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Filtration for Improved Bearing and Equipment Life

Martin Williamson
KEW Engineering Ltd.

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"Bearings can have an infinite life when particles larger than the lubricant film are removed." SKF

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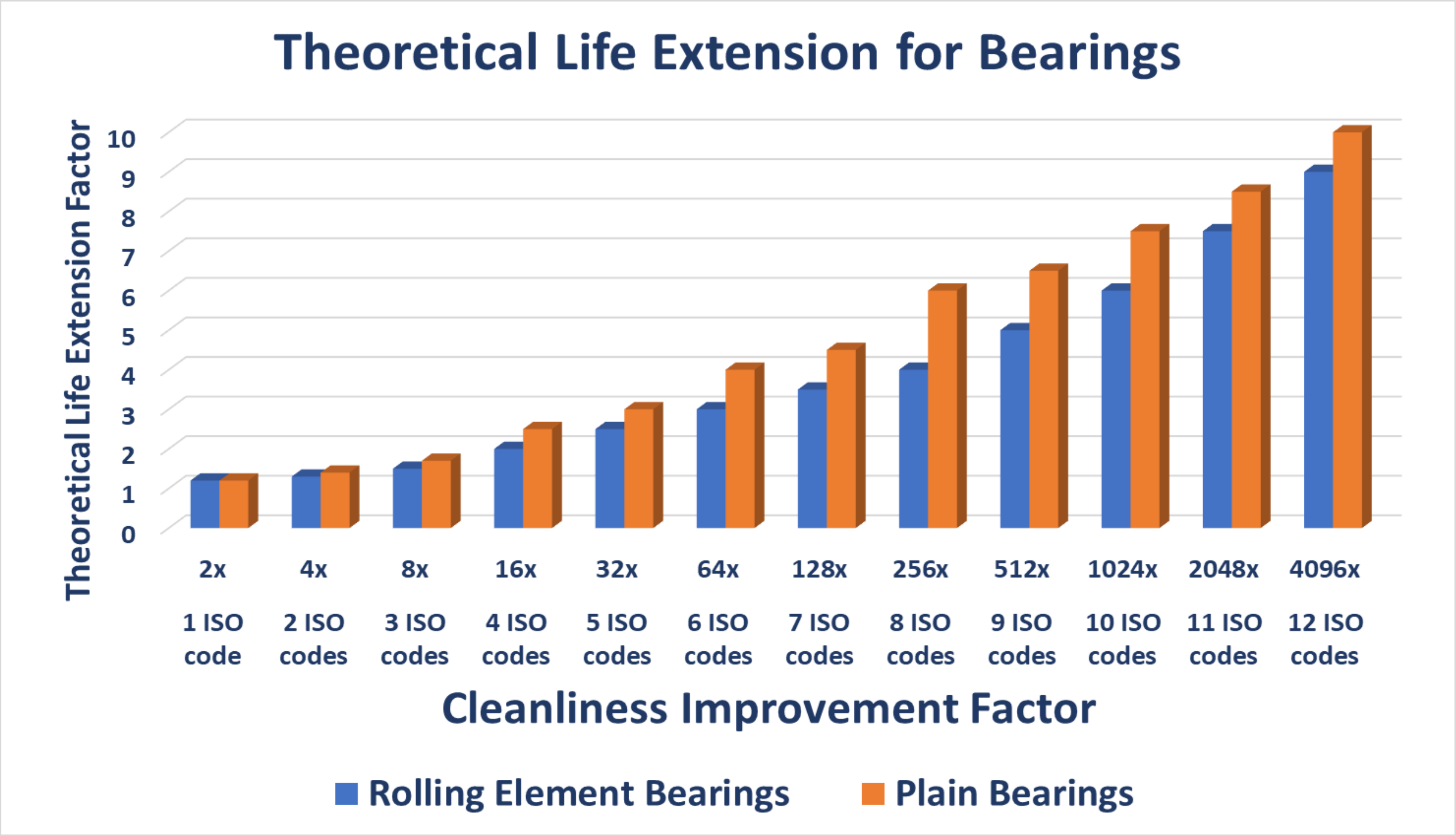

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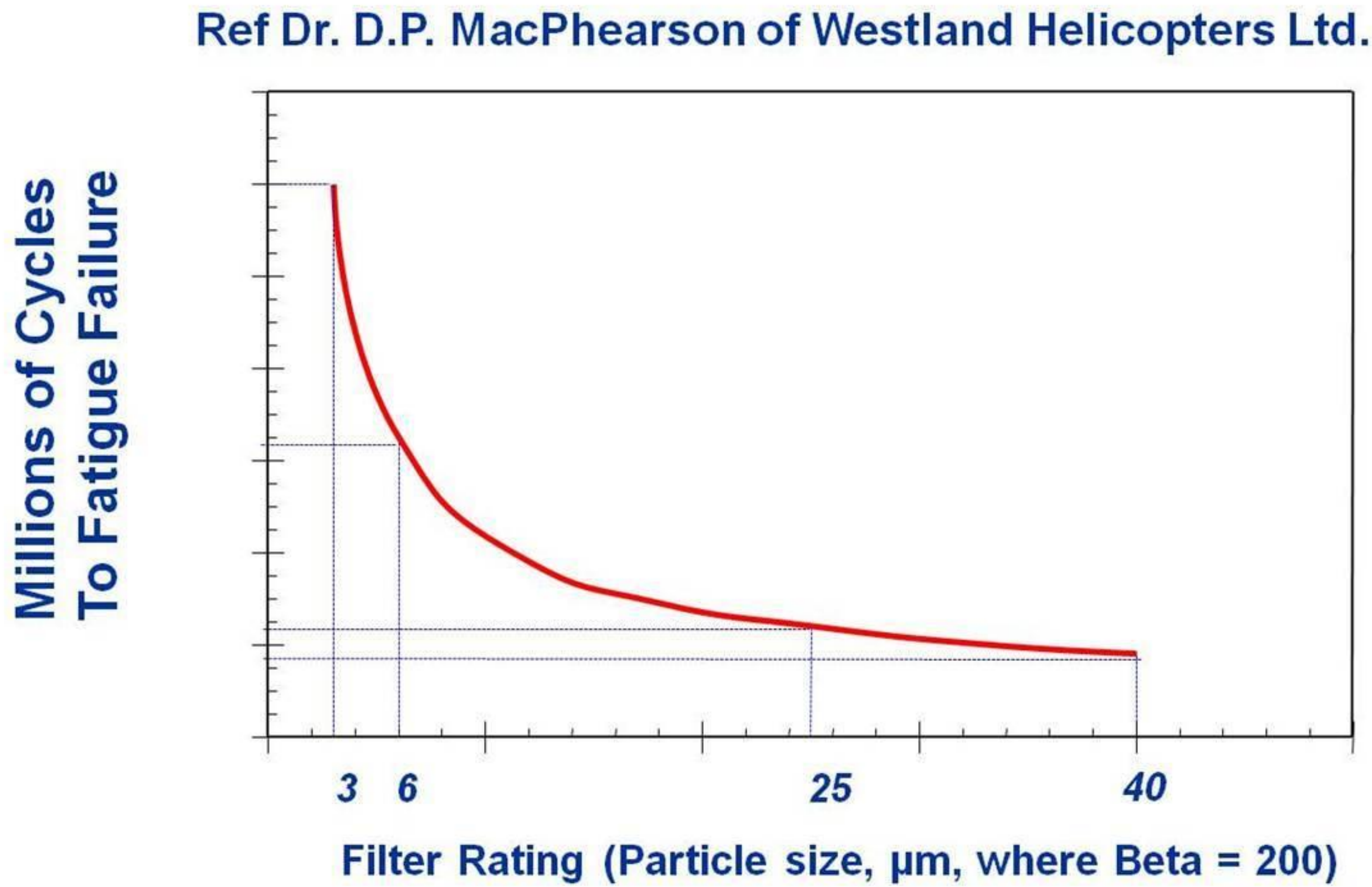
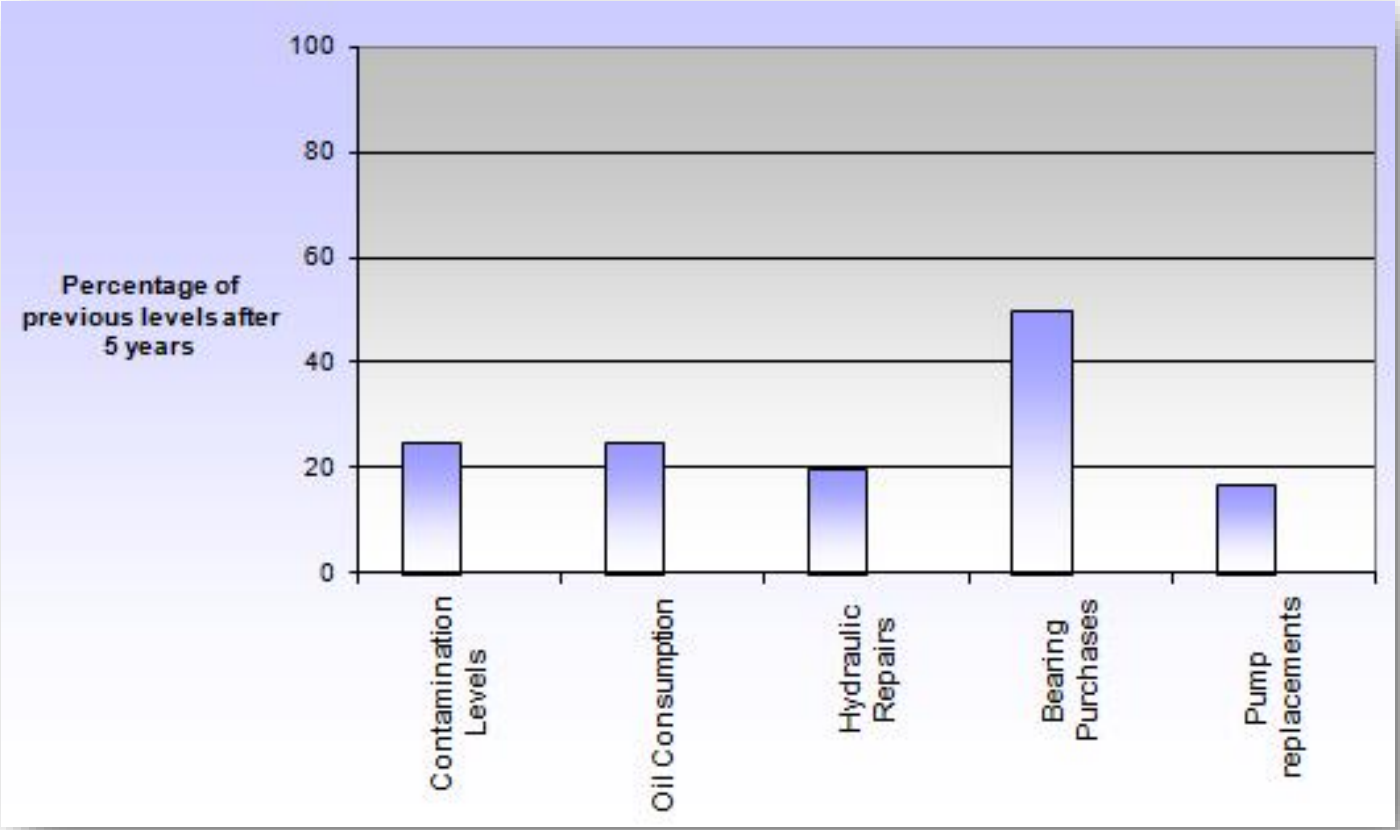
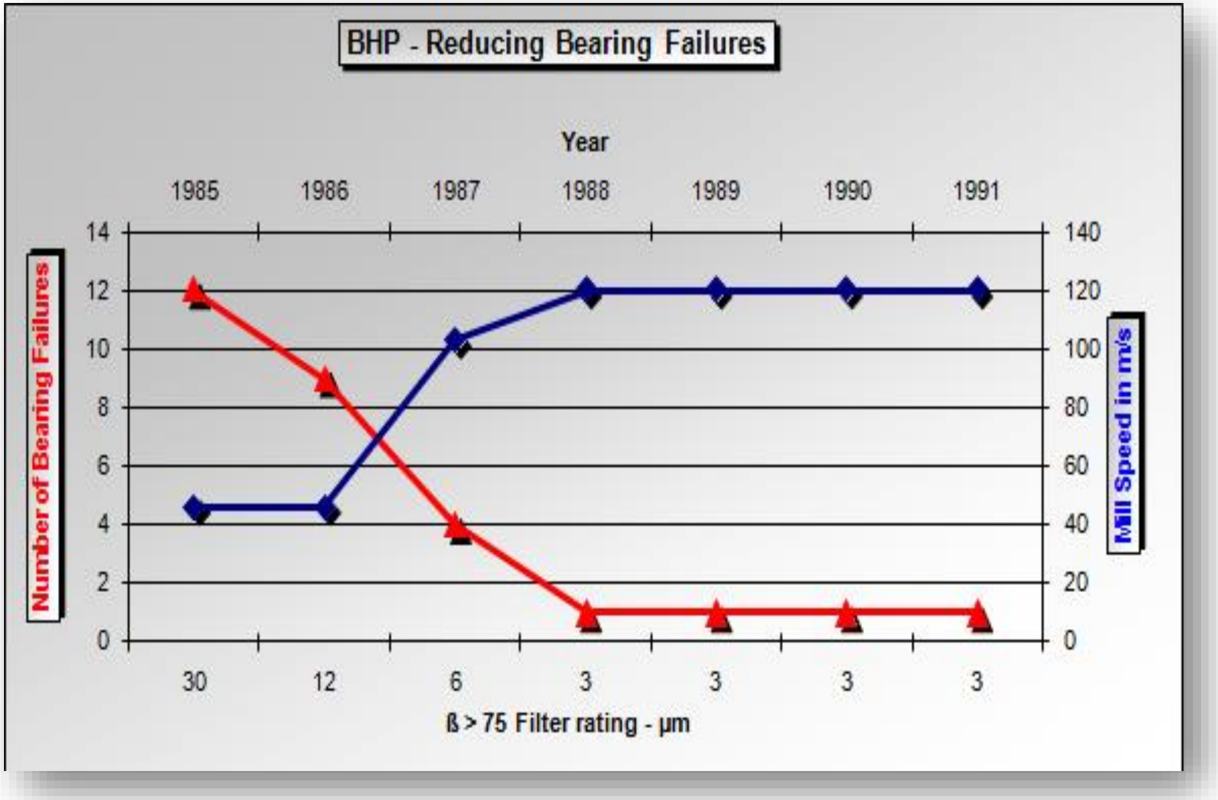


Case Studies & Successes – Nippon Steel



Nippon Steel: Hydraulic Machines & Bearings

Case Studies & Successes - BHP



BHP: Steel plating lines

- Reduced bearing failures improved productivity.

Fact: High pressure and system filters are more expensive than basic handling filters.

DO NOT rely on your system filters to clean up on your bad practices of handling, storage, maintenance and OEM quality Control.

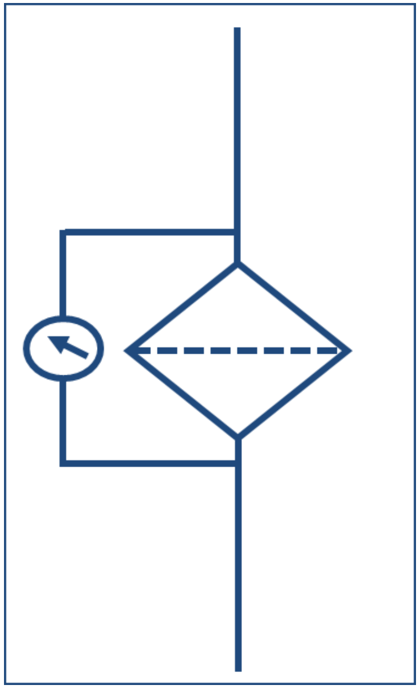
Putting dirty (unfiltered, straight from the drum) oils into the machine will:
- reduce the filter element useful life
- increase system wear until the filter cleans up
- impact oil quality with reduced service life
- increase maintenance costs
- increase the risk of catastrophic failure

Filter definition -

A device to separate solids or liquids from a fluid. The objective in industrial plant is to remove solid and liquid contaminants from the lubricating oils.

Other forms of filtration exist, but the most common is the barrier filtration method.

All quality filters conform to ISO standards for manufacturing quality checks, performance evaluation and safety checks.



Pressure -
resistance to flow of the fluid will create pressure in the system - defined as a force per unit area or:

- ISO - Pascal (Pa) - Newton/m^2
- Other terms - bar (10^5 Pa) or 14.5psi, lb/in^2

Pressure Drop -
Δp or dp, the differential pressure or pressure drop is the pressure loss experienced due to a restriction, such as the filter.

Other Filter Terms to know.

- Viscosity - Absolute (Pa s, 1 mPa s=1cP) and Kinematic (m^2/s, 1 mm^2/s=1 cSt)
- Specific Gravity - mass of liquid per unit volume kg/m^3
- Micrometre (micron) 1/1000th mm or µm
- Medium (pl. media) porous material which traps the dirt

Surface -

By definition, surface filters retain the contaminant particles on the upstream surface of the medium. This is known as interception. The medium fibre and the pores lie in one plane, in a sense a 1-dimensional filter.

In practice, some particulate may be trapped below the surface within the medium, since the depth of fibre may be a factor of 50 times or more of the pore dimension.

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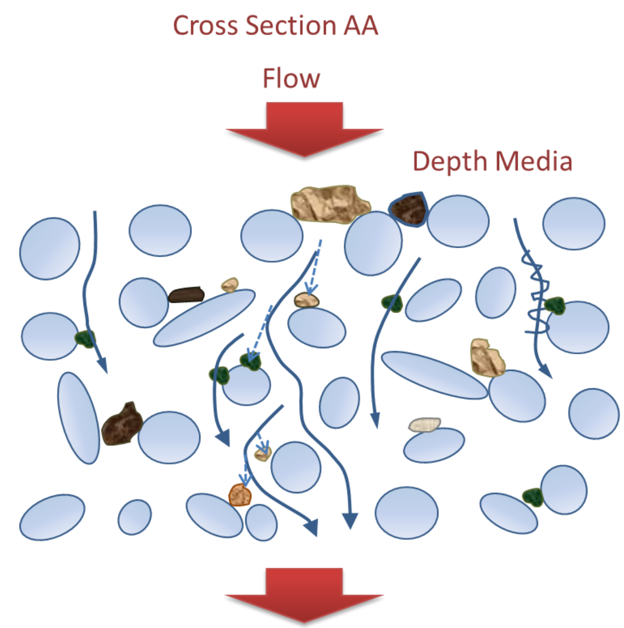
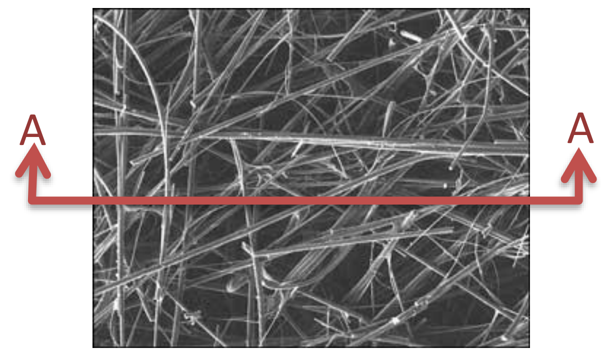
Depth -

By definition, depth filters remove the contaminant particles by trapping them in the medium. The depth medium is the porous part of the filter and actually provides the filtration through adsorptive filtration. By virtue of the particle size, some particulate will be trapped on the surface through interception.





The mechanisms of particle entrapment include:

- Inertial Impaction
- Diffusion
- Interception
- Sieving

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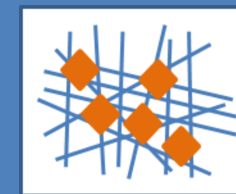
	Cellulose 	Synthetic 
The advantages -	• Cheaper • Ideal for use on filter carts and off-line systems	• Stronger fibres • More consistent pore sizing • Lower pressure drops • Higher dirt holding capacity • Ideal for pressure line and return line locations
The disadvantages -	• Affected by water • Higher pressure drops • Lower dirt holding capacity • Less consistent pore sizing	• More expensive • Affected by water

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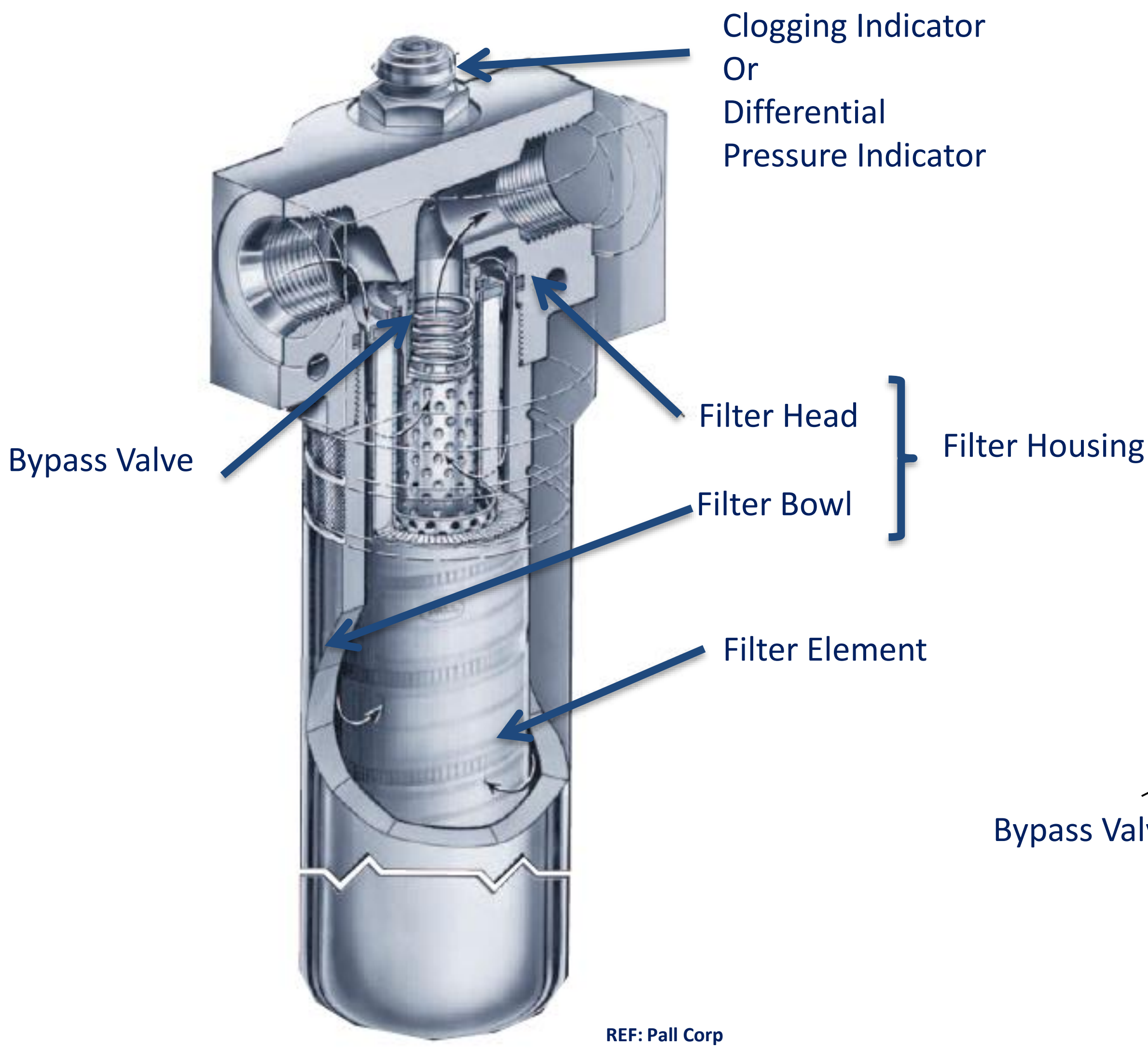
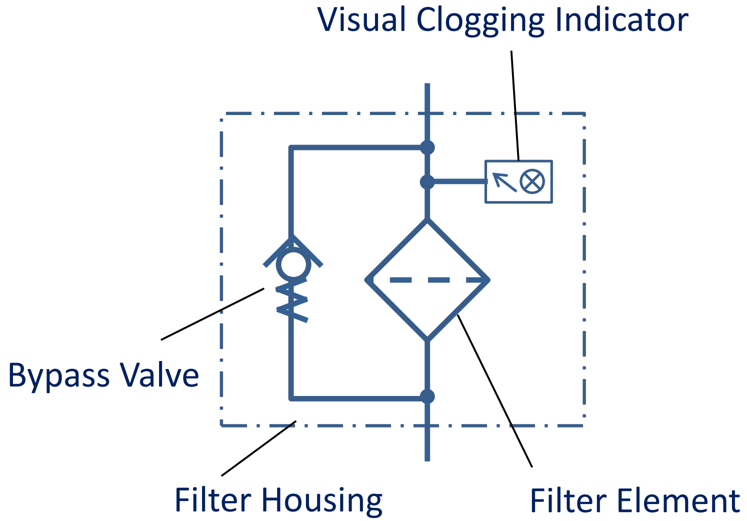


REF: Pall Corp



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Filter performance is measured under laboratory conditions by the amount of solid particle contamination taken out at each pass and the retained amount of solid particle contamination when the terminal differential pressure for the element is reached:

This is known as the filter's Beta Ratio denoted as β

$\beta_{x(c)}$ = Number of particles upstream > x µm $_{(c)}$ / Number of particles downstream > x µm $_{(c)}$

The **Retained Capacity** is the defined to be the mass of ISO Medium Test Dust (ISO MTD) retained by the filter element when the terminal differential pressure is reached.

Filter performance will vary in actual field conditions.

REF: Pall Corp

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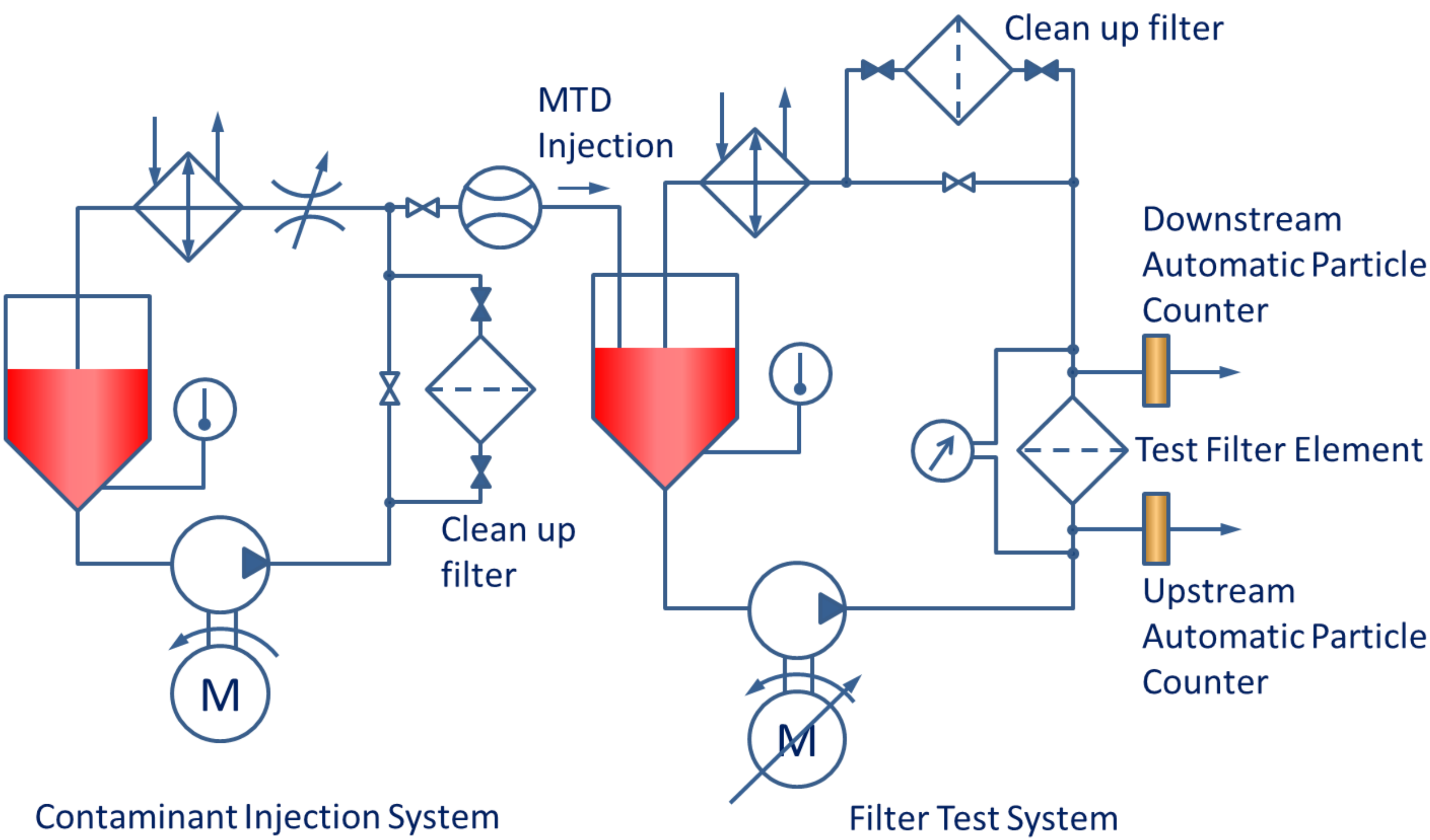

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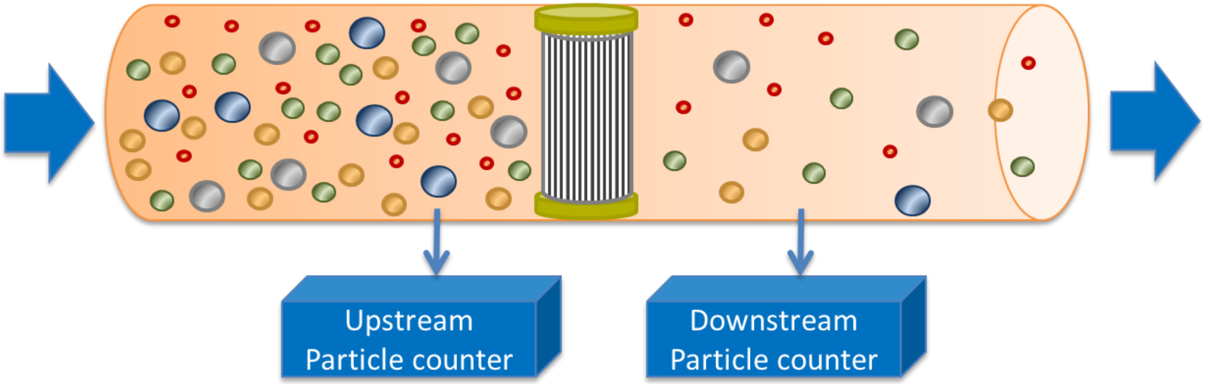

Upstream particle counts	Downstream particle counts	Beta ratio	Capture Efficiency
$4\mu m_{(c)}$～: 150 000 pcs/100mL	$4\mu m_{(c)}$～: 15 000 pcs/100mL	$\beta_{4(c)} = 10$	90%
$6\mu m_{(c)}$～: 80 000 pcs/100mL	$6\mu m_{(c)}$～: 4 000 pcs/100mL	$\beta_{6(c)} = 20$	95%
$8\mu m_{(c)}$～: 30 000 pcs/100mL	$8\mu m_{(c)}$～: 400 pcs/100mL	$\beta_{8(c)} = 75$	98.6%
$10\mu m_{(c)}$～: 8 000 pcs/100mL	$10\mu m_{(c)}$～: 40 pcs/100mL	$\beta_{10(c)} = 200$	99.5%
$12\mu m_{(c)}$～: 1 000 pcs/100mL	$12\mu m_{(c)}$～: 1 pcs/100mL	$\beta_{12(c)} = 1\,000$	99.9%

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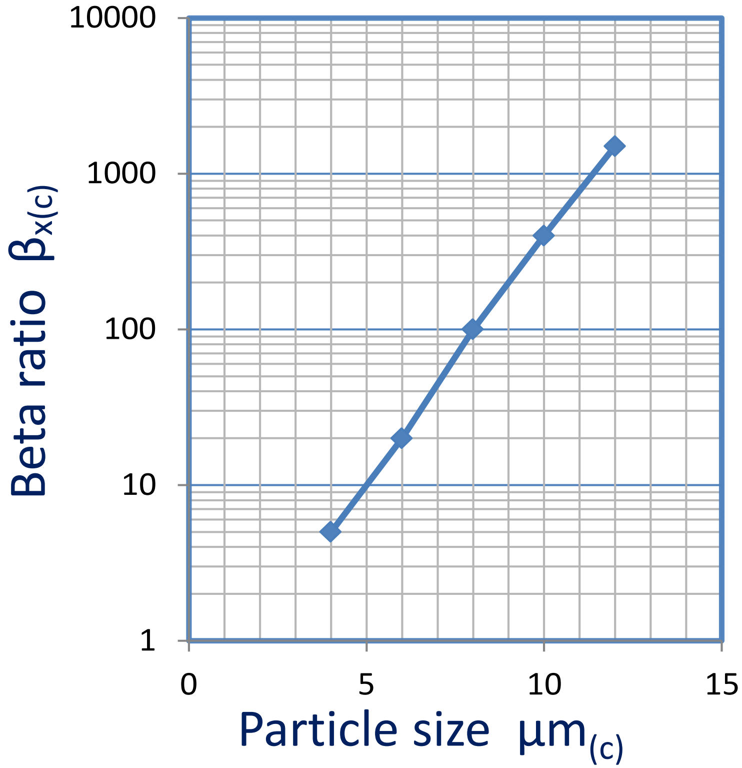

When a filter supplier talks about the micron size rating of their filter, they generally mean the micron size at which $\beta x_{(c)} \geq 200$.

Some filter producers define filter micron rating as the size that equates to $\beta x_{(c)} \geq 1000$.

Filter users should always confirm filtration ratio for the quoted size.

Average filtration ratio	2	10	75	100	200	1 000
Particle size, $\mu m_{(c)}$	---	5	7.6	8	9	11.4

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Beta ratio	Capture Efficiency
$\beta_{4(c)} = 10$	90%
$\beta_{6(c)} = 20$	95%
$\beta_{8(c)} = 75$	98.6%
$\beta_{10(c)} = 200$	99.5%
$\beta_{12(c)} = 1\,000$	99.9%

Capture Efficiency	$\beta_{x(c)}$	Number of passes each filter requires to reduce 1,000 particles down to 1 particle $>X\mu m_{(c)}$
90.0 %	10	3 passes
99.5 %	200	2 passes
99.9 %	1 000	1 pass

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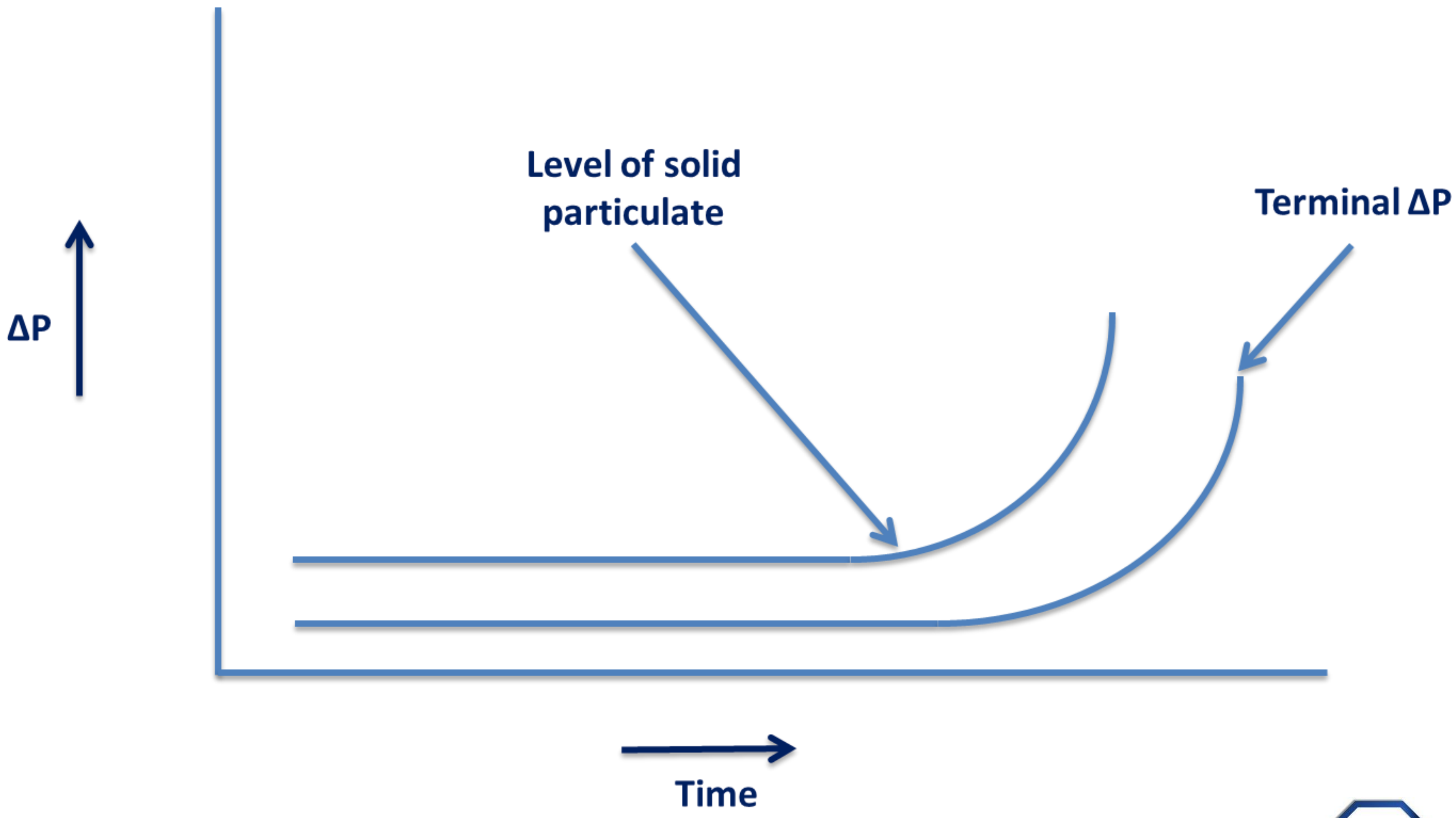

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Failure Mode	Cause	Effect
Channelling	• High differential pressures • Cyclic flow	• Release of trapped solids • Circulation of unfiltered fluid
Fatigue cracks	• Cyclic flow	• Circulation of unfiltered fluid • Release of filter media
Media migration	• Cyclic flow • Vibration • Cold starts	• Release of filter media
Filter disintegration	• Embrittlement • Cold starts • High differential pressures	• Heavy contamination of the fluid with filter fibres
Plugging	• Condensed moisture • Heavily contaminated fluids • High levels of oxidation by-products • Coolant contamination • High wear debris levels	• Increase in filter differential pressure.

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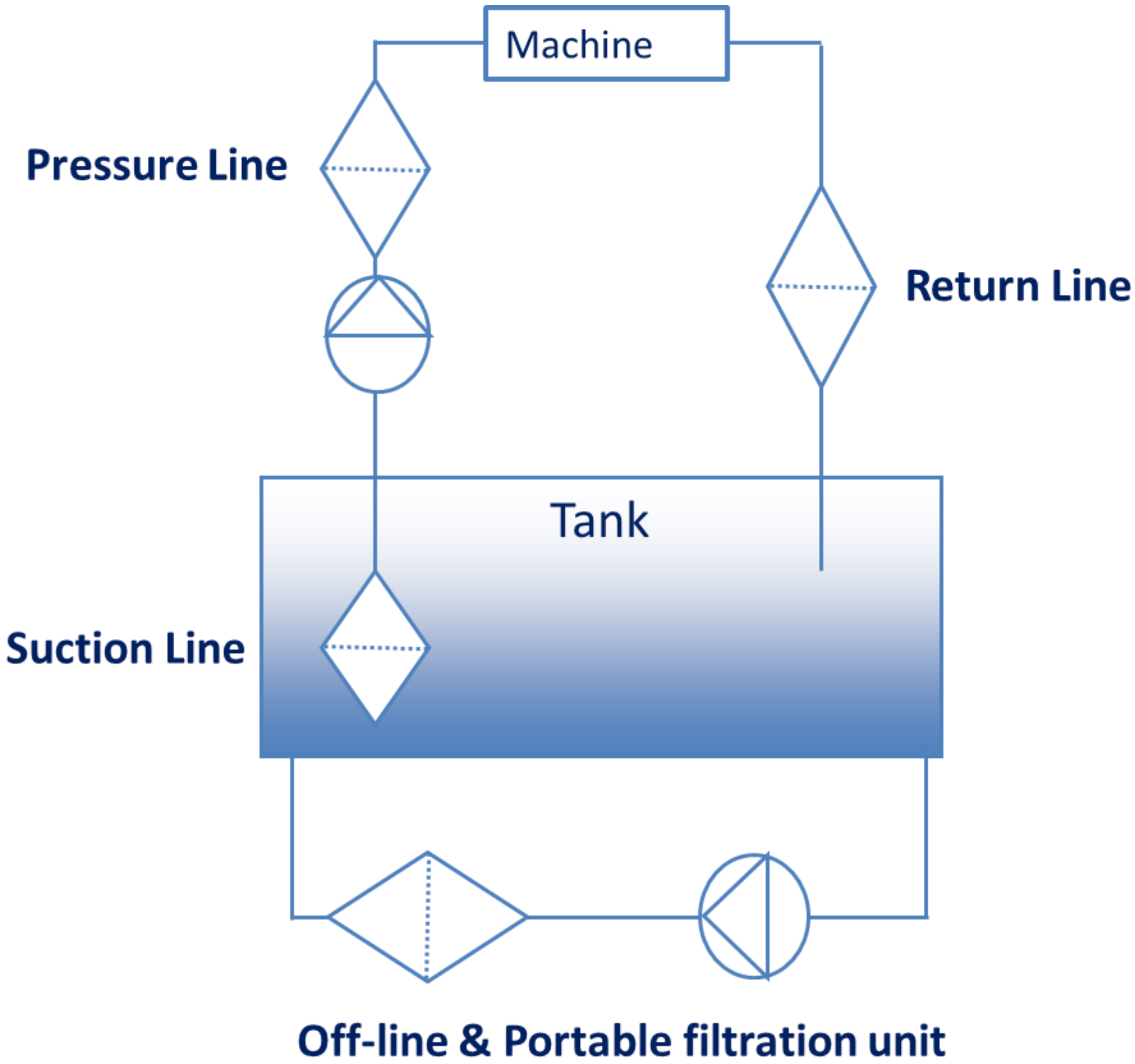

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Use a Can Cutter to open your filters for inspection of the debris.

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This proves the importance of including filter analysis in any lube programme.
I noticed a pressure rise on the filter unit and on inspection I noticed large amounts of metallic material caught in the filter.

The filter was sent away for analysis, and from the results we inspected the gearbox with a Borascope and found the thrust bearing had started to fail.

As the output shaft only rotated at 14rpm the fault could not be picked up on vibration analysis.

Failure of this gearbox on a production run can cost in excess of $500,000 in lost production costs.

Gary D’Henin, Liverpool

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Thank you.

Martin Williamson B.Sc.
KEW Engineering Ltd.
www.kewengineering.co.uk

In conjunction with:
The International Council for Machinery Lubrication.
www.lubecouncil.org