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Thrusters

Thruster Experience – Seal Issues

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General

Reliable sealing is very important in thruster operation, especially in offshore DP-thrusters where possibilities of maintenance are very limited.

This paper is aimed to give an overall picture of recent seal issues related to azimuth thrusters. A short introduction to different technologies will be given, focus being on DP-units (for example UUC-type thruster). Problems that have occurred will be described together with improvements and solutions.

Finally, a table containing information to seal supplier will be presented. This table has been made using the experience in various parts of marine business and direct feedback from major seal suppliers.

The focus of this presentation is on propeller shaft seals, although several more seals exist in azimuth thrusters. This is due to the criticality of propeller shaft sealing for the reliable and efficient operation of a thruster unit.

Topics of discussion

This paper gives a short introduction to seal issues, such as:

- Sealing technologies in azimuth thrusters
- Observed problems
- Applied solutions
- Information and requirements discussed with the seal supplier to ensure reliable solution

Sealing technologies

Propeller shaft seals in azimuth thrusters are divided into two major categories based on the draught of the propeller shaft. These categories are

- Low Pressure-applications (propeller shaft draught less than 7m)
- High Pressure-applications (propeller shaft draught more than 7m)

Almost every offshore DP-application belongs to the High Pressure-category.

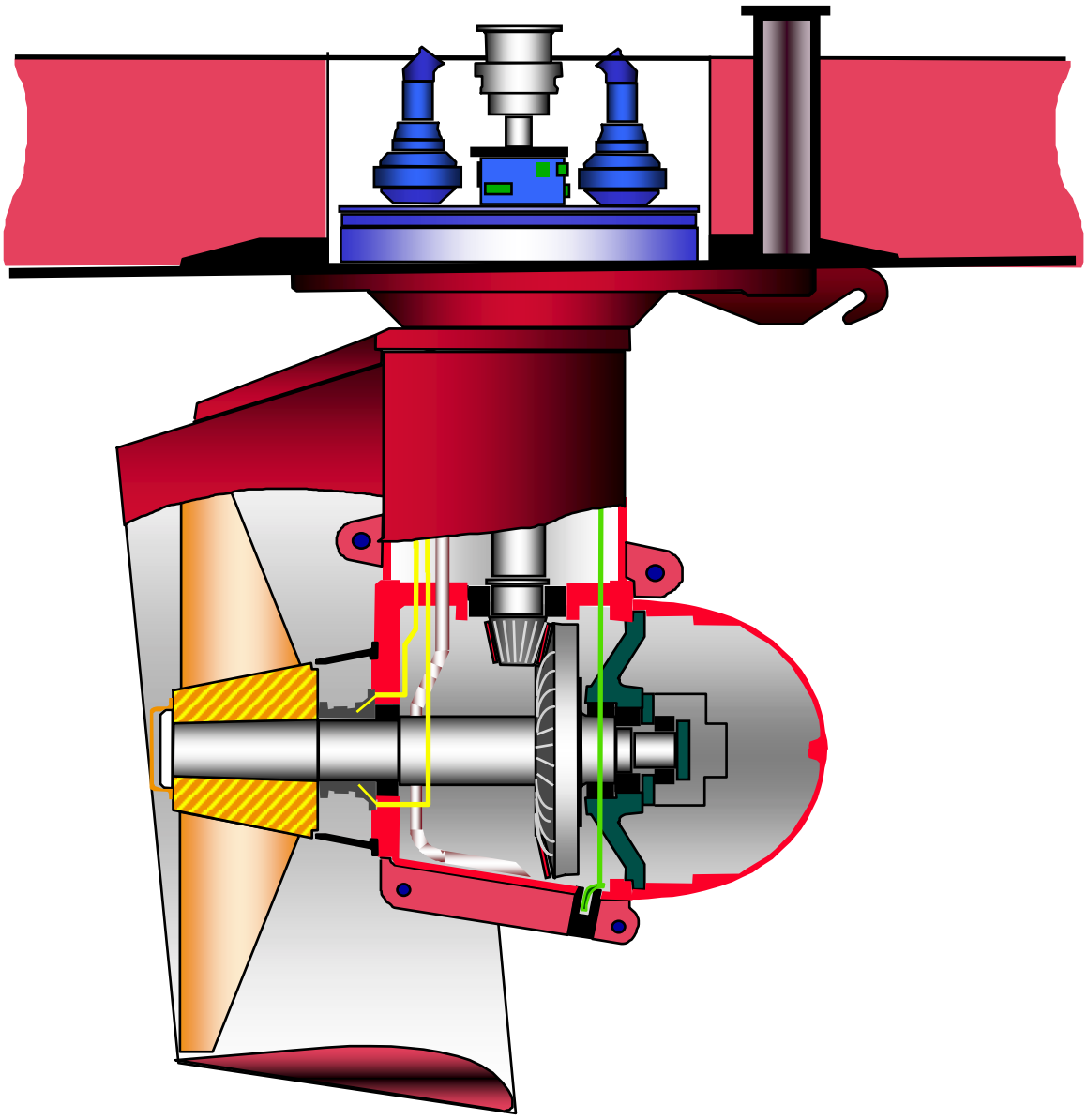
Following pictures show azimuth thrusters typically using low pressure-seals

Picture 1: Standard tugboat thruster

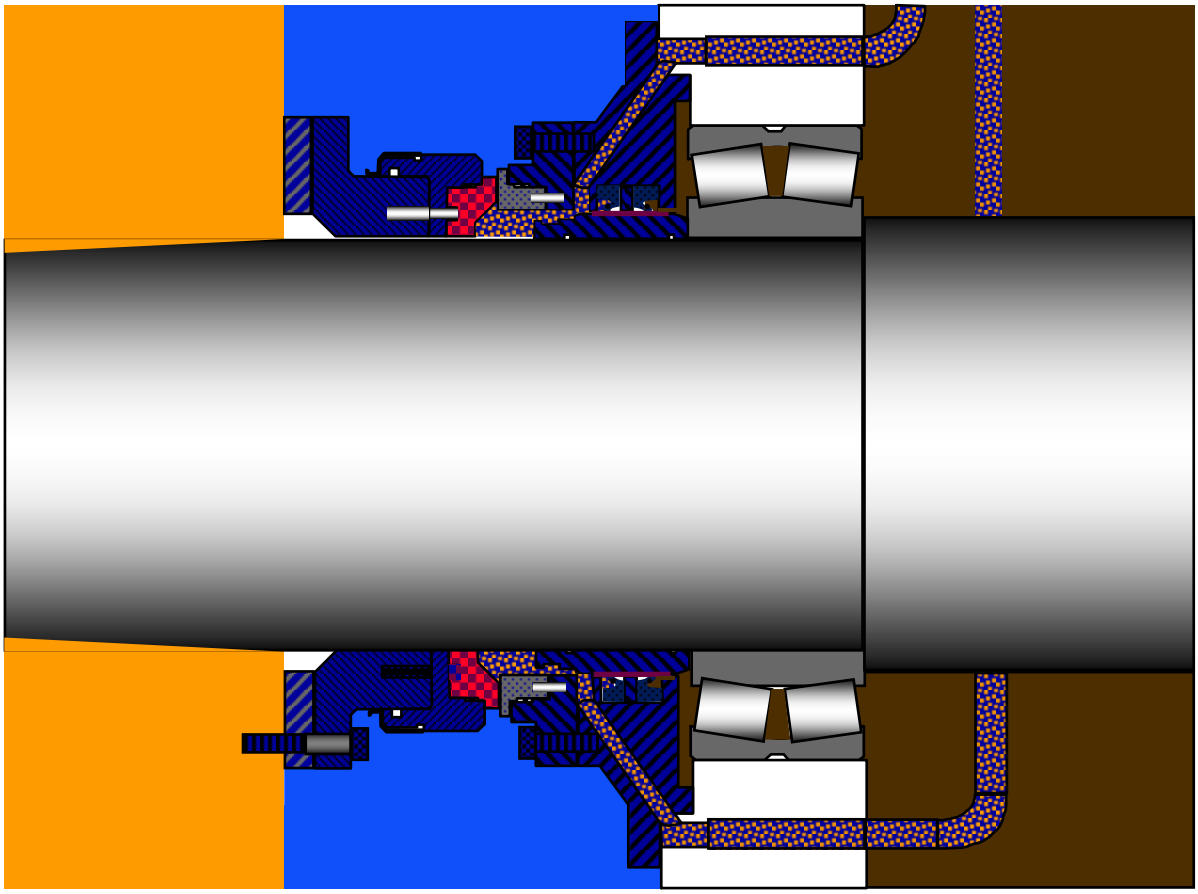
Picture 2: Twin-prop (CRP) Contaz-unit

In offshore DP-units, high pressure seals are used. Following pictures show the UUC-type DP-thruster and the seal installation.

Picture 3: UUC-type DP-thruster



Picture 4: UUC-type high-pressure seal installation



A typical seal configuration for high pressure-application consists of a face-type seal against seawater and a lip seal against gear oil. There is also one additional lip seal that forms a gravity chamber together with the face seal.

The typical face material is Manetex-fibre, seat material being silicon carbide. Lip seals are made of Viton-rubber.

Gravity chamber is pressurized with oil from the header (gravity) tank. There is also a line out from the gravity chamber enabling flushing.

Observed problems

Problems observed in the typical high-pressure seals have been

- oil leakage out
- water leakage in
- oil leakage between gravity chamber and gearbox
- pumping effect
- swelling
- shrinking
- face material wear
- housing fracture
- seat material corrosion

Applied solutions

To solve the problems, various kinds of analysis have been done. The most effective solutions have been

- change of seat material from NiResist (cast iron) to silicon carbide to avoid corrosion and wear
- increasing the gravity pressure by increasing the tank height and applying additional pressurization by air
- giving special attention to piping (correct slope and cleanliness) by improving communication with the yard
- change of housing material from composite to stainless steel

General understanding of causes

The general understanding gained by solving the problems is that we have been lacking knowledge of high-pressure application and sufficient communication with the seal supplier.

To correct this, the following table of specification has been created. This has been done together with major seal suppliers.

Table of requirements for seal supplier (values from actual case):

Specification of Requirements **Seals**		Given Value *Calculated Value*	
Basic Values			
Shaft diameter		480 Mm	
Shaft rotational speed		148 RPM	
Static pressure difference (max. over one seal)		3 Bar	
Line velocity		*3.7196 m/s*	
Static PV-value		*11.159 Bar m/s*	
Hydrodynamic Pulses			
Dynamic pressure difference (max. over one seal)		0.3 bar	
Dynamic PV-value		*1.1159 bar m/s*	
Total PV-value range	*From*	*10.043 bar m/s*	
	To	*12.275 bar m/s*	
Mechanical Vibrations			
Dynamic axial movement		0.1 mm	
Dynamic radial movement		0.1 mm	
Axial frequency		9.87 Hz	
Radial frequency		9.87 Hz	
Axial amplitude		*0.05 mm*	
Radial amplitude		*0.05 mm*	
Axial vibration speed (MAX)		*3.1008 mm/s*	
Radial vibration speed (MAX)		*3.1008 mm/s*	
Axial vibration speed (RMS)		*2.1926 mm/s*	
Radial vibration speed (RMS)		*2.1926 mm/s*	
Axial vibration acceleration (MAX)		*192.29 mm/s^2*	*0.019602 g*
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Axial vibration acceleration (RMS)	*135.97 mm/s^2*	*0.013861 g*
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Maximum Static Displacements (shaft related to surroundings, from 0-position to other end)

Axial Displacement	0.4 mm
Radial Displacement	0.4 mm

Lubrication (media)

Lubricant = liquid/gas at higher pressure

Lubricant	Seawater
Viscosity at 40 deg	1 cSt
Viscosity at 100 deg	1 cSt
Operating temperature	20 deg

Lifetime

Required lifetime without change of components

5 years with 7000 h / year

Operational profile

Time share	PV / Pvmax
80 %	100 %
10 %	50 %
10 %	25 %

Corrosion protection

yes

Acceptable level of leakage

In 5 ml/h

Out 0 ml/h

This table will be filled when selecting new sealing for azimuth thruster.