液壓潤滑過濾技術說明會

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說明會簽到表

說明會簡報

高效率淨油設備系列型錄

說明大綱

- 機械設備污染成因
- μm 精度的定義
- 機械磨耗機制
- 機械部件間隙說明
- 油品清潔度定義說明
- 過濾器效率定義
- 水對設備的影響
- 如何選擇適當的過濾器

Fluid Functions

- Transmits power
- Reduces friction between components
- Separates wearing surfaces
- Suspends contaminants
- Controls component oxidation
- Provides cooling

LUBRICATING FLUIDS FUNCTION BEST
WHEN CLEARANCE SIZE PARTICLES ARE CONTROLLED

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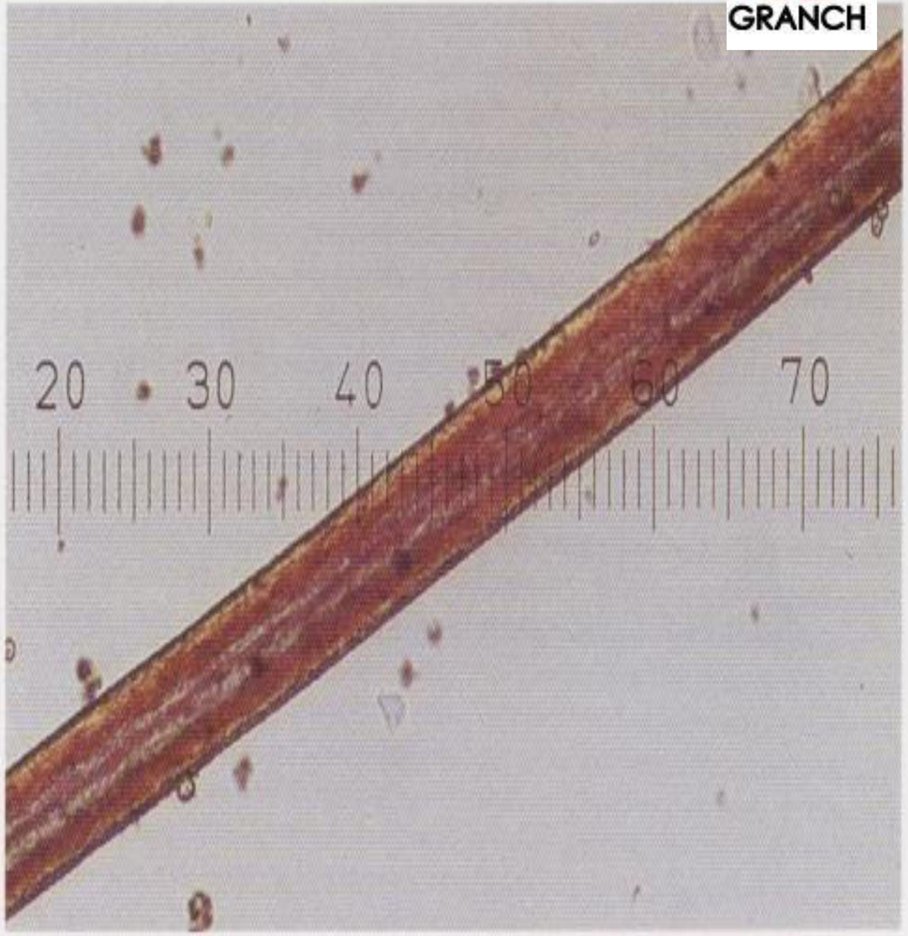
The Micrometer "µm"

"Micron" = micrometer = µm
1 micron = 0.000,039 inch
10 micron = 0.0004 inch

Smallest dot you can see with the naked eye ≈40 µm
Thickness of a sheet of looseleaf note paper≈75 µm

The micrometer is the standard for measuring particulate contaminants in lubricating and fluid power systems.



Human hair (75µm), particles (10µm) at 100x (14µm/division)

Sources of Contamination

Built in contaminants from components:

- Cylinders, fluids, hoses, hydraulic motors, lines and pipes, pumps, reservoirs, valves, etc.

Generated contaminants:

- Assembly of system
- Break-in of system
- Operation of system
- Fluid breakdown

External ingression:

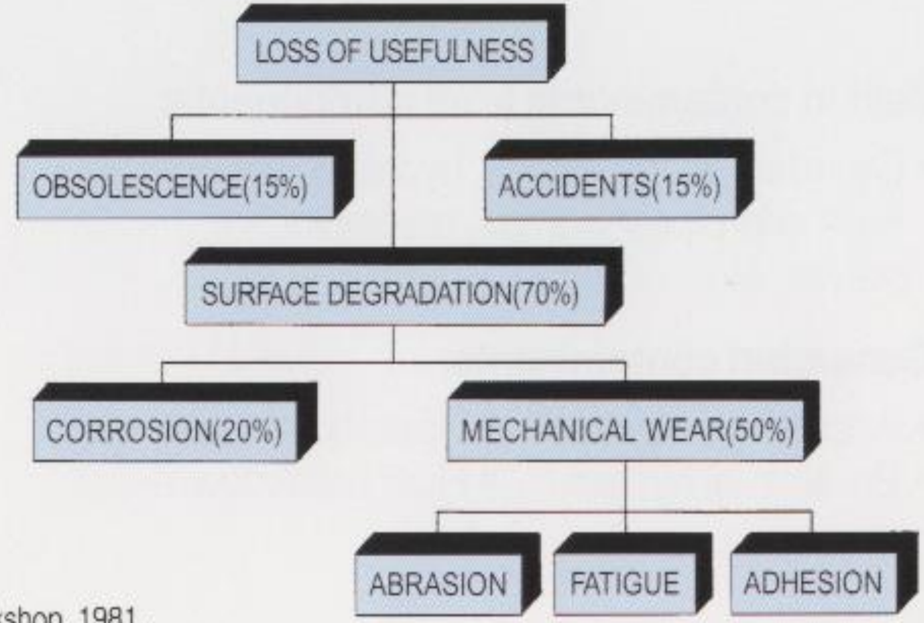
- Reservoir breathing
- Cylinder rod seals
- Bearing seals

Contaminants introduced during maintenance:

- Disassembly/assembly
- Makeup oil

Equipment Life Expectancy Factors

A study by Dr. E Rabinowicz at M.I.T. observed that 70% of component replacements or "loss of usefulness" is due to surface degradation. In hydraulic and lubricating systems, 20% of these replacements result from corrosion with 50% resulting from mechanical wear.



Presented at the American Society of Lubrication Engineers, Bearing Workshop, 1981.

Mechanisms of Wear

Type	Primary Cause
Abrasive wear	Particles between adjacent moving surfaces
Erosive wear	Particles and high fluid velocity
Adhesive wear	Metal to metal contact (Loss of oil film)
Fatigue wear	Particle damaged surfaces subjected to repeated stress
Corrosive wear	Water or chemical

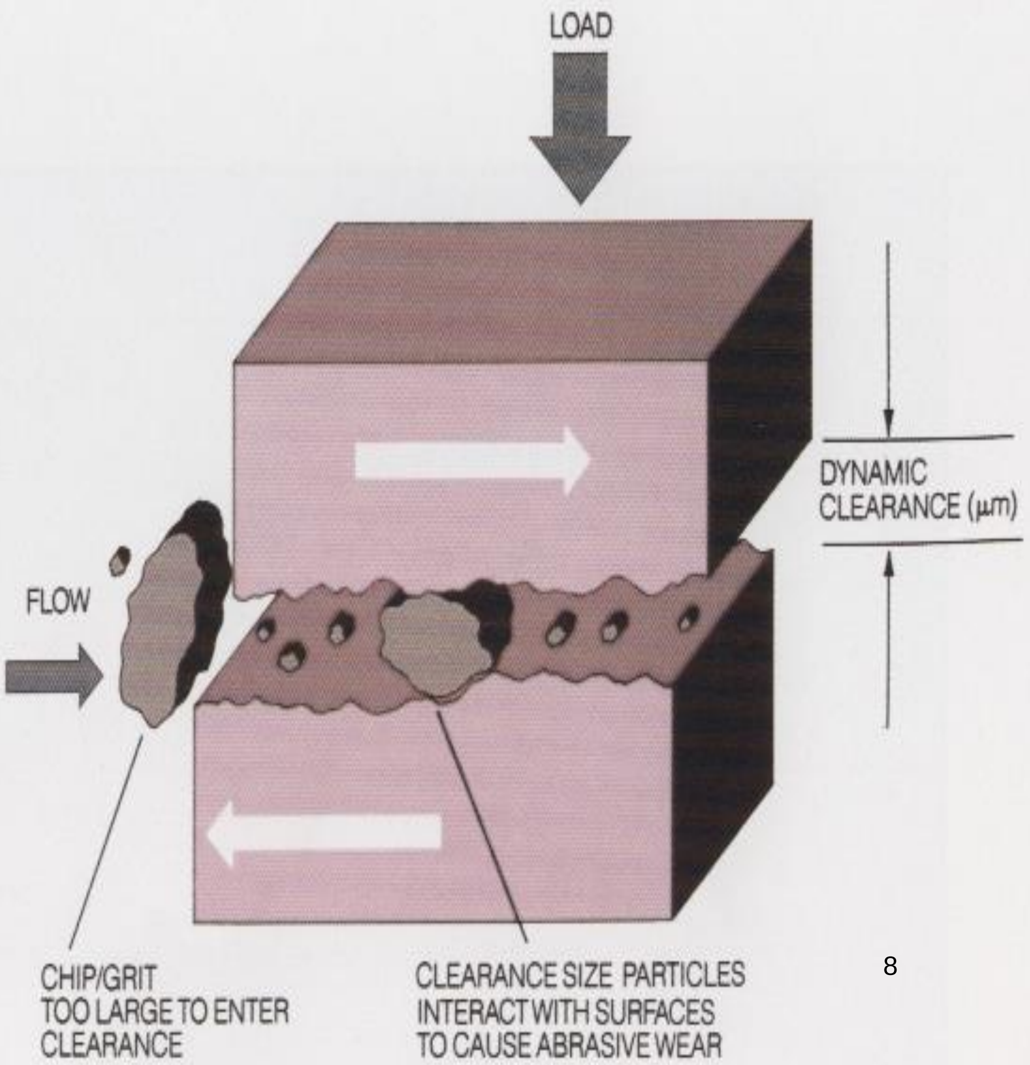
Each of these wear mechanisms results in the generation of particulate contamination capable of causing further component damage.

Abrasive Wear

Abrasive wear effects:

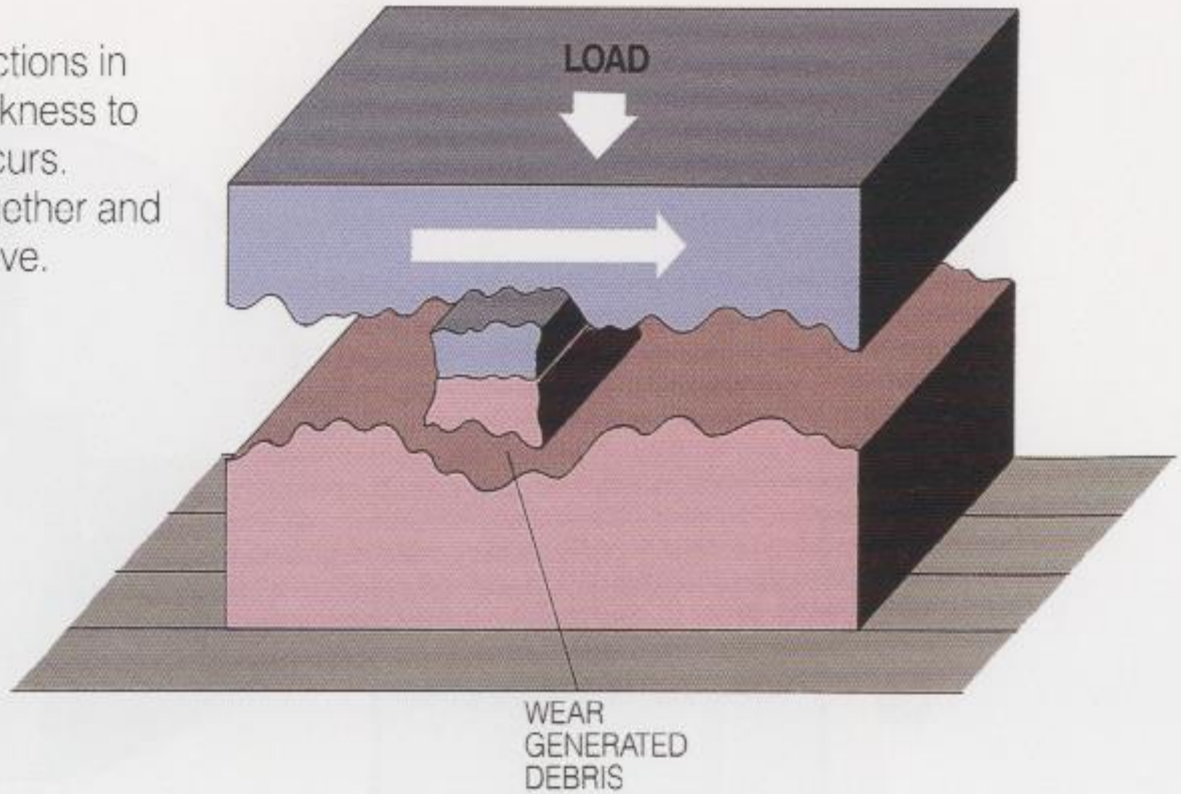
- Dimensional changes
- Leakage
- Lower efficiency
- Generated particles=more wear

Abrasive wear is the primary wear mechanism. Particles enter the clearance space between two moving surfaces, bury themselves in one of the surfaces, and act like cutting tools to remove material from the opposing surface. The particle sizes causing the most damage are those equal to and slightly larger than the clearance space. To protect opposing surfaces from abrasive wear, particles of approximately the dynamic clearance size range must be removed.



Adhesive Wear

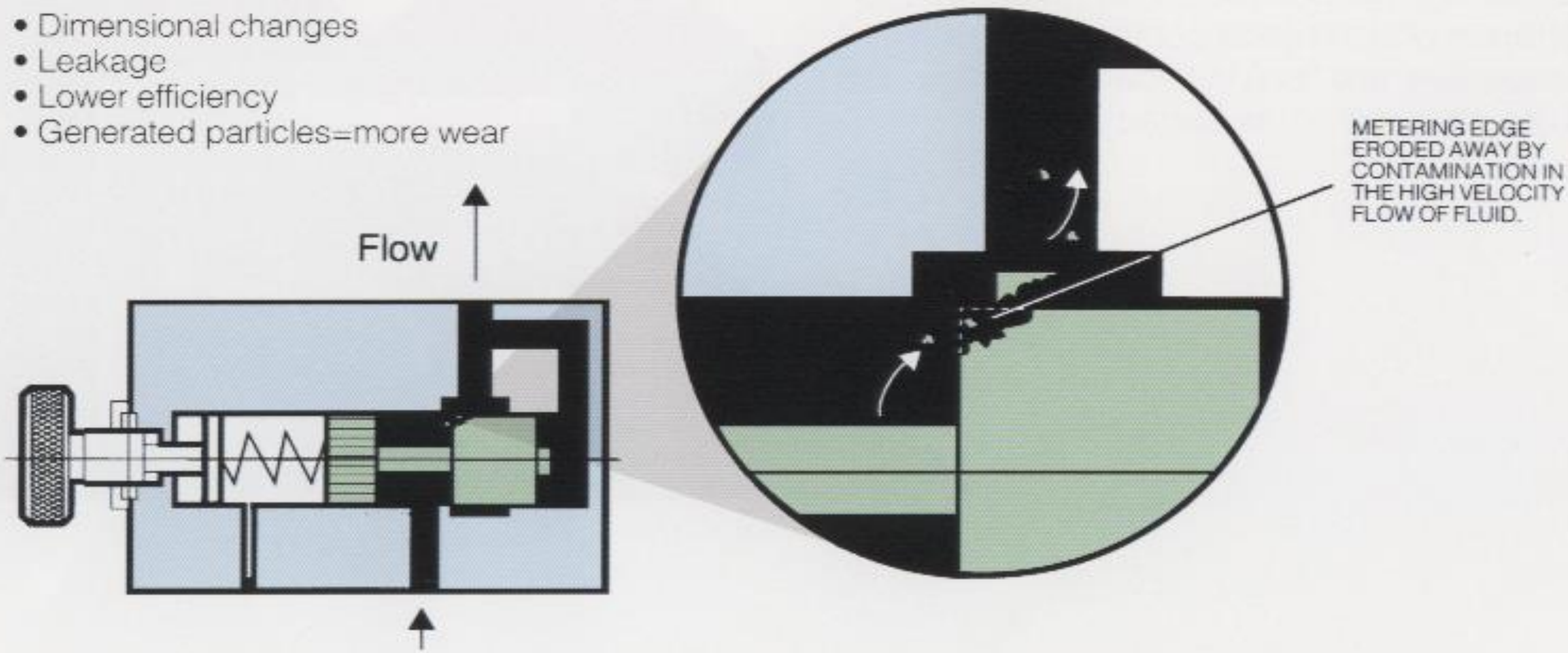
Excessive load, low speed, and/or reductions in fluid viscosity can reduce the oil film thickness to a point where metal to metal contact occurs. Surface asperities are "cold welded" together and particles are sheared off as surfaces move.



Erosive Wear

Erosive wear effects:

- Dimensional changes
- Leakage
- Lower efficiency
- Generated particles=more wear

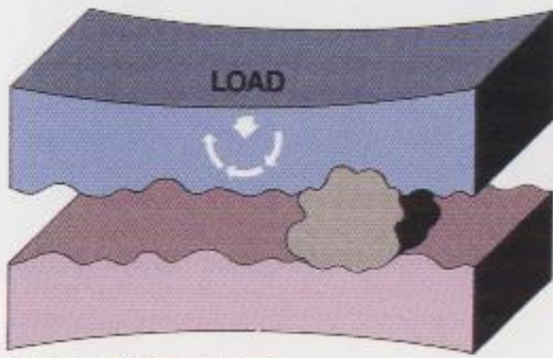


Erosive wear is caused by particles that impinge on a component surface or edge and remove material from that surface due to momentum effects. This type of wear is especially noticed in components with high velocity flows such as servo and proportional valves. Particles repeatedly striking the surface may also cause denting and eventual fatigue of the surface.

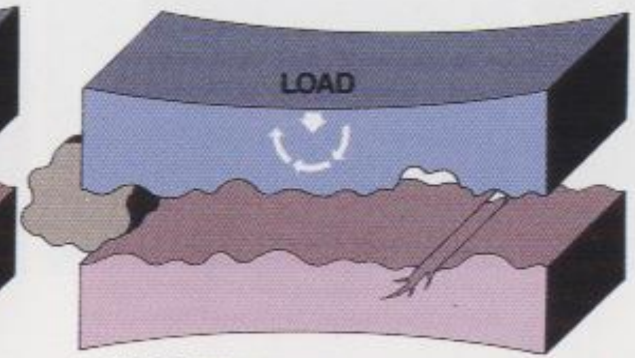
Reference. ASME Wear Handbook

Fatigue Wear

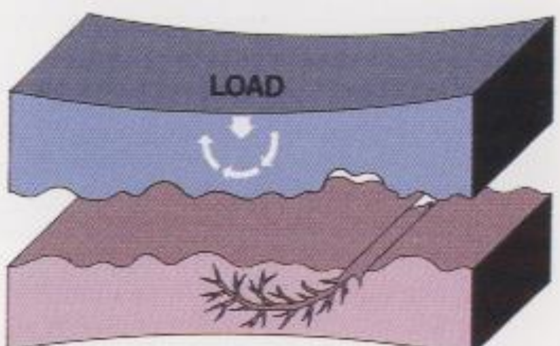
Bearing surfaces are subjected to fatigue failures as a result of repeated stressing caused by particles trapped by the two moving surfaces. At first, the surfaces are dented and cracking is initiated. These cracks spread after repeated stressing by the bearing load even without additional particulate damage and eventually the surface fails, producing a spall. Contamination reduces bearing life significantly through fatigue, abrasion, and roughening of operating surfaces.



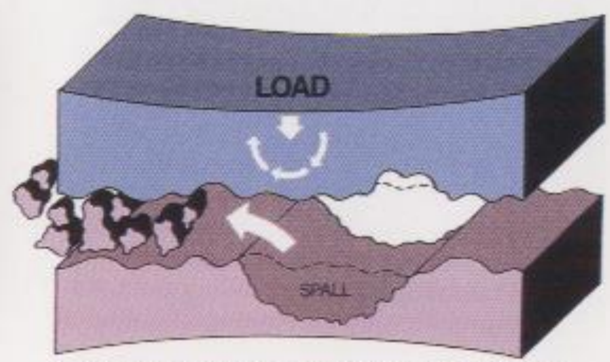
1. PARTICLE CAUGHT



2. SURFACES DENTED, CRACKING INITIATED

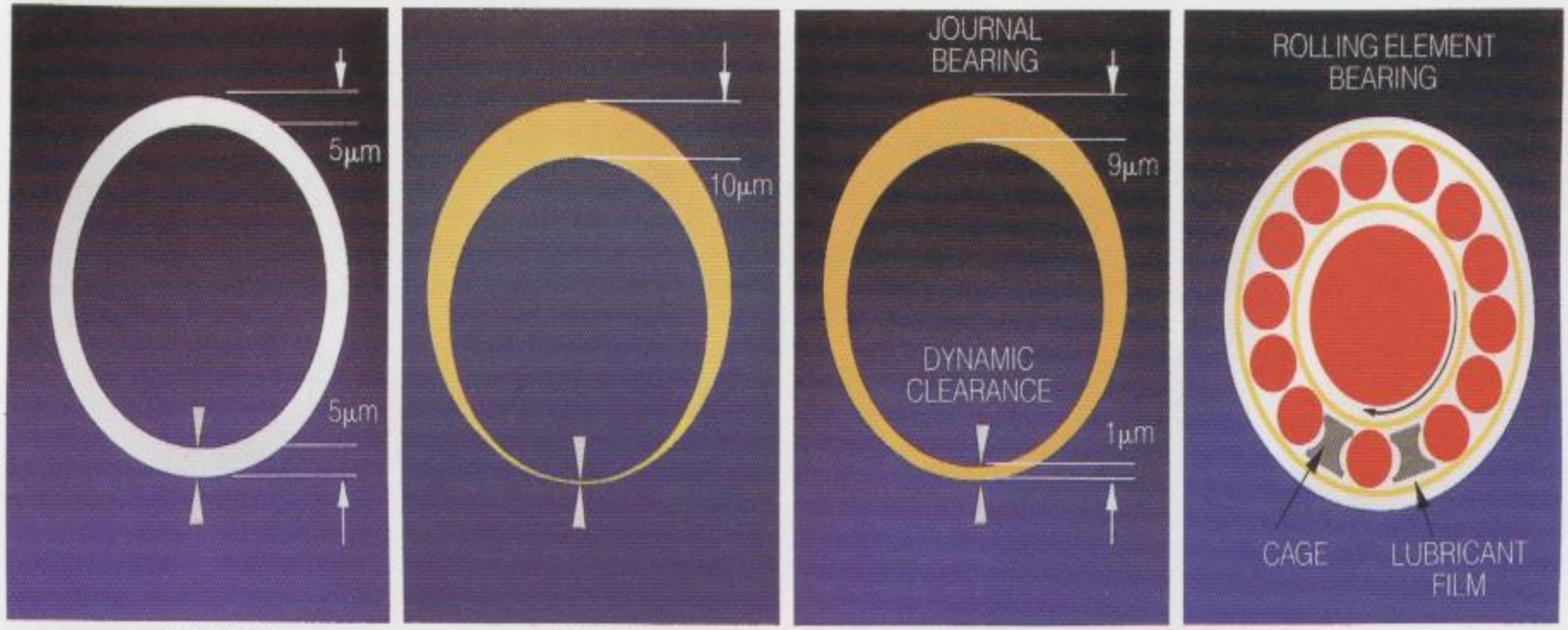


3. AFTER "N" FATIGUE CYCLES, CRACKS SPREAD



4. SURFACE FAILS, PARTICLES RELEASED

Bearing Wear



MACHINE CLEARANCE

LOAD, NO MOTION

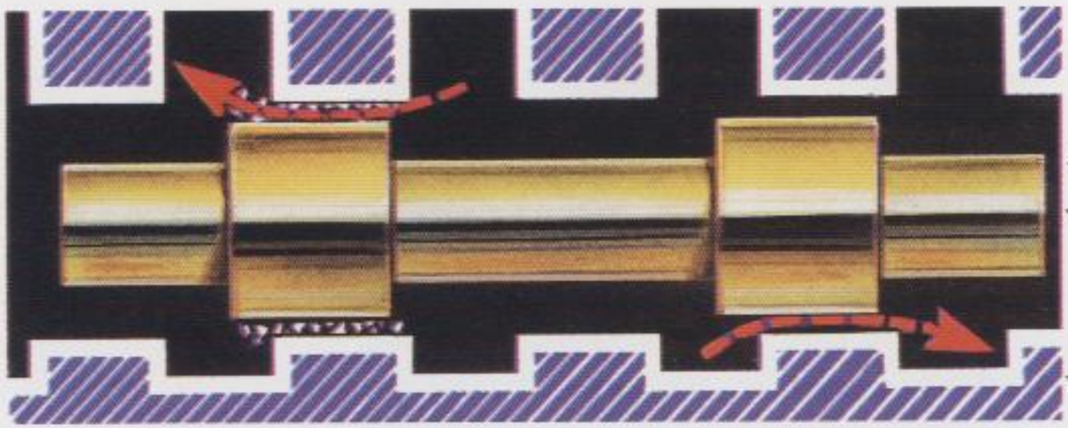
LOAD AND MOTION AND LUBRICANT

The operating or dynamic clearance is not equal to the machine clearance (fit) of the bearing but depends upon the load, speed, and lubricant viscosity. A lubricant film separates the moving surfaces to prevent metal-to-metal contact.

Component	Clearance (µm)
Journal bearings	0.5-100
Roller element bearings	0.1-3
Hydrostatic bearings	1-25

Reference: ASME Wear Handbook

Valve Wear



Typical valve dynamic clearances	
Servo valve	1-4 µm
Proportional valve	1-6 µm
Directional/control valve	2-8 µm

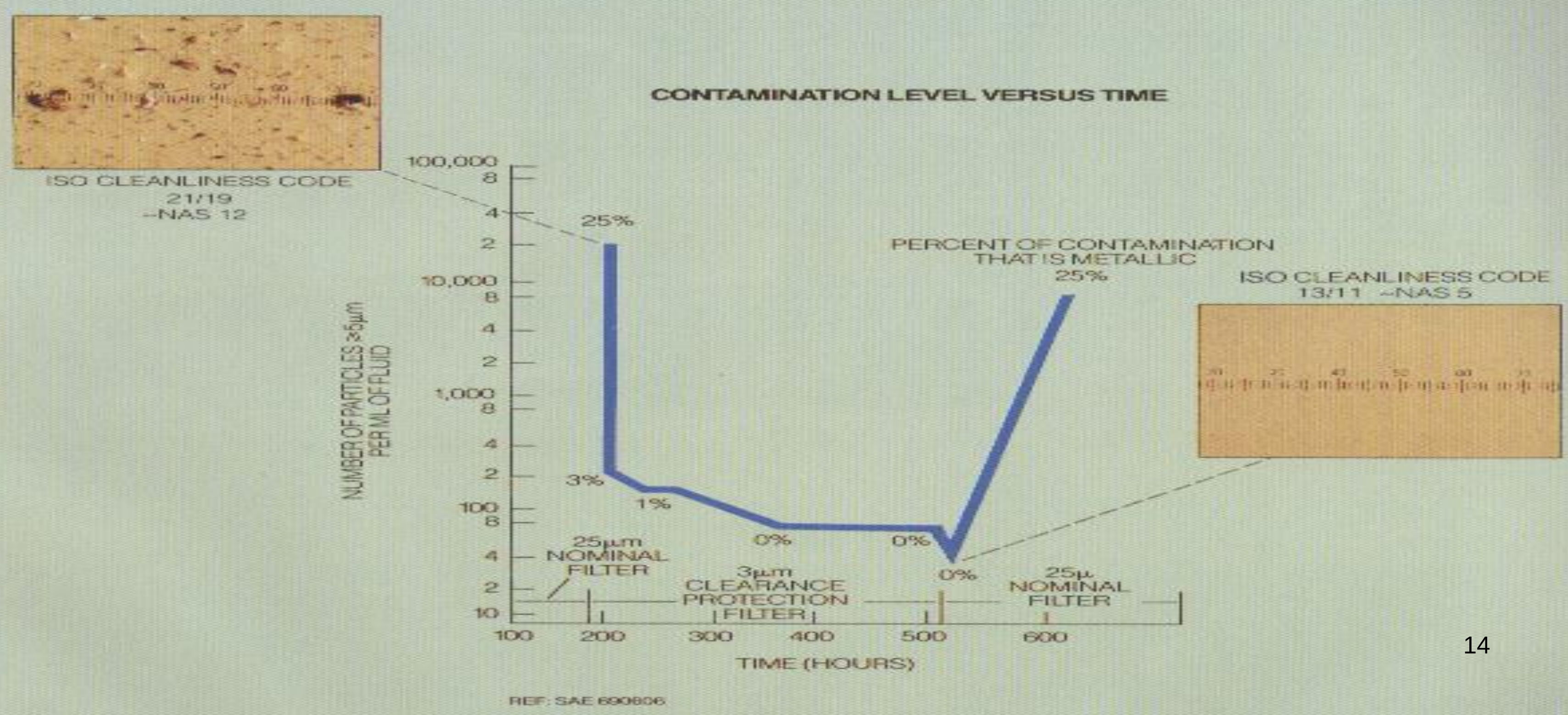
Clearance size particles cause:

- Slow response, instability
- Spool jamming/stiction
- Surface erosion
- Solenoid burn-out
- Safety systems fail

Reference: ASME Wear Handbook

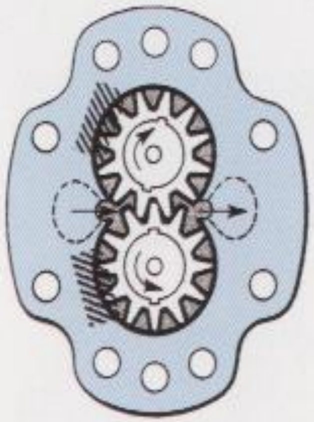
Chain Reaction of Abrasive Wear

Particles generated as a result of abrasive wear are work hardened; thus they become harder than the parent surface and, if not removed by proper filtration, will recirculate to cause additional wear. This "chain-reaction-of-abrasive-wear" will continue and result in premature system component failure unless adequate filtration is applied to "break the chain."

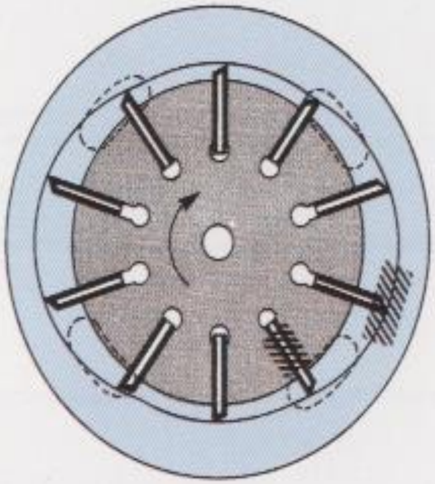


Pump Wear

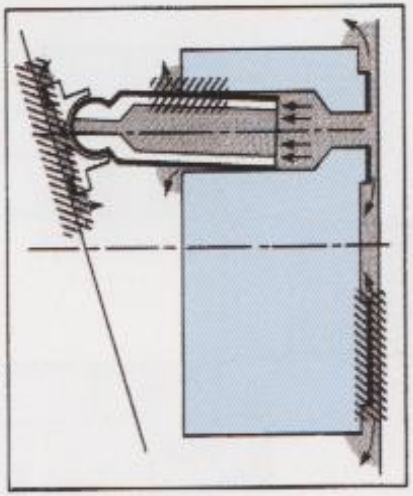
The fluid pump is one of the most dirt sensitive components. Clearance size particles increase the wear rate resulting in greater leakage, higher temperatures, lower oil pump pressures and reduced efficiency.



PUMP, GEAR
Dynamic clearance
Tooth to side plate: 0.5-5 µm
Teeth tip to case: 0.5-5 µm



PUMP, VANE
Dynamic clearance
Vane sides: 5-13 µm
Vane tip:0.5-1 µm



PUMP, PISTON
Dynamic clearance
Piston to bore: 5-40 µm
Valve plate to cylinder: 0.5-5 µm

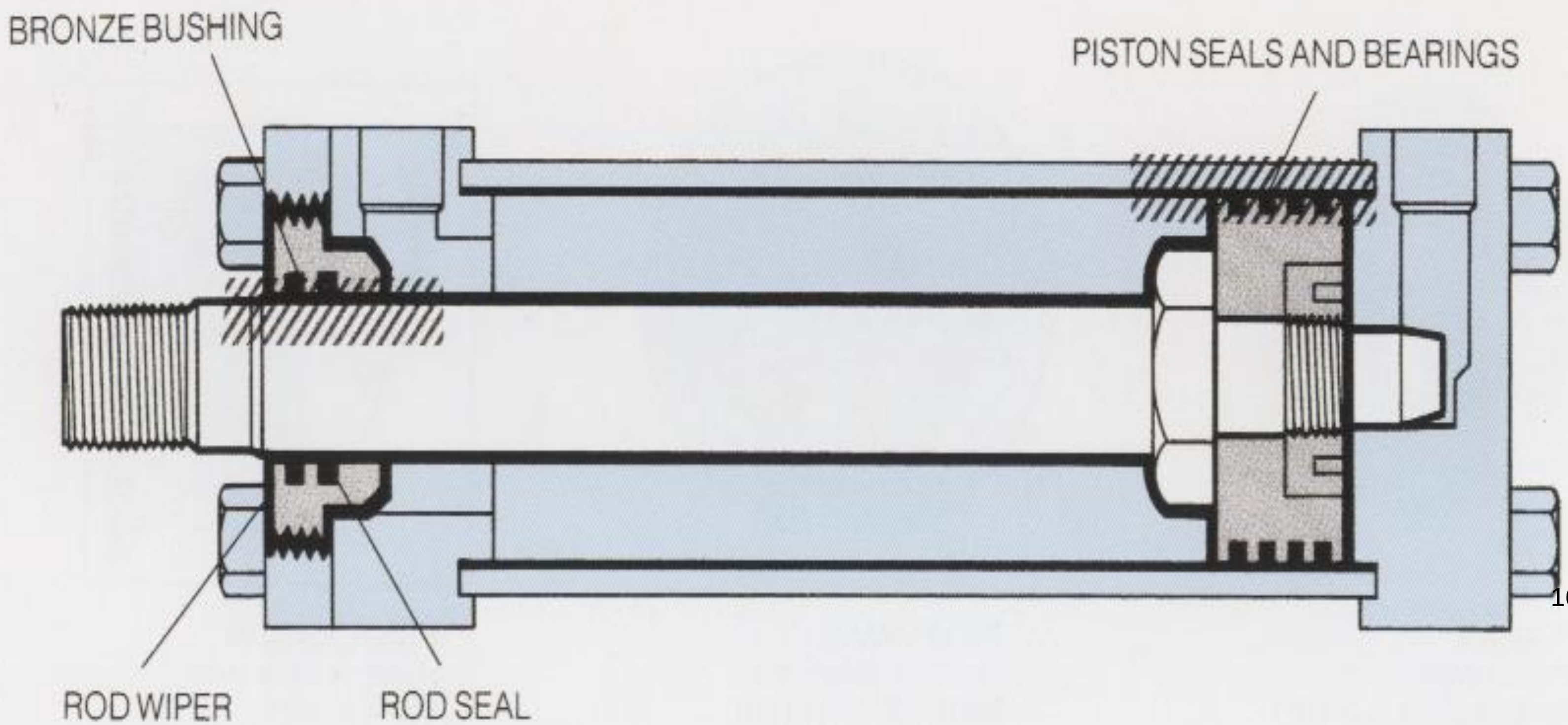
Ref. ASME Wear Handbook

Cylinder Wear

Cylinder rods and seal systems are major contributors to contaminant ingression. The extended rod, coated with an oil film, will capture particulate contamination from the surrounding atmosphere. When the rod re-enters the cylinder housing, system fluid rinses the particles from the rod into system hydraulic oil.

Clearance size contamination consequences

Rod seal wear:	Loss of oil through leakage
Bronze bushing wear:	Loss of rod alignment
Piston seal wear:	Loss of cylinder speed Loss of holding characteristics
Piston bearing wear:	Loss of alignment



Measuring Filter Performance – Filter Ratings

Nominal rating – An arbitrary micrometer value, based on weight percent removal, indicated by the filter manufacturer. Due to lack of reproducibility, this rating is deprecated.

Absolute rating – The diameter of the largest hard spherical particle that will pass through a filter under specified test conditions. This is an indication of the largest opening in the filter element.

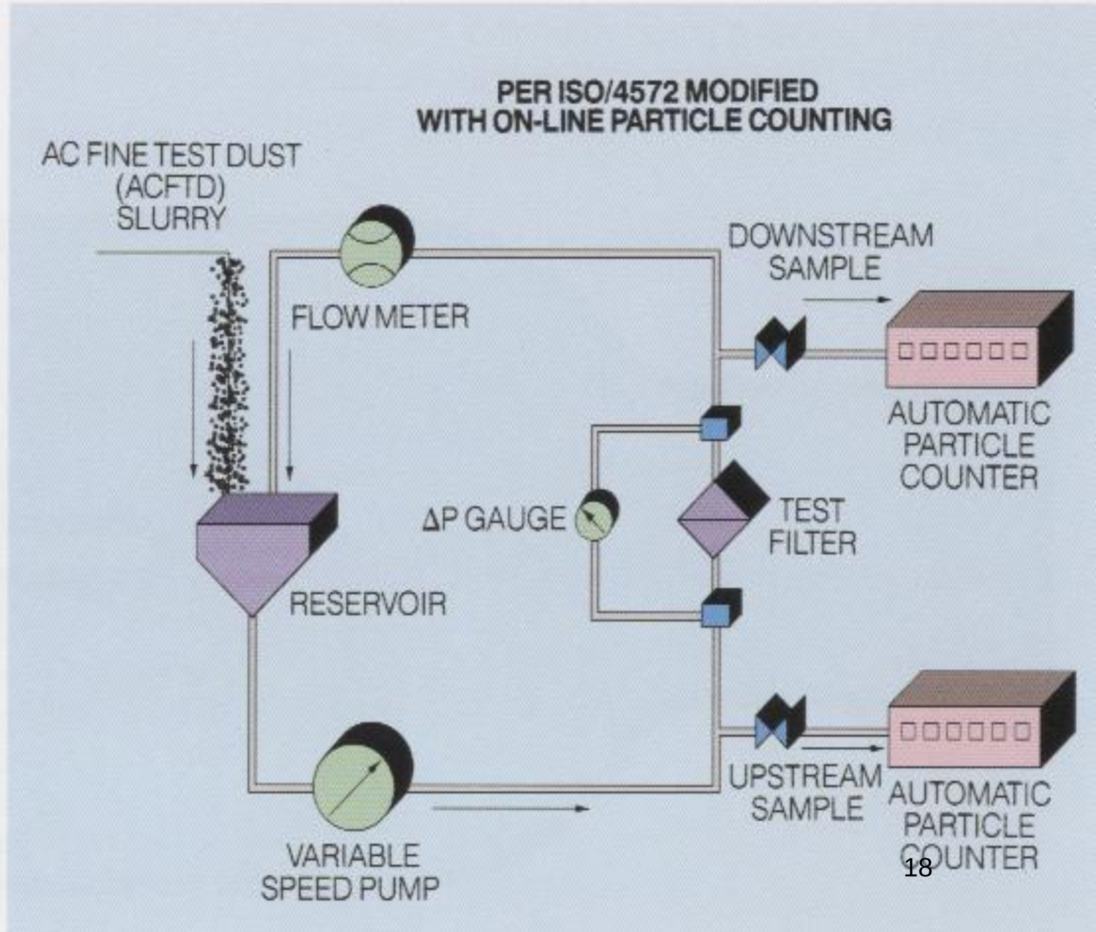
Filtration ratio (β_X) – The ratio of the number of particles equal to and greater than a given size (x) in the influent fluid to the number of particles equal to and greater than the same size (x) in the effluent fluid.

The Multi-pass Filter Performance Test

Internationally recognized as the most reliable means to obtain consistent and repeatable information on a filter's ability to control specific size particles.

The multi-pass "beta" (ß) test uses real dirt (ACFTD) challenging the filter in the same way an operating system would.

Fresh contaminant is introduced in a slurry form into the test reservoir, mixed with the fluid in the reservoir, and pumped through the test filter. Contaminant not captured by the filter is returned to the reservoir for another pass through the filter – thus the name "multi-pass". Upstream and downstream fluid samples are analyzed to determine their respective particle counts.

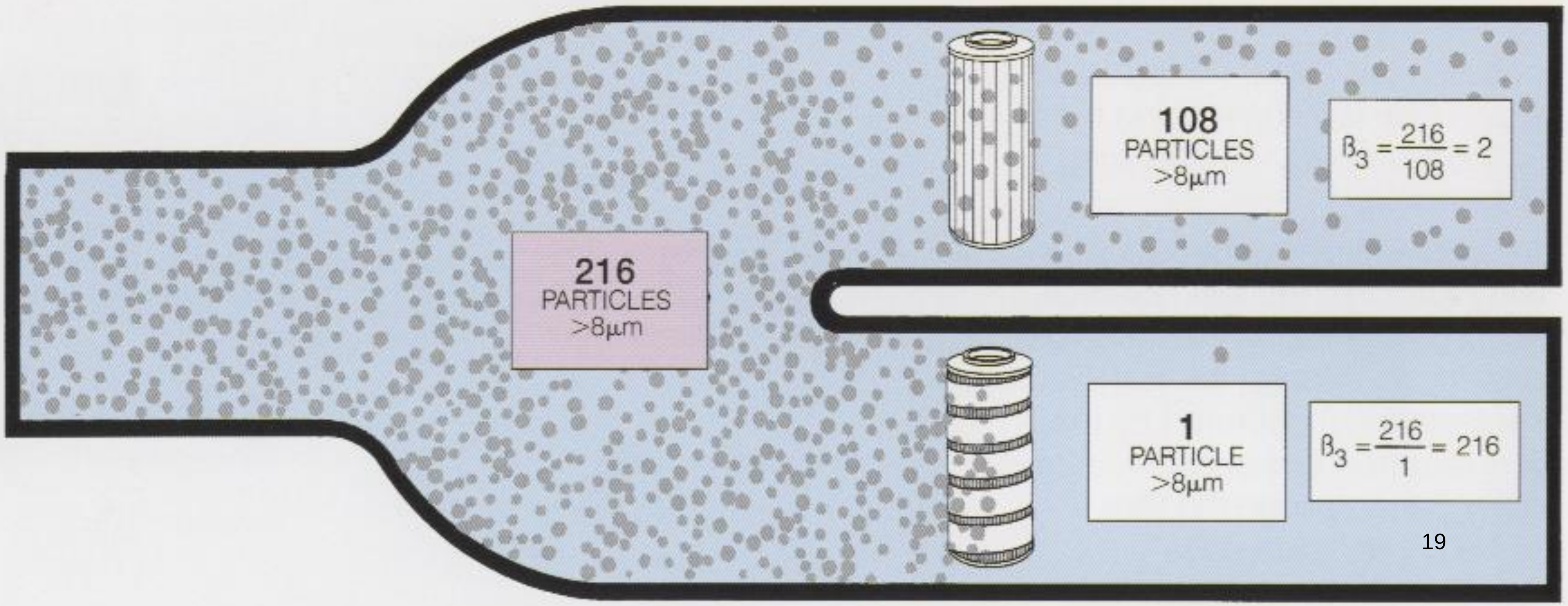


Beta (ß) Ratio

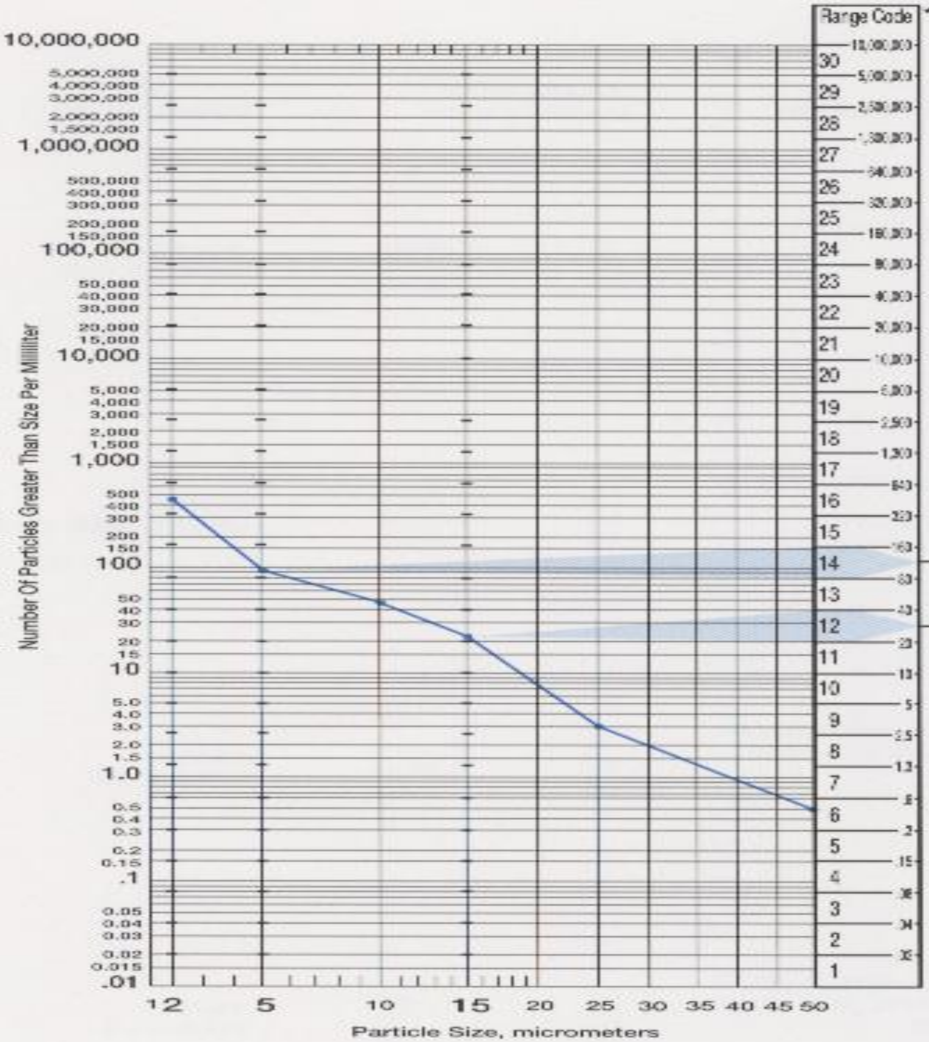
Beta ratio

The separation capability of a filter is presented as a filtration ratio beta sub x (β_X), defined as "the ratio of the number of particles greater than a given size (x µm) in a given volume of influent fluid to the number of particles greater than the same size (x µm) in the same volume of effluent fluid."

$$\text{Filtration ratio } \beta_X = \frac{\text{Number of upstream particles x µm and larger}}{\text{Number of downstream particles x µm and larger}}$$



ISO Clealiness Code



ISO Cleanliness Code:
14 / 12

PARTICLE COUNT SUMMARY		
PARTICLE SIZE	NUMBER PER ML. GREATER THAN SIZE	RANGE CODE*
5μm	90.00	14
10μm	44.00	
15μm	21.00	12
25μm	3.00	
50μm	0.50	

The ISO Cleanliness Code references the number of particles greater than 5 and 15 microns in each milliliter of fluid. The results of particle counting are plotted on a graph showing at the left.

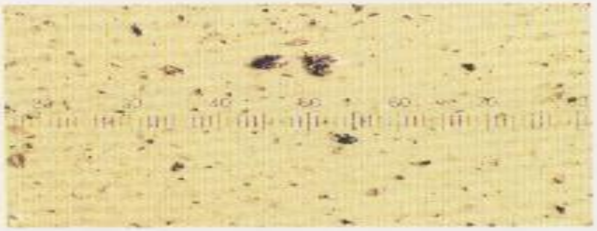
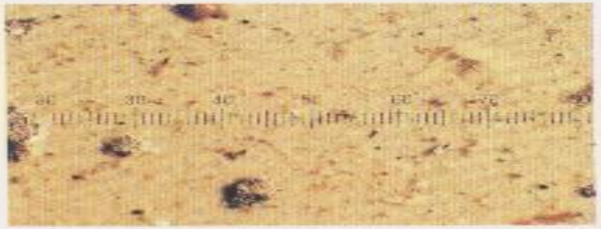
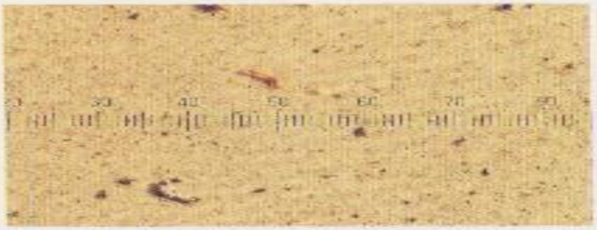
The corresponding range code, shown at the right of the graph, gives the cleanliness code number for each of the two particle sizes.

Notes:

Each increase in range number represents a doubling of the contamination level.

Contamination Level Comparison

Harmful clearance size particles can be effectively controlled only with high performance clearance protection filtration.

Photomicrograph(100× mag.)	Description	Number of Particles/ml		ISO NAS CLASS
	New oil from barrel	> 5 >10 >15	7,820 5,010 2,440	**20/18 NAS 11-12**
	New system with built-in contaminants	> 5 >10 >15	21,070 12,320 8,228	**22/20 OVER NAS CLASS**
	System with typical hydraulic filtration	> 5 >10 >15	2,400 1,800 540	**18/16 NAS 9-10**
	System with $\beta_3 \geqq 75$ clearance protection filtration	> 5 >10 >15	41 20 12	**13/11 NAS 4-5**

CONTAMINATION LEVEL CLASSIFICATION SYSTEMS PARTICLE COUNT LIMITS IN 100 ml

NAS 1638

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SIZE RANGE μm	CLASS 00	0	1	2	3	4	5	6	7	8	9	10	11	12
2-5*	625	1,250	2,500	5,000	10,000	20,000	40,000	80,000	160,000	320,000	640,000	1,280,000	2,560,000	6,120,000
5-15	125	250	500	1,000	2,000	4,000	8,000	16,000	32,000	64,000	128,000	256,000	512,000	1,024,000
15-25	22	44	89	178	356	712	1,425	2,850	5,700	11,400	22,800	45,600	91,200	182,000
25-50	4	8	16	32	63	126	253	506	1,012	2,025	4,050	8,100	16,200	32,400
50-100	1	2	3	6	11	22	45	90	180	360	720	1,440	2,880	5,760
Over 100	0	0	1	1	2	4	8	16	32	64	128	256	512	1,024

CLEANLINESS LEVEL CORRELATION TABLE

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BS5540/4 ISO 4406	NAS 1638 CLASS	SAE749 CLASS
23/20		
21/18	12	
20/18		
20/17	11	
20/16		
19/16	10	
18/15	9	6
17/14	8	5
16/13	7	4
15/12	6	3
14/12		
14/11	5	2
13/10	4	1
12/9	3	0
11/8	2	
10/8		
10/7	1	

TAISEI INDUSTRIAL HYDRAULICS & LUBRICATION TOTAL CLEANLINESS CONTROL

System Component	System Cleanliness Level Guidelines								
Servo valve	1	2	3	4	5				
Proportional valve		1	2	3	4	5			
Variable volume pump			1	2	3	4	5		
Cartridge valve				1	2	3	4	5	
Fixed piston pump				1	2	3	4	5	
Vane pump		Hydraulic Systems			1	2	3	4	5
Pressure/flow control valve					1	2	3	4	5
Solenoid valve					1	2	3	4	5
Gear pump					1	2	3	4	5
Ball bearings		1	2	3	4	5			
Roller bearings			1	2	3	4	5		
Journal bearings		Lubrication Systems		1	2	3	4	5	
Gear box (industrial)				1	2	3	4	5	
Gear box (mobile)					1	2	3	4	5
Cleanliness level (ISO)	10/7	11/9	12/10	13/11	14/12	15/12	16/13	16/14	17/14
TAISEI KOGYO Filtration Media				3M					
						6M			
								10M	

Hydraulic Systems
Maximum permissable recommended cleanliness level.

Pressure Range (bar)

3	>160
4	100 to 160
5	<100

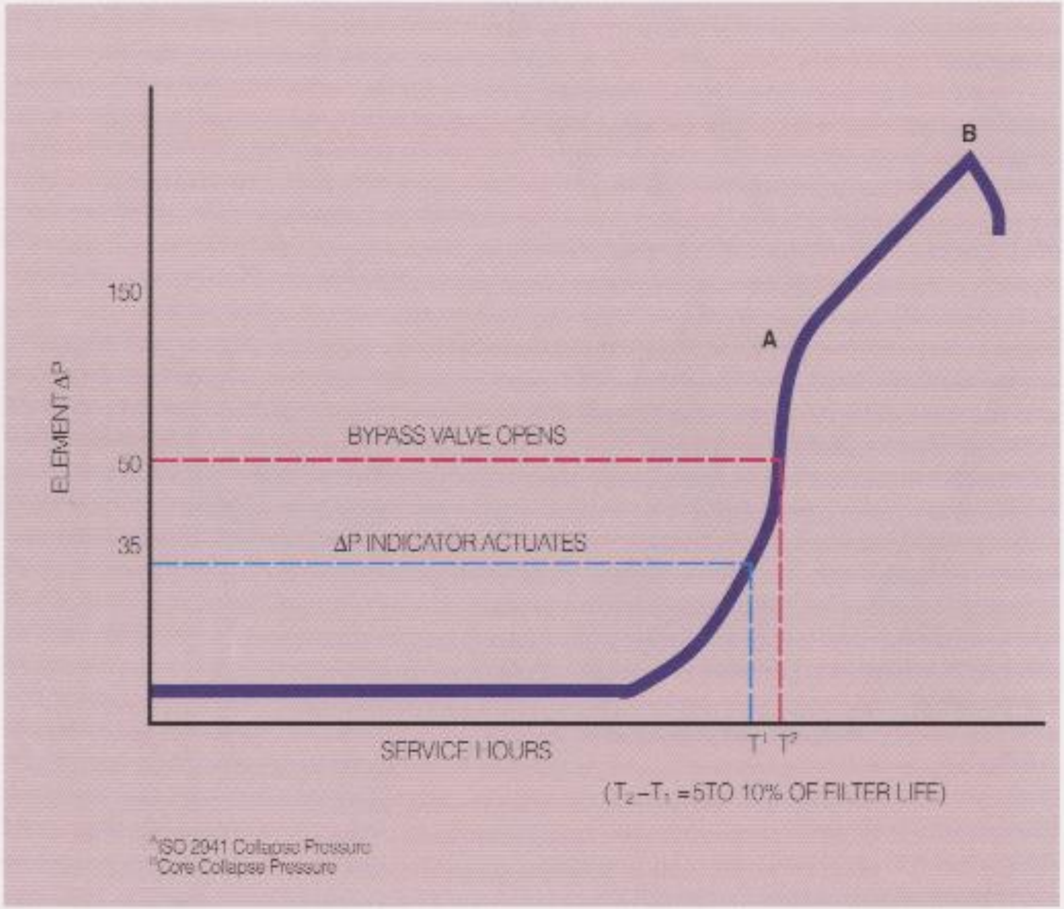
Lubrication Systems
Pressure ranges do not apply to lubrication systems
Start at mid-range 3 and adjust as per guidelines below.

To Determine Recommended System Cleanliness Level:

1. Start at the top of the system components list Find the first item used in your hydraulic or lubrication system. Subject to system type the recommended cleanliness level will be subject to the most sensitive component.
2. Locate box to the right of the selected component which corresponds to the operating pressure range.
3. Recommended cleanliness level is given at the bottom of each column that the box falls into.
4. Apply one column to the left if any of the following factors apply:
   a. System is critical to maintaining production schedules.
   b. High cycle / severe duty application.
   c. Water containing hydraulic fluid is used.
   d. System is expected to be in service more than seven years.
   e. System failure can create a safety concern.
5. Shift two columns to the left if two or more factors apply.
6. For lubrication system shift one level to the right if operating viscosity is greater than 150 cSt.

Contaminant Loading Curve

As dirt is trapped by the filter, differential pressure (ΔP) increases. A differential pressure indicator is used to signal element change before the bypass relief valve opens. The bypass valve protects the filter and system from excessive differential pressure and/or element collapse.



Water and Air Contamination in Oil

Water contamination in fluid systems causes:
- Fluid breakdown, such as additive precipitation and oil oxidation.
- Reduced lubricating film thickness
- Accelerated metal surface fatigue
- Corrosion
- Jamming of components due to ice crystals formed at low temperatures
- Loss of dielectric strength in insulating fluids

Sources of water contamination:
- Heat exchanger leaks
- Seal leaks
- Condensation of humid air
- Inadequate reservoir covers
- Temperature drops: dissolved water to free water

Forms of water in oil:
- Free water (emulsified or in droplets)
- Dissolved water (below saturation)

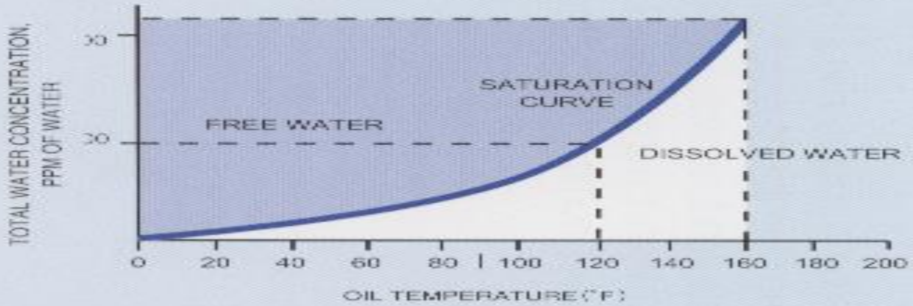
Free and dissolved water cause component and oil degradation. When oil becomes milky in appearance, the saturation limit at the oil temperature has been exceeded, indicating that both dissolved and free water are present.

Dissolved air and other gases in oils cause:
- Foaming
- Slow system response with erratic action
- A reduction in system stiffness
- Higher fluid temperatures
- Pump damage due to cavitation
- Inability to develop full system pressure
- Acceleration of oil oxidation

Water measurement techniques:
- Crackle test (free)
- Centrifugal (free)
- Karl Fischer (free and dissolved)
- Distillation (free and dissolved)

Typical oil saturation levels:
- Hydraulic – 200-400 ppm (.02-.04%)
- Lubrication – 200-750 ppm (.02-.075%)
- Transformer – 30-50 ppm (.003-.005%)

FREE AND DISSOLVED WATER IN OIL VS. TEMPERATURE



Ref: EPRI CS-4555;Typical turbine oil;

To minimize the harmful effects of free water(formed at lower system temperatures),water concentration in oil should be kept as far below the oill saturation point as possible.

Effect of Water and Metal Particles on Oil Oxidation

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Oil oxidation is increased in a hydraulic or lubricating oil in the presence of water and particulate contamination. Small metal particles act as catalysts to rapidly increase the neutralization number or acid level.

Run	Catalyst	Water	Hours	Total* Acid Number Change
1	None	No	3500 +	0
2	None	Yes	3500 +	+.73
3	Iron	No	3500 +	+.48
4	Iron	Yes	400	+7.93
5	Copper	No	3000	+.72
6	Copper	Yes	100	+11.03

*Total acid number increases, which exceed 0.5 indicate significant fluid deterioration.

Reference: Weinschelbaum, M., Proceedings of the National Conference on Fluid Power, VXXIII: 269.

Common Methods for Water Removal

Coalescence —
Free water only

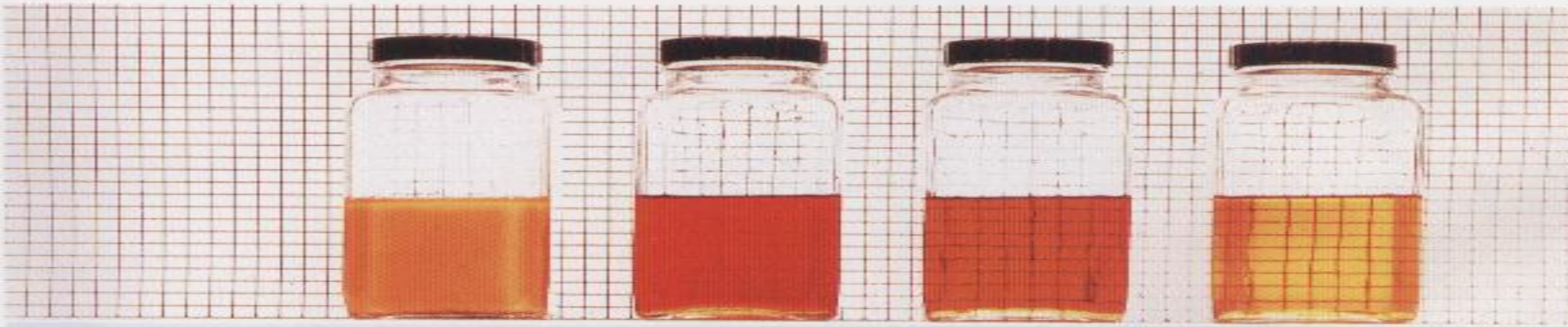
Centrifugation —
Free water only, expensive, high maintenance

Absorption —
Free water

Vacuum dehydration —
Free and dissolved water, good for unit and bulk processing

Vacuum dehydration is best for maximum water removal at minimum cost and greatest ease of use. This is accomplished without altering the physical or chemical properties of the treated fluid.

The following samples and test data illustrate the dramatic effect that the vacuum dehydration method coupled with high performance filtration has on measured contamination:



Run Time (Min)	Initial	60	135	165
Water Content (PPM)	8,650	1,240	466	340
Particulate Level (ISO Cleanliness Level)	20/16	14/11	13/11	13/10

Reference: SAE Paper 840716

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ADVANCE
Vacuum Dehydration Technology
Taisei Kogyo
WT2000 Series

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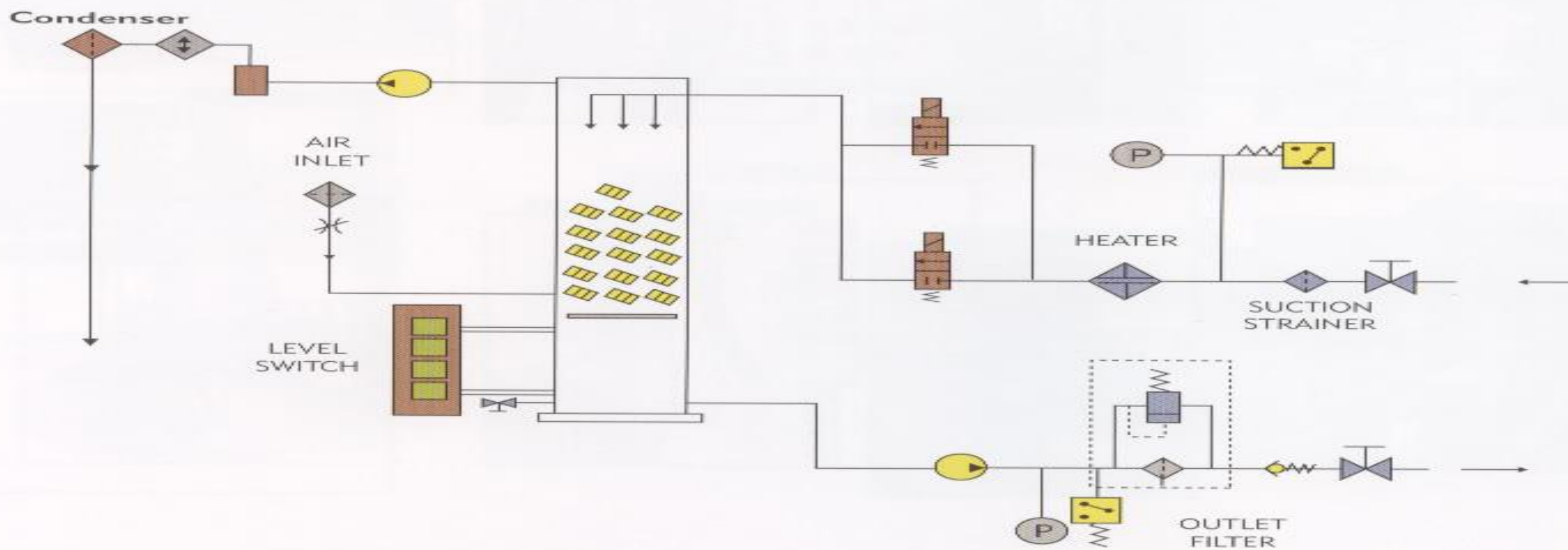
說　明

Taisei WT 2000 系列真空式淨油機是以質量交換的原理在中度真空的條件下進行油中水份及氣體的去除，設備並搭配高效率過濾器用以除去顆粒性污染。
本設備可設計為移動或固定型式，操作非常簡單，除供應3相電源外，無須外接任何水或空氣管路，啓動後可自動運轉及保護，遇有液位或其他條件異常時即可自動停機，同時有逆止閥和電磁閥來保護系統可能的回油及背壓。

The Taisei WT 2000 Vacuum type oil purifier has been employs the process of mass transfer with middle degree vacuum level to removal water,gases. Meanwhile use highly efficient filter to removal solid particles.
Taisei WT 2000 can be moved from one system to other or left as a permanent installation. Purifier has been designed simply operation,just connected to a 3p hase electrical supply, Then open the inlet and outlet valves and turned the switches to on to start the machine.
Automatic controls, integral to the unit, constantly monitor its operation and will safely shut down the system if fluid levels and pressure is outside normal limits . A solenoid valve on the inlet and check valve on the outlet prevents fluid draining back into the tower from a reservoir with a positive head.

參考流程圖　Flow Schematic



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FLOW SCHEMATIC

Filter Placement

Filter Flushing
- To remove contaminants that will cause catastrophic failures
- To remove wear causing particles prior to system start up
- To extend "in-service" filter element life

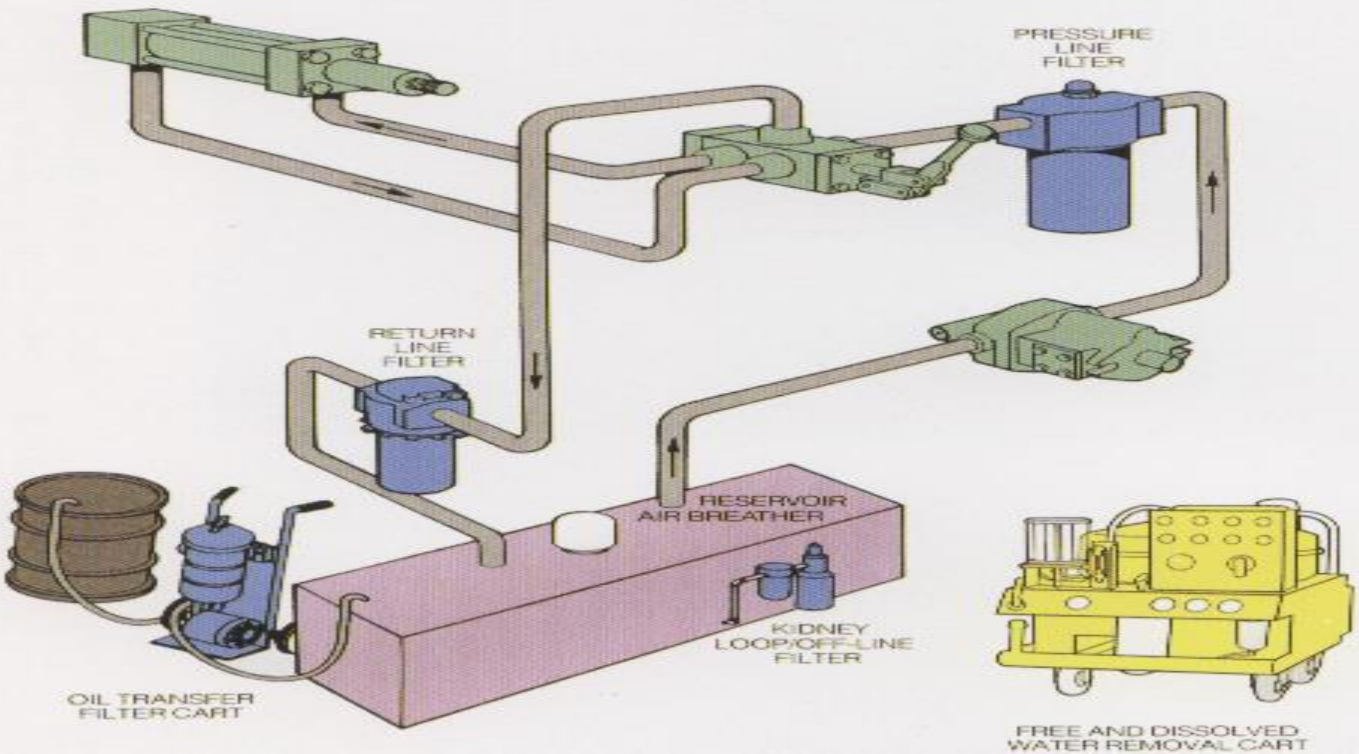
Pressure Line
- To stop pump wear debris from traveling through the system
- To catch debris from a catastrophic pump failure and prevent secondary system damage
- To act as a last chance filter to keep dirt out of circuit

Return line
- To capture debris from component wear or ingression returning from circuit
- To promote general system cleanliness

Air breather
- To extend filter element service life
- To maintain system cleanliness

Kidney loop/off-line
- To control system cleanliness when pressure line flow diminishes (i.e. compensating pumps)
- For systems where pressure or return filtration is impractical
- As a supplement to in-line filters to provide improved cleanliness control and filter service life in high dirt ingression systems.

Additional filters should be placed ahead of critical or sensitive components
- To reduce wear
- To stabilize valve operation (prevents stiction)
- To protect against catastrophic machine failure (often non-bypass filters are used)



Flushing

High velocity oil flush using high efficiency full flow filters

Reynolds Number

$$Re = \frac{21,220\ Q}{v\ d}$$

Where:

Re =	Reynolds Number	dimensionless
v =	Kinematic viscosity	cSt
d =	Pipe inside diameter	mm
Q =	Flow rate	lpm

Turbulent flow is ensured whenever the Reynolds Number exceeds 4,000.
The Reynolds Number equation depends on three variables; flow velocity, viscosity and fluid density.

A flushing pump - should be capable of supplying the oil flow necessary to achieve Reynolds Number over 4000.

Flushing oil - should be continuously passed through a full flow filter.

Filtration efficiency - should be defined as 3 um absolute with Beta ratio at 3 micron of 75(B_3=75)

工業用潤滑油之國際標準

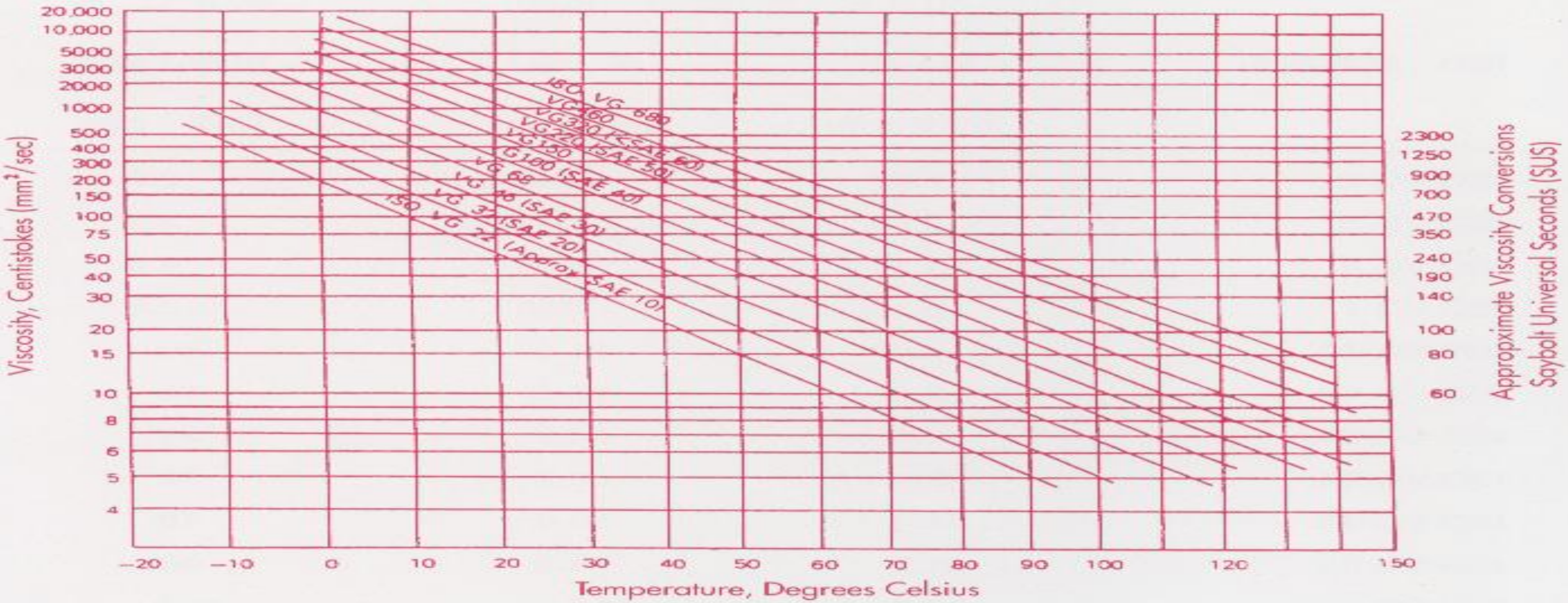
ISO Viscosity Classification

(ISO 3448, 1975-01-15)

ISO 粘度級別	40.0° C 動力粘度 (cSt) 範 圍 Minimum		(約 值) Maximum	40.0° C 時 中點之動力 粘度 cSt.
ISO VG 2	1.98	—	2.42	2.2
ISO VG 3	2.88	—	3.52	3.2
ISO VG 5	4.14	—	5.06	4.6
ISO VG 7	6.12	—	7.48	6.8
ISO VG 10	9.00	—	11.0	10
ISO VG 15	13.5	—	16.5	15
ISO VG 22	19.8	—	24.2	22
ISO VG 32	28.8	—	35.2	32
ISO VG 46	41.4	—	50.6	46
ISO VG 68	61.2	—	74.8	68
ISO VG 100	90.0	—	110	100
ISO VG 150	135	—	165	150
ISO VG 220	198	—	242	220
ISO VG 320	288	—	352	320
ISO VG 460	414	—	506	460
ISO VG 680	612	—	748	680
ISO VG 1000	900	—	1100	1000
ISO VG 1500	1350	—	1650	1500

潤滑油粘度—溫度關係圖

Approximate Temperature Conversions Degrees Fahrenheit



Viscosity - Temperature Chart

NOTE: Viscosity classification numbers are according to International Standard ISO 3448-1975 for oils having a viscosity index of 95.
Approximate equivalent SAE viscosity grades are shown in parentheses.

謝謝聆聽

說明會簽到表

說明會簡報

高效率淨油設備系列型錄