




Design of Safe, Reliable and Efficient Electro-Hydraulic Systems for Subsea Applications

Wagner Mattos / Alexandre Orth, Bosch Rexroth

WIEFP2016 @ LASHIP / UFSC, Florianopolis – SC – BR, 26th October 2016.

Topics

-  The Company
-  The Motivation
-  The Application
-  The Concept
-  Further Research

Bosch Rexroth: Part of Bosch-Group

Bosch-Group

- ▶ 70.6 billion euros in sales
- ▶ 374,778 associates

Mobility Solutions

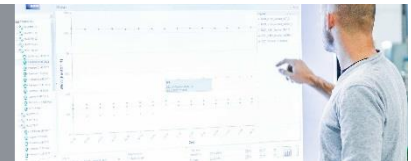
- ▶ One of the world's largest suppliers of automotive technology

59% share of sales



Industrial Technology

- ▶ Leading in drive and control technology, packaging, and process technology



Energy and Building Technology

- ▶ Leading manufacturer of security technology
- ▶ Global market leader of energy-efficient heating products and hot-water solutions

41% share of sales



Consumer Goods

- ▶ Leading supplier of power tools and accessories
- ▶ Leading supplier of household appliances



Original excerpt Presentation of the Bosch Group | C/CCB; C/CCD | April 2016






We are the Drive & Control Company

Marine & Offshore: Our World

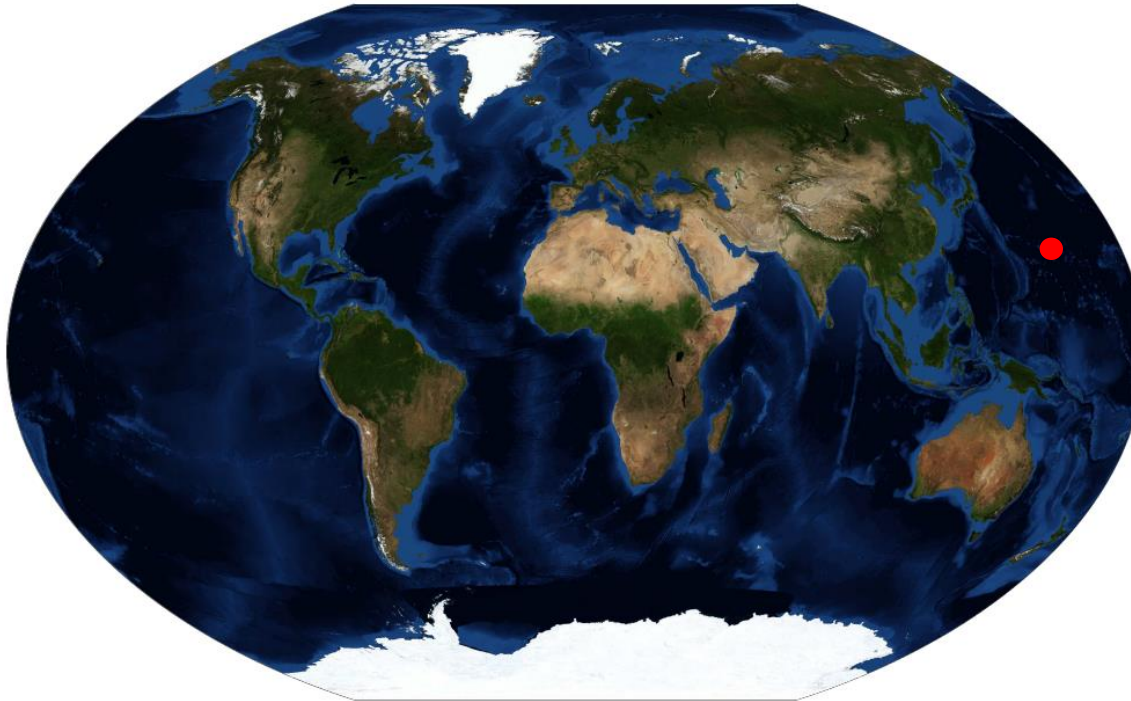


Rexroth
Bosch Group

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World see depth landscape: 2/3 underwater!!!



Shallow water

Depth: 0 to 305 m (1.000 ft)

Deep water

Depth: from 305 m (1.000 ft)
to 1.830 m (6.000 ft)

Ultra deep water

Depth: from 1.830 m (6.000 ft)
to 10.911 m (35.800 ft)

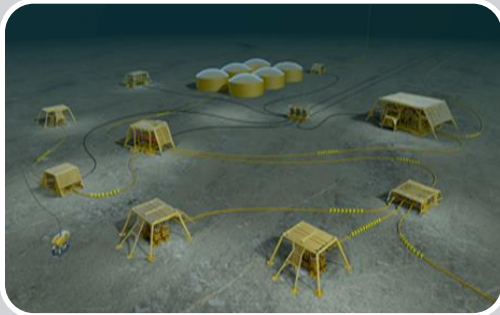
- 72% of the worlds surface is covered with water
- About 88% of the ocean is deeper than 1.000 m
- Deepest part of the ocean is in a depth of 10.911 m* (with 1.100 bar)

Source: http://www.ginkgomaps.com/de/rl1w_xx_weltkarte_satbmngtb08_jr_0_a4.pdf

<http://de.wikipedia.org/wiki/Erde> * deepest part of the ocean is Mariana Trench, see red dot
26/10/2016 | Dr. Alexandre Orth (DC-IA/SDM14-Lo) | Marine & Offshore | Project Subsea | © Bosch Rexroth AG 2016. All rights reserved, also regarding any disposal, exploitation, reproduction, editing, distribution, as well as in the event of applications for industrial property rights.

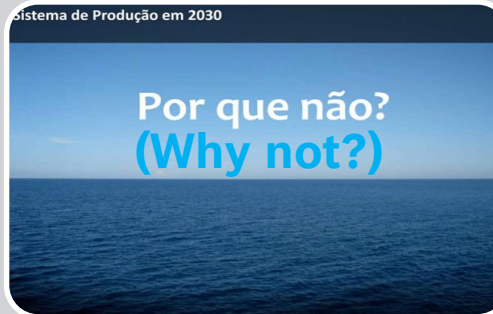
Market sees Subsea as major trend in offshore

Verbatim's of key stakeholders:



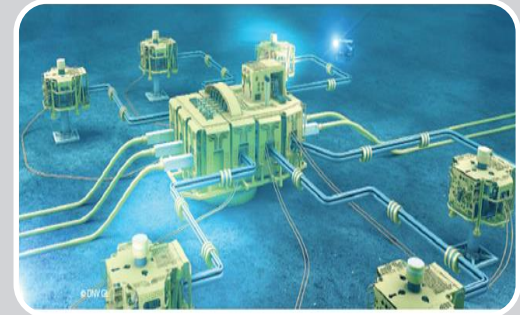
Statoil* - Subsea Factory:

"We are taking subsea longer, deeper and colder ... aim to develop the elements required for a subsea factory by 2020."



Petrobras** - Subsea Prod.:

"Future Perspective: 2030 the production is subsea"
"Pre-Salt fields require new innovative solutions"



DNV GL*** – All Subsea:

"The question for the subsea sector therefore is not whether it will grow, but rather by how much"

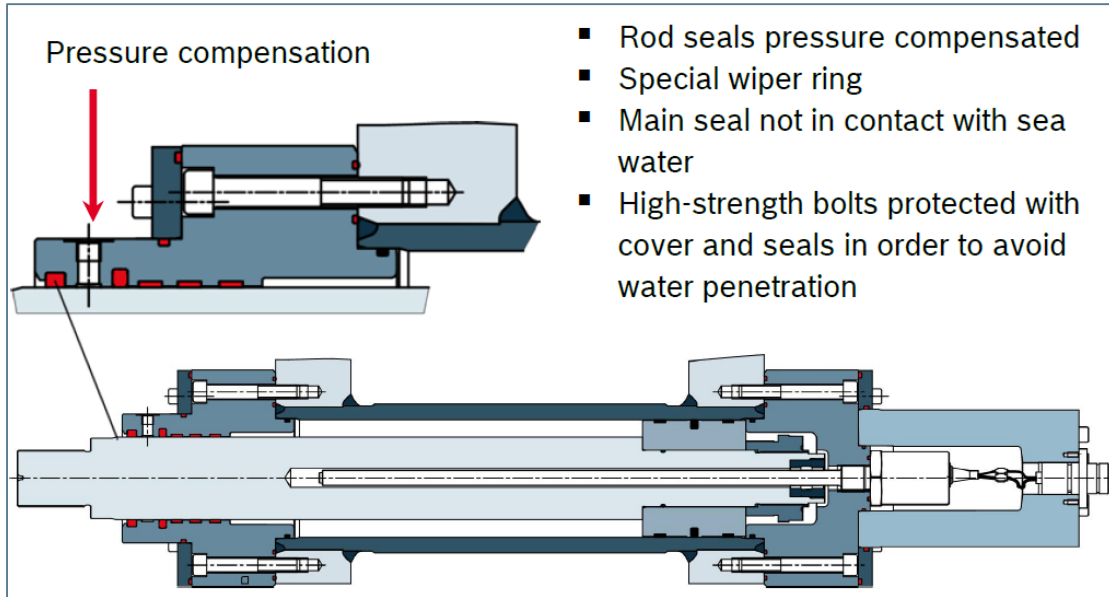
➤ The future is subsea...

Source: *Statoil – [The Subsea Factory](#) ** Petrobras – Presentation of Mr. Camerini at IEPUC (BR)

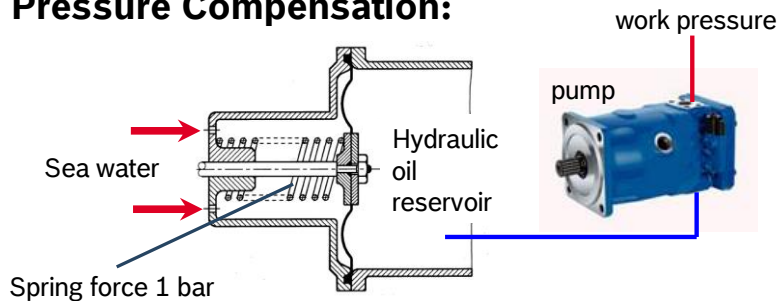
*** DNV GL – [All Subsea White Paper](#)

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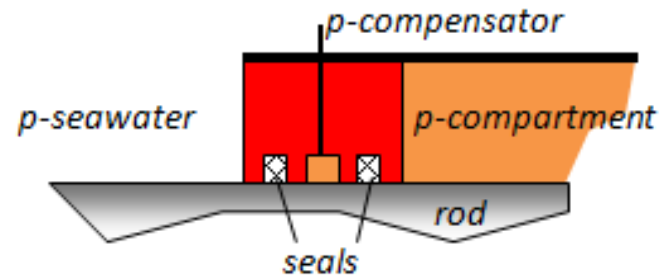
Subsea Hydraulic Cylinder



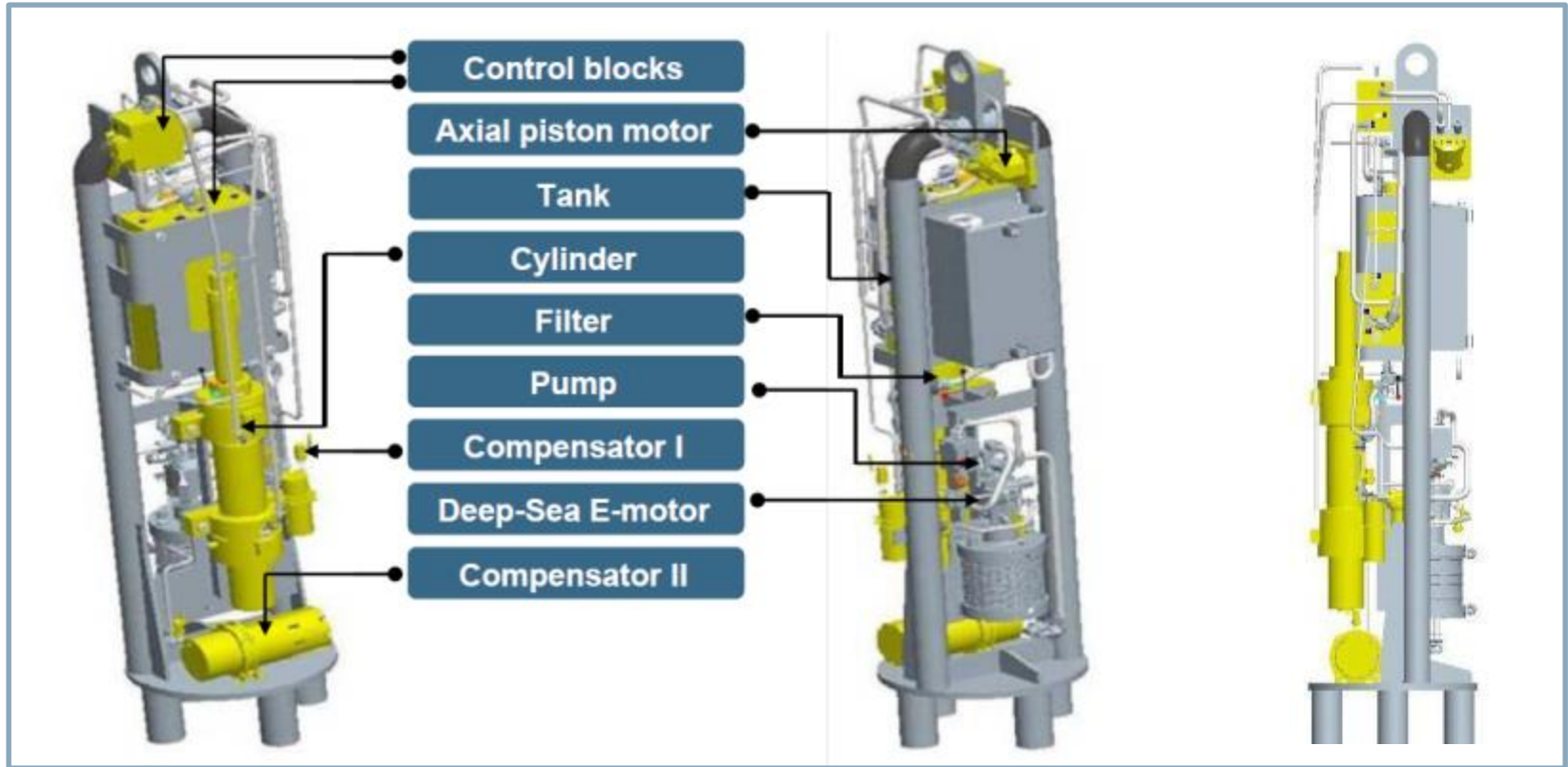
Pressure Compensation:



Special (Double) Sealing:

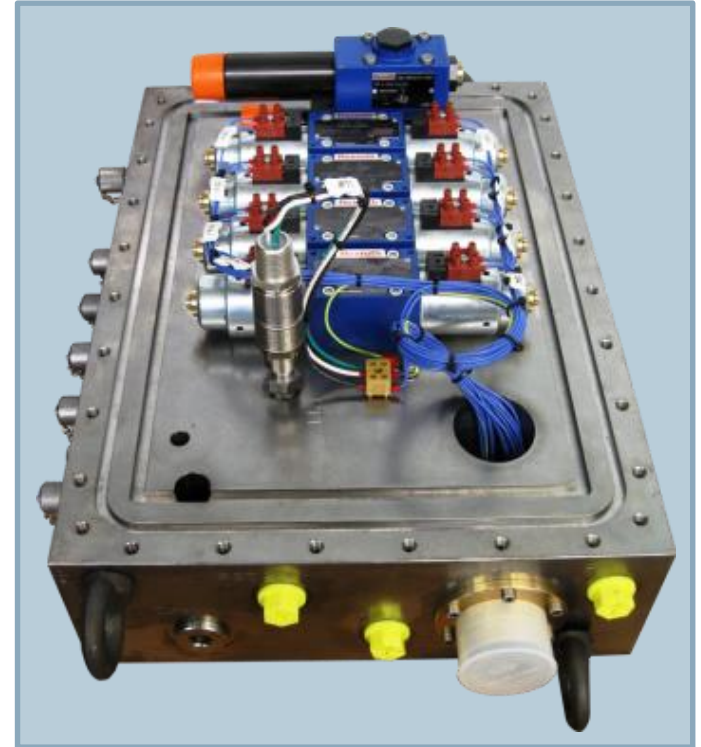
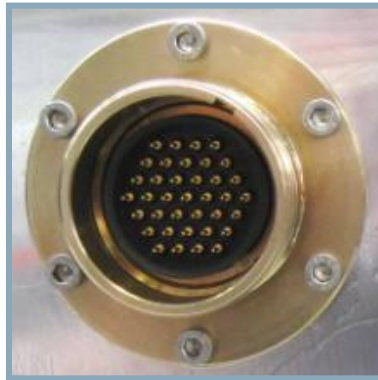


Subsea Hydraulic Power Unit (HPU)








Electro-Hydraulics Controls adapted for Subsea

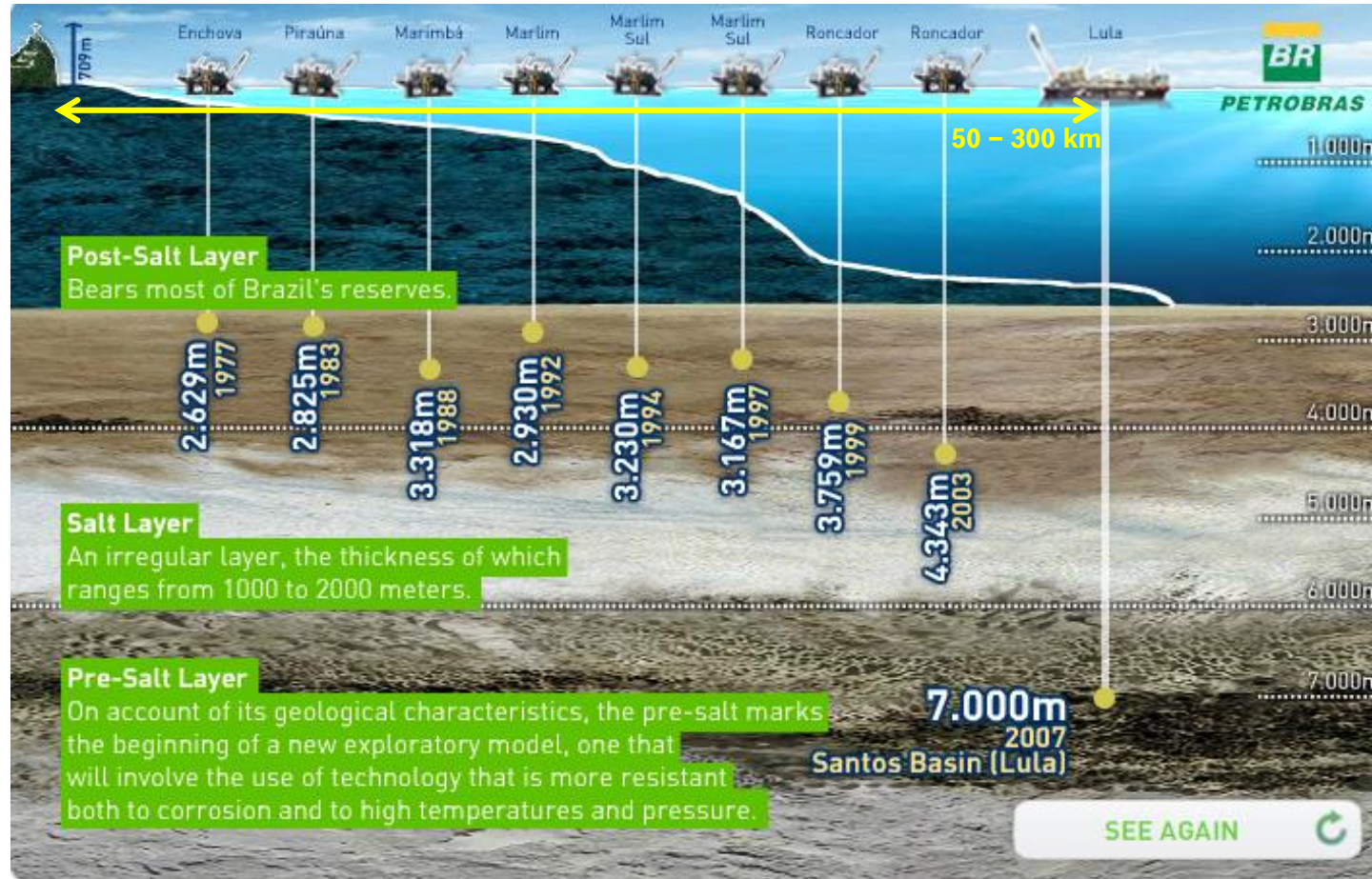
- Encapsulated manifold, oil filled and pressure compensated
- Sea water resistant seal for cover
- Air has to be vented completely
- Specially developed on-off and prop. valves with modified solenoids, pole tubes and terminal strips
- Sub sea electrical connector



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Subsea oil & gas: what that means?



Consequences

- High external pressures (> 300 bar)
- Long distances (> 300 Km)
- Higher weights (big vessels)
- Wave movements (big marine currents)
- Remote control (full automation)
- Corrosive environment
- Explosive atmosphere
- Long service time (30a)

Source - <http://www.petrobras.com.br/en/about-us/profile/activities/oil-and-gas-exploration-and-production/>

-
- The diagram illustrates a control system for oil flow rate. It features a main oil flow line and a control loop. The main line has an 'Oil flow' input and a 'controlled oil flow' output. A 'Control volume flow' block is connected to the main line. The control loop consists of four blocks: 'Energy supply', 'Transform energy', 'Control actuated energy', and 'Realize actuation'. 'Electricity' enters the 'Energy supply' block, which outputs 'Mechanical, Electrical' to the 'Transform energy' block. The 'Transform energy' block outputs 'Mechanical, Hydraulic, Pneumatic' to the 'Control actuated energy' block. 'Auxiliary energy for actuation control' enters the 'Control actuated energy' block. The 'Control actuated energy' block outputs 'Mechanical, Hydraulic, Pneumatic, Electrical' to the 'Realize actuation' block. The 'Realize actuation' block outputs 'Mechanical, Electrical' to the 'Control oil flow' block. The 'Control oil flow' block outputs 'controlled oil flow' back to the main line. Feedback lines connect the 'controlled oil flow' output to the 'Control volume flow' and 'Control oil flow' blocks.

Key Requirements & Available Competencies

Oil & Gas Production

- Process industry (continuous flow)
- High productivity
- High availability
- Explosive atmosphere
- Earth quake safe

Offshore Application

- Huge dimensions
- Corrosive environment
- Wave movements
- Snow crust
- Ecological system (mussels...)

Water Depth (> 3.000 m)

- High pressures
- Long distances
- Low visibility
- Remote control only (no manual)
- New technologies (unknown effects)

Testing Methods

Subsea Experience

Condition Monitoring

Functional Safety

Reliability Engineering

Corporate Research

Bosch Engineering System

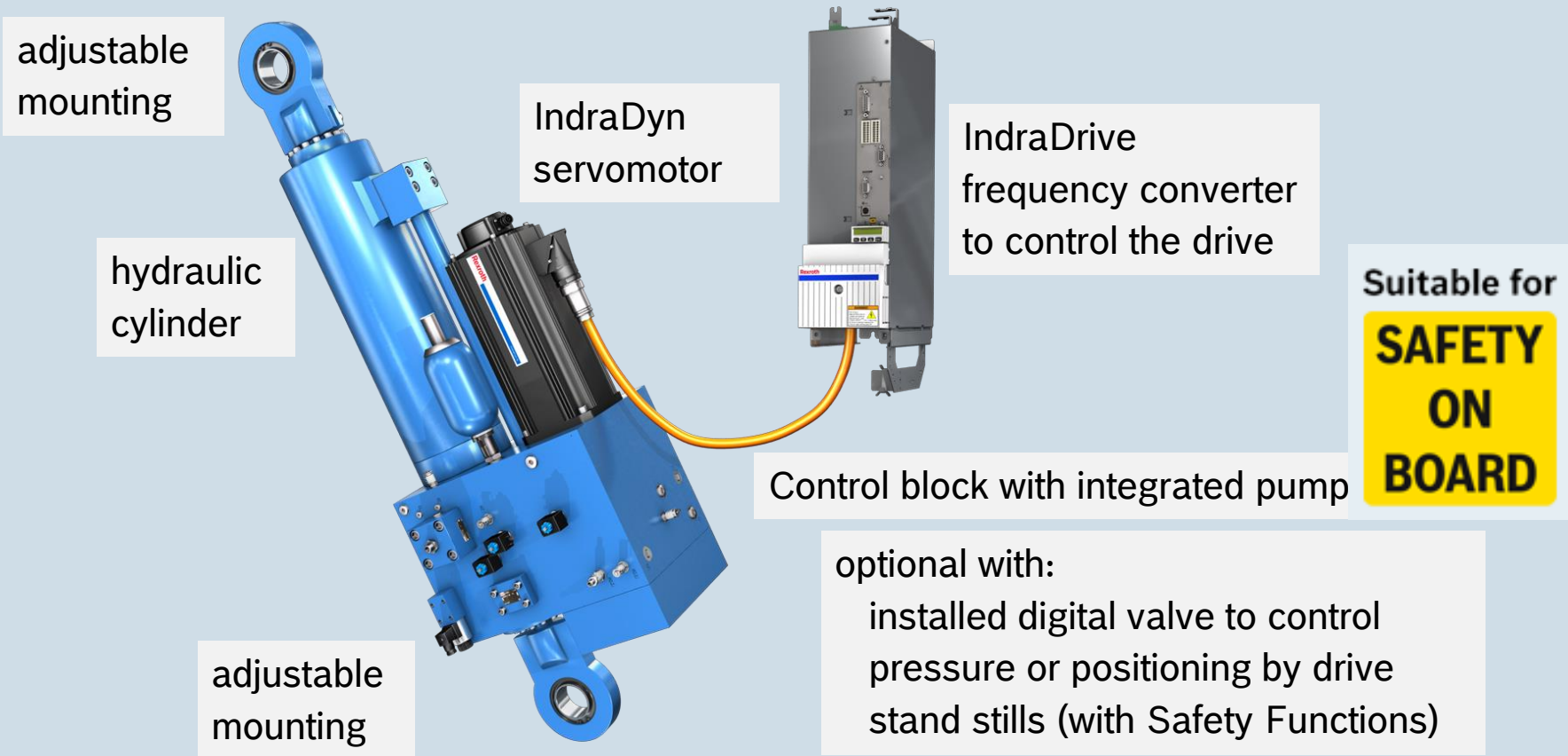
System Availability

Topics

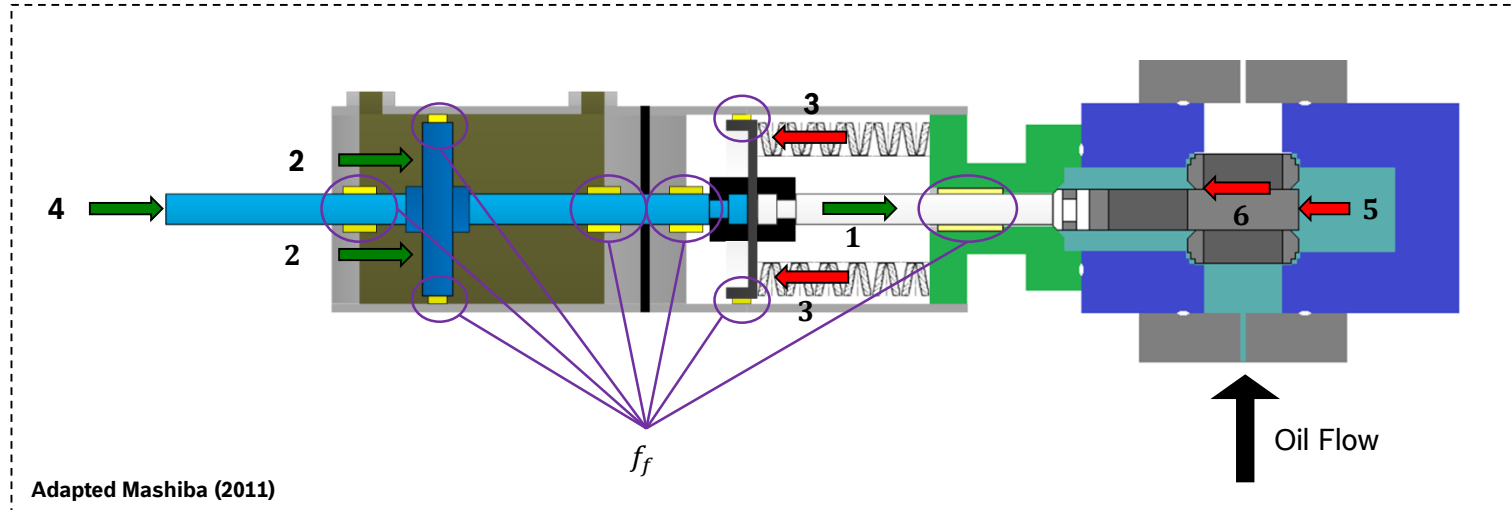
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Self-Contained Hydraulic Actuator - Industry

- **Self-contained electro-hydraulic servo axis: suitable for Subsea?**



Force in Gate Valve (Fail-Safe Close):

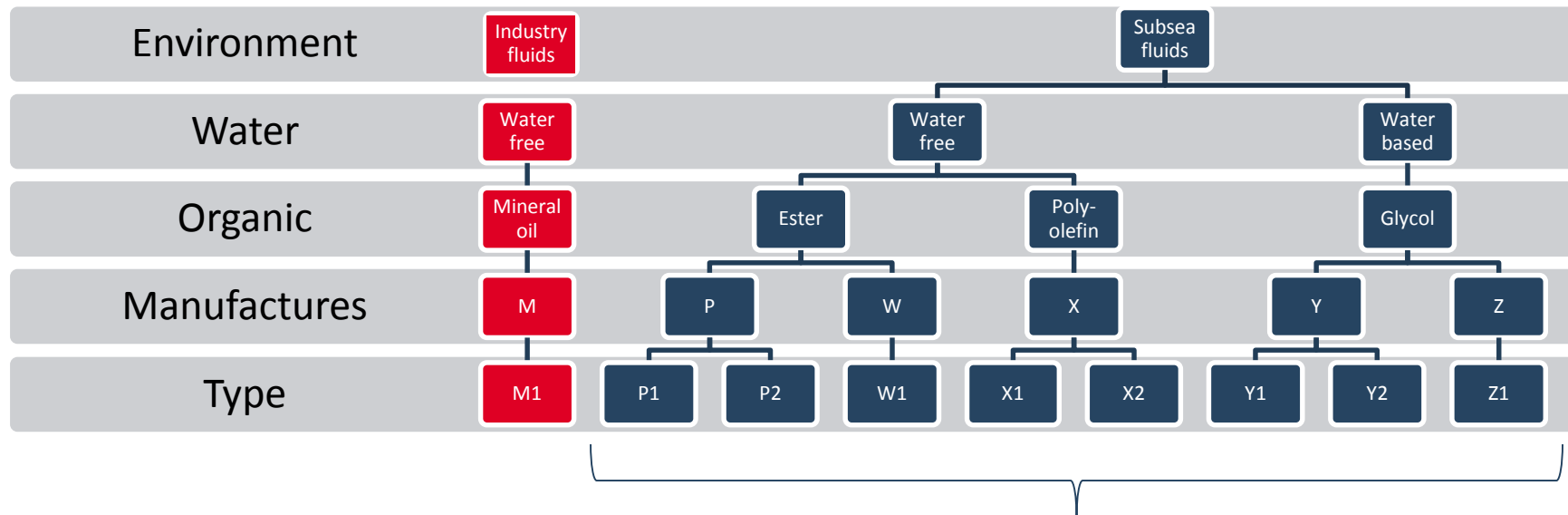


$$\begin{array}{ccccccc}
 \overbrace{F_{at}}^1 & = & \overbrace{F_{hydraulic}}^2 & - & \overbrace{F_{spring}}^3 & + & \overbrace{F_{sea}}^4 & - & \overbrace{F_{ingate}}^5 & - & \overbrace{F_{drag}}^6 & - & \overbrace{f_f}^7
 \end{array}$$

Topics

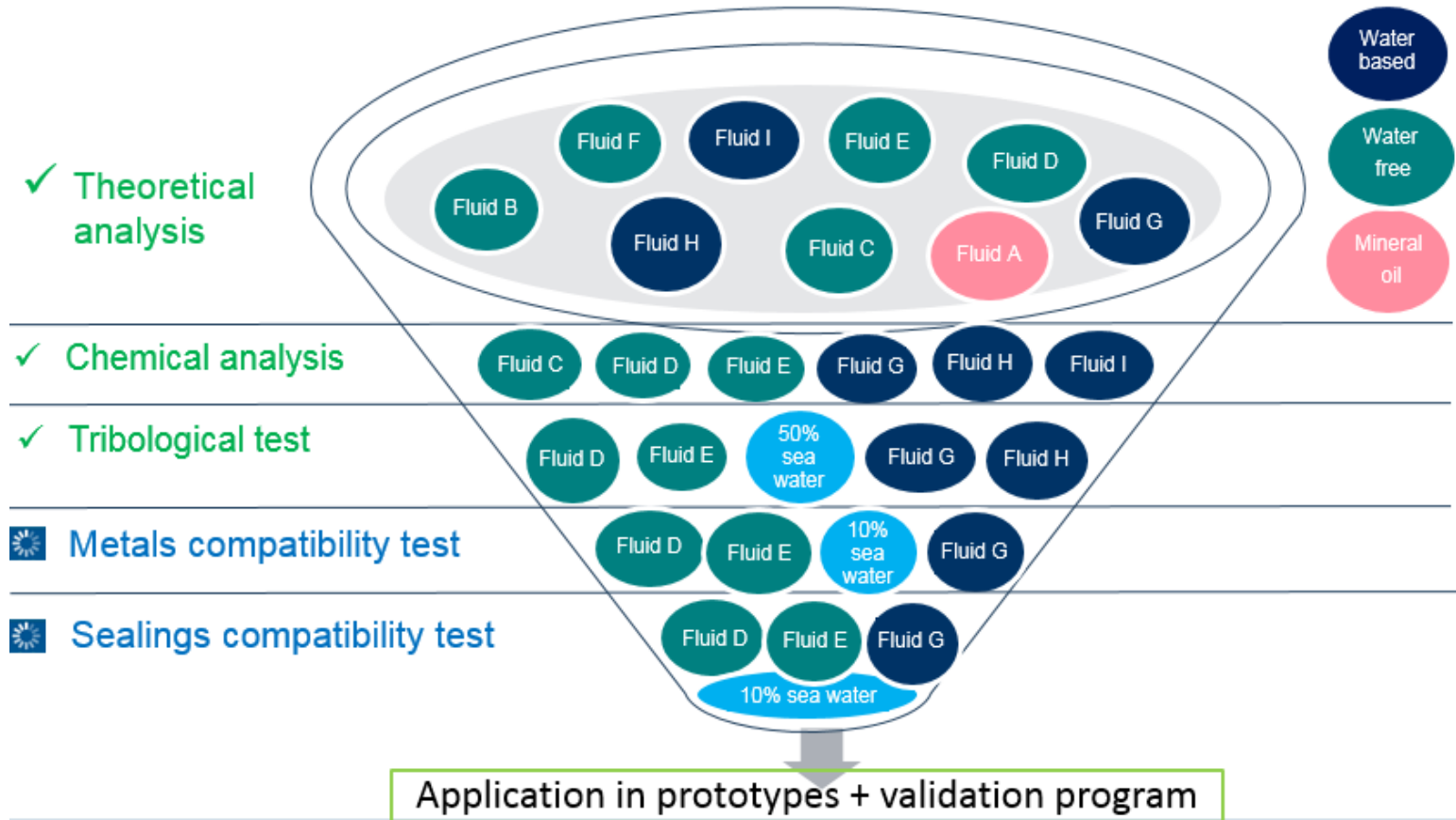
-  The Company
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Types of hydraulic fluids



All these fluids are environmental friendly and approved for application in subsea conditions!

Approach based on API 17F / ISO 13628-6

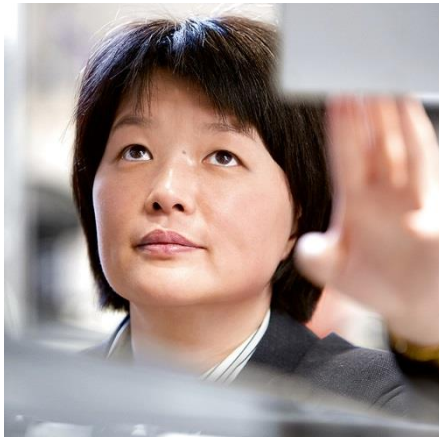


We never give up until the right solution is found

Further Information:

www.boschrexroth.com/SUBSEA

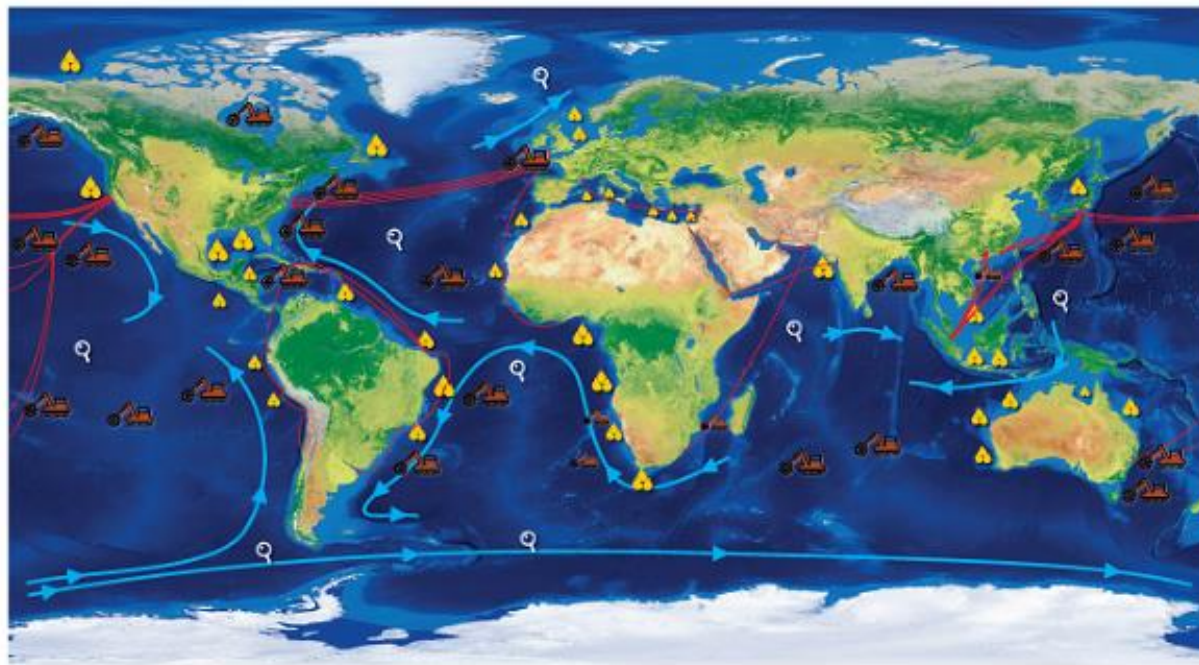
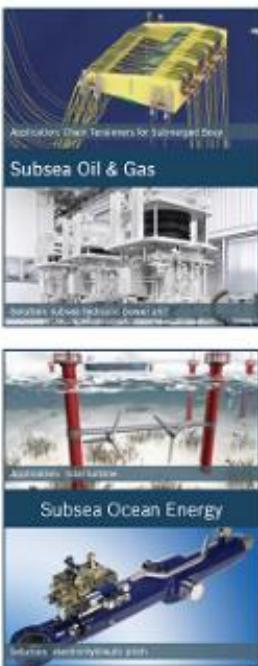
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Thank you for your attention!

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Would you like any additional information?
You will find example of applications, systems and components at: www.boschrexroth.com/SUBSEA

Legend:



Mining



Oil & Gas



Communication



Currents



Research