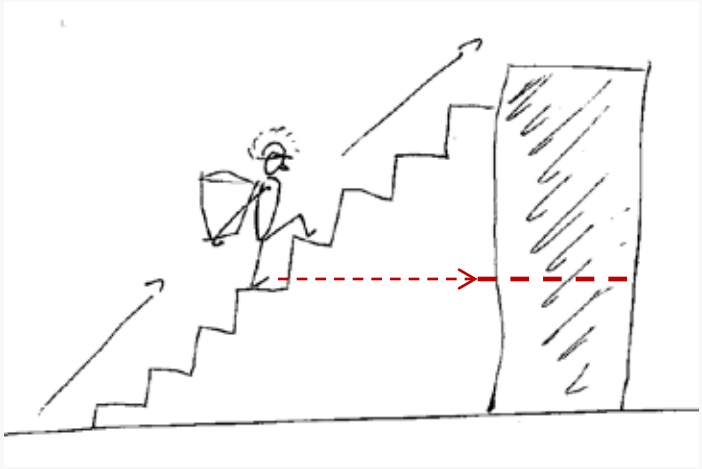
Adding **KINETIC ENERGY** to the fluid
and converting it into flow *(and pressure)*
depending on the required system pressure.



Hydrostatic Pumps = Twin Screw Pump (TSP)

Moving a fixed **VOLUME**
against the given system pressure.

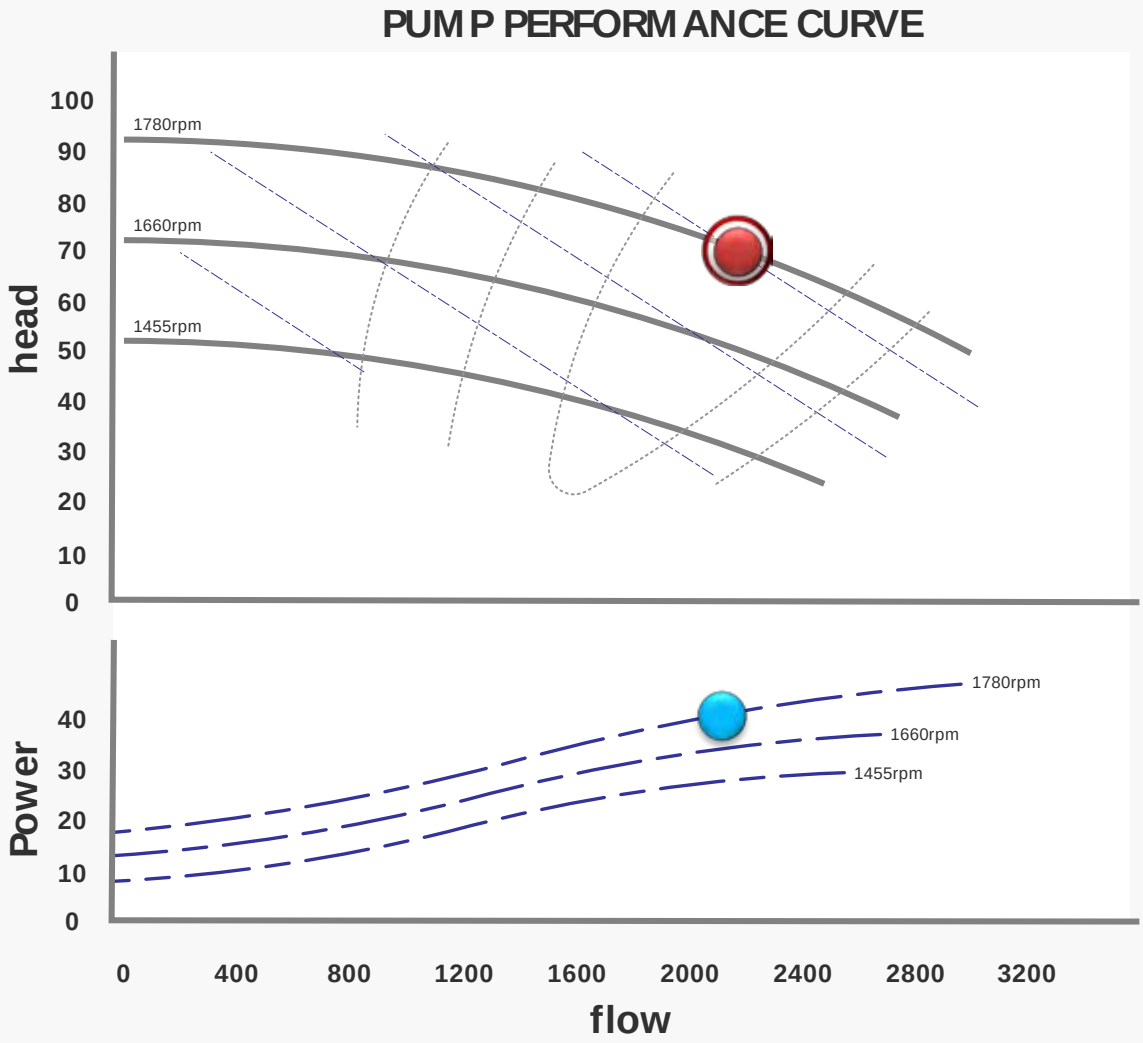
(Positive Displacement – PD)



Hydrodynamic Pumps:

Flow is depending on Pressure (or head).

Power is a relation of pump speed and efficiency at operating point.



axel.jaeschke@itt.com / twinscrew@bornemann-USA.com

Centrifugal Pump Consideration

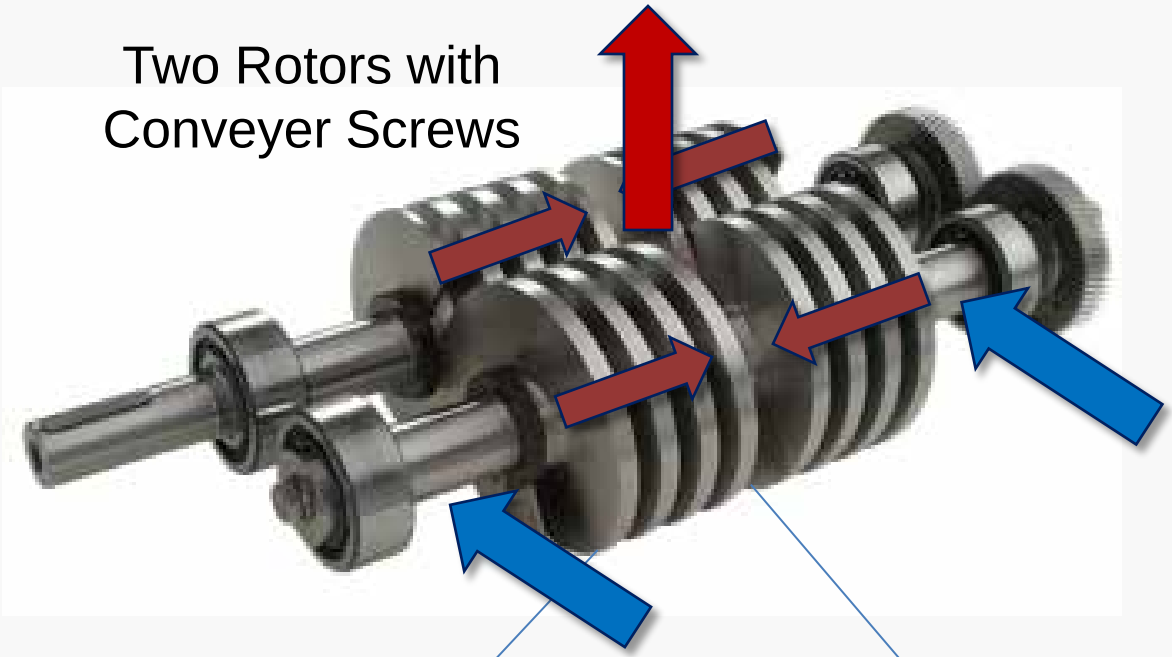
- Good Peak Efficiency at BOP (best operating point)
- Low Cost
- Sensitive to Gas, High Fluid Viscosities, changing Fluid Density
- Sensitive to low Inlet-Pressure and Cavitation
- Not operating at BOP can lead to reduced pump lifetime
- Limited Overall Efficiency

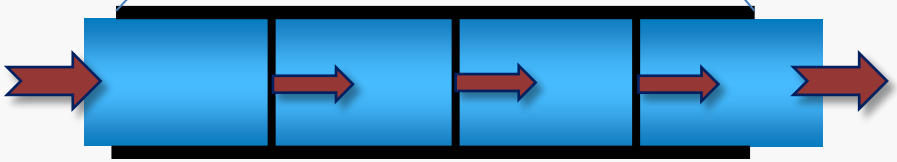
Why Twin Screw Pumps

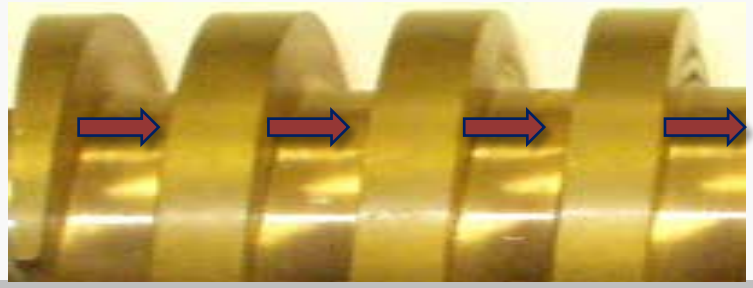
- Handles almost all types of fluids – conventional and unconventional
- Fluid density does not influence pump performance – self priming
- Very wide operating range at overall high efficiency
- Very low NPSH requirements and not sensitive to vapor and cavitation
- Very good flow control
- Higher Cost compared to Centrifugal Pumps

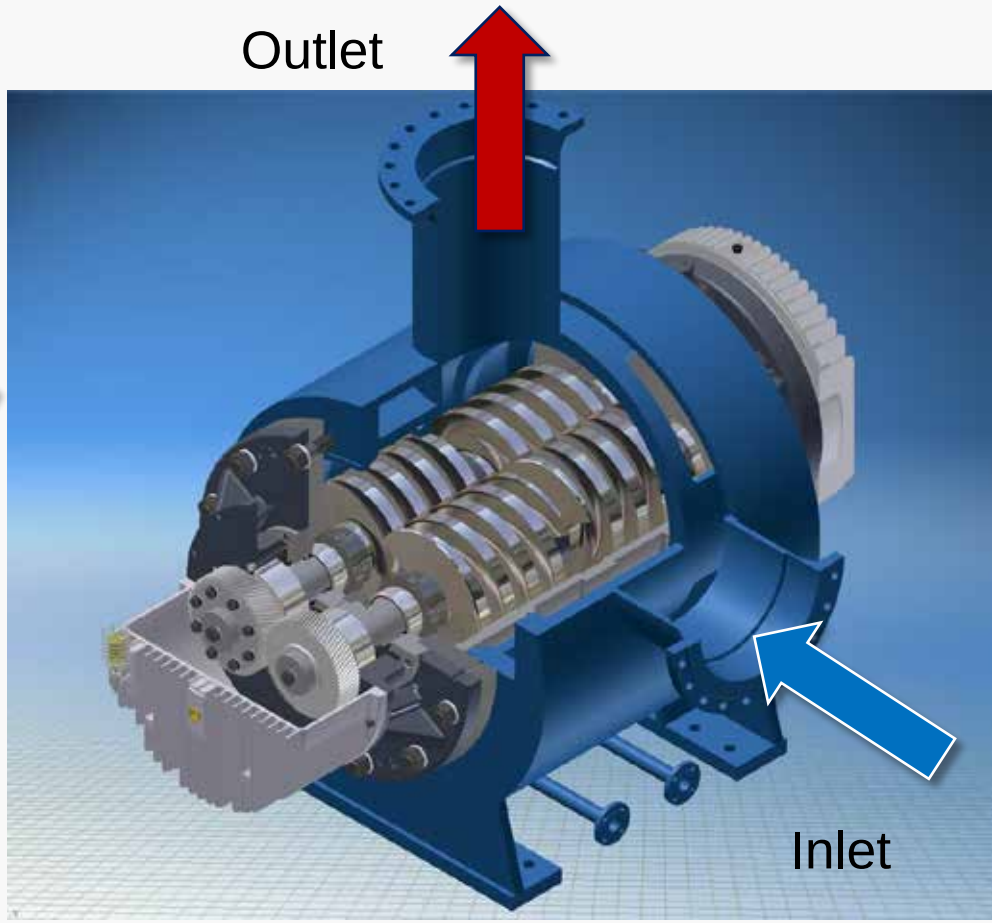
Twin Screw Pump (TSP)
Performance.

Twin Screw Pump – Flow Inside Pump

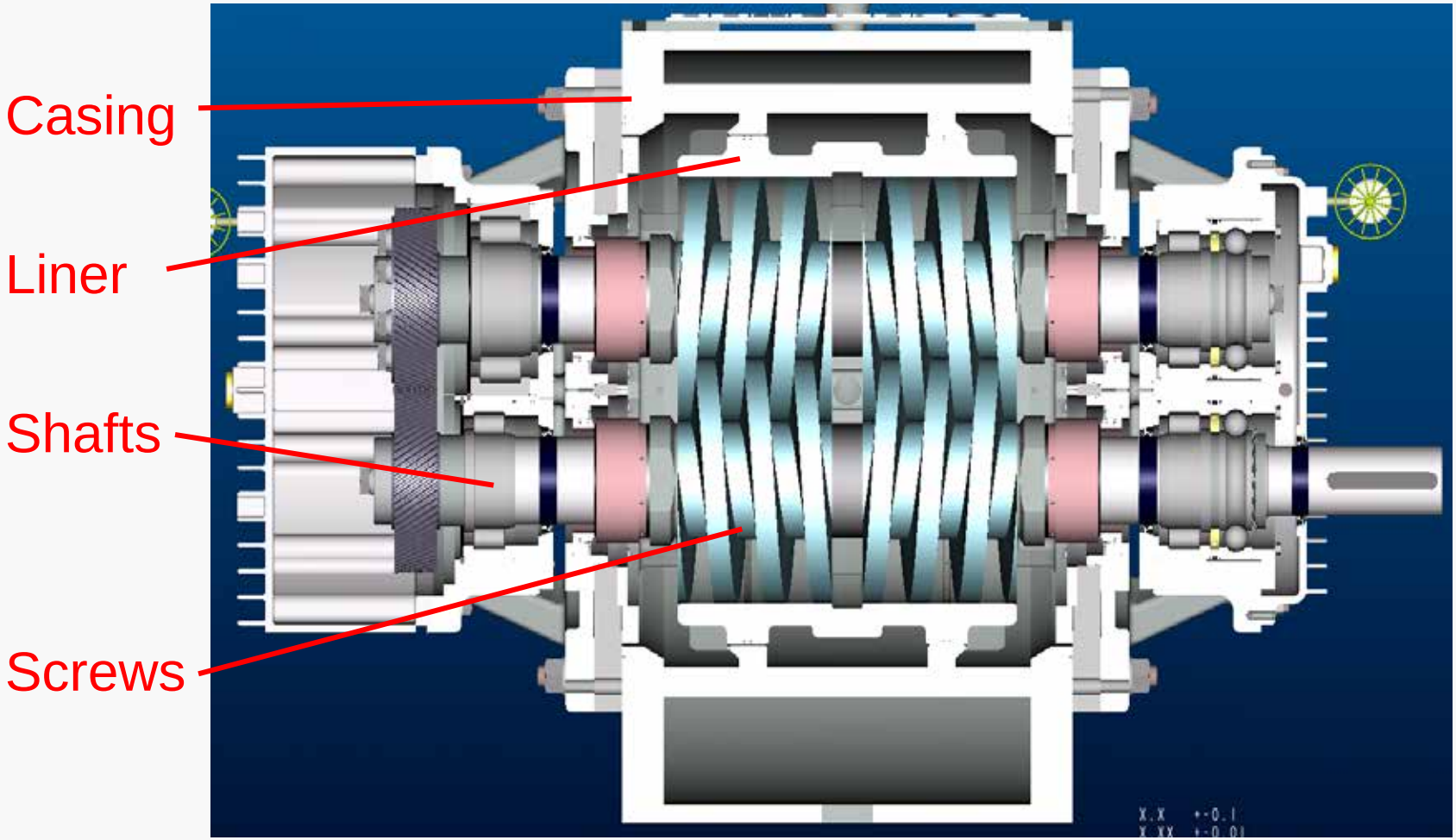








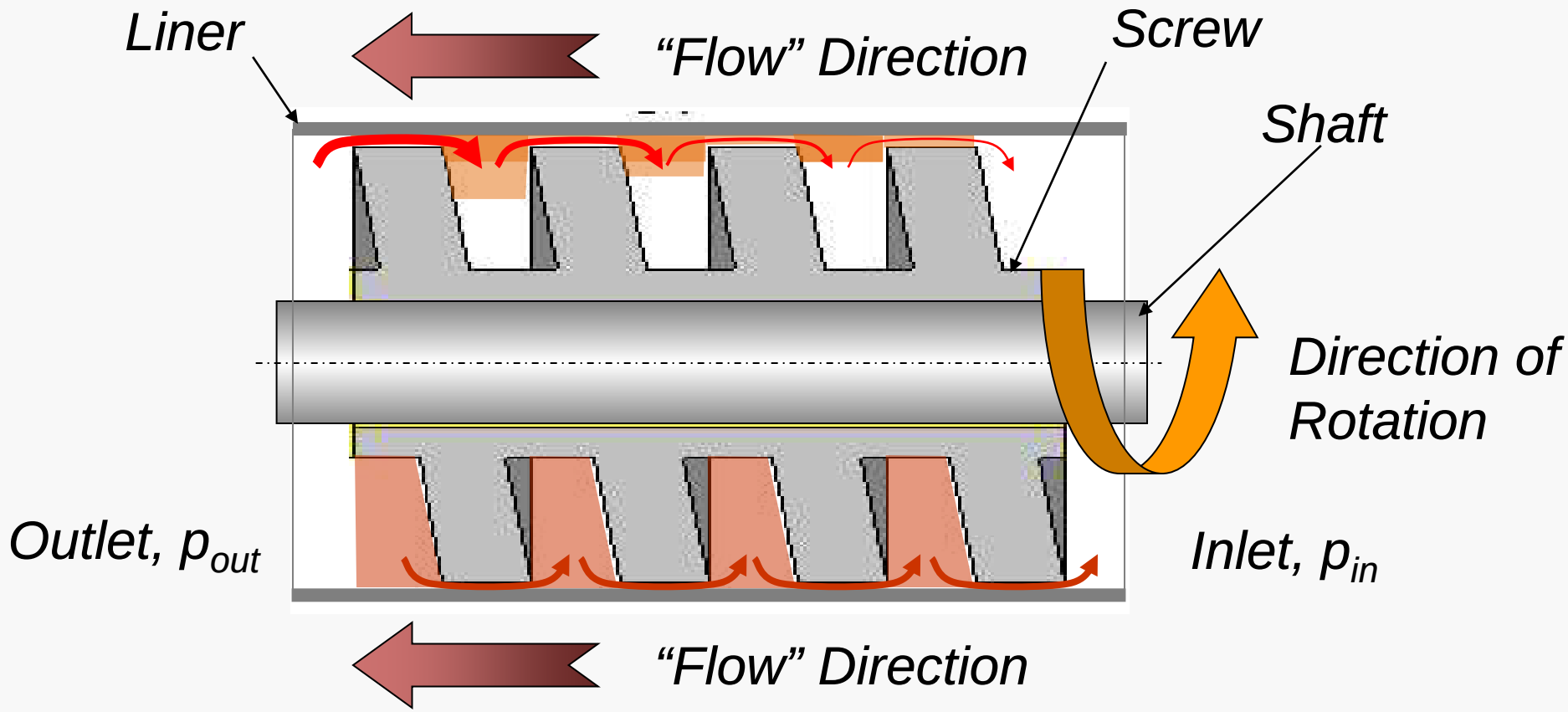
Typical Twin Screw Pump



No Contact between Screw and Screw and Screws and Liner / Casing

No Contact à small Gaps!

Flow and Backflow inside the Rotor



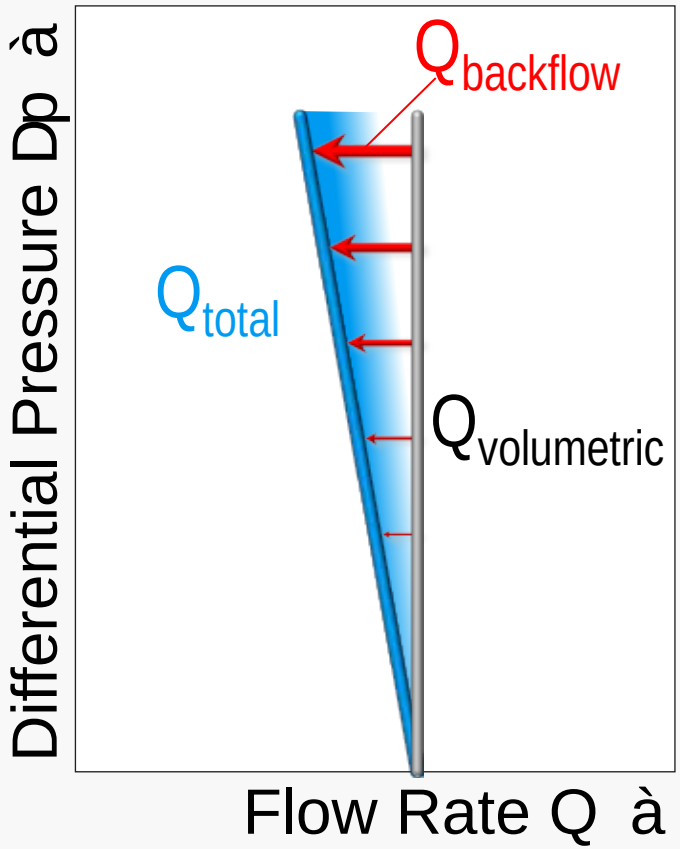
Capacity depends on:

- Chamber Size + number of screw
- Speed
- Differential Pressure (Dp)
- Viscosity
- Gap Design (screws, liner/casing)

Total Flowrate = Volumtric Flow – Backflow

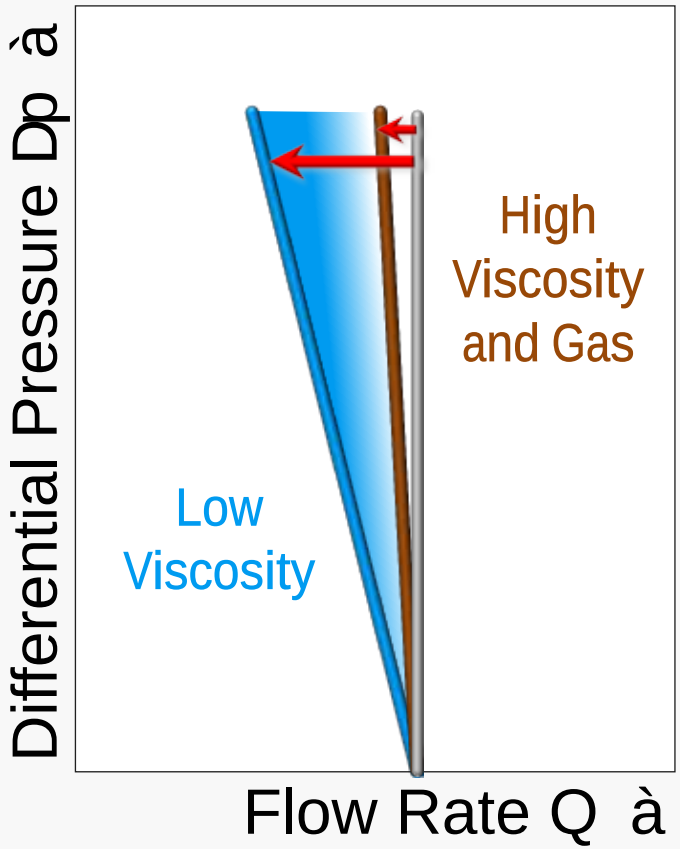
$$Q_{total} = Q_{volumetric} - Q_{backflow}$$

$Q_{backflow}$ » Dp; Viscosity; Gap Design



Capacity depends on:

- Chamber Size + number of screw
- Speed
- Differential Pressure
- **Viscosity, Gas Content**
- Gap Design (screws, liner/casing)



Less Backflow with higher fluid Viscosity!

Less Backflow with Gas.

Power Consumption depends on:

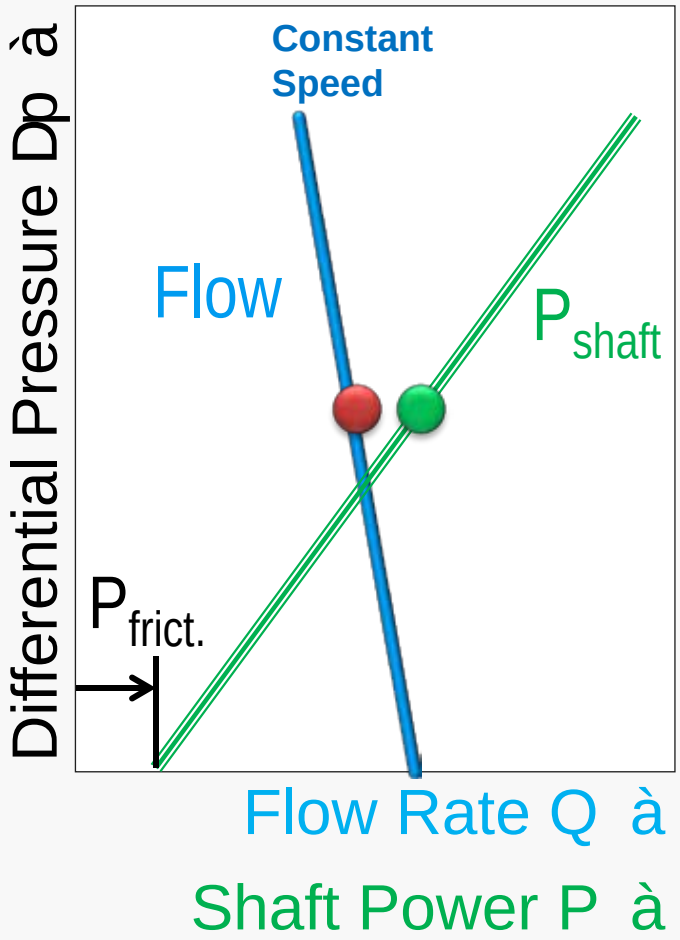
- Speed
- Differential Pressure
- Viscosity

Shaft Power = Hydraulic Power + Friction

$$P_{shaft} = P_{hydraulic} + P_{friction}$$

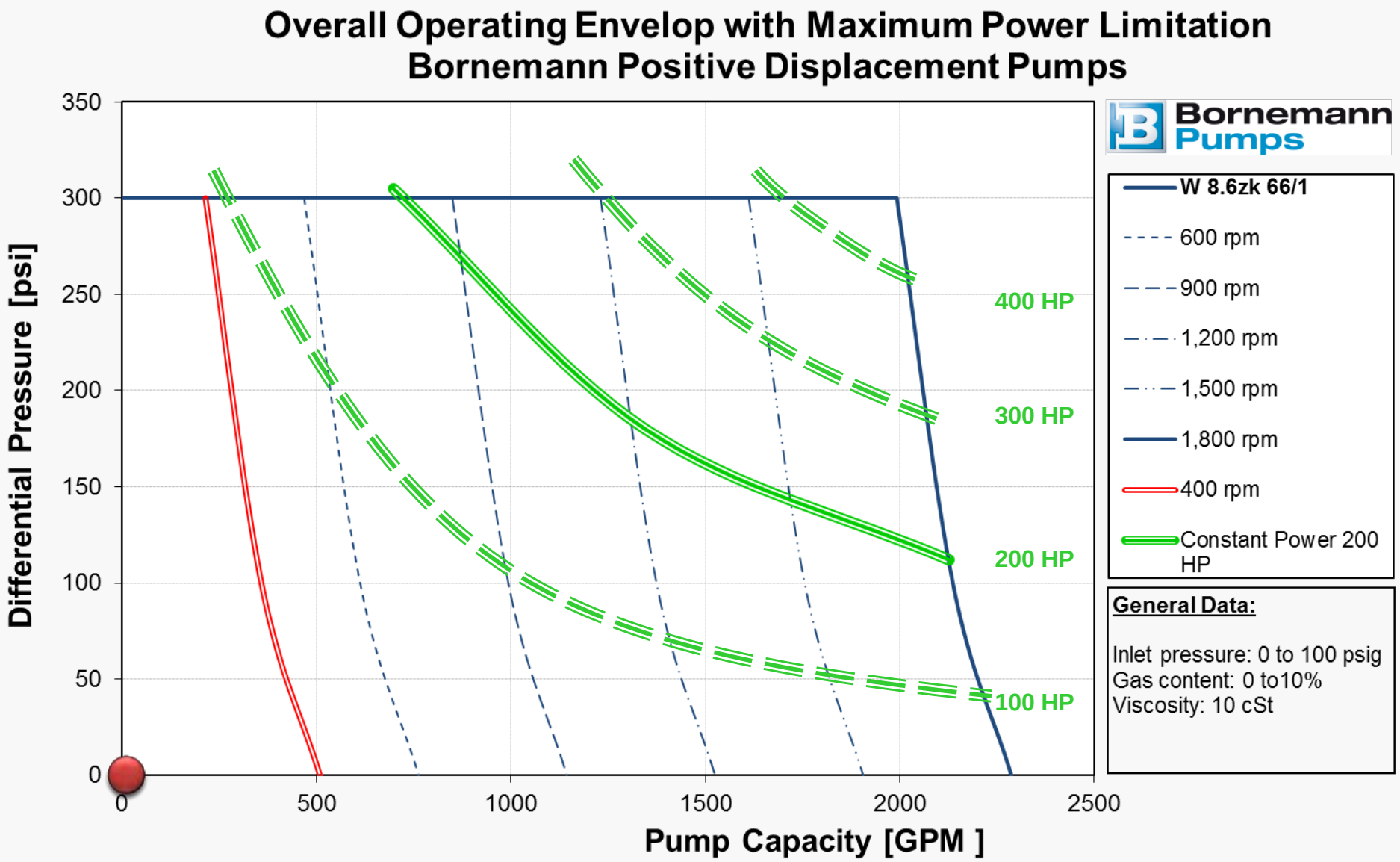
$P_{friction}$ » speed; viscosity

$P_{hydraulic}$ » speed * differential pressure



Flow Rate is directly proportional to speed.

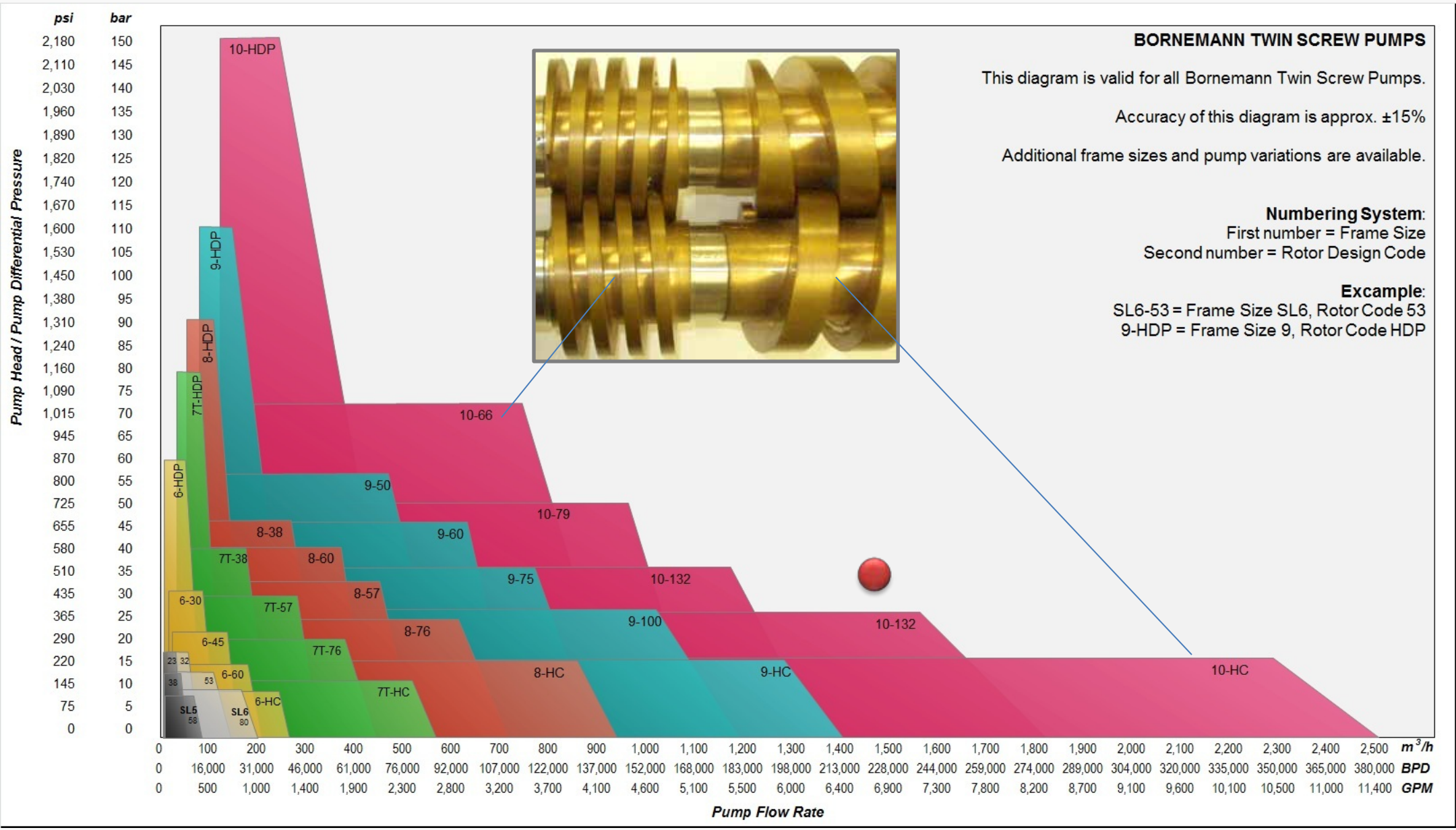
Power Consumption depends on
speed and differential pressure.


Overall Operating Envelop with Maximum Power Limitation
Bornemann Positive Displacement Pumps
Differential Pressure [psi]
350
300
250
200
150
100
50
0
0
500
1000
1500
2000
2500
Pump Capacity [GPM]
400 HP
300 HP
200 HP
100 HP
Bornemann Pumps
W 8.6zk 66/1
600 rpm
900 rpm
1,200 rpm
1,500 rpm
1,800 rpm
400 rpm
Constant Power 200 HP
General Data:
Inlet pressure: 0 to 100 psig
Gas content: 0 to10%
Viscosity: 10 cSt

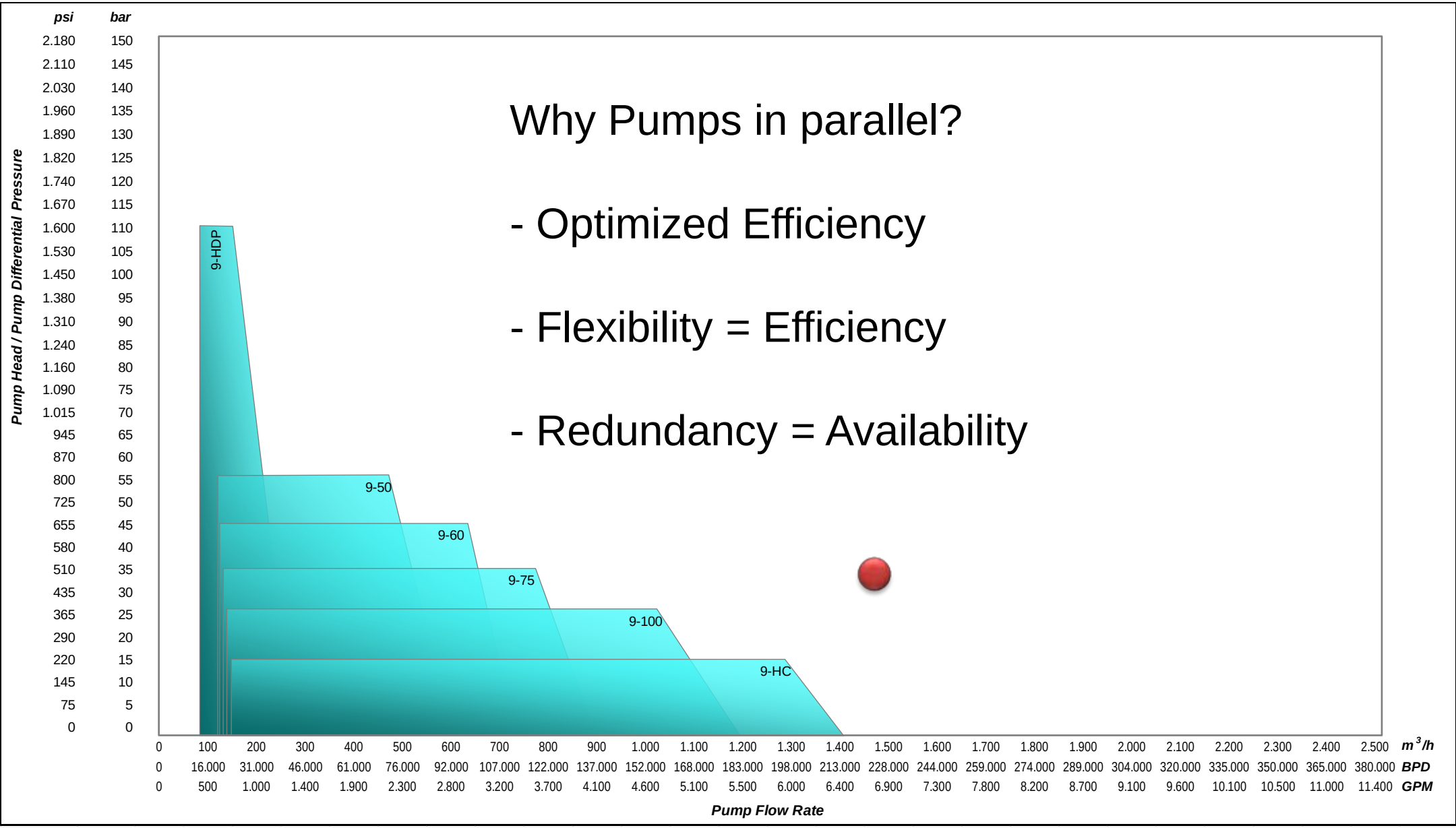
Performance Range,

Parallel Installation
and
Installation in Series

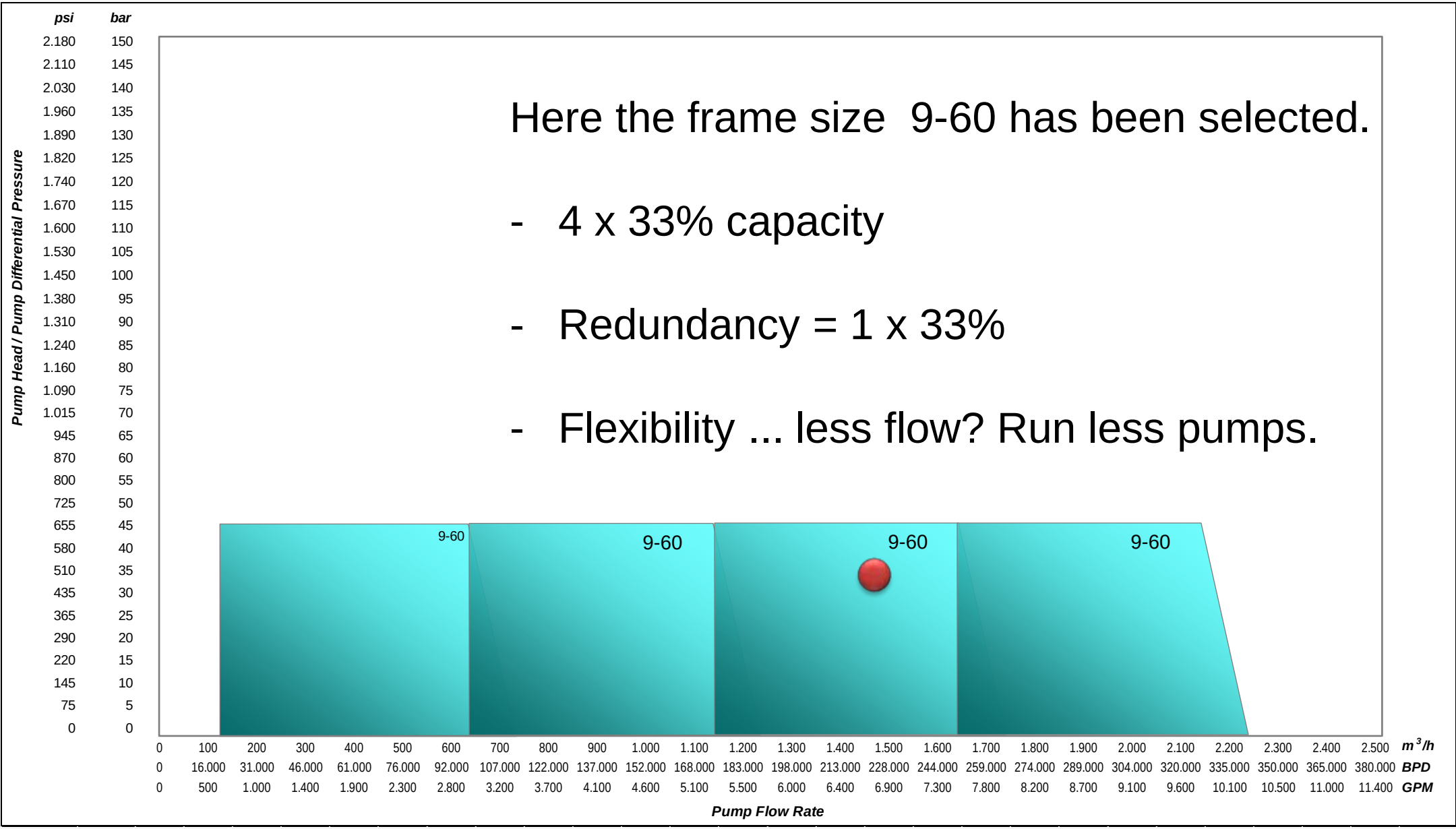
Overall Operating Range of our TSPs



Pumps in Parallel



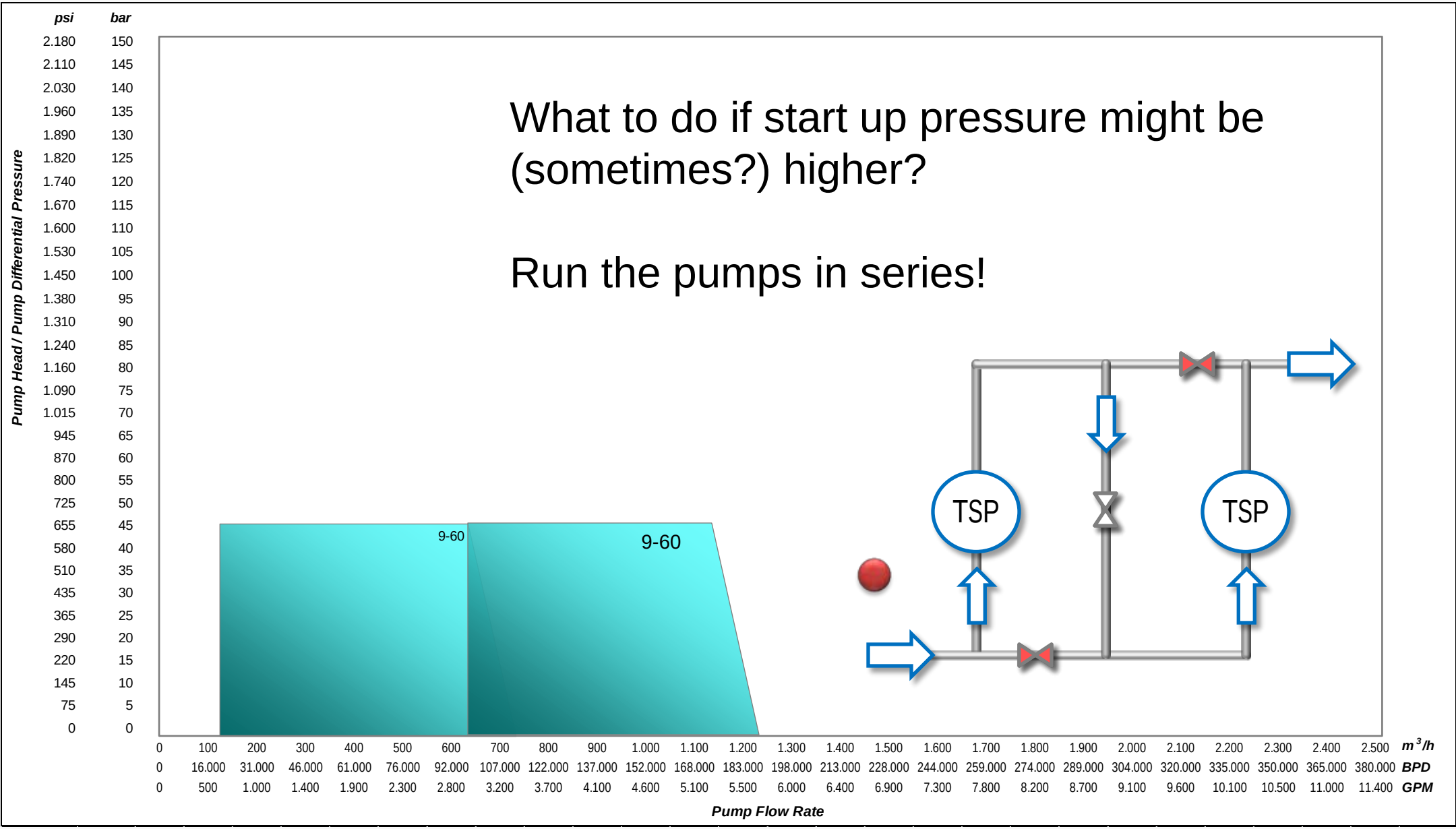
Pumps in parallel



Pumps in Series

What to do if start up pressure might be (sometimes?) higher?

Run the pumps in series!



TSP Applications

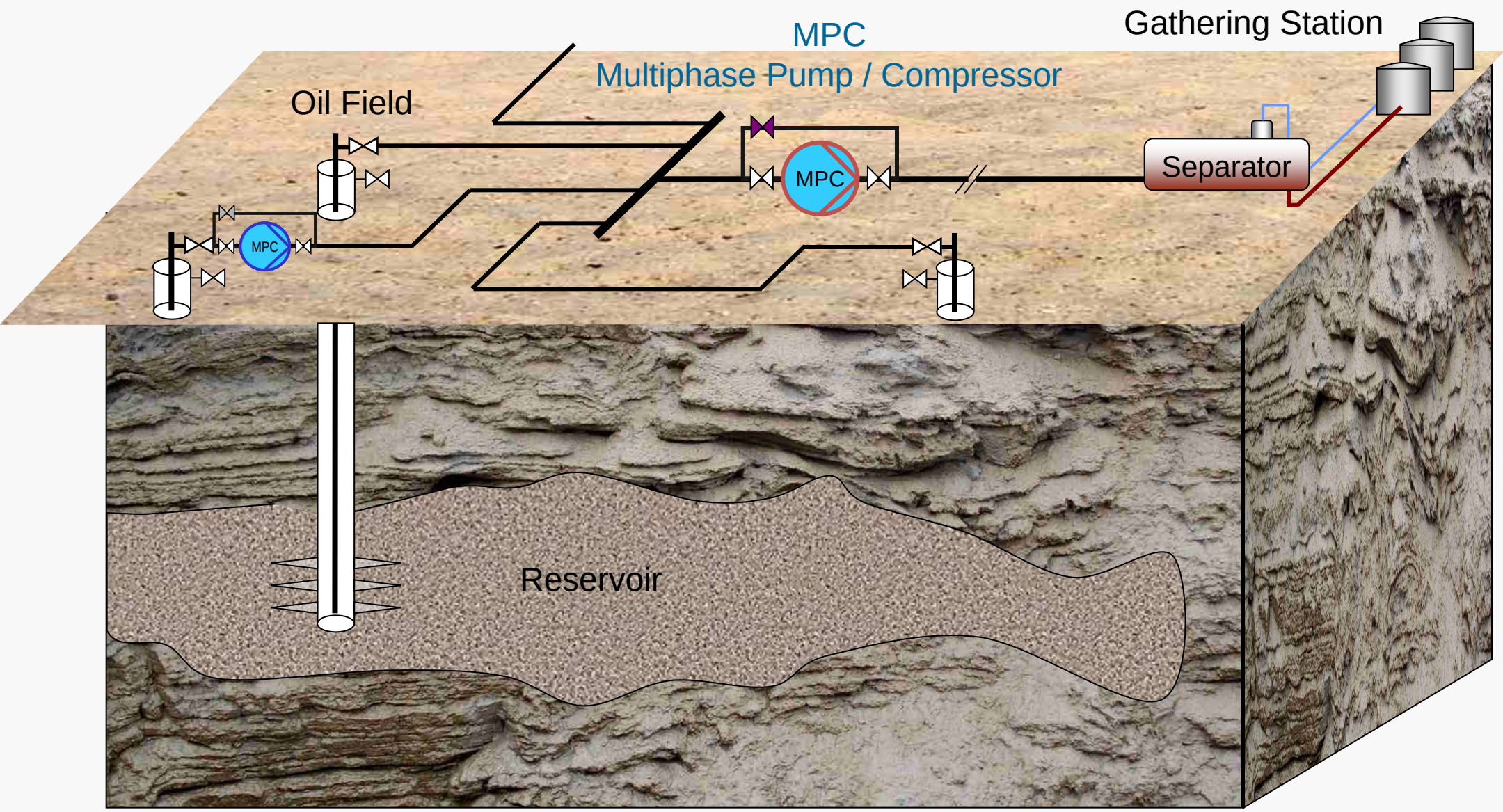
Application	Special Process Requirements
Asphalt and Bitumen	High viscosity, high temperature, low NPSH
Vacuum Residue Oil	Very low NPSH, various viscosities
Liquid Sulfur	High temperature, high viscosity
Polymer	Changing viscosity and wide capacity-range
Loading / Unloading	Different viscosities, wide capacity-range, temporary gas content, low NPSH
Stripping	High gas content, wide viscosity- and capacity-Range
Tank Farm Operation	Wide viscosity- and capacity-range, good control of flow rates, temporary gas handling
Pipeline Transport	Wide, high viscosity-range, adjustable reliable capacity at changing system pressures
Marine (Fluid handling on Tankers)	Wide viscosity- and capacity-range, good control of flow rates, temporary gas handling
Food (sanitary) Beverage, Dairy (Yoghurt, Cheese Curds), Meat, Chocolate, Cosmetics, etc.	Wide range of viscosities, flow rates. Low NPSH and low shear required. Cleaning and sterilisation of pump and pipeline with the same pump (CIP, SIP)
Multiphase / Oil and Gas Production	Very much changing operating conditions, slug-flow, gas
Wet Gas Compression / Vapour Recovery	Up to 99.999% gas, changing pressures and flow rates

Multiphase Boosting

Control the **OIL & GAS** Well Production
by
controlling the **Wellhead Pressure**
and
overcoming the Pipeline Backpressure .

Improve the Oil Production!

Multiphase Production



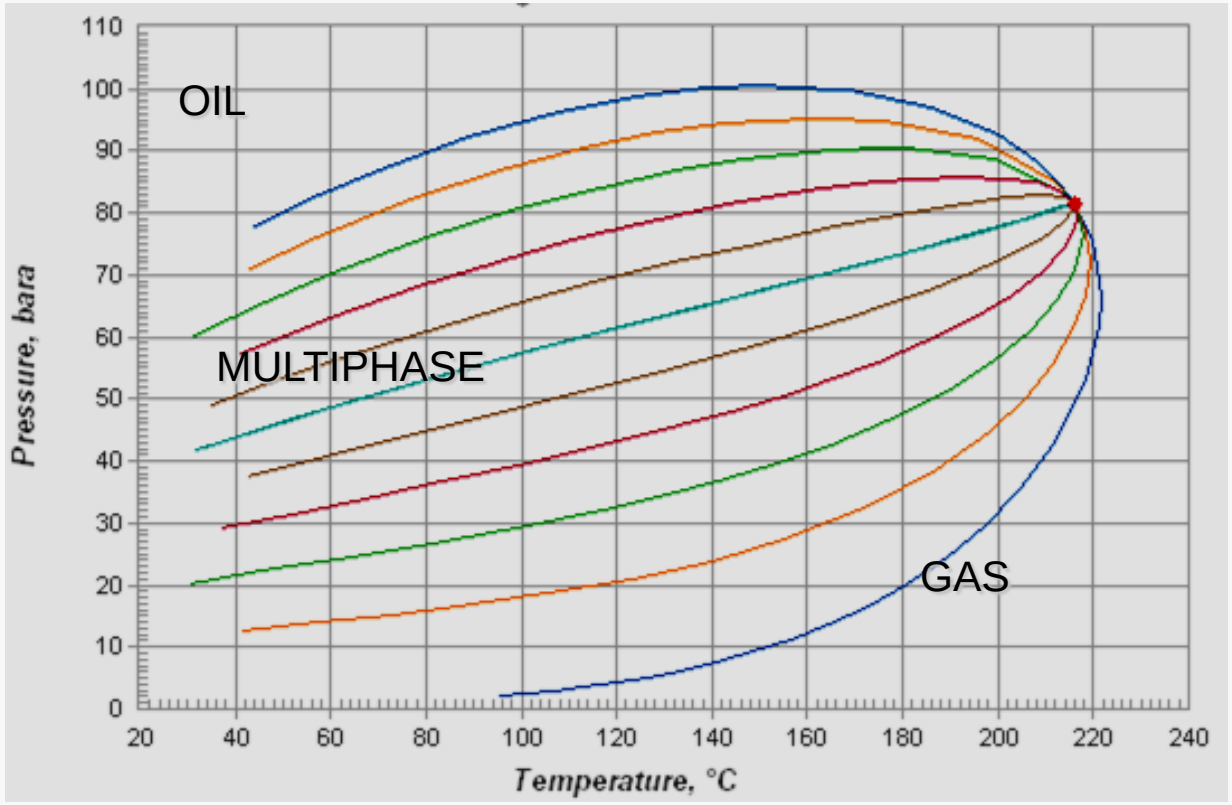
Multiphase Mixture

Multiphase includes a wide range of hydrocarbon compositions, CO_2, H_2S, N_2, water and other components.
They all together are influencing the physical phases (gas, multiphase, liquid) and the total volume, which will be present at the pump at the required pressure and temperature.

COMPONENT	MOLE PERCENT
C1	24.8
C2	7.34
C3	6.406
I-C4	1.2
N-C4	3.673
I-C5	1.734
N-C5	2.335
C6	4.13
C7+	42.86
H2S	1.868
CO2	3.654
C7+ MW	301
C7+ SP.GR	0.9263
WATER CUT(VOL. %)	0-20%
GOR(SCF/BB)	400-450

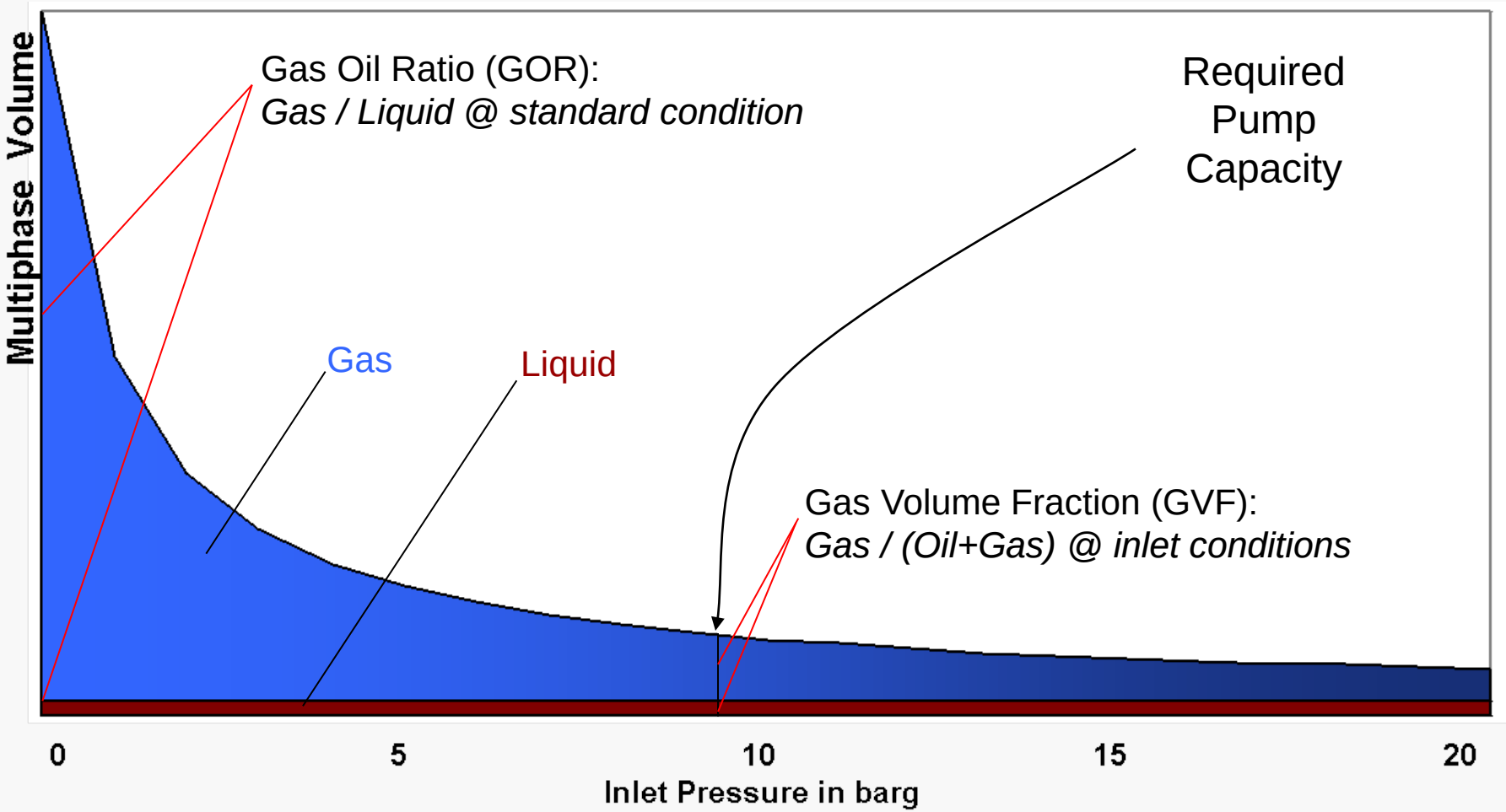
RAZAVI

Stand 01.2009



Multiphase Oil and Gas Mixture

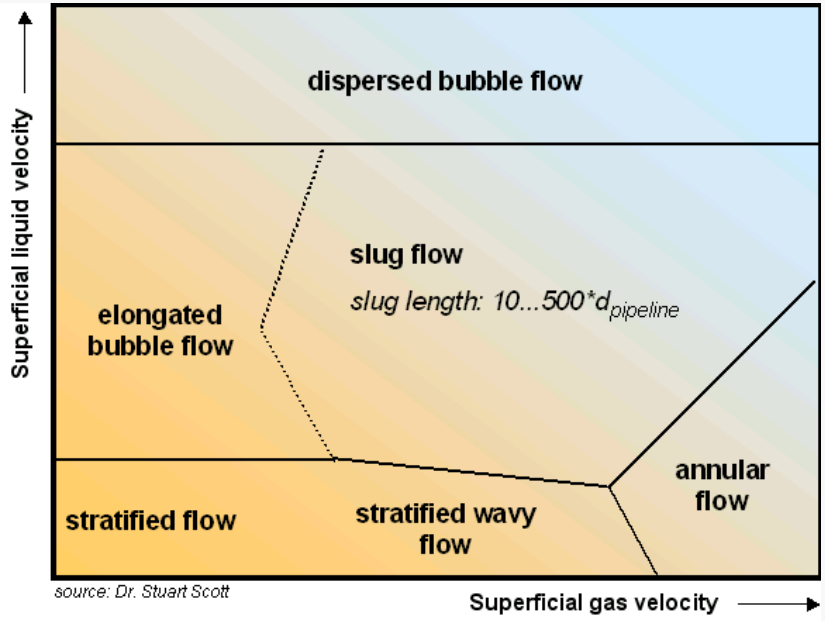
Oil produced offshore is transported through pipelines as a mixture of liquid and gas. The amount of gas is given in standard volume compared to the oil content (GOR) or in percentage of the total flow (GVF).



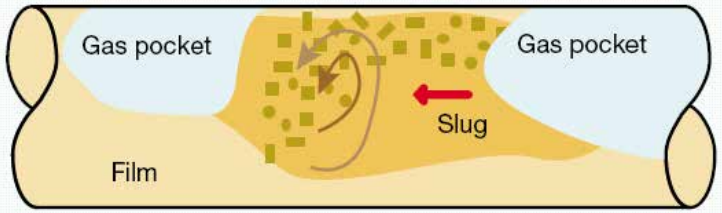
Multiphase Slug Flow

Oil produced offshore is transported through pipelines as a complex mixture of oil, gas and water. One flow regime is known as slug flow, in which liquid flows intermittently along the pipes. It is highly complex and instable, difficult to predict. It depends on flow velocity, gas content, pipeline position, etc.. Slug flow and gas pockets have to be handled by Multiphase Pumps.

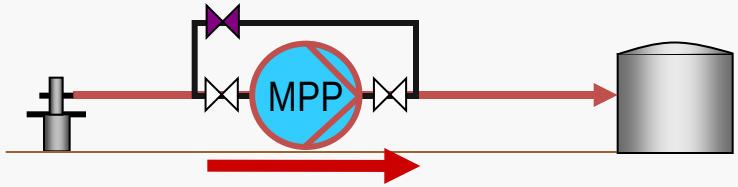
Flow regime and slugflow probability



Slug flow inside pipeline



Multiphase Production



Pressure

Gas + Oil Flow

Pipeline Performance

p_{out}

p_{in}

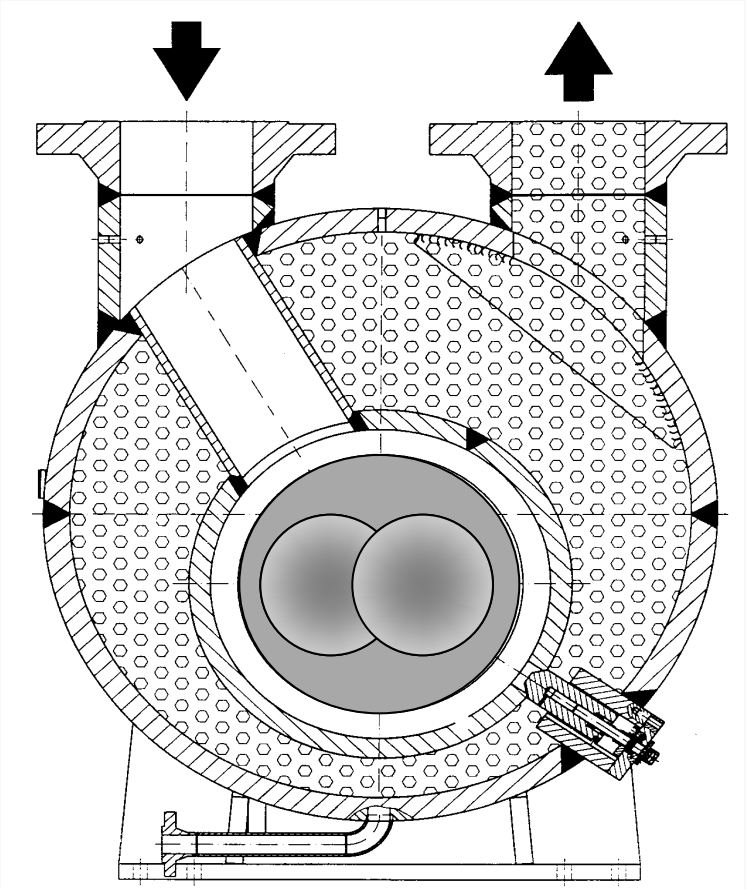
natural production

potential production

Actual Volume Flow (Oil+Gas)

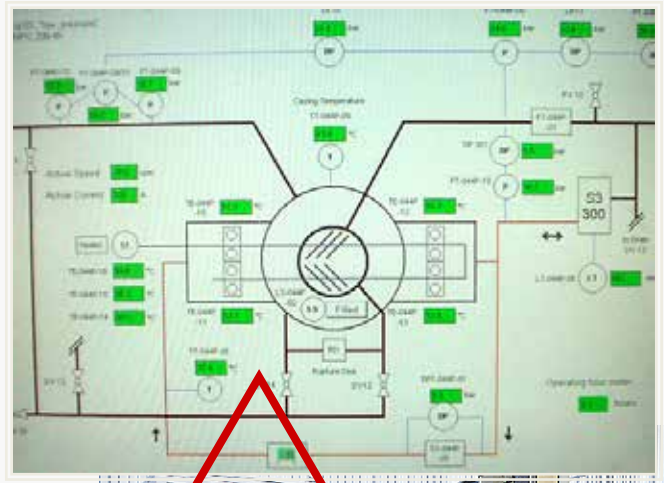
Liquid Separation
and Liquid Hold Up.

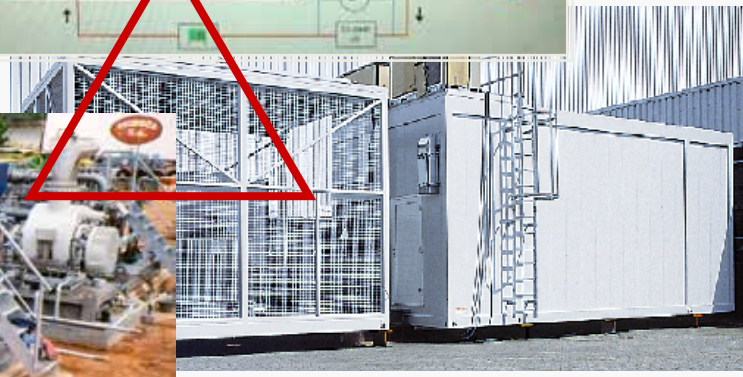
Controlled Liquid Circulation.



Plug & Pump Systems, combining

Pumps and **Drives** with **Control Equipment** and **Process Know How**!



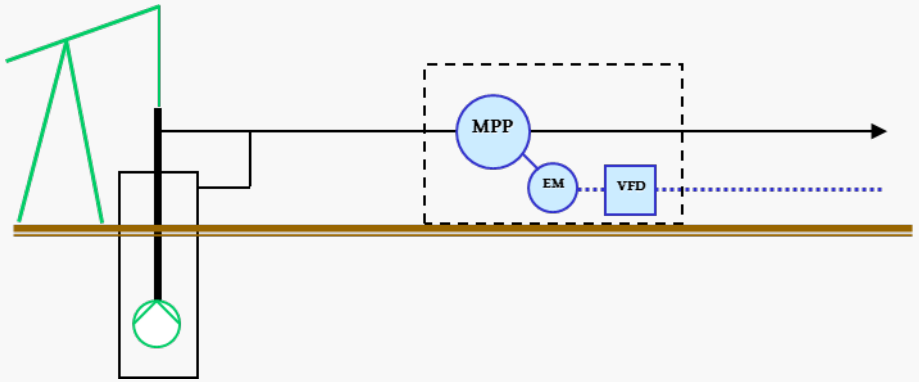


Multiphase Boosting is an approved technology, based on different pump types and provided by various vendors. More than 2000 installations are worldwide in operation – on shore, off shore and subsea.

Multiphase Boosting

some typical installations.

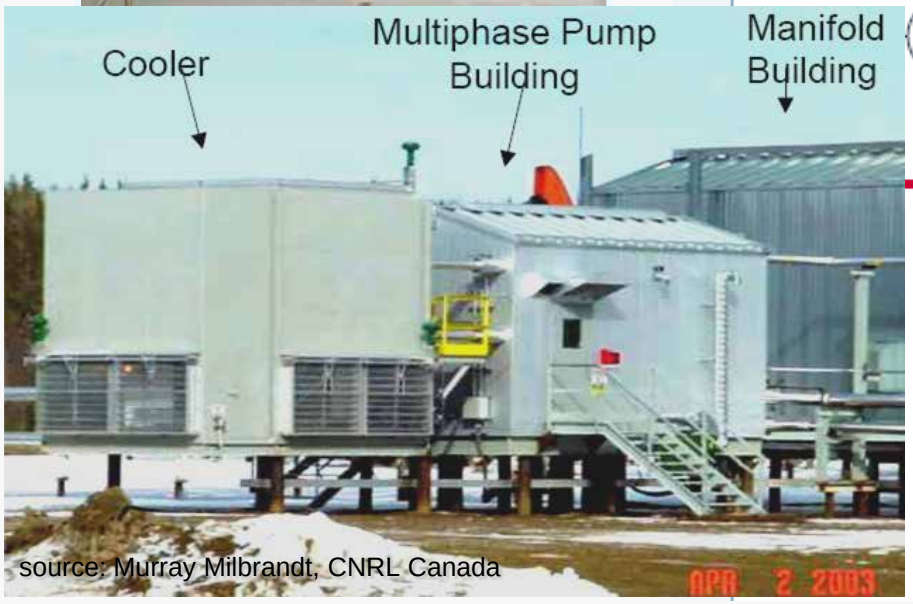
Single Well and Casing Gas



Arctic Conditions

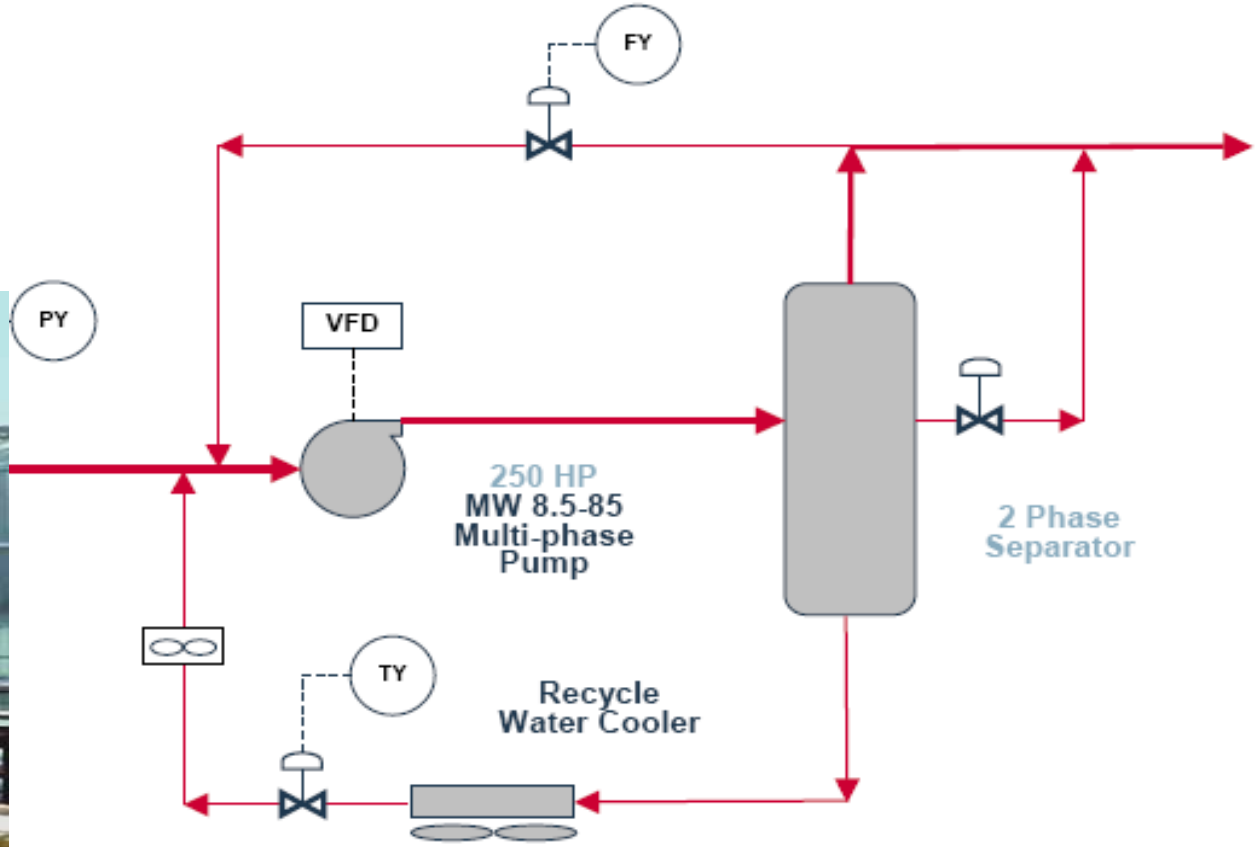
Installation in Series

Wet Gas Boosting

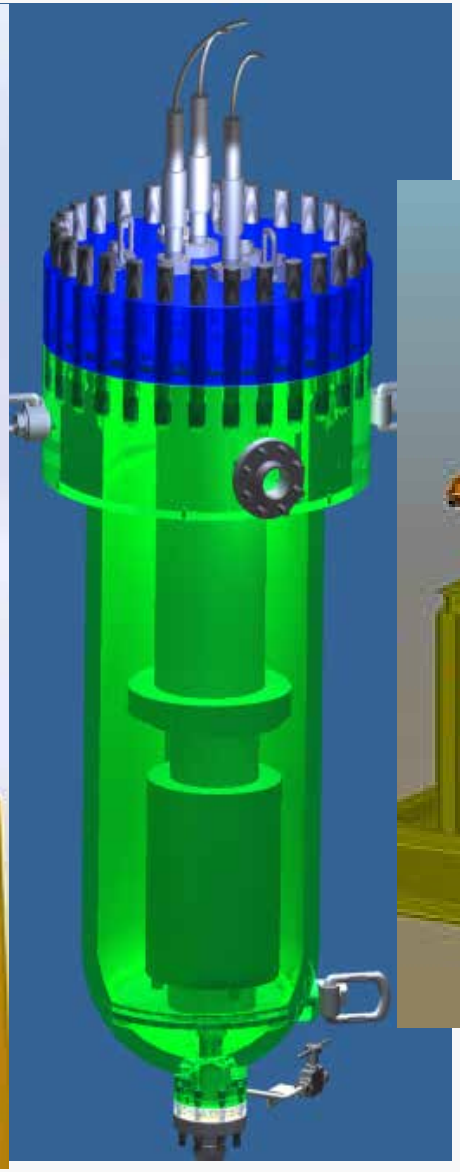


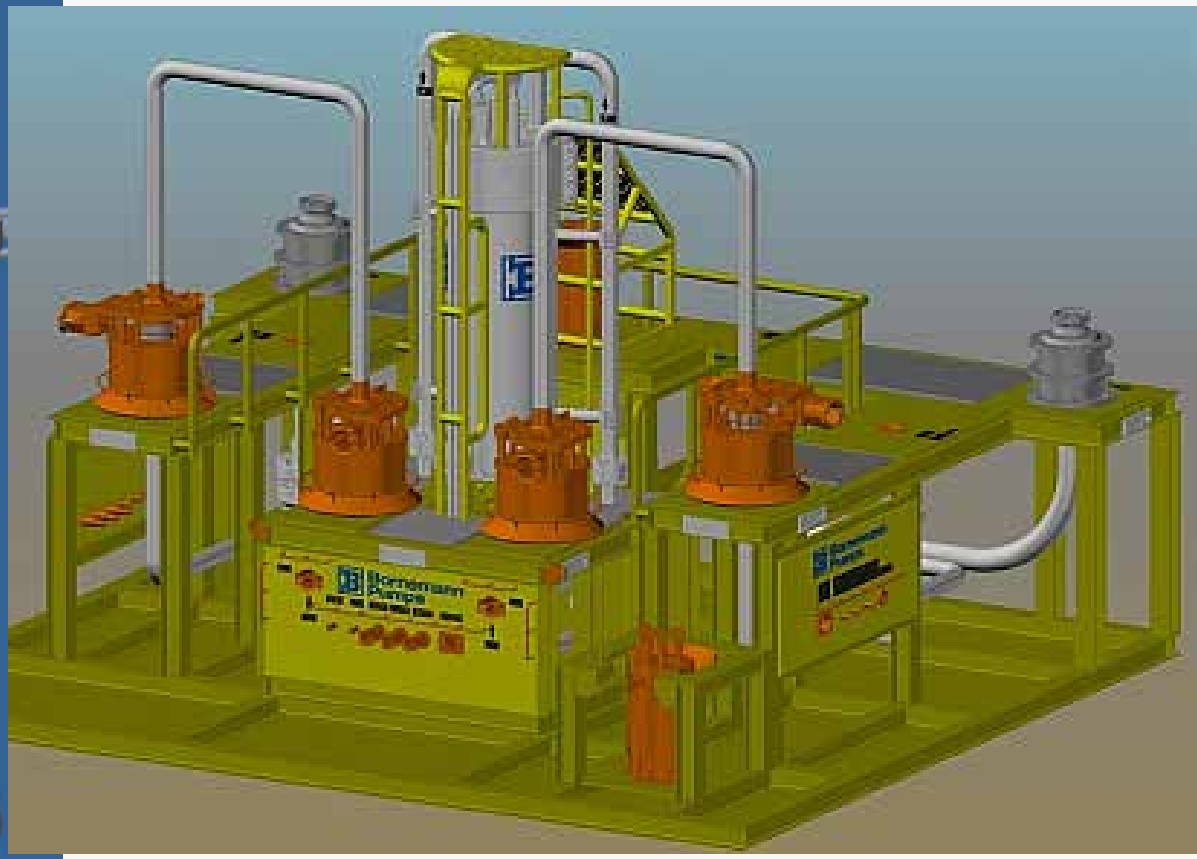
source: Murray Milbrandt, CNRL Canada

Original Production Model MPP VRU

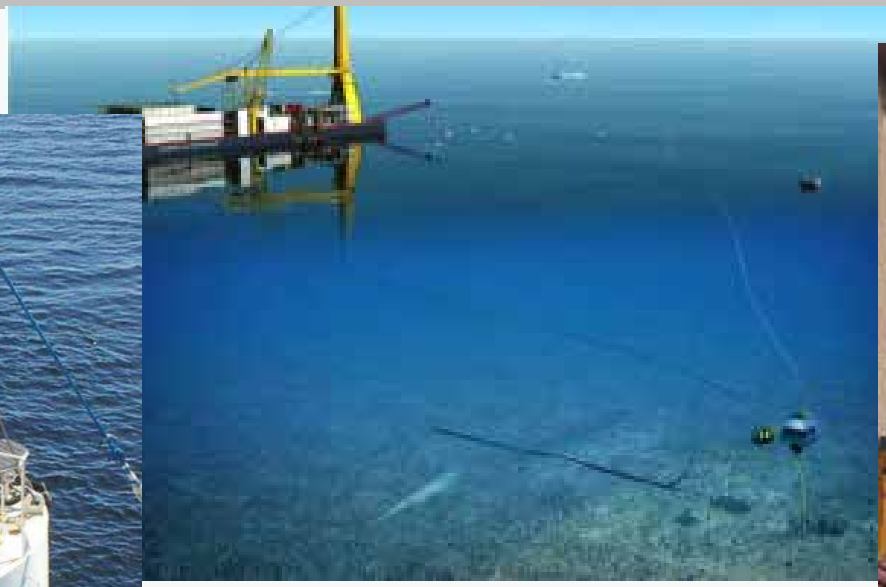


source: Murray Milbrandt, CNRL Canada





Subsea Vacuum Cleaner



Still ....

a Pump is a Pump ….

Questions?