



**BOLLFILTER**  
**Protection Systems**

**FILTRATION  
FOR  
ALTERNATIVE MARINE FUELS**

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Boll & Kirch Filterbau GmbH

14. Mai 2024, Nautisch-Technischer Inspektoren-Kreis Hamburg

# Kompetenz aus mehr als 70 Jahren Erfahrung

1950



## Gründung

Gründung der Boll & Kirch Maschinenfabrik in Köln-Ehrenfeld durch die Herren Walter Boll und Josef Kirch

1968



## Patent

Produktionsstart für den neuen patentierten Automatikfilter mit druckluftunterstützter Rückspülung

1976



## Internationalität

Unterzeichnung des ersten internationalen Vertreter-vertrages mit der japanischen Firma Misuzu Machineries & Engineering Ltd.

1978



### Filterkerzen

Wickelkerzenserienfertigung:  
Endlosproduktion von  
Kerzenelementen mit spiralförmigen,  
vorgespannten Stützkörpern.

1980



### Automatikfilter

Erste Serienproduktion für  
Automatikfilter.

2017



### Produktion in China

Eröffnung der ersten Produktionsstätte  
im Ausland, der Bollfilter China  
Manufacturing Ltd.

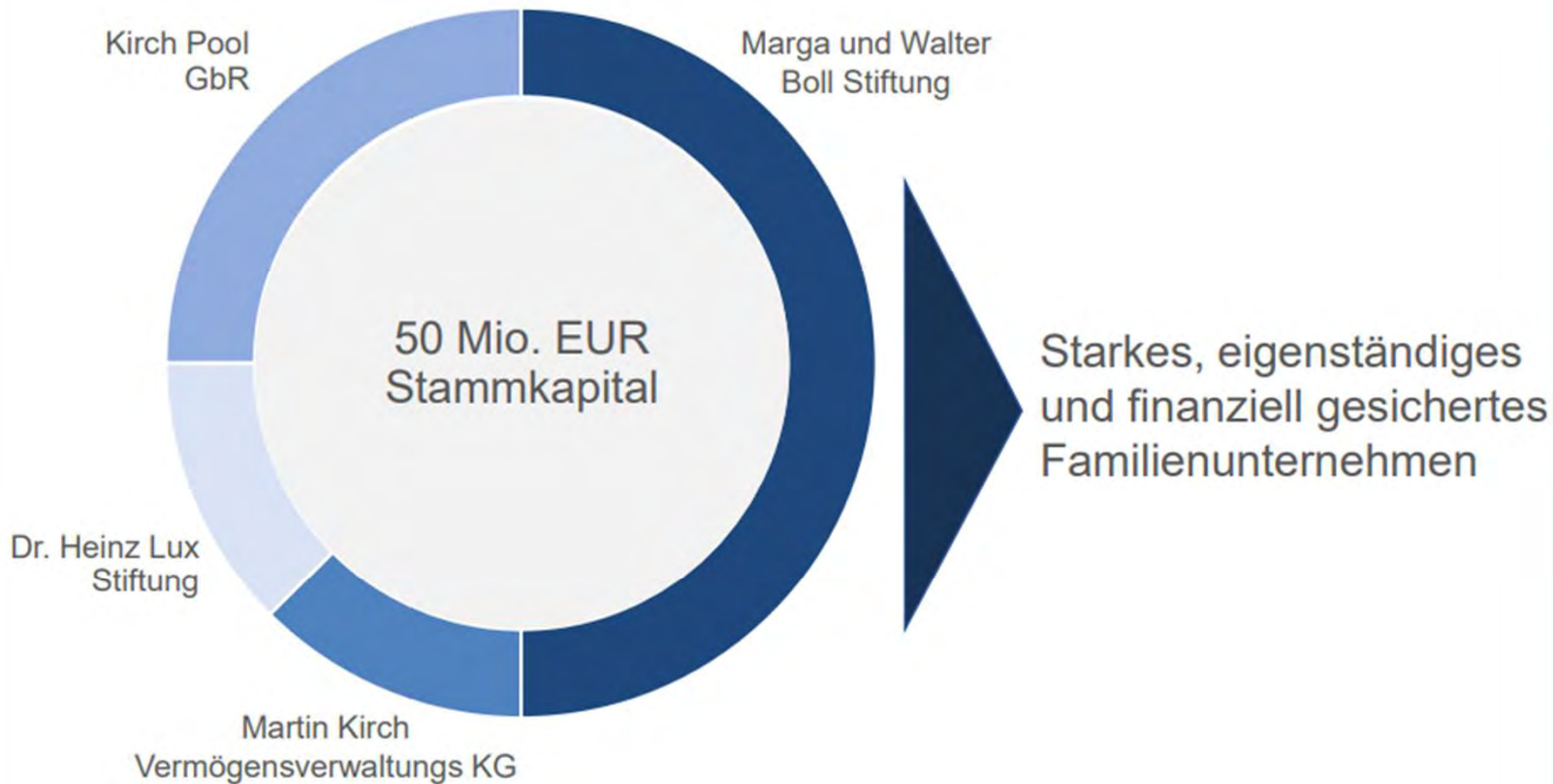
2021



### Expansion - Fertigstellung Werk II

- Gründung BOLLBRANIC zur  
Entwicklung und Produktion von SiC  
Membranen
- Forschung & Entwicklung
- Ersatzteillogistik

## Starker Partner mit 50 Mio. EUR Stammkapital unter vier Gesellschaftern verteilt



Die  
Gesellschafterstruktur  
ist die Basis für die  
**finanzielle**  
**Unabhängigkeit**

# Filtration for Alternative Marine Fuels



## Agenda

### 1. Introduction to Alternative Marine Fuels

- Pathway to the Future
- Key Characteristics and Challenges
- Product Portfolio for Alternative Marine Fuels
- Reference of Fuel Filter Application

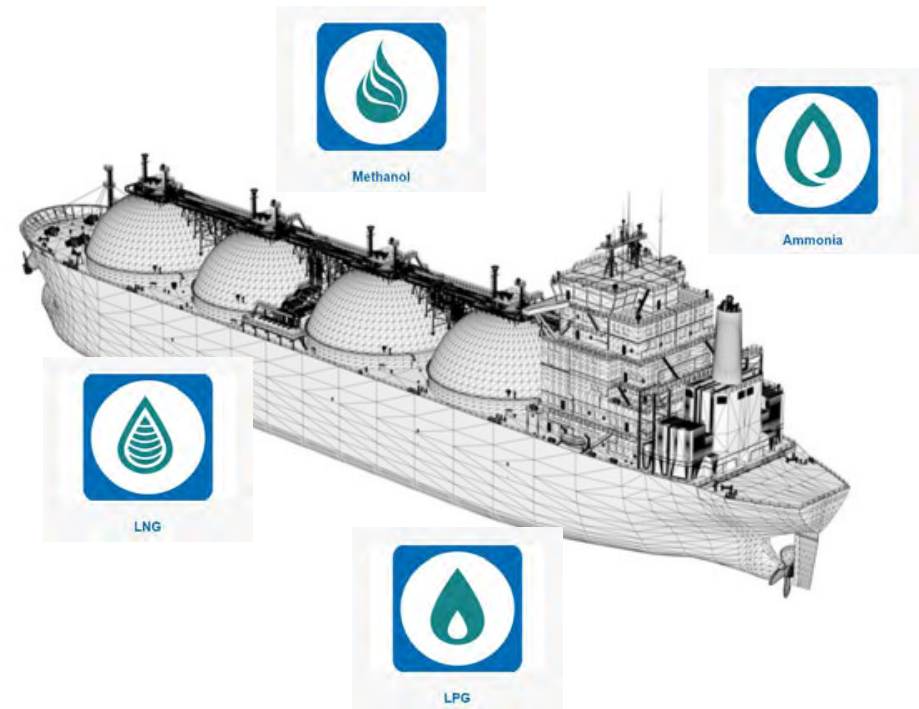
### 2. Filtration Standards

- ISO 16889
- ISO 4406

### 3. Practical Experience

- LNG Filtration
- LPG Filtration

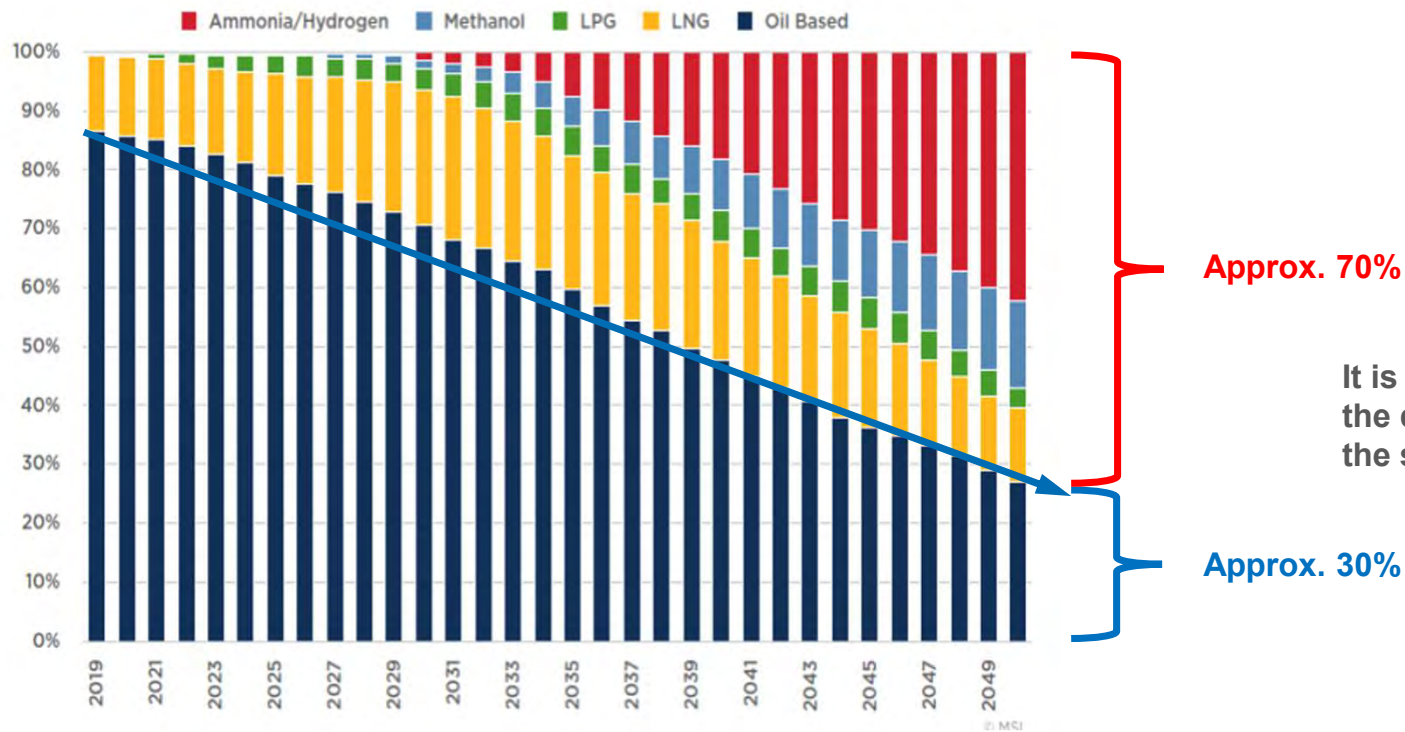
### 4. Summary and Discussion



# Filtration for Alternative Marine Fuels



## Pathway to the Future



Approx. 70%

It is to be expected that a combination of the different fuels will shape the picture on the seas in the coming decades.

Approx. 30%

Source: ABS, Zero Carbon Outlook 2022  
Figure 71, Fuel mix forecast

# Filtration for Alternative Marine Fuels



## Key Characteristics and Challenges

	Conventional Marine Fuels		Alternative Marine Fuels			
	HFO	Low Sulphur Fuels	LNG	LPG	Methanol	Ammonia
Energy density	●	●	●	●	●	●
Toxicity	●	●	●	●	●	●
Standardization of fuel quality and filtration	●	●	●	●	●	●
Degree of contamination	●	●	●	●	●	●
Required size of the filtration surface	▬	▬	▬	▼	▲	▲
Tendency of applied filtration fineness	▬	▬	▬	▼	▼	▬
Requirements on filtration equipment	●	●	●	●	●	●

Explanation of symbols	Trend		Ranking		Comment
	▲	Upwards	●	Good	
	▬	Persistent	●	Average	
	▼	Downwards	●	Bad	

Please note, even finer gradations within the colors are possible, but are neglected for the sake of simplicity.

Each fuel brings its own advantages and challenges

- Harmful/Toxic
- High Pressures
- Low Temperatures

In this presentation we would like to share our experience in regard to fuel contamination

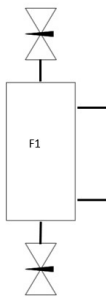
Source: Boll & Kirch, CIMAC Congress 2023  
Paper 2023 | 390, Table 2

# Filtration for Alternative Marine Fuels



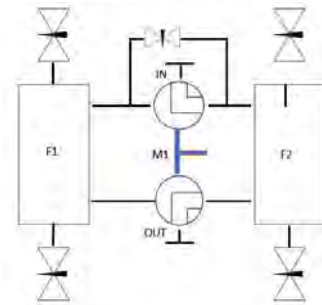
## Product Portfolio for alternative Marine Fuels

### Simplex Filters



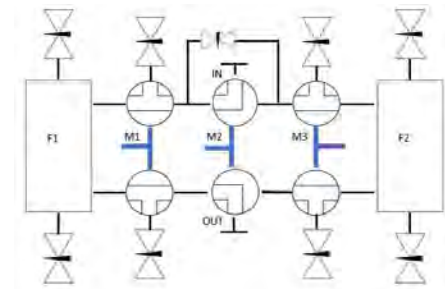
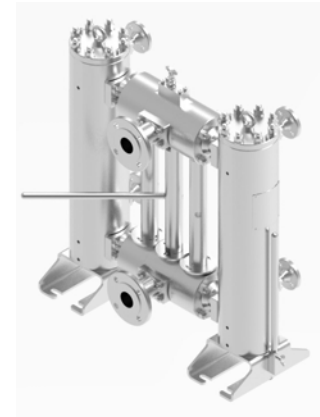
### Duplex Filters

Single-Block Design



### Duplex Filters

Double-Block and Bleed Design





# Filtration for Alternative Marine Fuels

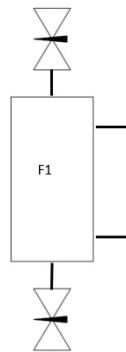


## Product Portfolio for alternative Marine Fuels

- Simplex Filters

### Main Product used for

- Safety filter
- FVT, GVU, GVT etc. close to the Engine



### Product Criteria

- Bolted Design (no welds)
- Material dual certified Stainless Steel 316/L
- Compact Design
- Connections for wall mounting
- Floor mounting feet available
- Simple maintenance (few parts)
- Gas-tested / Gas-tight

# Filtration for Alternative Marine Fuels

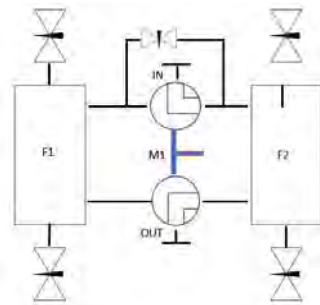


## Product Portfolio for alternative Marine Fuels

- Duplex Filters Single-Block Design

### Main Product used for

- Harmless Gases- / Liquids



### Product Criteria

- Bolted Design (no welds)
- Material dual certified Stainless Steel 316/L
- Easy handling
- Compact Design
- Integrated pressure equalisation line
- Floor mounting feet available
- Gas-tested / Gas-tight

**Duplex Single-Block Filters** have rarely been used for the **alternative Marine Fuels**. So far, mainly supplied for test bench purposes.

The marine propulsion market is moving towards **Duplex Double-Block and Bleed Filters** due to the safety benefits.

# Filtration for Alternative Marine Fuels

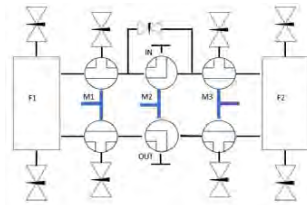


## Product Portfolio for alternative Marine Fuels

- Duplex Filters Double-Block and Bleed Design

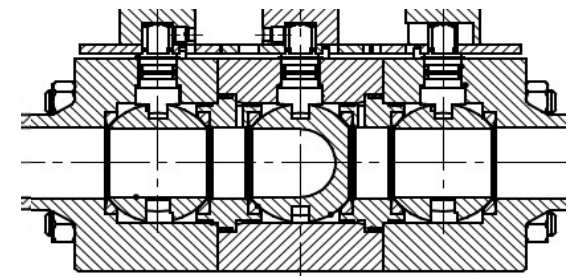
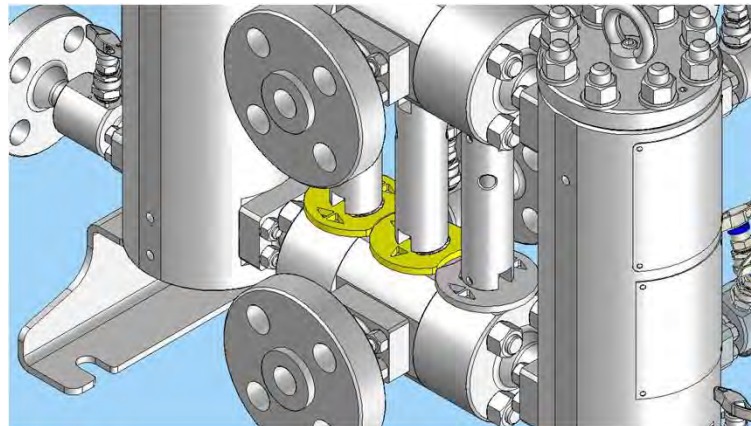
### Main Product used for

- Harmful / Toxic / Hazardous Medias (e.g. MeOH, NH<sub>3</sub>)/ or
- High Pressures/ or
- Low Temperatures



### Product Criteria

- Bolted Design (no welds)
- Material dual certified Stainless Steel 316/L
- Double sealing on all ports and connections
- High Safety Level
- Gas-tested / Gas-tight
- Special Switch-over valve without flow interruption



# Filtration for Alternative Marine Fuels



## Reference of Fuel Filter Application

### Duplex Double Block and Bleed Fuel Filter

#### Area of Application

- Harmful / Toxic / Hazardous Media Tank
- High pressure applications
- Low temperature applications

#### Key Advantages

- High Safety Level for operator & environment
- Easy maintenance and purging
- Protection against incorrect operation

LFSS

Duplex Double Block and Bleed Fuel Filter

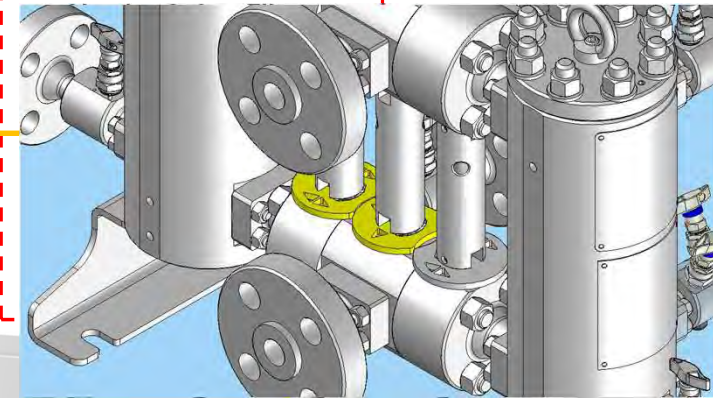
FVT

DBB Valve Safety Feature

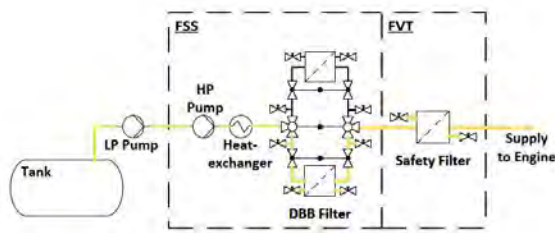
LP Pump

HP Pump

Heater

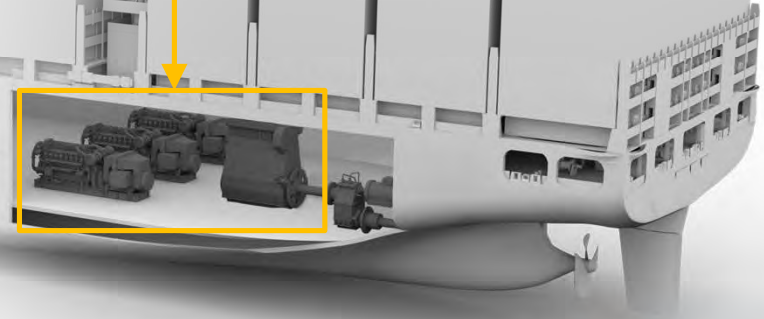


### Schematic example of a Fuel Supply System



Filtration Technology

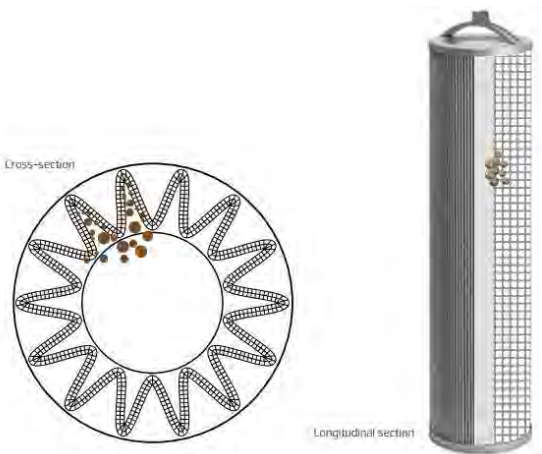
Engines



# Filtration for Alternative Marine Fuels

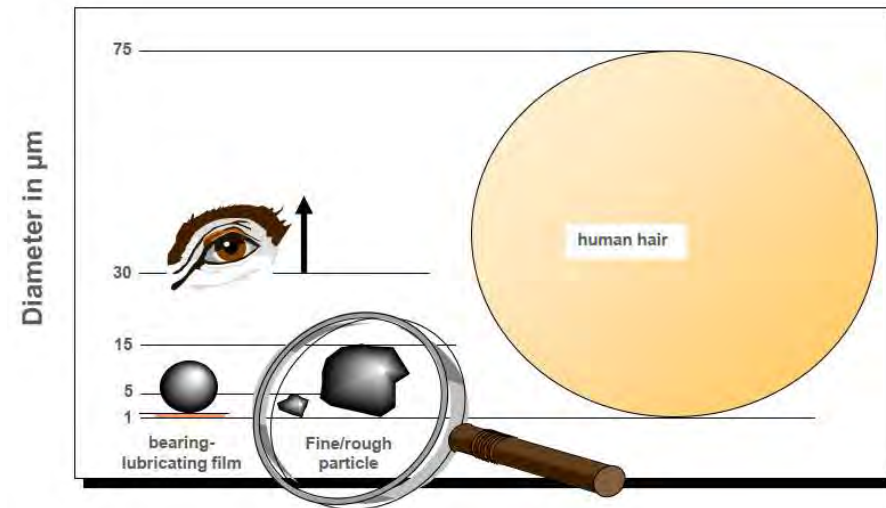
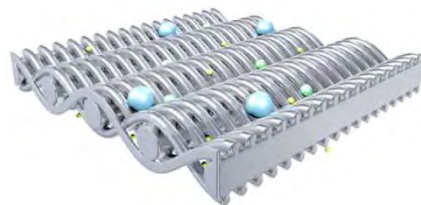


## Filtration



### Filter Element Details

- Fully welded construction, not crimped
- Material stainless steel 316
- Flow possible in both directions
- Pleated surface area for more filtration area and higher dirt hold capacity
- Tested on efficiency as per ISO 16889 ( $\beta$ -values / % efficiency rating)
- Differential pressure resistance 10 bar



# Filtration for Alternative Marine Fuels



## Filtration Standards

### ISO 16889: Solid Particle Removal Efficiency of Hydraulic Filters

**Multi-pass** test method for assessing **fluid** filter efficiency via  $\beta$ -values.  
(Measurement of particles up-and downstream of filter element)

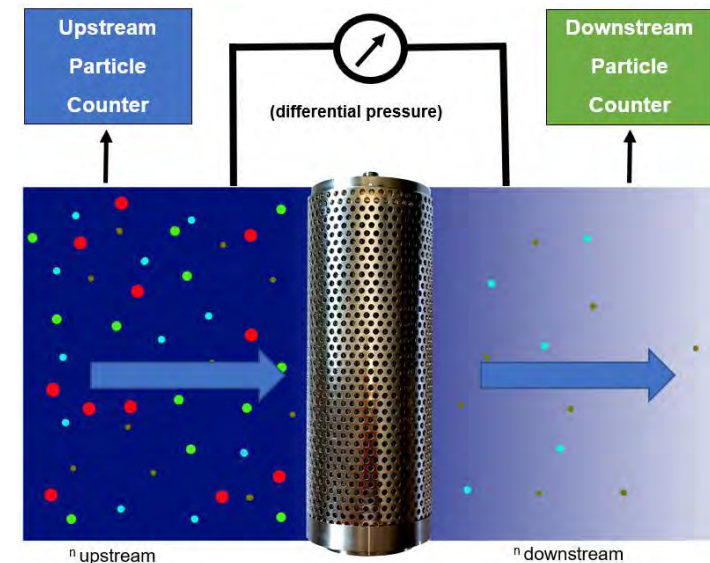
#### Benefits:

- International standard for evaluating filter performance
- Enables comparison of different hydraulic filters
- $\beta$ -values are globally accepted for the respective application

#### Lesson Learned:

- It is not enough to just specify 10  $\mu\text{m}$  filter elements:
  - $\beta_{10}=10$  (90% particle removal  $\geq 10 \mu\text{m}$ )
  - $\beta_{10}=200$  (99,5% particle removal  $\geq 10 \mu\text{m}$ )

### Illustration of the function of a filter element



$$\beta(x) = \frac{\text{counts upstream } (x \mu\text{m})}{\text{counts downstream } (x \mu\text{m})}$$

$$\text{efficiency } (x) [\%] = \frac{\beta(x) - 1}{\beta(x)}$$

# Filtration for Alternative Marine Fuels



## Filtration Standards

### ISO 4406: Oil Purity Classification

Method for determining the level of contamination of solid particles inside oils (hydraulic- and lubrication oils)

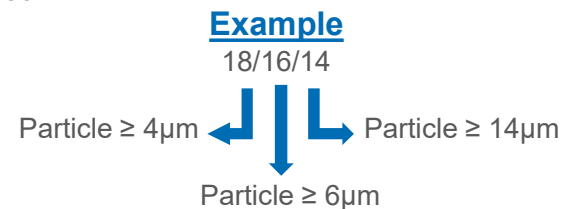
- 1st digit = Amount of particles  $\geq 4 \mu\text{m}$  per 100 ml of fluid
- 2nd digit = Amount of particles  $\geq 6 \mu\text{m}$  per 100 ml of fluid
- 3rd digit = Amount of particles  $\geq 14 \mu\text{m}$  per 100 ml of fluid

### Benefits:

- Enables comparison of fluid purity
- International accepted standard

### Lesson Learned:

- Could be used as a reference to develop fuel purity specifications



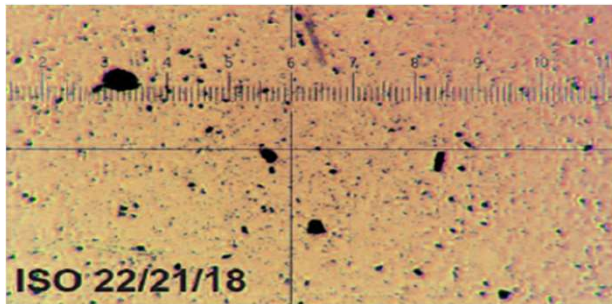
Number of particles per milliliter		$\geq 4 \mu\text{m (c)}$	$\geq 6 \mu\text{m (c)}$	$\geq 14 \mu\text{m (c)}$	ISO 4406:2021 Scale Number
More than	Up to and including				
2500000	-				> 28
1300000	2500000				28
640000	1300000				27
320000	640000				26
160000	320000				25
80000	160000				24
40000	80000				23
20000	40000				22
10000	20000				21
5000	10000				20
2500	5000				19
1300	2500				18
640	1300				17
320	640				16
160	320				15
80	160				14
40	80				13
20	40				12
10	20				11
5	10				10
2,5	5				9
1,3	2,5				8
0,64	1,3				7
0,32	0,64				6
0,16	0,32				5
0,08	0,16				4
0,04	0,08				3
0,02	0,04				2
0,01	0,02				1
0,00	0,01				0

# Filtration for Alternative Marine Fuels

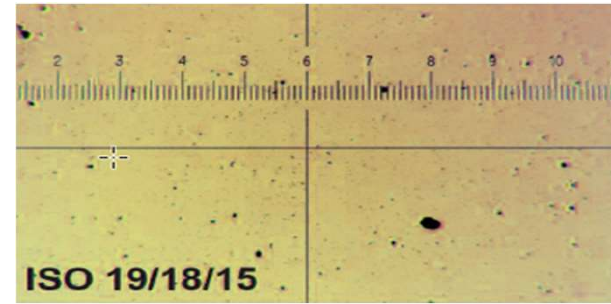


## Filtration Standards

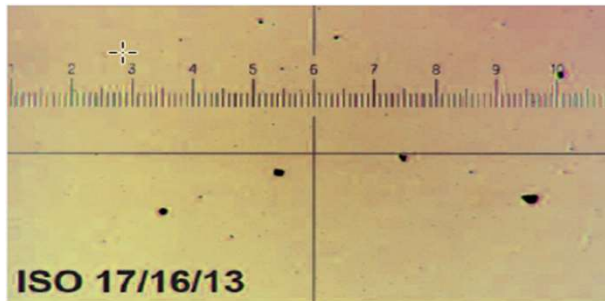
### Difference in ISO 4406 classes



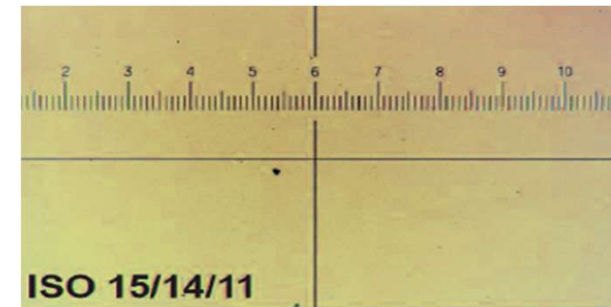
New Oil, delivered in drums



New Oil, delivered in road tanker



New Oil, delivered in mini-container



Required for modern hydraulic systems



# Filtration for Alternative Marine Fuels



## Practical Experience

### Sources of Fuel Contamination

- Extraction and production
- Storage
- Transport
- Pipe work installation with missing or insufficient flushing process
- Clogging due to frozen impurities
- Gas carrier vessel in ballast vs. cargo voyage



# Filtration for Alternative Marine Fuels



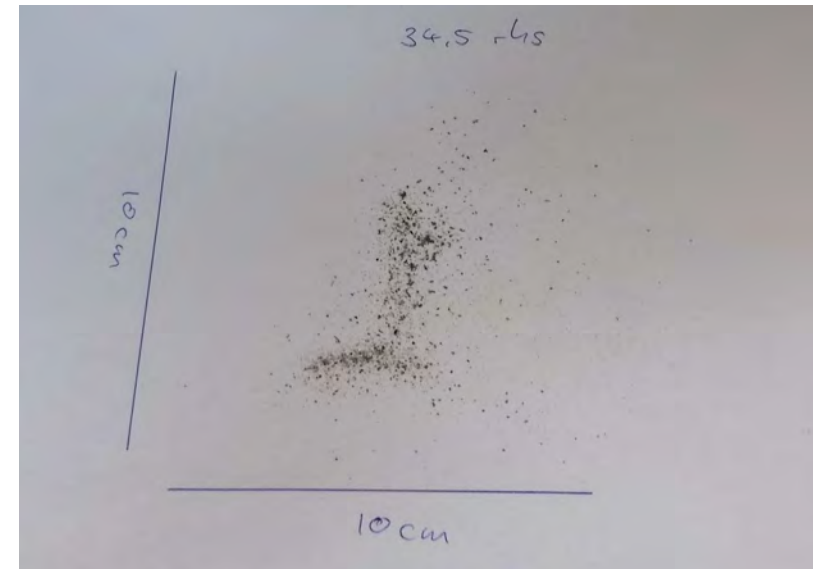
## Practical Experience

### LNG Filter upstream to Fuel Supply System



**Description:** Contamination found in filter element after only 38 running hours

**Source:** Missing or insufficient flushing process after pipe welding



**Description:** After 4 months of system operation and after  $\approx 35$  running hours

**Source:** Common contamination of LNG fuel

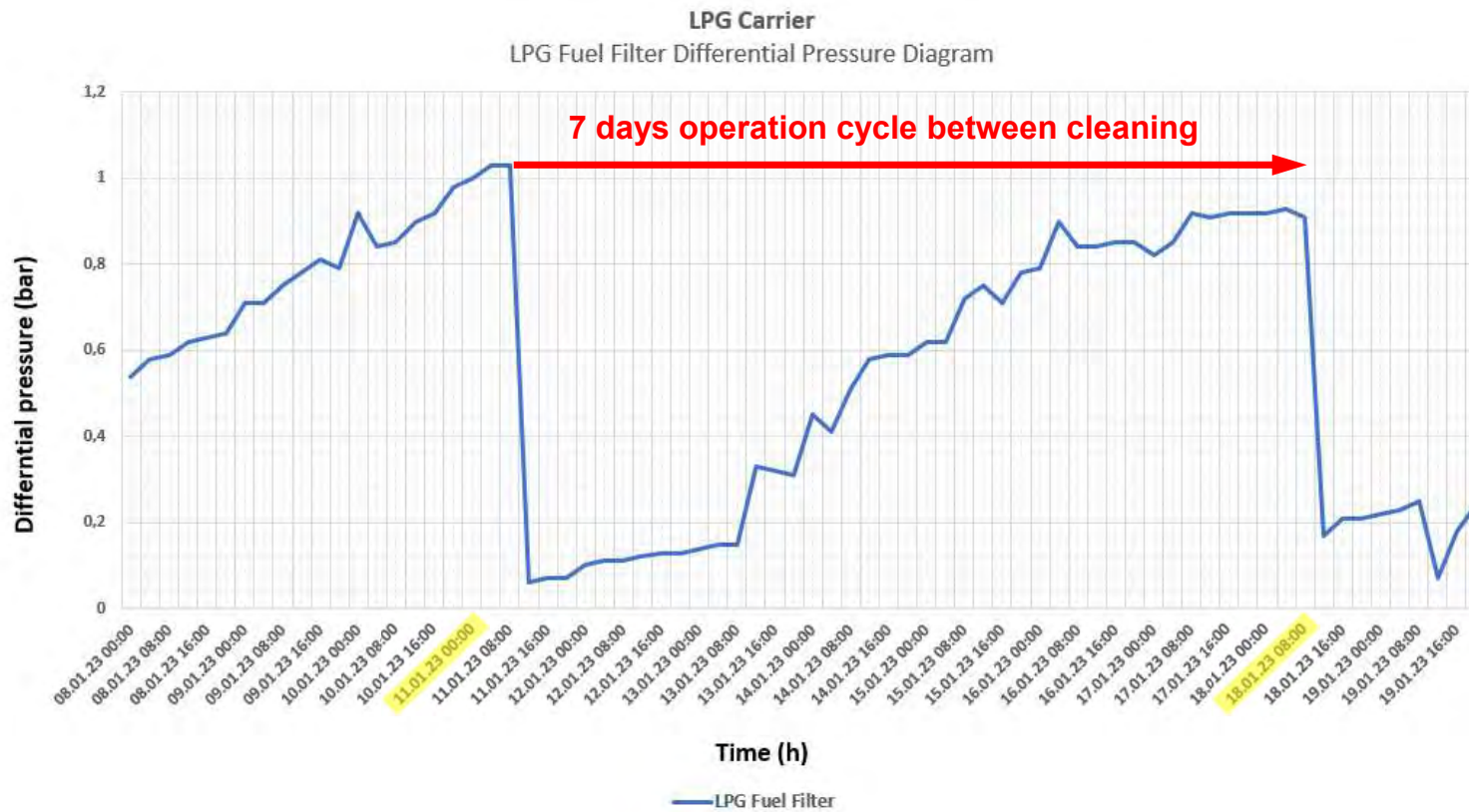


# Filtration for Alternative Marine Fuels



## Practical Experience

### LPG Filter Fuel Supply System



### Contamination found in LPG Filter



# Filtration for Alternative Marine Fuels



## Summary & Discussion

### Improvements and Lessons Learned

- Filter selection acc. to ISO 16889 with  $\beta$ -values
- Fuel standards must be developed in order to create a global fuel purity (ISO/TC28/SC4/WG18 Methanol Working Group)
- Flushing procedures to be established
- Gas leakage tests and double block and bleed filter arrangements are necessary to manage the challenges and critical characteristics of the future fuels (toxicity, cryogenic, high pressure ...)



Passion. Tradition. Expertise.

# Filtration for Alternative Marine Fuels



**THANK YOU FOR YOUR ATTENTION**