PLANET FILTERS S.p.A.
Фильтрация

Содержание

- Гидравлика, введение.
- Загрязнение, причины и последствия.
- Типы и источники возникновения загрязнений.
- Стандарты чистоты рабочей жидкости.
- Фильтрующие материалы, типы и степень фильтрации.
- Выбор материала фильтрации.
- Ресурс фильтроэлемента.
- Filters allocations.
- Фильтры, выбор и применение.
- Анализ загрязнения рабочих жидкостей.
- Обзор линейки фильтров.

Фильтрация, обучение#1

Гидравлика,

Введение

Гидравлика. Введение “гидравлические жидкости”

- Главное задача гидроприводов –передача механической энергии через трансформацию в гидравлическую и обратно – «передавать движение»
- Смазка контактирующих пар.
- Обеспечение масляной плёнки для гарантии отсутствия «адгезии».
- Отвод избыточного тепла.

Как следствие, для обеспечения этих функций, жидкость должна быть максимально очищена от загрязнений.

Фильтрация, обучение#1

Загрязнения

Причины/следствия

+

Типы и источники возникновения загрязнений

Типы загрязнений

- **В анализируемых нами гидросистемах, существуют три типа загрязнений:**
  - **Твёрдые (пыль и осадок).**
  - **Жидкие (вода).**
  - **Газообразные (воздух и растворённые газы).**

Загрязнения
Причины/следствия

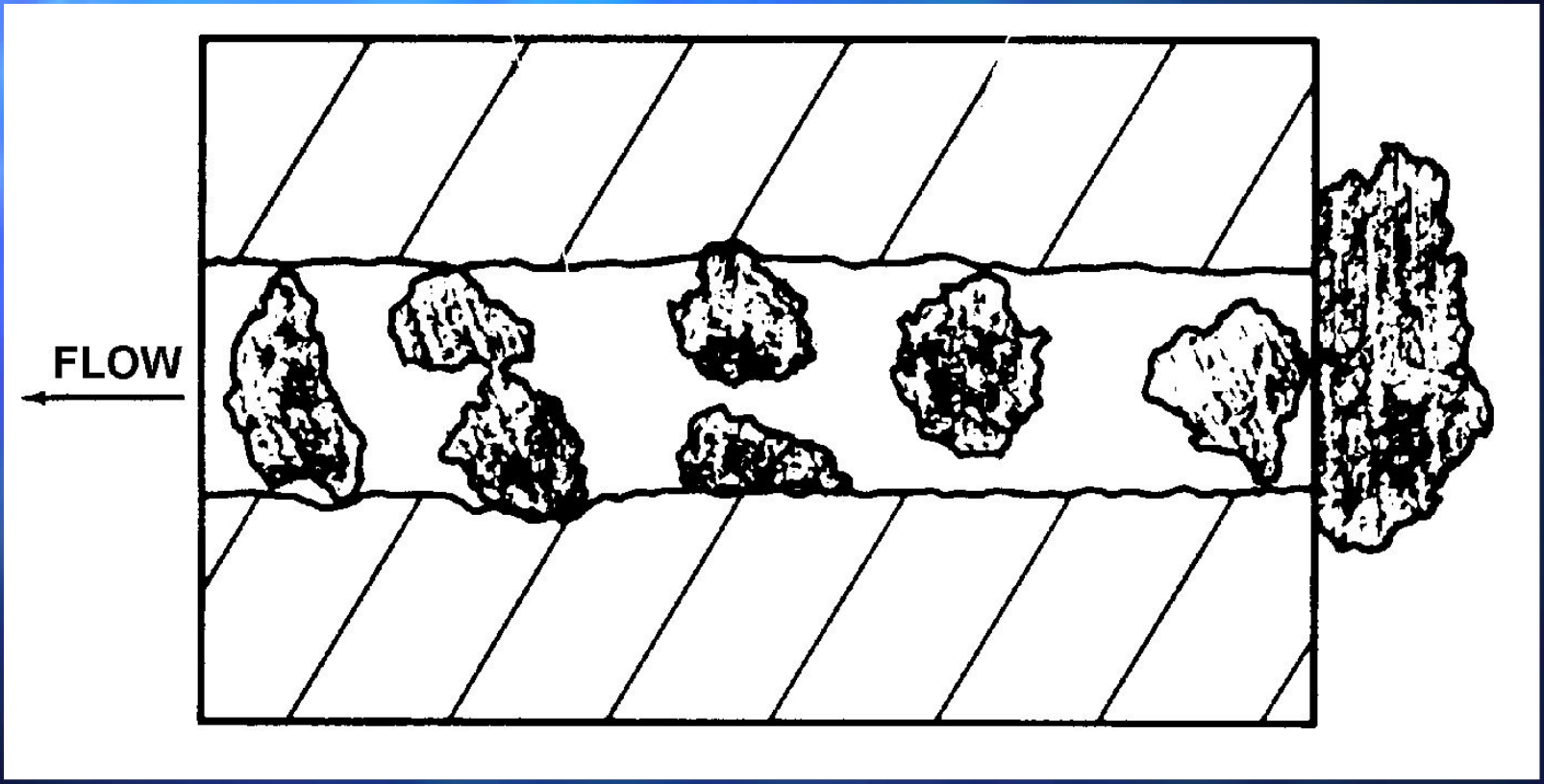
- Статистические исследования проведённые Др. Рабинович из (Massachusset Institute of Technology) Бостон, подтверждают, что 70% выхода из строя гидроприводов происходят по причине:

  - Механический износ (наличие твёрдых частиц).
  - Коррозия (присутствие воды).

“Твёрдые” Загрязнения

- Твёрдые загрязнения (частицы) в гидравлической жидкости могут быть условно квалифицированы по размеру и по производимому ущербу:
  - Крупные частицы: > 50 мкм обычно не более 2 ÷ 5% от всех присутствующих; являются причиной так называемого «Катастрофического» выхода из строя гидравлических компонентов.
  - Средние частицы: 25 ÷ 50 мкм обычно не более 5 ÷ 7% от всех присутствующих в системе; являются причиной «абразивного» выхода из строя гидравлических компонентов.
  - Тонкие частицы: 2 ÷ 25 мкм в наличии около 50 ÷ 70% от всех присутствующих в системе; являются причиной выхода из строя гидравлических компонентов по состоянию износа.

“Твёрдые” Загрязнения



“Твёрдые” Загрязнения

“Катастрофический” выход из строя происходит когда в зазоры между движущимися компонентами гидроузлов попадают частицы с большими размерами, чем поля допусков; данные случаи определяются по:

- Прекращению движения/заклиниванию.
- Падению давления.
- Отсутствию реакции на управляющее воздействие.
- Как следствие
  - Заклинивание
  - Потеря управления

“Твёрдые” Загрязнения

“Абразивный” выход из строя, происходит когда в зазоры между движущимися компонентами гидроузлов попадают частицы с примерно такими же размерами, как и поля допусков; данные случаи определяются по:

- Временному или полному заклиниванию
- Повреждению поверхностей компонентов.
- Генерации новых частиц загрязнения.
- Как следствие:

  - Сокращение срока службы гидроузлов.
  - Увеличение количеств ремонтных работ.
  - Повышение стоимости обслуживания.

“Твёрдые” Загрязнения

“Износ” происходит когда в зазоры между движущимися компонентами гидроузлов попадают частицы с меньшими размерами, чем поля допусков; данные случаи определяются по:

- Изменению полей допусков.
- Истирании покрытий/регенерации новых частиц.
- Разрушению на кромках движущихся компонентов.
- Как следствие:

  - Снижение КПД.

  - Снижение точности работы привода.

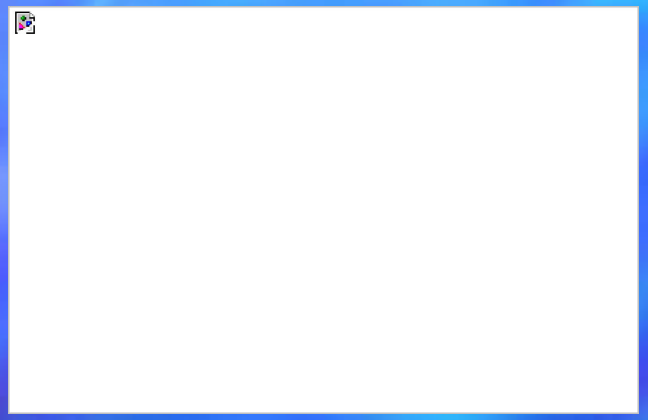
  - Увеличение выхода бракованной продукции (для индустриального применения приводов).

  - Увеличение потребления энергии (из-за падения КПД)

“Твёрдые” Загрязнения/последствия

- Падение эффективности производства.
- Увеличение затрат на запасные части.
- Увеличение затрат на замену масла.
- Увеличение затрат на утилизацию масла.
- Увеличение затрат на техобслуживание.
- Увеличение затрат на электроэнергию или топливо.
- Снижение надёжности машины.

“Твёрдые” Загрязнения/последствия



поршень/ изношенный башмак

Изношенный поршень

Изношенный распределительный золотник аксиально поршневого насоса.

“Твёрдые” Загрязнения

Допуски ряда гидравлических компонентов.

Компонент	мкм
Подшипники	0,5
Пластинчатые насосы (пазы ротора)	0,5 ÷ 1,0
Шестерённые насосы	0,5 ÷ 5,0
Серво-клапаны	1,0 ÷ 4,0
Элементы гидростатической трансмиссии	1,0 ÷ 25
Поршневая группа насосов (Поршень / Гильза)	5,0 ÷ 40,0

“Твёрдые” Загрязнения

Размеры частиц некоторых веществ:

Вещество	мкм (μm.)
Гранула поваренной соли	100
Человеческий волос	70
Предел видимости человеческого глаза	40
Гранула хлебной муки	25
Красные кровяные тельца	8
Бактерии	2

“Твёрдые” Загрязнения

Примерная классификация

Твёрдые частицы

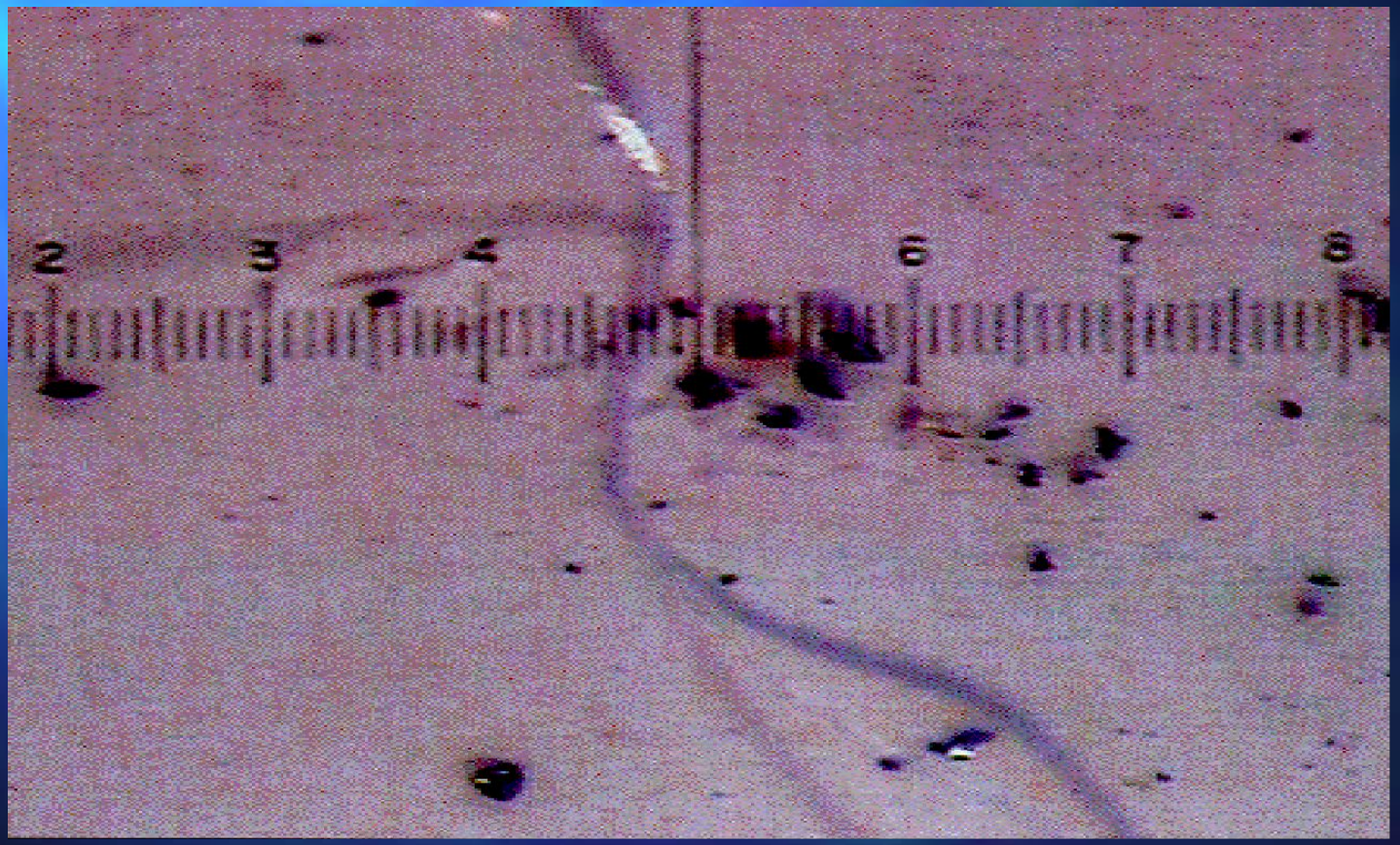
- Кремний (пыль).
- Углерод (сварка).
- Металлические частицы (продукты износа).

Мягкие частицы

- Резина (уплотнения - шланги).
- Частицы неорганического волокна
- Микроорганизмы (бактерии).

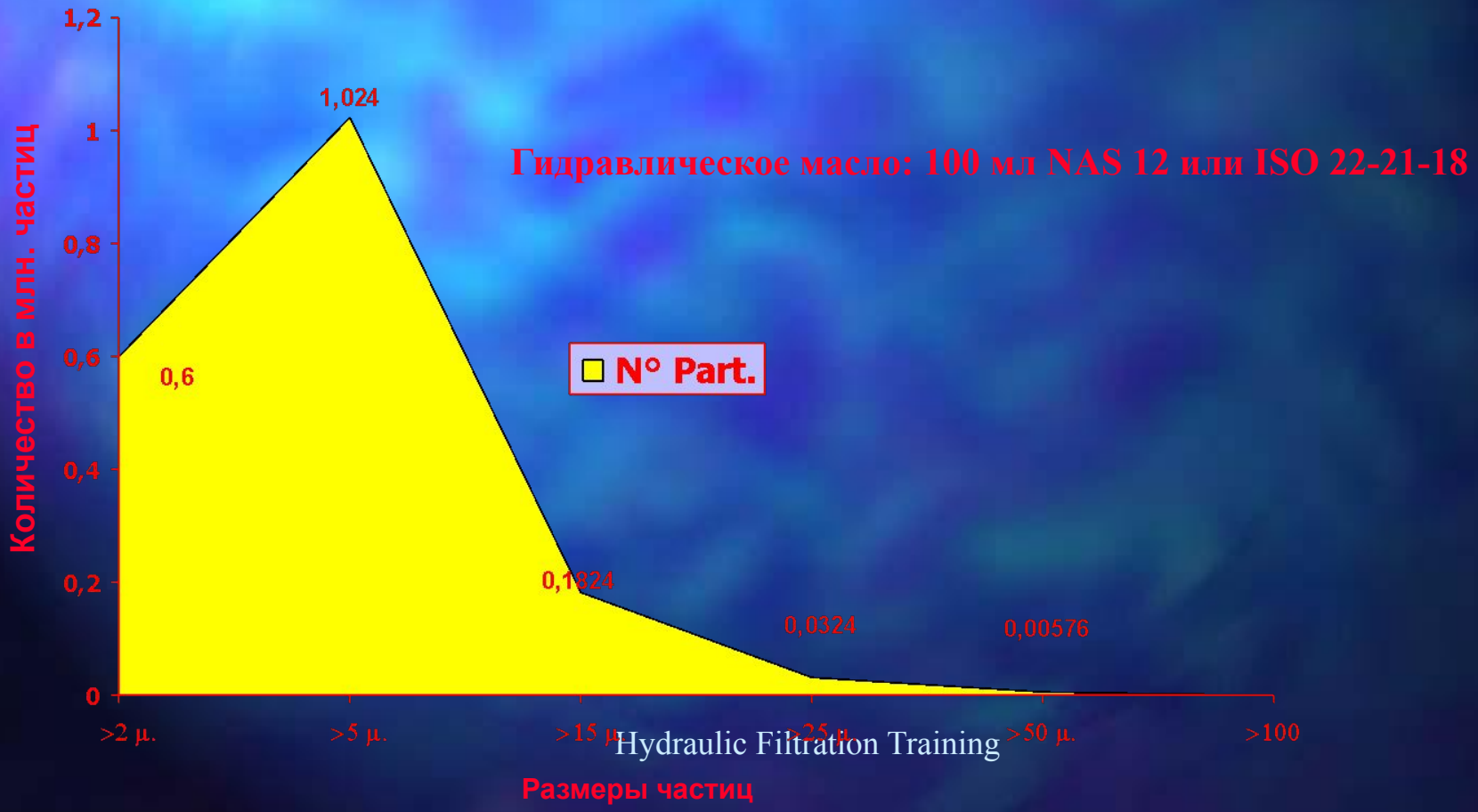
“Твёрдые” Загрязнения

Фото загрязнениЙ (100 кратное увеличение)



“Твёрдые” Загрязнения

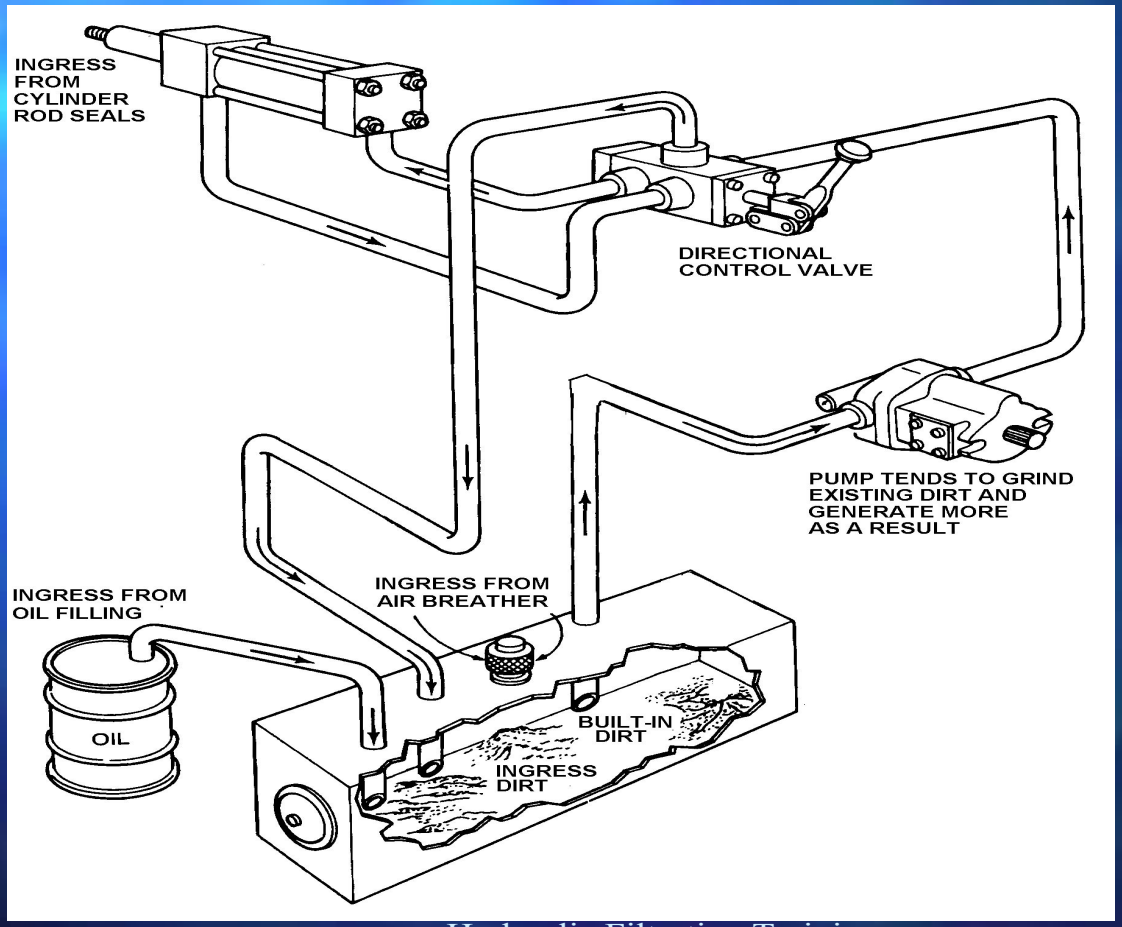
Распределение частиц по размерам в 100 мл.



“Твёрдые” Загрязнения/Зарождение

- Попадание в процессе сборки (сварка, механические работы, литьё).
- Попадание во время работы; через цилиндры, уплотнения, соединения, крышки бака, сапуны.
- Внутренняя генерация частиц.
- Неправильная заправка.
- Усталость гидравлической жидкости.
- Зарождение микроорганизмов.
- Дополнительные попадания с доливом масла, ремонтными работами.

Твёрдые Загрязнения
Источники



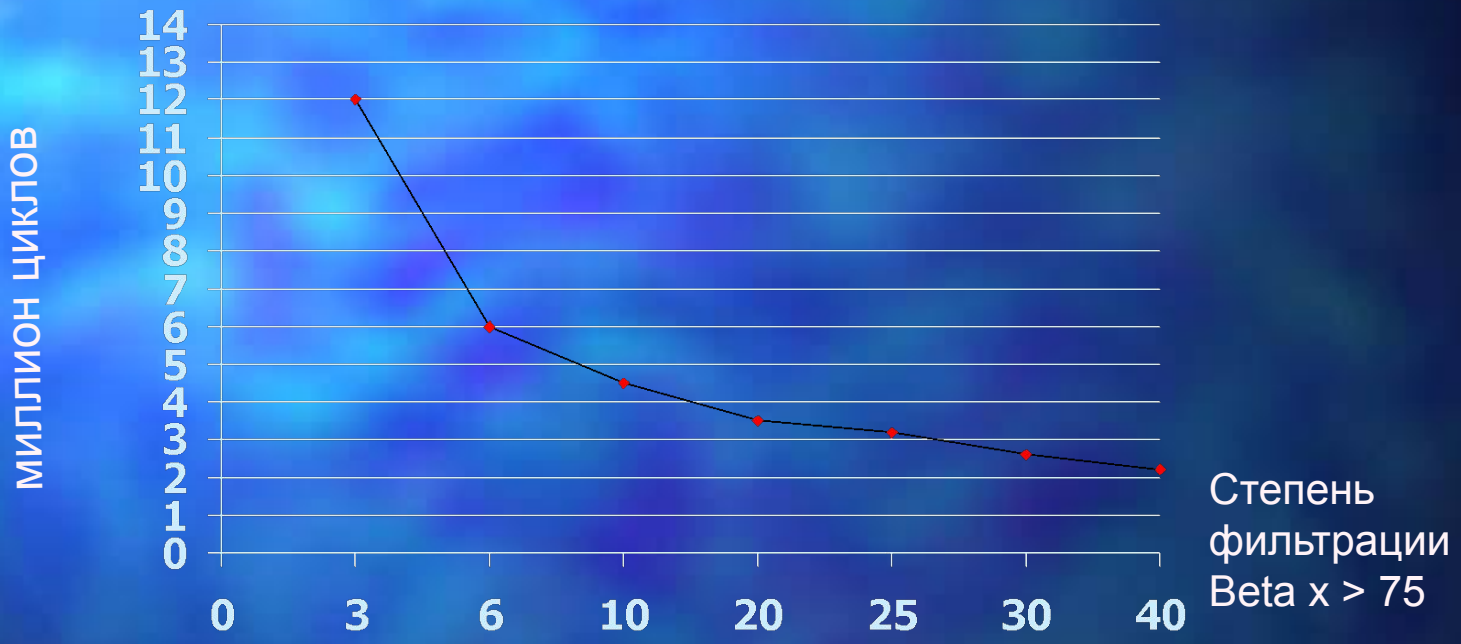
Интенсивность поступления загрязнений

Количество частиц*

- Мобильная техника 10^8 - 10^{10} в мин.
- Производственные предприятия 10^6 - 10^8 в мин.
- Сборочные предприятия 10^5 - 10^6 в мин.

- Среднее число частиц попадающее в гидросистему извне и генерирующихся изнутри

Исследование Mac Pherson
Кривая усталостной прочности подшипников



Исследование д-ра Мас Ферсон для Westland Helicopter, Усталостная прочность для роликовых подшипников зависит от тонкости фильтрации фильтров, используемых в системе смазки. Испытания, проведенные на сотнях подшипников показывают, что усталостная прочность выше при тонкости фильтрации фильтрующего материала до 3мкм, при $Beta_3 > 75$ или $beta_6 > 75$.

Твёрдые загрязнения/Классификация жидкостей, содержание твёрдых загрязнений

Основные стандарты определения класса чистоты

- ISO 4406 - 1999 MTD.
- ISO 4406 - ACFTD.
- NAS 1638
- ГОСТ 17216:2001
- Несколько специфических стандартов “SAE; MIL; NAVAIR”.

Твёрдые Загрязнения
Методы анализа

Существуют несколько методов анализа

- Исследования пятна (калиброванная мембрана + микроскоп).
- Метод: анализ “затемнения сетки” (Pall PMC100 + Parker LCM II).
- Лазерные счётчики частиц
(Parker PLC3000, UCC CM20, ARGO PODS, HYDAC FCU2000, MAHLE Pi C 9000, INTERNORMEN CCS1, VICKERS Target-Pro, MP Filtri etc.).

Обучение

Чистота рабочей жидкости

Классификация

Твёрдые загрязнения

ISO/DIS 4406-1999 MTD

(текущий стандарт)

Code ISO: 21/18/15

> 4 µm (c).

> 6 µm (c).

> 14 µm (c).

Твёрдые загрязнения

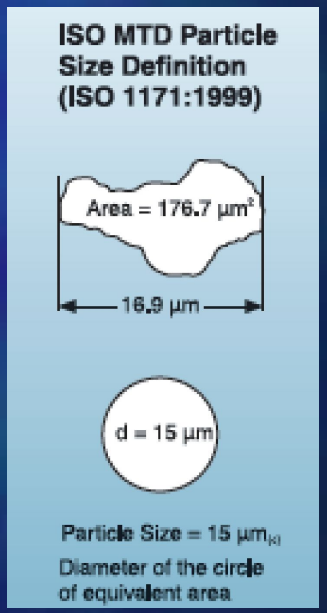
ISO 4406 Таблица

ISO 4406 Normative		
Max. concentration level per 100 ml.		
Contamination	Number of Particles	
Class	More than	Up to
24	8 000 000	16 000 000
23	4 000 000	8 000 000
22	2 000 000	4 000 000
21	1 000 000	2 000 000
20	500 000	1 000 000
19	250 000	500 000
18	130 000	250 000
17	64 000	130 000
16	32 000	64 000
15	16 000	32 000
14	8 000	16 000
13	4 000	8 000
12	2 000	4 000
11	1 000	2 000
10	500	1 000
9	250	500
8	130	250
7	64	130
6	32	64
5	16	32
4	8	16
3	4	8
2	2	4
1	1	2

Твёрдые загрязнения

ISO/DIS 4406-1999 MTD

- Оборудование калибруется в соответствии с ISO 1171:1999.
- Используется ISO - MTD как калибровочная пыль.
- Размер определяемой частицы принимается, как диаметр окружности, эквивалентной по площади тени частицы, (взамен максимального размера)
- Стандарт сегодняшнего дня.



Твёрдые загрязнения

ISO/DIS 4406-1999 MTD

- Используется старая классификация (бывшая просто 4406). – количество частиц на 100 мл.
- Те же количества для каждого класса (таблица).
- 3 классификационных числа.
- Градация частиц по размерам
  4 µm (c). - 6 µm (c). - 14 µm (c)
- Выше, чем ранее точность обработки данных

Твёрдые загрязнения

ISO 4406 (ACFTD – air cleaner fine test dust) бывший стандарт

Code ISO: 21/18/15

> 2 µm.

> 5 µm.

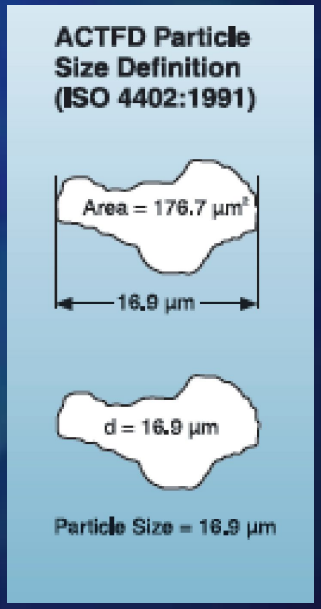
> 15 µm.

Обычно, первая цифра не сообщается, достаточно следующих двух.

Твёрдые загрязнения

ISO 4406 (ACFTD – air cleaner fine test dust) бывший стандарт

- Оборудование калибруется в соответствии с ISO 4402.
- Выбирается пыль ACFTD как калибровочная пыль (2>5>15).
- Частицы градуируются по максимальному размеру.
- Ушедший стандарт.



Твёрдые загрязнения

ISO 4406 (ACFTD – air cleaner fine test dust) бывший стандарт

- Используется старая классификация (бывшая просто 4406). – количество частиц на 100 мл.
- Те же количества для каждого класса (таблица).
- Классификационных чисел от 2 до 3 цифр.
- Градация частиц с размерами
  2 µm. - 5 µm. - 15 µm.
- Более низкая точность обработки данных.

Твердые загрязнения

Стандарт NAS 1638

(National Aerospace Society)

- Оборудование калибруется по ISO 4402.
- Используется пыль ACFTD как калибровочная
- Градация частицы принимается по максимальному размеру частицы.
- Уходящий стандарт
- Используется в коммерческих целях.

Твердые загрязнения

Стандарт NAS 1638

(National Aerospace Society)

- 14 классов чистоты.
- Разделяются на пять подгрупп: 5÷15; 15÷25; 25÷50; 50÷100; > 100 µm.
- **Одно!** Классификационное число, которое является «худшим».
- Невозможно понять к какому размеру частиц оно относится.

Твердые загрязнения

Стандарт NAS 1638

(National Aerospace Society)

Code NAS 1638 = 10

- Что значит класс 10?
- К какой размерной подгруппе относится?

Твердые загрязнения

Стандарт NAS 1638

(National Aerospace Society)

NAS 1638 NORMATIVE														
Max Concentration Level in 100 ml.														
Cleanliness Classes														
Particles Dimension in Micron	00	0	1	2	3	4	5	6	7	8	9	10	11	12
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	182.400
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
> 100	0	0	1	1	2	4	8	16	32	64	128	256	512	1.024

Твердые загрязнения

Требуемая чистота рабочей жидкости

Гидравлические компоненты	ISO Code
Сервоклапаны	16/14/11
Радиально поршневые насосы/моторы	18/16/13
Распределители & Регуляторы давления	18/16/13
Шестерённые насосы/Моторы	19/17/14
Регуляторы расхода/Цилиндры	20/18/15
Новая неиспользованная жидкость	20/18/15

Должен указываться в паспорте покупного изделия

Твёрдые загрязнения
Гравиметрическая таблица

> 10 Micron per ml.	ISO 4406	NAS 1638	Gravimetry
140 000	26/23		1 000
85 000	25/23		
14 000	23/20		100
4 500	21/18	12	
2 400	20/18		
2 300	20/17	11	
1 400	20/16		10
1 200	19/16	10	
580	18/15	9	
280	17/14	8	
140	16/13	7	1
70	15/12	6	
40	14/12		
35	14/11	5	
14	13/10	4	0,1
9	12/9	3	
5	11/8	2	
3	10/8		
2,3	10/7	1	
1,4	10/6		0,01
1,2	9/6	0	
0,6	8/5	00	
0,3	7/5		
0,14	6/3		0,001
0,04	5/2		

SOLID Contamination

Determination of one year contaminant "Re-Circulate"

Consider a system with this technical characteristics (i.e. Injection Moulding Machine):

- Pump Flow Rate = **150 L/1'.**
- Working hours: (50 wks x 6 days x 16 h.) = **4.800 annual hours**.
- Cleanliness Level: **ISO 21/18**.
- How much contaminant the pump re-cycle in one year, if we consider that at Cleanliness Class ISO 21/18 corresponds a gravimetric level of 32 mg/L?

150 x 60 x 4800 x (32 / 1.000.000) = 1.382 Kg.

Filtration Training #1

Filter Media

Types
and
Filtration Degree

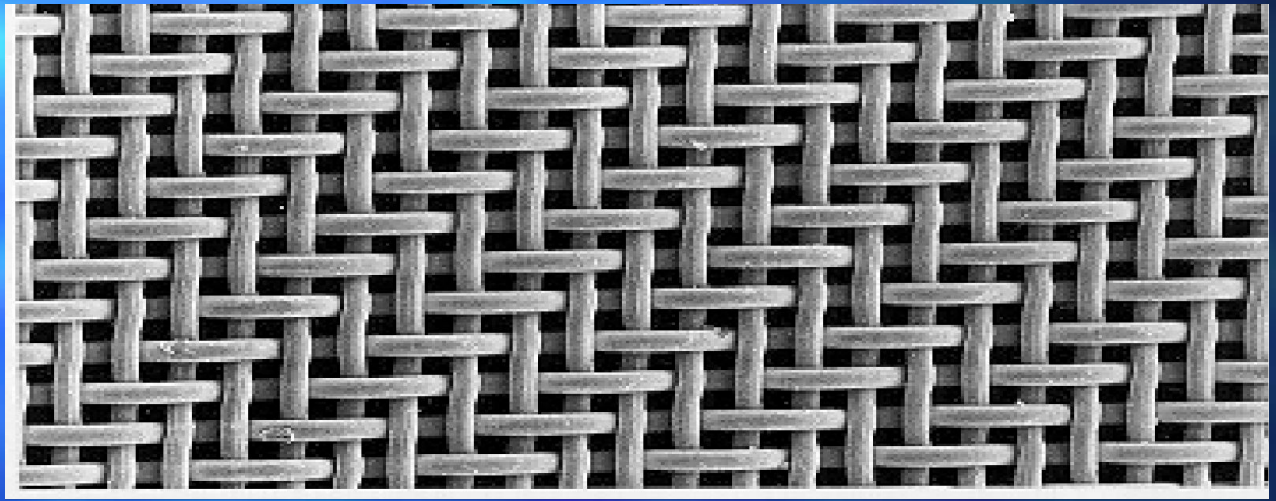
SOLID Contamination
Filter Media

Filter Media Classification

- "Surface" filter Media.
  - Wire mesh.
  - Membrane (not included in this training).
- "Depth" Filter Media.
  - Paper impregnated with resin.
  - Inorganic Fibre impregnated with resin.
  - Wound (not included in this training).
  - Depth (not included in this training).

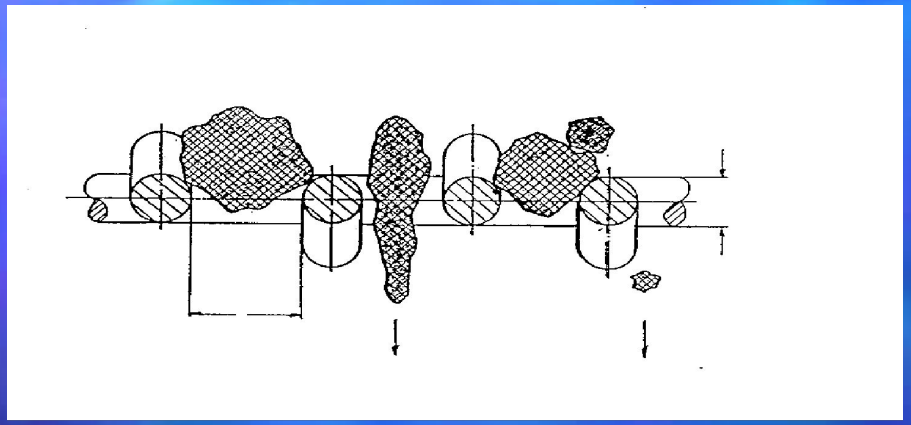
SOLID Contamination Surface Filter Media

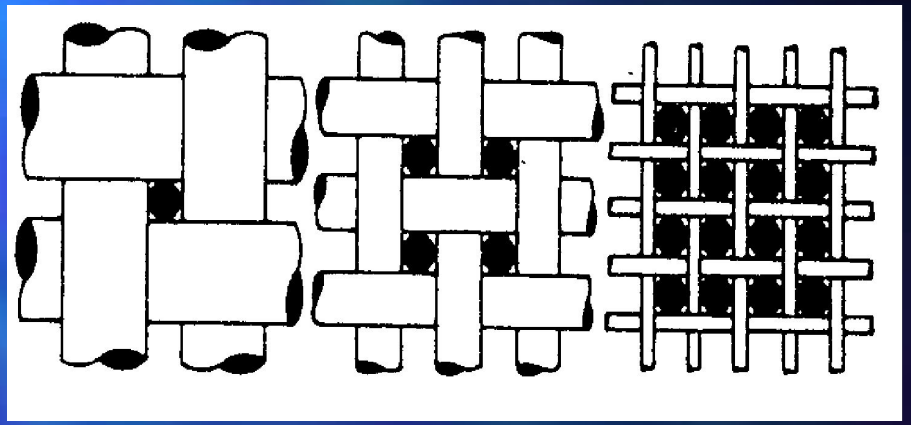
Wire Mesh



- It's classified in function of "Largest diameter of hard spherical particle that will pass trough the media".
- Actually Existing some different Wire Mesh Media:
  - With Square Mesh
  - With Interweave Mesh.

SOLID Contamination
Surface Filter Media

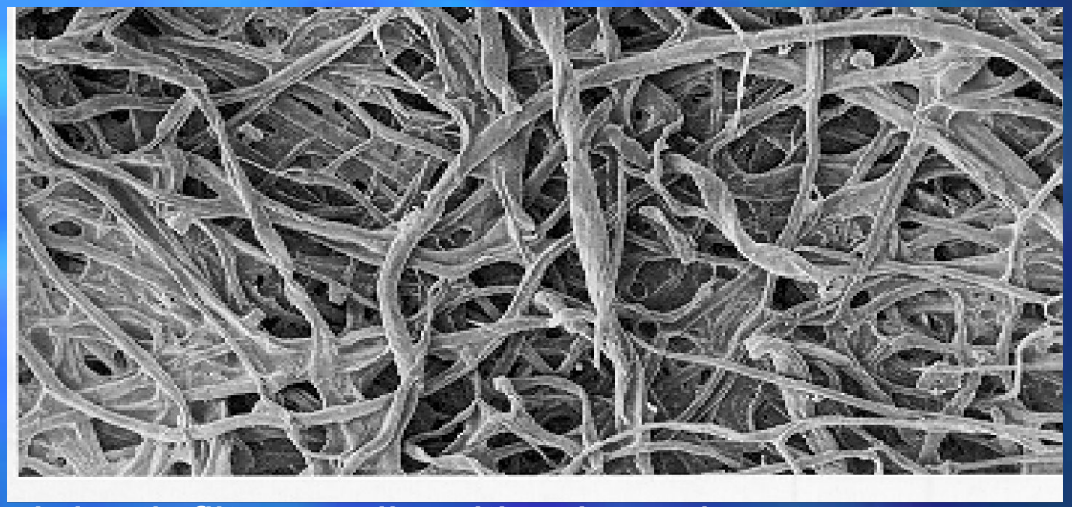




- Like single layer, doesn't give us assurance to catch fibre strand (longer) contaminant.
- Its filtration degree is the largest diameter of hard spherical particle that will pass trough the media µm.
- Low dirt holding capacity, contamination particles are catched only on outside surface.
- Good resistance at differential pressure.
- High cost, consequently low ratio between Quality / Price.

SOLID Contamination
Depth Filter Media

Paper impregnated with Resin



- Are considered depth filter media with a irregular structure.
- Are classified on average pore dimension.
- Existing in two main different paper's type:
  - "couring".
  - "no couring".

SOLID Contamination
Depth Filter Media

Inorganic Fibre impregnated with resin

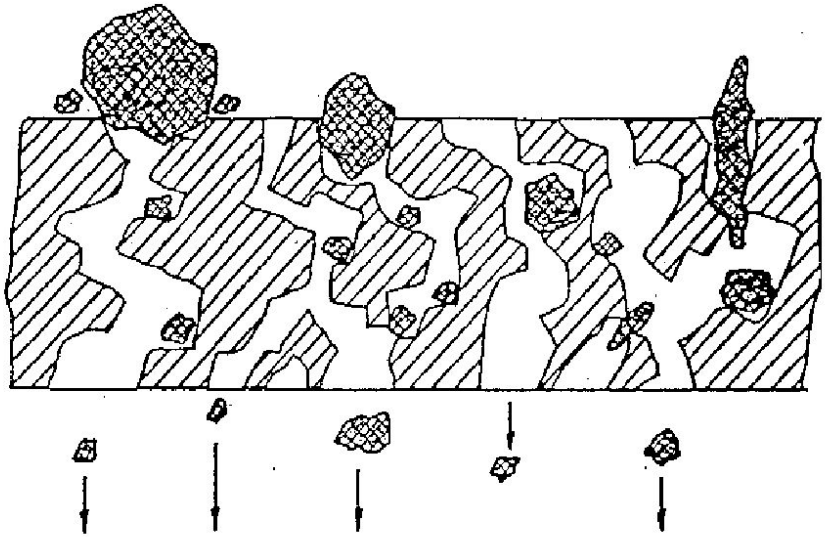
- Are considered Depth filter media with regular structure.
- Are classified on average pore dimension.
- Existing in two main different fibre's type :
  - "single layer".
  - "multi layer".

SOLID Contamination
Depth Filter Media

How Depth Filter Media Works

- Direct interception.
- Inertial impact.
- Brownian diffusion.

- More stable filtration degree.
- Better filtration efficiency.
- Contaminant is catched in the “depth” thickness media.
- Higher dirt holding capacity.



SOLID Contamination
Depth Filter Media

How Depth Filter Media are classified

- **NOMINAL filtration degree:**
  - Data expressed in µm., not significant because the test data are not indicated.
- **ABSOLUTE filtration degree:**
  - Data expressed in µm., it doesn't consider differential pressure and element status; in this case too the Test data are not indicated.
- **Filtration Ratio "βeta Ratio":**
  - Is the ratio between the number of particles upstream and downstream the filter, it considers the differential pressure and element status; this test is in accordance with ISO Standard 16889 (former ISO 4572).

SOLID Contamination
βeta Ratio

- βeta ratio, is the ratio existing between the number # particles with a specific size "x" upstream the filter and the number # of particles the same size downstream the filter.

$$\beta eta_x \text{ Ratio} = \frac{\text{\# of Particles "x" before the filter}}{\text{\# of Particles "x" after the filter}}$$

where "x"= Size of specific particle (e.g. 10 µm.)

SOLID Contamination
βeta Ratio vs. Efficiency

- βeta ratio number alone means very little, but this is the first step to find a filter's particle capture efficiency, with this simple equation:

$$\text{Efficiency \%} = \frac{\beta\text{eta}_x - 1}{\beta\text{eta}_x} \times 100$$

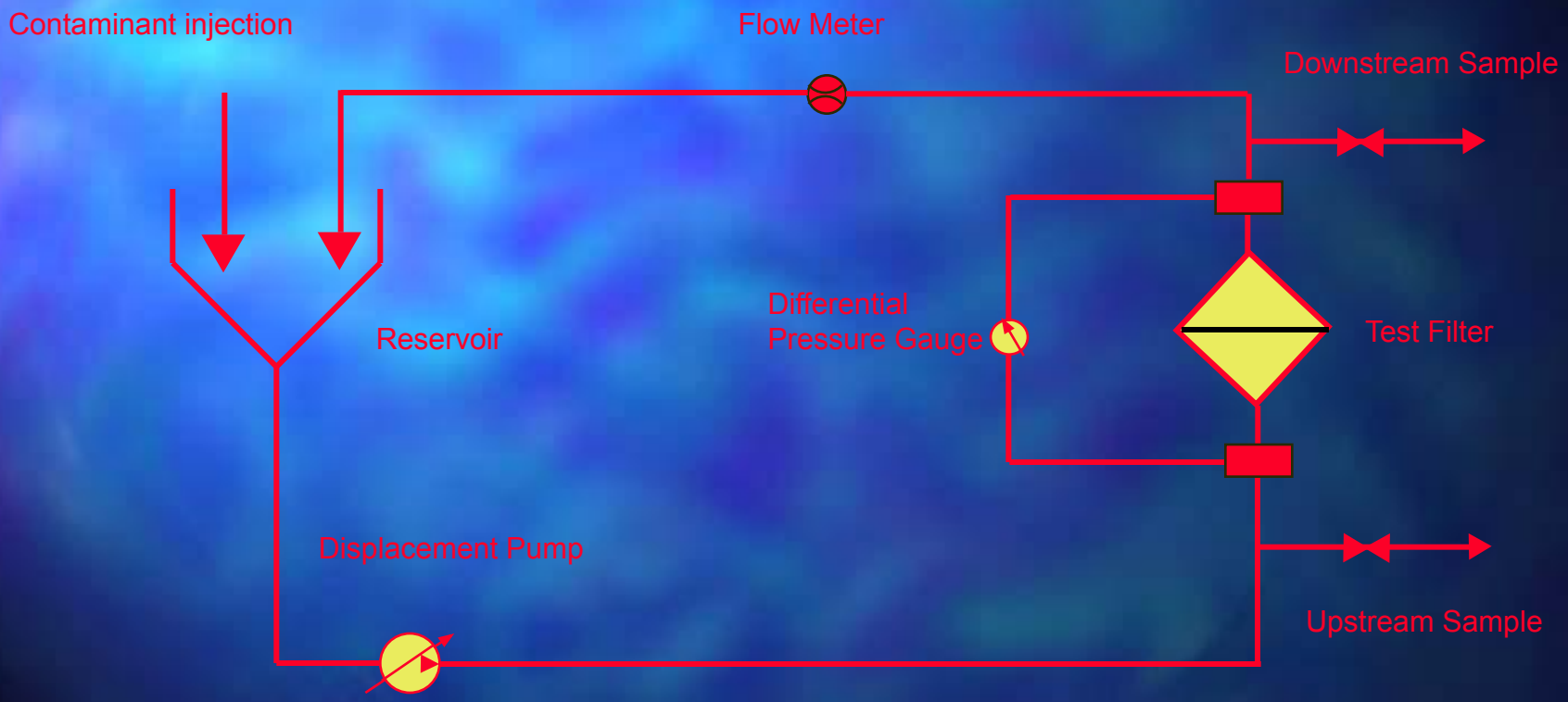
SOLID Contamination
βeta Ratio Table Vs. Efficiency

βeta	Efficiency
2	50,00
5	80,00
10	90,00
20	95,00
40	97,50
60	98,33
75	98,67
100	99,00
200	99,50
1000	99,90
5000	99,98

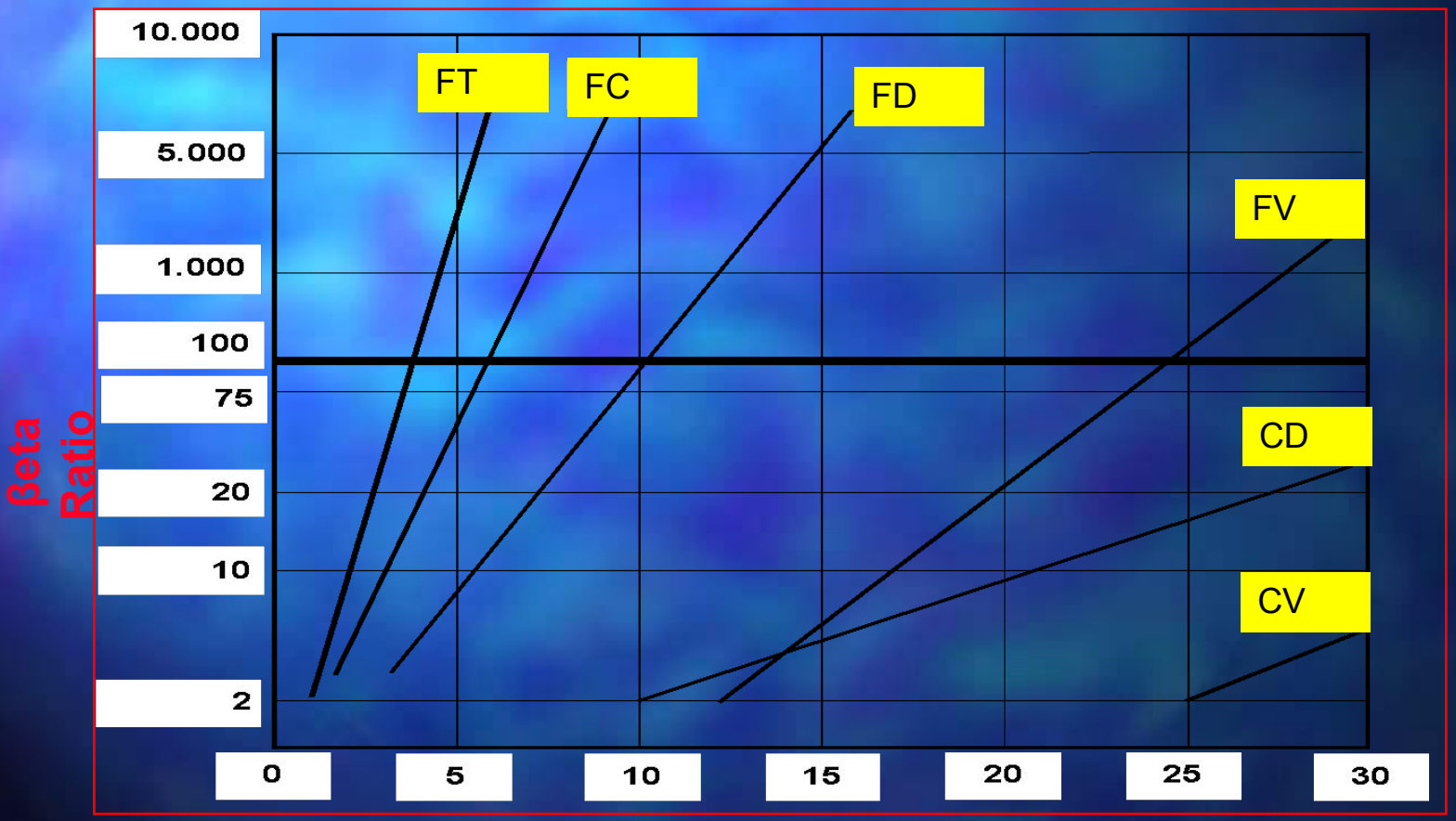
SOLID Contamination βeta Ratio's evaluation

- Filtration industry uses a Multi-Pass Test method to evaluate a filter element βeta Ratio.
- Standard ISO 4572 with A.C.F.T.D. like Test Dust, (outmoded).
- Standard ISO 16889 with ISO M.T.D. like Test Dust, (actual).
- From a Multi-Pass Test we obtain three very important element performance characteristics: βeta Ratio, Dirt Holding Capacity "D.H.C." (in grams), Differential Pressure at the end of test in kPa (bar).
- All those three data βeta ratio, D.H.C. and final pressure drop are indispensable data in order to make a filter element evaluation.

SOLID Contamination Multi-Pass Test Scheme



SOLID Contamination
UFI Filter media βeta Ratio



SOLID Contamination
βeta Ratio variation

- βeta ratio is a measure (data) obtained in laboratory with no pressure and flow rate variation (important).
- In a standard hydraulic system, we don't have this working situation.
- Pressure peaks and fast flow rate variations, influence in a negative way βeta ratio.
- By-Pass valve option also, aids to decrease βeta ratio value.
- Only one filter application is similar to Multi-Pass Test system:

OFF-LINE filtration.

Filtration Training #1

Right Filter Element / Media Selection

SOLID Contamination
Filter Media Selection

- One method to select right filter media was developed by

  B.F.P.A. BRITISH FLUID POWER ASSOCIATION
- Method of the "Weighting" factors (8) effecting the system life.
- Operating Pressure and Duty Cycle.
- Environment.
- Component Sensitivity.
- Life Expectancy.
- Components Cost.
- Economic Liabilities (Downtime).
- Safety Liabilities.

SOLID Contamination
Filter Media Selection

- **Operating Pressure and Duty Cycle:**

- **Light duty** = Continuos operation at rated pressure or lower.
- **Medium duty** = Medium pressure changes up to rated pressure.
- **Heavy duty** = Zero to full pressure.
- **Severe duty** = Zero to full pressure, with transients at high frequency.

Pressure (kPa)	Light	Medium	Heavy	Severe
0 - 70	1	2	3	4
70 - 150	1	3	4	5
150 - 250	2	3	4	6
250 - 350	3	5	6	7
> 350	4	6	7	8

SOLID Contamination Filter Media Selection

- Environment:

		Weight
Good	Clean Area, Laboratory	0
Average	General machine shop, Lift	1
Poor	Mobile plant	2

SOLID Contamination Filter Media Selection

- **Components Sensitivity:**

- Ask component manufaturer the requirement ISO cleanliness Code.
- Alternatively use the following table as a guide to the ISO cleanliness Code.

Sensitivity	Examples	ISO Code	Weight
extra high	High performance servo valves	13/9	8
high	Industrial servo valves	14/10	6
above average	Piston pumps, proportional valves Compensated flow control valves	15/11	4
average	Vane pumps, spool valves	16/13	3
below average	Gears pump, manual and poppet valves	17/14	2
minimal	Ram pumps, cylinder	18/15	1

SOLID Contamination Filter Media Selection

- Life expectancy:

Service life required for components	Weight
0 - 1.000 hours	0
1.000 - 5.000 hours	1
5.000 - 10.000 hours	2
10.000 - 20.000 hours	3
> 20.000 hours	5

SOLID Contamination Filter Media Selection

- **Economic liabilities (components):**

Cost of components replacement		Weight
Very High	Large piston pumps, or high torque low speed motors	4
High	Cylinders, Servo valves	3
Average	Pumps, line mounted valves	2
Low	Cartridge valves, Gears pumps	1

SOLID Contamination Filter Media Selection

- **Economic liabilities (operational):**

Downtime Cost		Weight
Very High	Steel Mill Equipment	5
High	High Volume Production Plant	3
Average	Mobile Installation	2
Low	Equipment not Critical to Production	1

SOLID Contamination Filter Media Selection

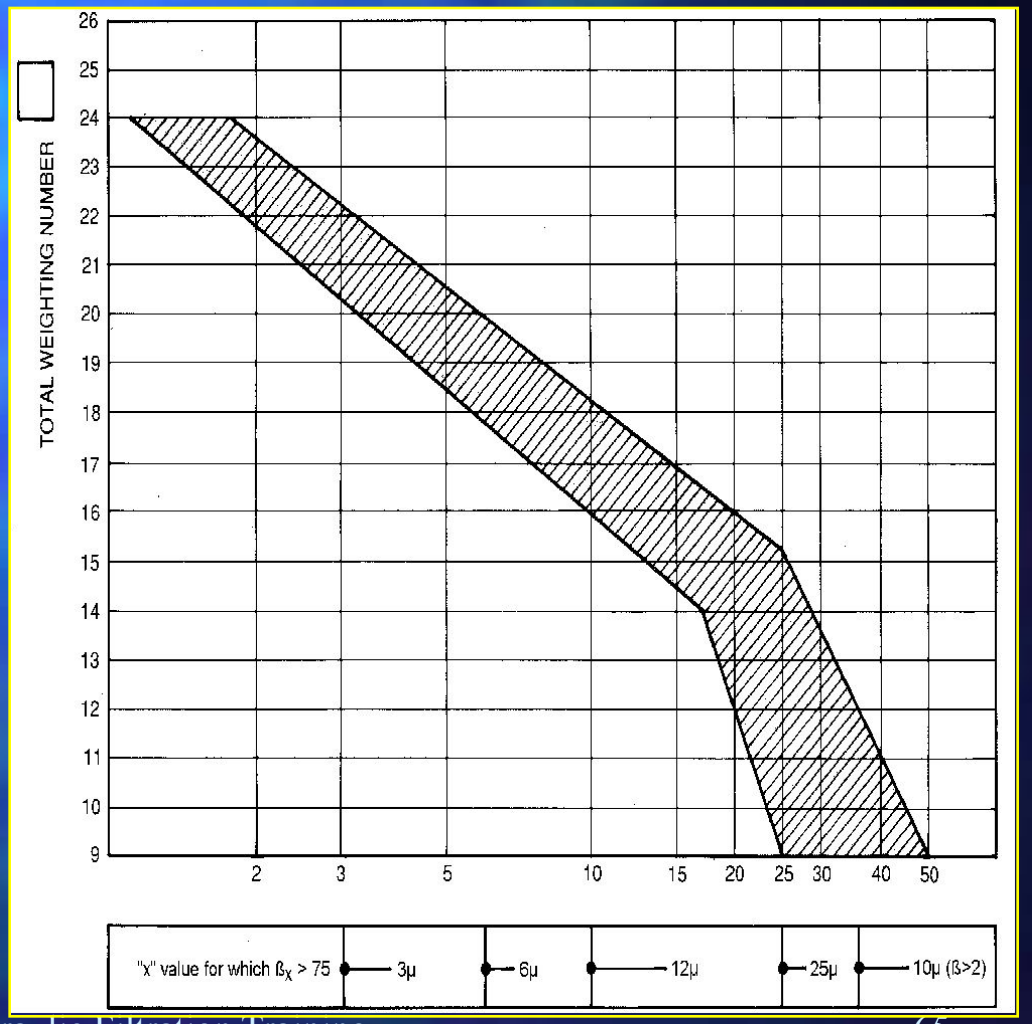
- **Safety Liabilities:**

Need for Additional Safety of Operation		Weight
High	Mine Winding Gear Bracking System	3
Average	Where Failure is Likely to Cause a Hazard	1
Low	Some Hydraulic Component Test Rigs	0

SOLID Contamination Filter Media Selection

- From Weight result to right filtration degree for our application.

- Example:
  Tot. Weight = 18
  Max. Filtration 12 µm.
  Min. Filtration 6 µm.



Filtration Training #1

Filter Element's

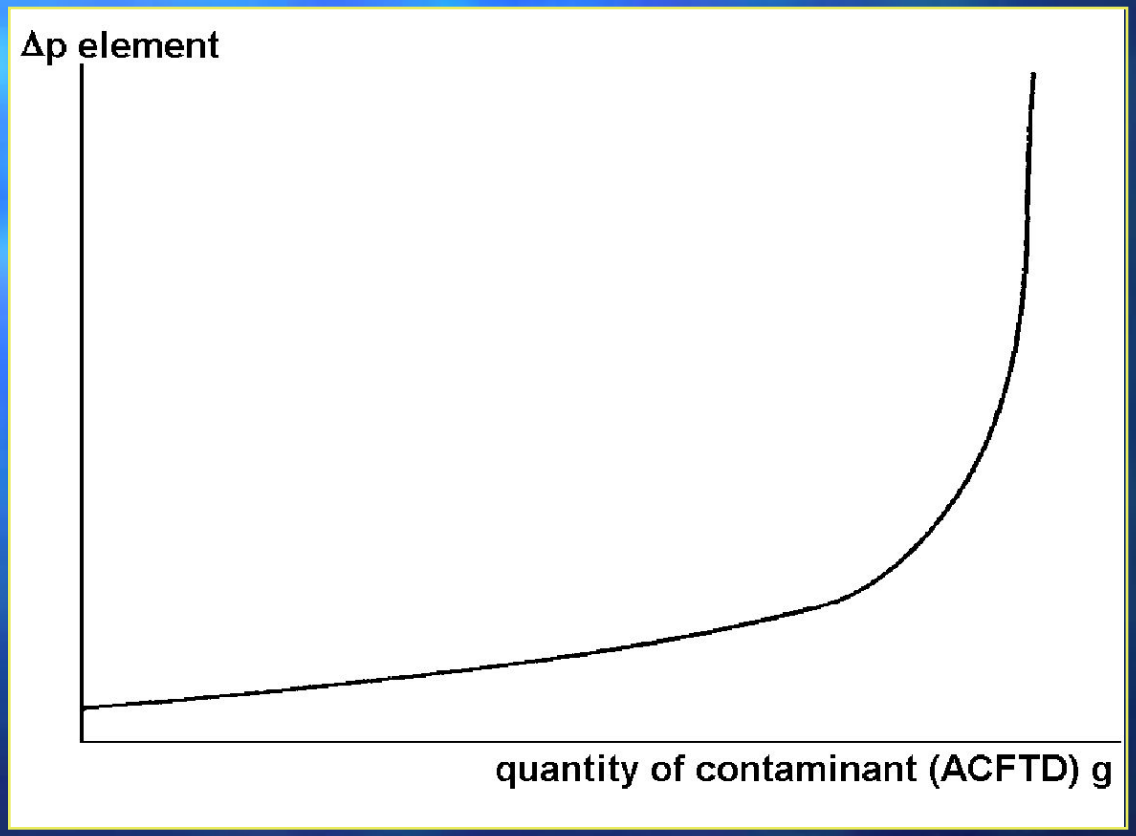
"LIFE"

SOLID Contamination Filter Element's Life

It is related to :

- D.H.C. value.
- Contaminant ingression into the system.
- System's contamination generation.
- Fluid's flow rate trough the filter.
- Indicator or By-Pass setting value.
- Initial Δp value at clean filter.
- Fluid filtrability factor.
- Organic substance presence into the fluid.
- Liquid contaminant presence into the fluid (water).

SOLID Contamination
D.H.C. Curve



SOLID Contamination
How to prevent or limit it

- Wash and protect all components (reservoirs, manifolds, pipes, hoses, etc.).
- Protect components during assembling process.
- Right flushing system before to start up.
- Filter oil before to fill up the reservoir, even if it's new.
- Replace frequently cylinder's seals.
- Verify connectors sealing.
- Prevent contaminant ingression during maintenance process (plugs pipes, protect valves and manifolds).
- Use good Air filter for a very efficient "barrier" action.
- Don't leave open holes without appropriate protection.

SOLID Contamination
How to remove it

- Use the appropriate filtration system in function of:
  - System type.
  - Contamination level to be achieved.
  - Components sensibility.
  - Direct or indirect filtration.
  - Cost and type of machine / equipment.
  - Available space.
  - Maintenance operation.

Filtration Training #1

“LIQUID”

Contamination

“LIQUID” Contamination

About 10 - 20% of failure in hydraulic system is due to water presence; it may be present in two different phases:

- DISSOLVED; up to “fluid saturation level”.
- FREE; when water level is higher than fluid saturation level. In this case we should have water in the bottom of the reservoir (mineral oil) or up of level oil (synthetic oil phosphate ester).

LIQUID Contamination Saturation Level

Some average fluid saturation level.

Type of FLUID	PPM	%
• Mineral Fluid	300	0,03%
• Lubrication Fluid	600	0,06%
• Transformer Fluid	50	0,005%

** Each type of fluid has its own saturation level, this value is normally supplied by petrol manufacturing company.

LIQUID Contamination Damage Effects

- Corrosion of metal surface.
- Accelerated abrasive wear.
- Bearings fatigue.
- Variation of viscosity index.
- Organic compounds formation.
- Fluid additive breakdown (copper, zinc).
- Increase of solid contaminant.
- Increase in electrical conductivity < safety.

LIQUID Contamination
Visual Effects

How to recognise a fluid contaminated by water:

- **It's cloudy, instead of transparent.**
- **Colour is similar to "milk".**
- **It's possible to have a small "droplet" formation.**
- **With mineral fluid you should find "water" in the reservoir's bottom.**
- **Apply a flame under the container (small fluid volume), if "bubbles" arise from the heated point you have free water and fluid becomes transparent.**

LIQUID Contamination Analysis Method - Counting

Actually existing two different analysis and counting methods.

- Karl Fischer method (according to DIN 51777 standard).
  - Represents a scientific method for water presence determination.
  - It's a "sample" analysis and it's necessary to make it in laboratory.
  - Complex analysis and takes "some" time.
- "INFRARED Ray Absorbing" method.
  - System made by UCC.
  - It's based on infrared rays absorbed by water molecules.
  - Sample or in situ analysis, time ≈ 3 minutes.

LIQUID Contamination
Contamination Sources

Like for Solid contamination there are “Contamination Sources” also for Liquid one:

- Condense.
- Worn cylinders seals.
- Not sealing of reservoir’s covers.
- Re-filling oil.
- Leakage or breaking from heat exchanger.

LIQUID Contamination
How to prevent or limit it

- Replace frequently cylinder's seals.
- Guarantee a perfect seal between cover and reservoir.
- Re-filling reservoir only with filtered oil (without solid and liquid contaminant).
- Verify frequently heat exchanger.

LIQUID Contamination
How to remove it

Actually existing three methods to remove water from Hydraulic fluid:

- ADSORBING: removes free water up to 90%; it's possible to do this with filter element "WA" (water adsorbing) type.
- CENTRIFUGATION: removes free water up to 90%; it's possible to do this with centrifugal machine, expensive and in some case it's possible to lose heavy additives.
- VACUUM DEHYDRATION: remove 100% free water and up to 80% of dissolved water.

Filtration Training #1

“AIR”

Contamination

AIR Contamination

We can find Air contamination in three different status

- FREE Air: trapped air into Hydraulic system like air pocket.
- SUSPENSION Air: when we can see in a fluid sample some small air bubbles.
- DISSOLVED Air: when air is a fluid's molecular part. A standard mineral fluid should include inside of his molecule up to 7% ÷ 9% of air, without any visual changing.

AIR Contamination Damages Effects

- Loss of transmitted power.
- Reduced pump output (air compressed).
- Loss of lubrication.
- Increasing operating temperature; in air bubbles impact area, “implosion” generates a thermal energy (up to 800 °C.) and carbon solid particles.
- Reservoir fluid foaming.
- Modifications and chemical compounds formation, i.e. components surface and contaminant oxidation.
- Fluid’s molecule modifications with organic compounds formation.

AIR Contamination
Contamination Sources

As for Solid & Liquid contaminant, also for the Air one we have “Contamination Sources”:

- System leaks.
- Reservoir fluid turbulence.
- Fluid aeration (from return pipes / reservoir).
- Pump aeration.

AIR Contamination
How to prevent and limit it

- Reservoir pressurisation.
- System air bleeds.
- Flooded suction pump.
- Right reservoir design and dimensions.
- Ensure that all return pipes are under the fluid level.
- Include return line diffusers (less return fluid velocity).

AIR Contamination
How to remove it

- Actually there are not any specific method to remove this contaminant type.
- We can adopt all or some “shrewdness”, in order to prevent Air contaminant generation.

AIR Contaminant Analysis Method - Counting

Existing three methods to analyse and count Air contaminant content :

- Working fluid manometer.
- Sonic velocity.
- Turbidity or fluid opacity.

Filtration Training #1

FILTERS

Insertion points

SOLID Contamination
Filters insertion points

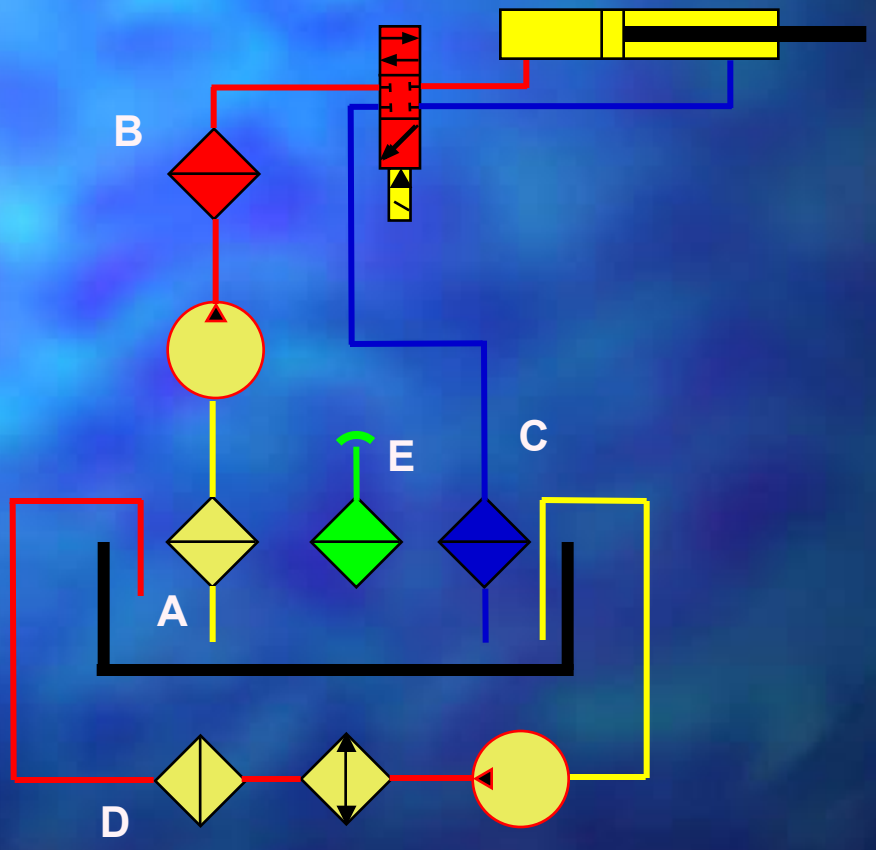
A: Suction Filter

B: Pressure Filter

C: Return Filter

D: Off-Line Filter

E: Filter / Air Breather



Filters Insertion Points
Suction Filters

Types:

- immersed in the reservoir.
- Sub-immersed, on reservoir's side wall.
- In Line, external or tank top mounted.
- Closed loop mounting, "hydrostatic transmissions".

Suction Filters
Advantage & Disadvantage

Advantage

- Last possibility to protect the pump.
- Easy installation and low cost, especially with immersed type “Strainers”.

Disadvantage

- It’s not possible to achieve a certain contamination level, due to the “possible” filtration degree.
- Relatively high cost (benefit / cost).
- Doesn’t protect downstream components.
- It’s not recommend with variable displacement pumps (vane or piston).

Suction Filters
Calculation's parameters

- Max. allowable Δp with clean filter = 10 kPa (0,1 Bar).
- Use connections of same or bigger size than the pump.
- Use always a electrical clogging indicator.
- For strainers "suggest" to mount the indicator on the pump pipe connection between filter and pump.
- Magnetic inserts in the "clean" filter's area are useless.
- Don't use filtration degree below 60 µm. (open loop).

Filters Insertion Points
Pressure Filters

Types:

- Low, Medium, High pressure.
  - Line mounting.
  - Manifold mounting (lateral, head), in accordance with CETOP standard.
  - Sandwich mounting.
  - To protect a specific component (Last Chance).
  - Single or Duplex configuration.

Pressure Filters
Advantage & Disadvantage

Advantage

- Protect all components downstream the pump.
- It should be possible to mount it, to protect a specific component (last chance).
- Uses high efficiency and high collapse elements.
- It contributes to achieve a specific contamination class.
- Captures all the contaminant generated by the pump.

Disadvantage

- Not cheap cost.
- Doesn't protect from contaminant generated from component (downstream components).

Pressure Filters
Calculation's parameters

- Max. allowable Δp with clean filter = 100 kPa (1 Bar), or in any case up to not more than 1/3 ratio of By-Pass valve or clogging indicator setting.
- It is useful to calculate the housing of the filter with the lower possible Δp.
- Use *always* a "high collapse" element, when By-Pass valve is not used.
- In presence or back flow, insert in filter's outlet port anti back flow valve (Check Valve).
- Choice of right filtration degree is related to the most sensible component to protect.
- On filter for direct component's protection, No By-Pass.

Filters Insertion Point
Return Filters

Types:

- Tank Top mounting.
- In Line mounting, outside reservoir.
- Close loop mounting “Hydrostatic Transmission”.
- With filter element Inside to outside filtration direction.
- Simple or Duplex version.

Return Filters
Advantage & Disadvantage

Advantage

- Capture all built in and system's generated particles.
- Give several mounting possibilities (In Line, Tank Top, Duplex).
- Not high cost, related to low pressure in this system's points.

Disadvantage

- Do not protect directly the components, especially the pump.
- Must be calculated "carefully" in consideration to the "real" flow rate (not pump flow rate).
- Doesn't capture the contaminant generated to the pump.

Return Filters
Calculation Parameters

- Max. allowable Δp at clean filter = 50 kPa (0,5 Bar), in any case up to not more than 1/3 ratio of By-Pass setting value.
- Always calculate filter size in consideration of flow rate cylinder's areas ratio and unsteady flow rate (cycles).
- It's suggested to use always By-Pass valve, in order to guarantee a flow passage when filter element is blocked.
- It's better to choose a return filter allowing to remove the bowl together with the filter element during replacement, in order to clean the bowl and also to avoid the contaminant falling into the reservoir.

Filters Insertion Points
Off-Line Filters

Types:

- Tank Top mounting.
- In Line mounting, outside of reservoir.

Off-Line Filters
Advantage & Disadvantage

Advantage

- It's normally combined with a cooler system.
- It's possible to replace filter element without stopping the system.
- Similar to Multi-Pass test conditions, it's possible to choose flow rate and pressure for better performances.
- It works also, when the main system is stopped.
- It's possible to achieve a specific contamination class level.

Disadvantage

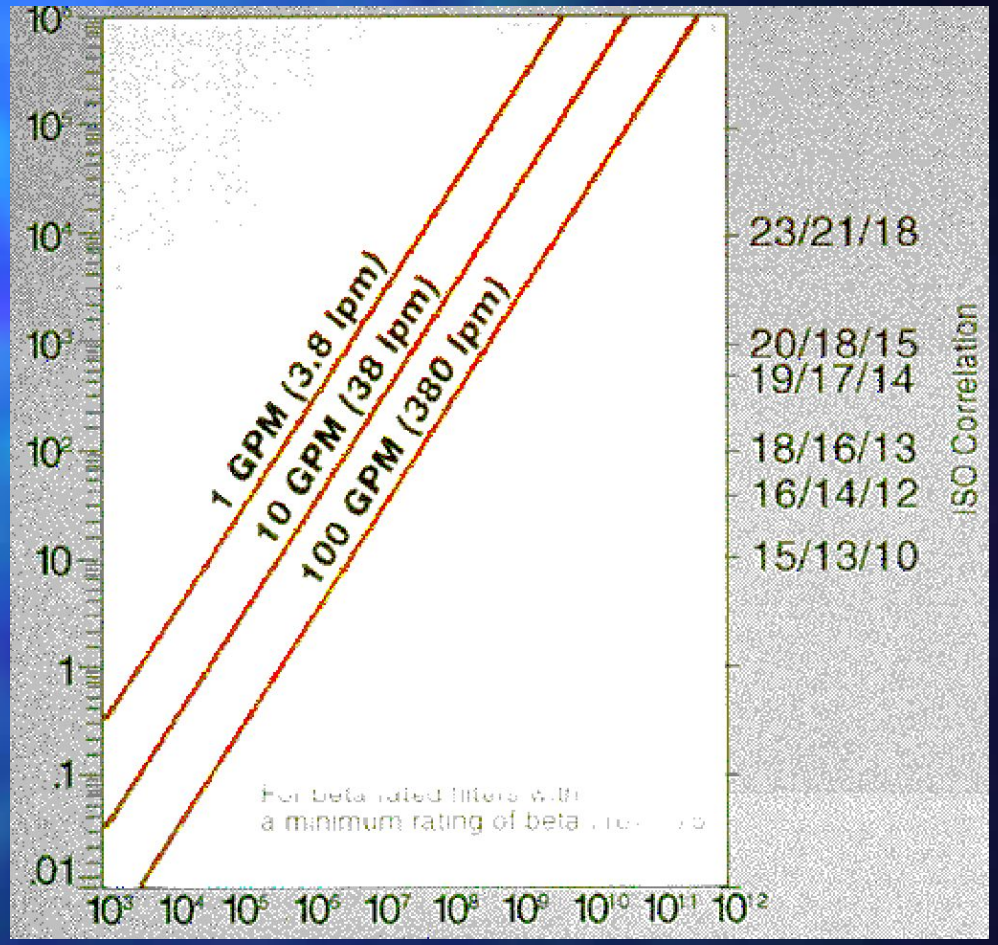
- Doesn't protect directly the components.
- High initial cost.
- Needs an extra space, in the machine's layout.

OFF - LINE Filters
Calculation Parameters

- Max. allowable Δp at clean filter ≤ 50 kPa (0,5 Bar).
- Flow rate must be about 10 ÷ 20% of the reservoir volume.
- Filter must be with the largest possible filtration area.
- It's "recommended" not using By-Pass valve.
- It's useful to use a finer filtration degree than main system.
- Do not use Off-Line system to make some machine's functions "superimposition", in this case flow rate and pressure aren't constant.
- Cooler must be located "before" the filter, to avoid any back pressure.

OFF - LINE Filters
Calculation Parameters

- **Sources Based on Dr. Fitch, E.C. Fluid Contamination Control, FES Inc. Stillwater, Oklaoma, 1988.**
- **Particles ingression with dimension > 10 µm. per minute.**
- **Curve obtained with element with filtration degree = 10 µm. $\beta_{10} \geq 75$ it represent relation between:**
  - **Number ingression particles.**
  - **Off-Line pump's flow rate.**
  - **ISO contamination classes achieve with number of circulating particles.**



Filters Insertion Points
Filters - Air Breathers

Types:

- Dry, to remove solid contaminant.
- Dry, to remove solid & humidity contaminant.
- Oil bath, to remove solid contaminant.

Filtration Training #1

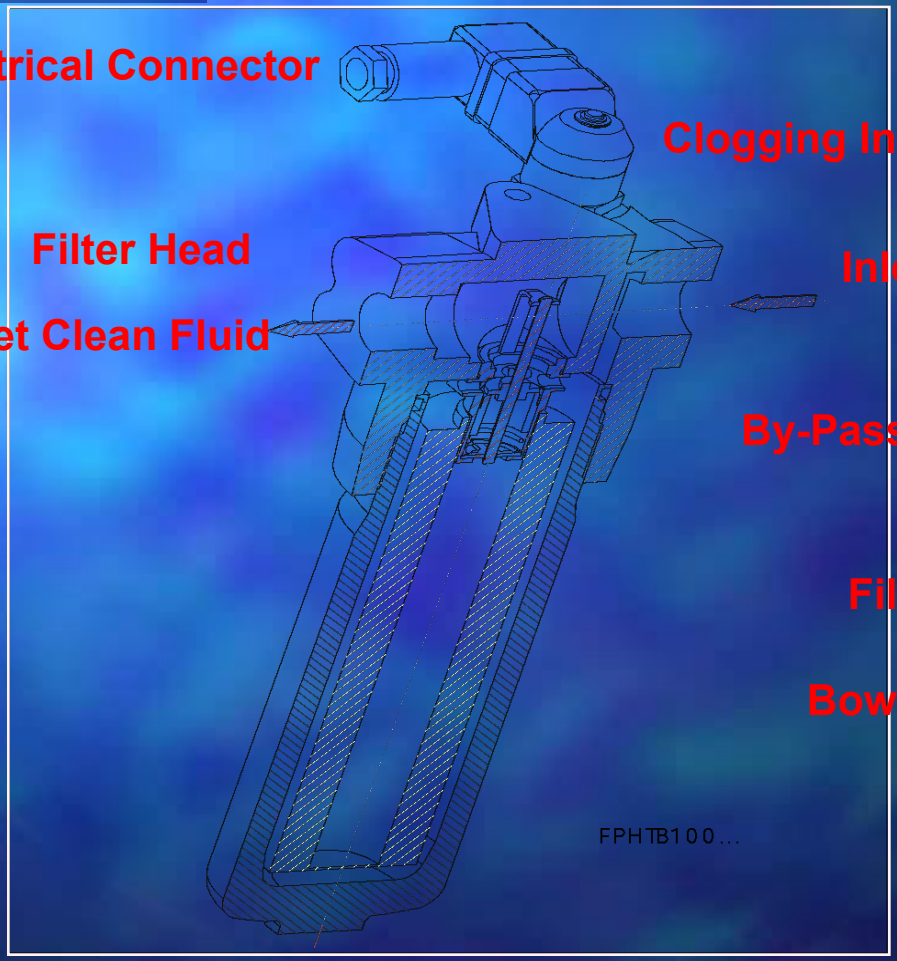
Function's scheme of a

FILTER

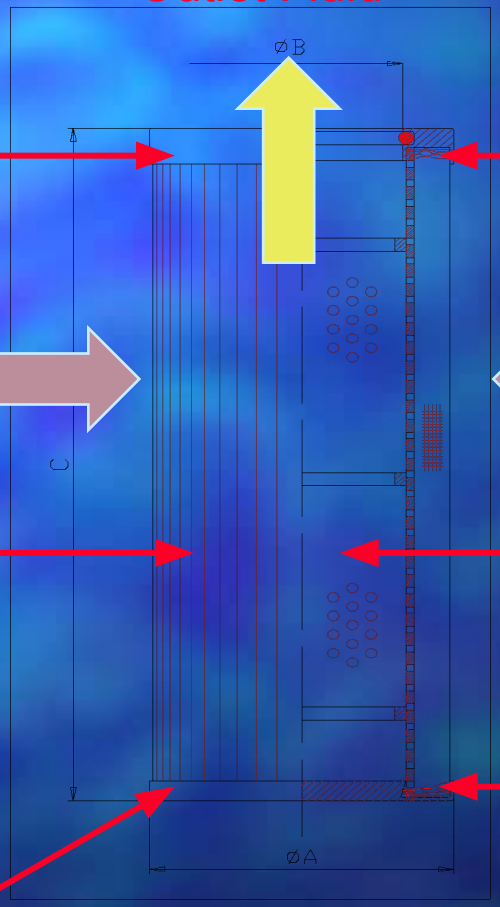
and

FILTER ELEMENT

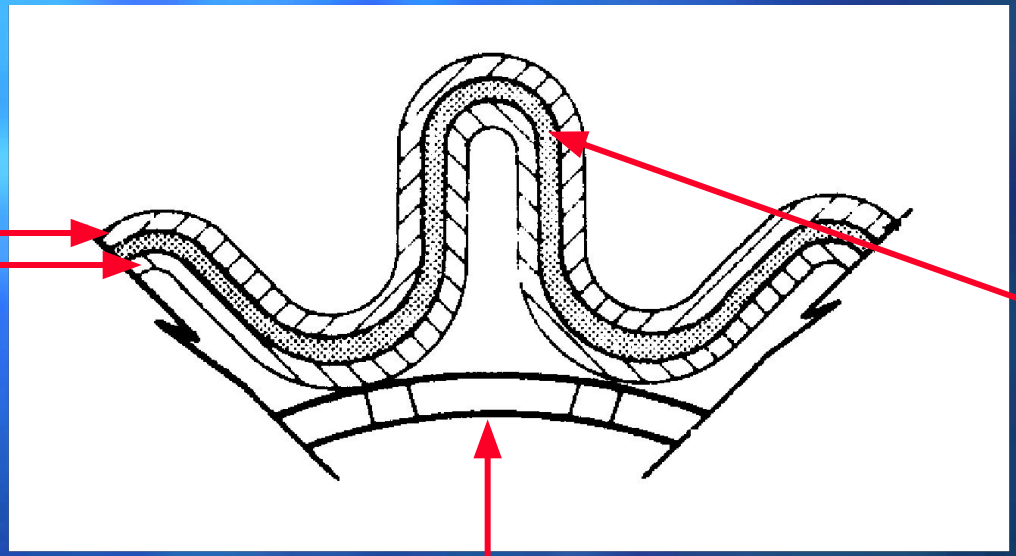
Hydraulic Filter Construction



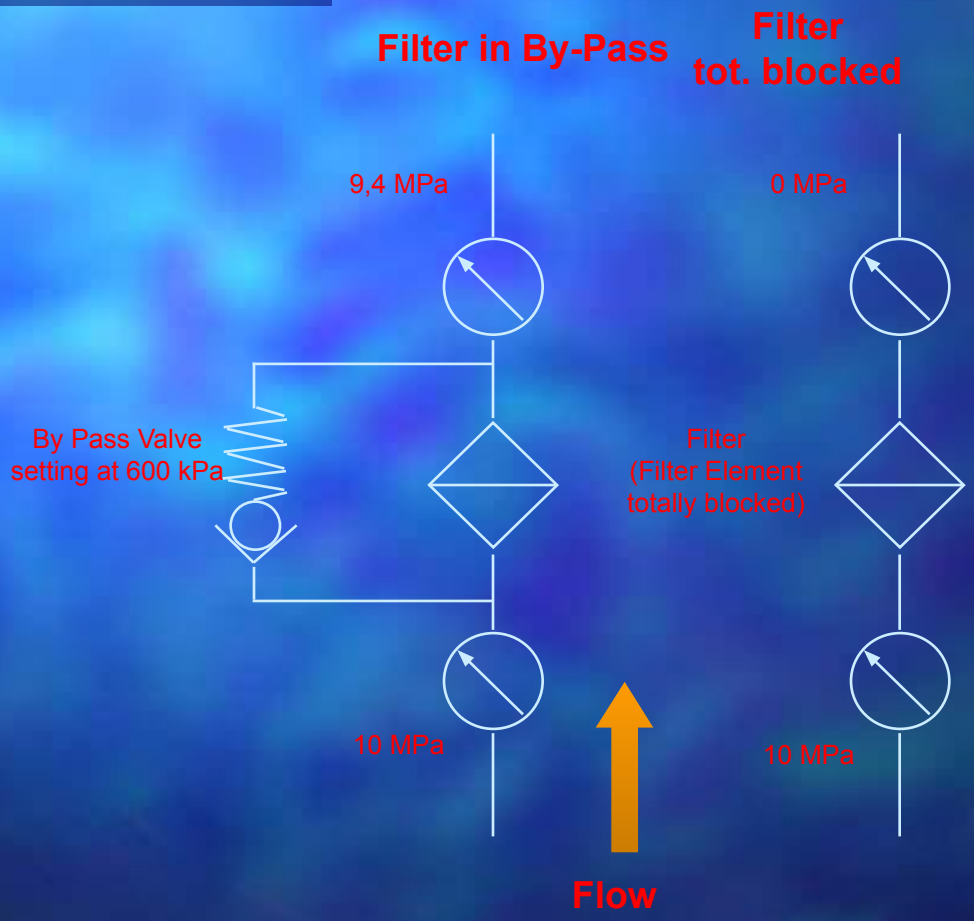
Filter Element Construction



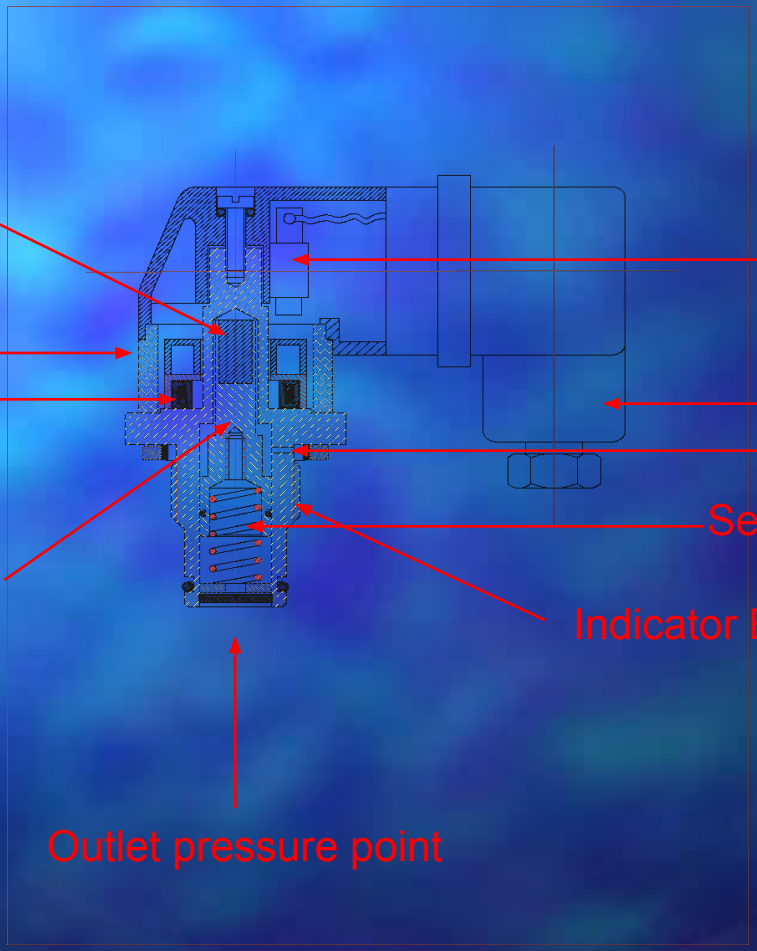
Filter Media Construction



By-Pass Valve Function Scheme



Differential Clogging Indicator Construction

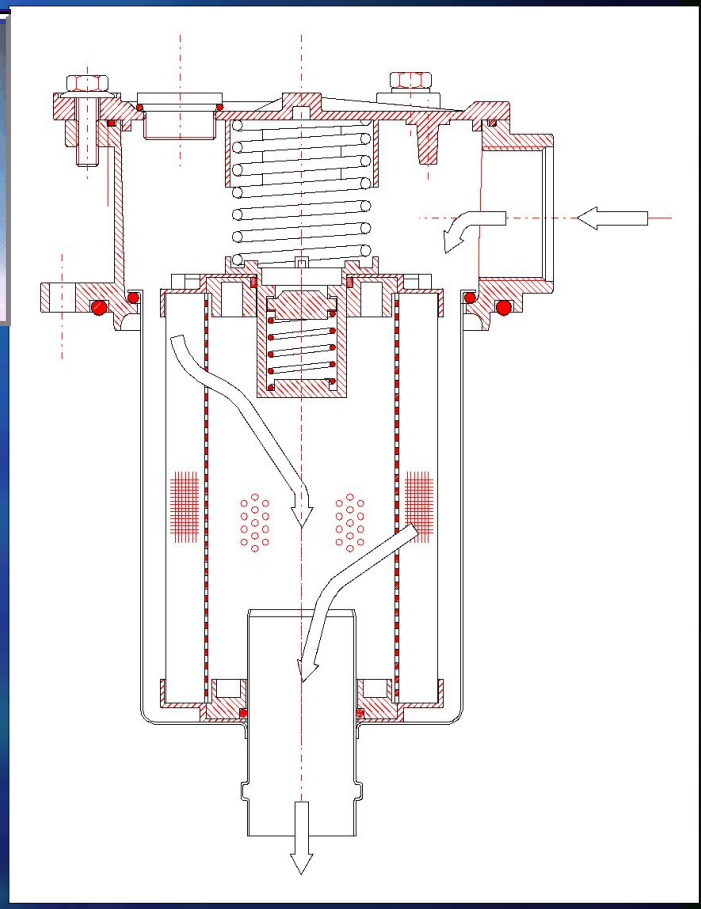


Filtration Training #1

Filter's Application
&
Products Analysis

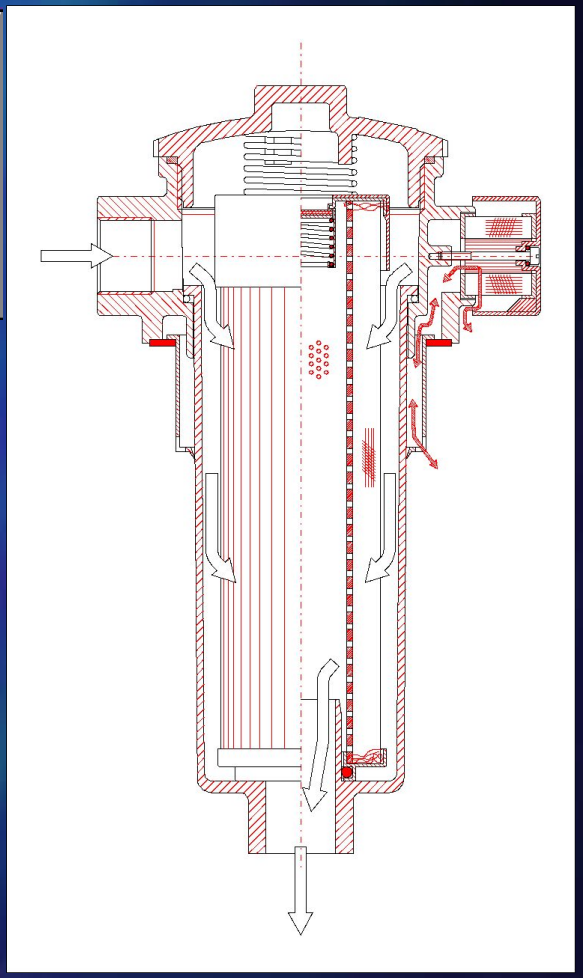
Product Analysis
RETURN - RFM Series

- Type: Return Filter.
- Mounting: Tank Top.
- M.A.O.P.: 300 kPa.
- Nominal Flow Rate: up to 700 Lpm.
- Ports: from 3/8” ÷ 2” BSPP.
- Filtration Degree: FC; FD; FV; CD; CV; MS; MCV.
- Indicators: Visual (Manometer); Electrical (Pressure switch).
- Applications: Industrial; Agriculture; Mobile Equipment.



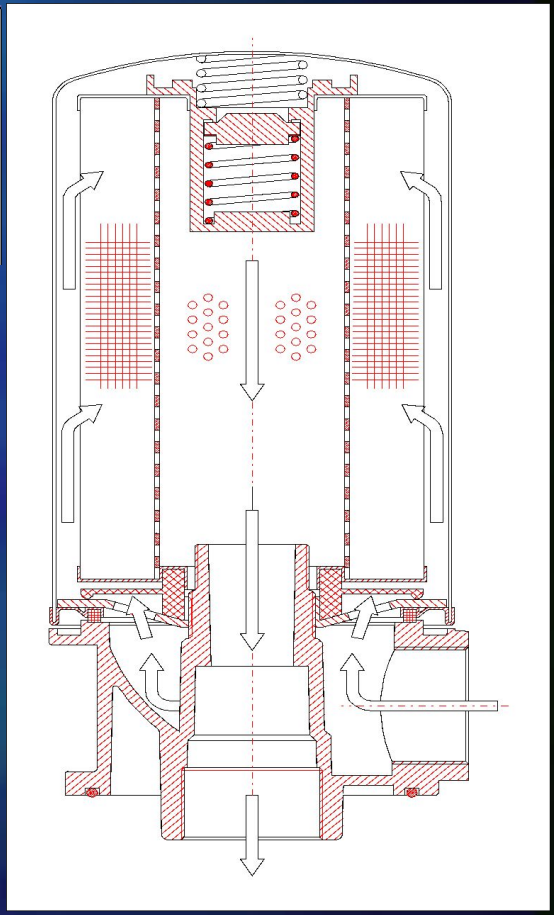
Product Analysis
RETURN - RFB Series

- Type: Return Filter.
- Mounting: Tank Top.
- M.A.O.P.: 300 kPa.
- Nominal Flow Rate: up to 140 Lpm.
- Ports: from 1/2” ÷ 1” BSPP.
- Filtration Degree: FD; FV; CD; CV.
- Indicator: Visual (Manometer); Electric (Pressure Switch).
- Applications: Industrial; Agriculture; Mobile Equipment.

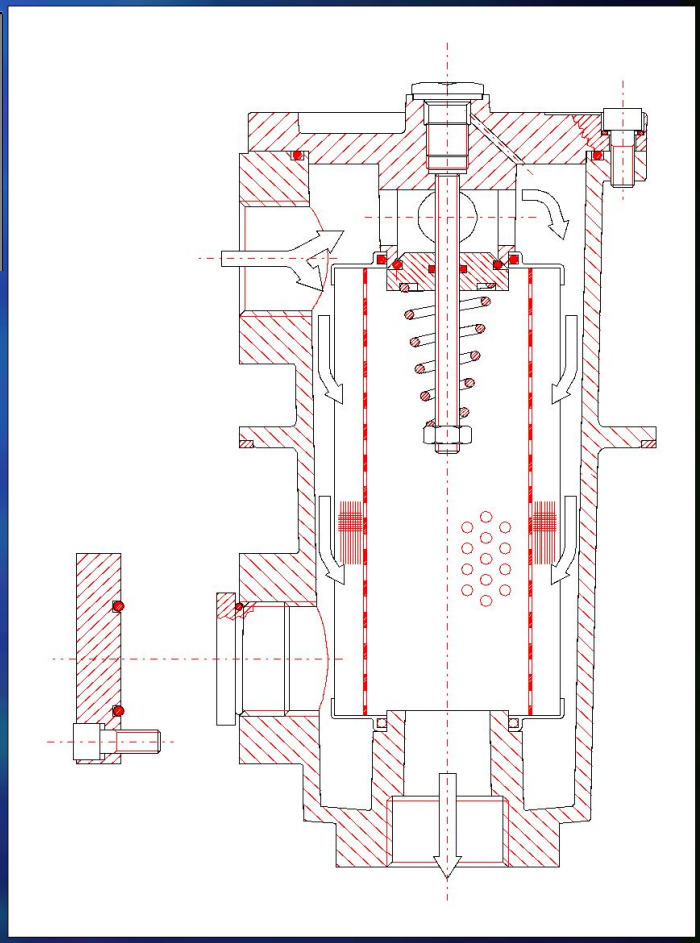


Product Analysis
RETURN - MAR Series

- Type: Return Filter.
- Mounting: Tank Top.
- M.A.O.P.: 700 kPa.
- Nominal Flow Rate: up to 150 Lpm.
- Ports: from 3/4” ÷ 1”1/2 BSPP.
- Filtration Degree: FC; FD; FV; CD; CV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch).
- Applications: Industrial; Tooling Machine, small Power Packs.
- Advantages: Spin-On Filter Element.



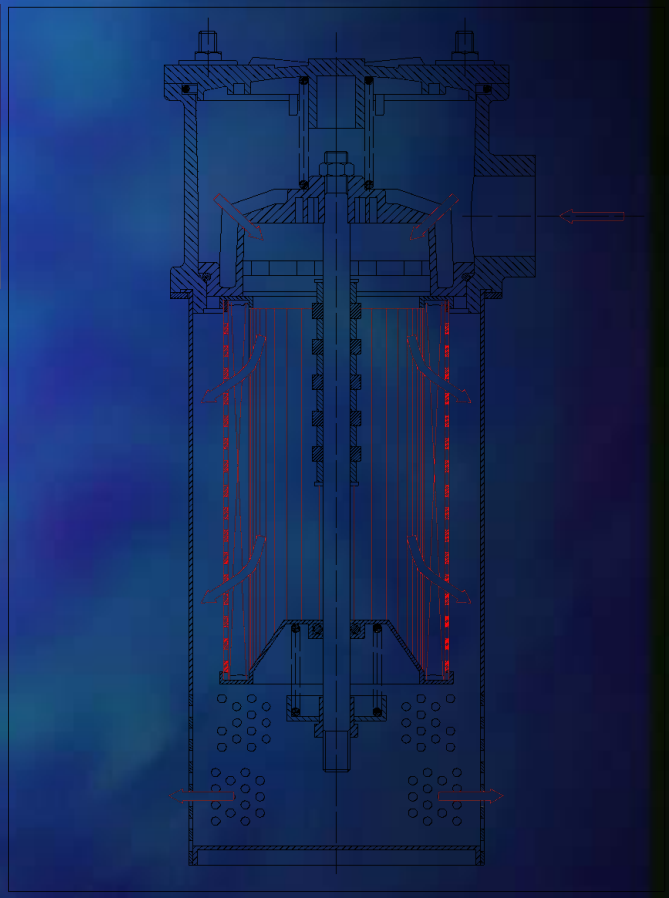
Product Analysis
RETURN - MRH Series



- Type: Return Filter.
- Mounting: In Line or Tank Top.
- M.A.O.P.: 2 MPa.
- Nominal Flow Rate: up to 1.000 Lpm.
- Ports: From 1/2” ÷ 3” 1/2 BSPP o SAE Flange.
- Filtration Degree: FT;FC; FD; FV; CD; CV; MS; MCV.
- Indicators: Differential Visual; Visual and Electric; Electric with thermostat.
- Applications: Industrial; Hydraulic & Lubrication Power Packs, Presses (injection & Die Casting), Tooling Machine.

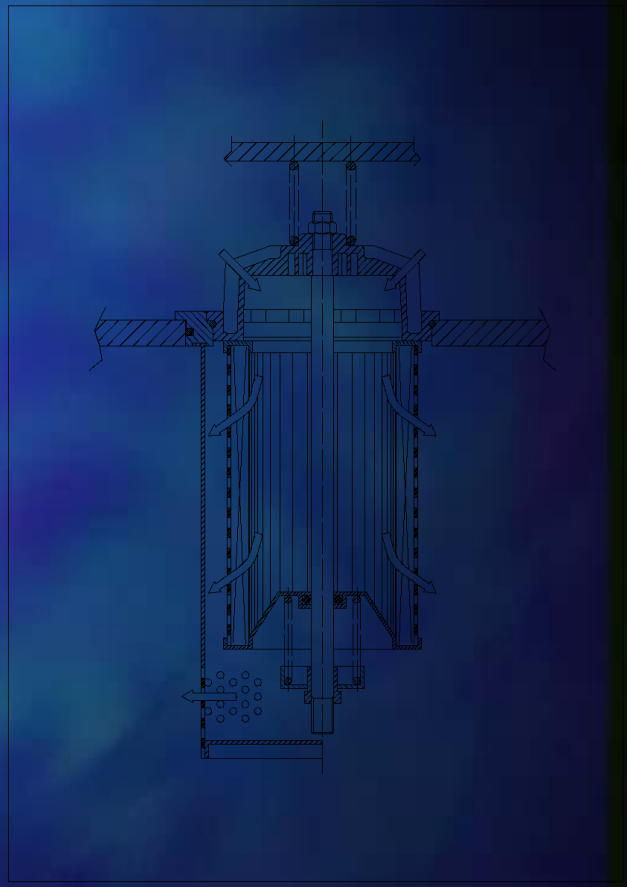
Product Analysis
RETURN - RFC Series

- Type: Return Filter.
- Mounting: Tank Top.
- M.A.O.P.: 700 kPa.
- Nominal Flow Rate: up to 1.000 Lpm.
- Ports: from 1” ÷ 2” 1/2 BSPP.
- Filtration Degree: FC; FD; FV; CD; CV; MS; MCV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch) or differential indicator, visual, visual-electric.
- Applications: Industrial; Agriculture; Mobile Equipment.



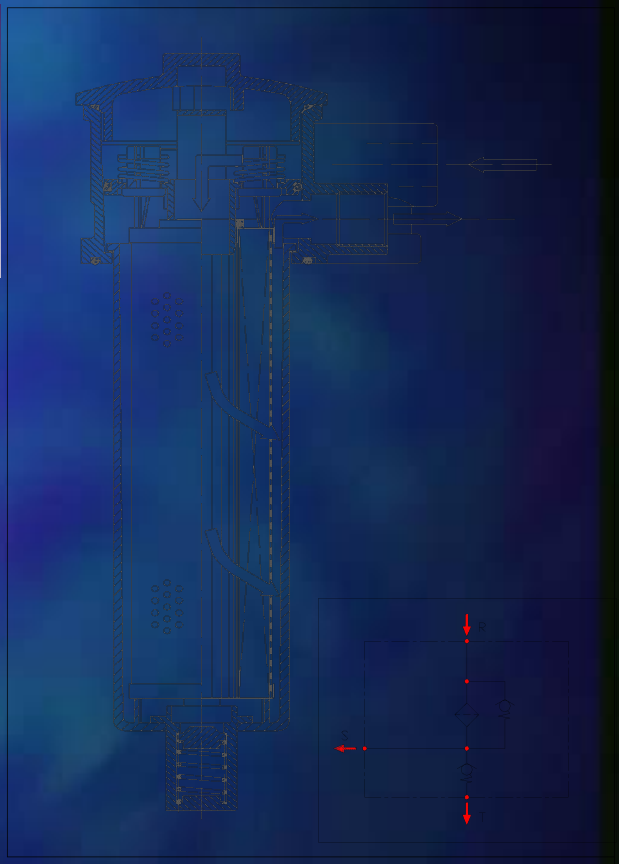
Product Analysis
RETURN - RSC Series

- Type: Return Filter.
- Mounting: Under tank cover.
- M.A.O.P.: 700 kPa.
- Nominal Flow Rate: up to 1.000 Lpm.
- Ports: =====.
- Filtration Degree: FC; FD; FV; CD; CV; MS; MCV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch).
- Applications: Industrial; Agriculture; Mobile Equipment.



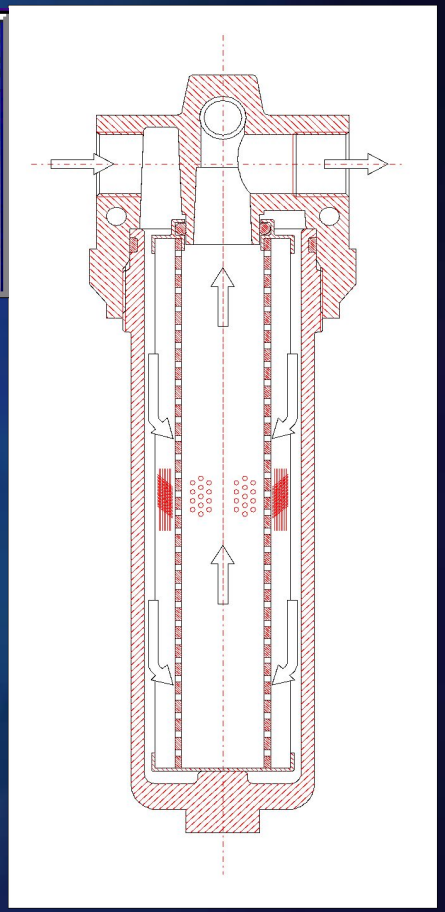
Product Analysis
RETURN - HTS Series

- Type: Suction/Return Filter “Hydrostatic Transmission”.
- Mounting: Tank Top.
- M.A.O.P.: 1.000 kPa.
- Nominal Flow Rate: up to 150 Lpm.
- Ports: Return from 3/4” ÷ 1” BSPP.
- Filtration Degree: FD; FV; CD; CV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch).
- Applications: Mobile Equipment.

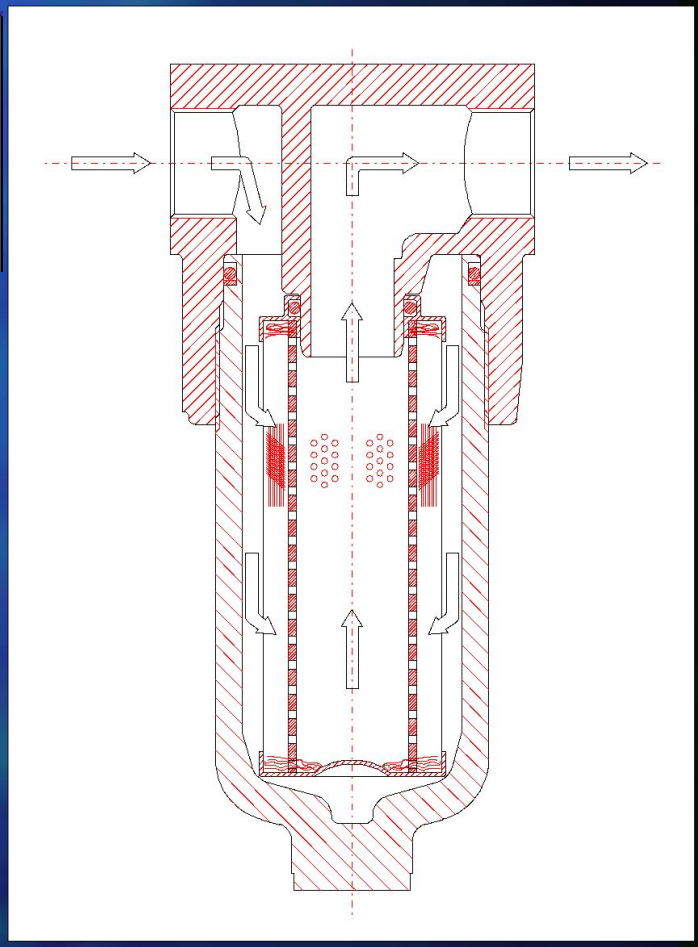


Product Analysis
PRESSURE - MDM Series

- Type: Pressure Filter.
- Mounting: In Line.
- M.A.O.P.: 11 MPa.
- Nominal Flow Rate: up to 60 Lpm.
- Ports: 1/2” BSPP.
- Filtration Degree: FT; FC; FD; FV; CD; CV.
- Indicator: Differential Visual, Visual Electric, Electric+Thermostat.
- Applications: Industrial, tooling Machine; Agriculture; Mobile Equipment.

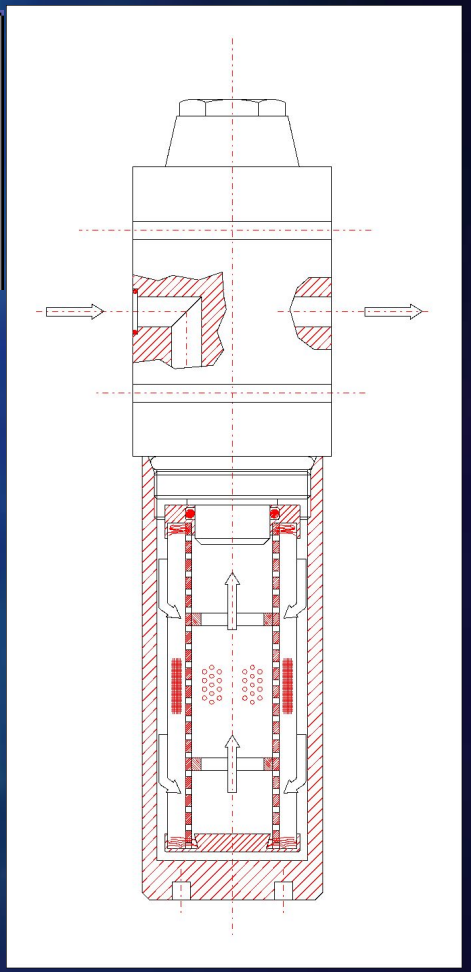


Product Analysis
PRESSURE - MHT Series



- Type: Pressure Filter.
- Mounting: In Line.
- M.A.O.P.: 42 MPa.
- Nominal Flow Rate: up to 400 Lpm.
- Ports: from 1/2” ÷ 1 1/2” BSPP.
- Filtration Degree: FT; FC; FD; FV; CD (collapse 2 Mpa “1”); FT; FC; FD; FV (collapse 21 Mpa “2”)
- Indicator: Differential Visual, Visual Electric; Electric+Thermostat.
- Applications: Industrial; Agriculture; Mobile Equipment.

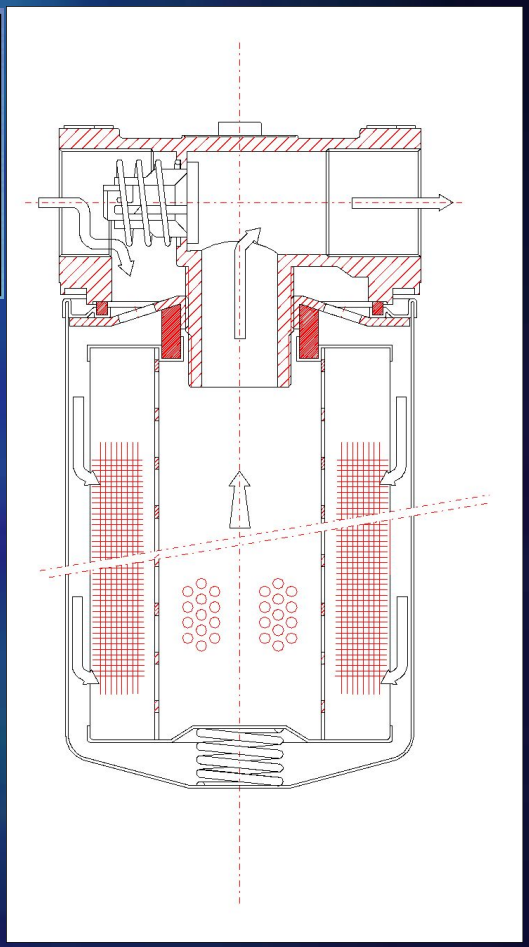
Product Analysis
PRESSURE - MDF Series



- Type: Pressure Filter.
- Mounting: Manifold (Sandwich or by Head).
- M.A.O.P.: 31,5 MPa.
- Nominal Flow Rate: up to 40 Lpm.
- Ports: CETOP 3 - 5 - 7.
- Filtration Degree: FT; FC; FD; FV (collapse 21 Mpa “2”)
- Indicator: Differential Visual, Visual Electric; Electric+Thermostat.
- Applications: Industrial; Logic block Manifolds; Presses.

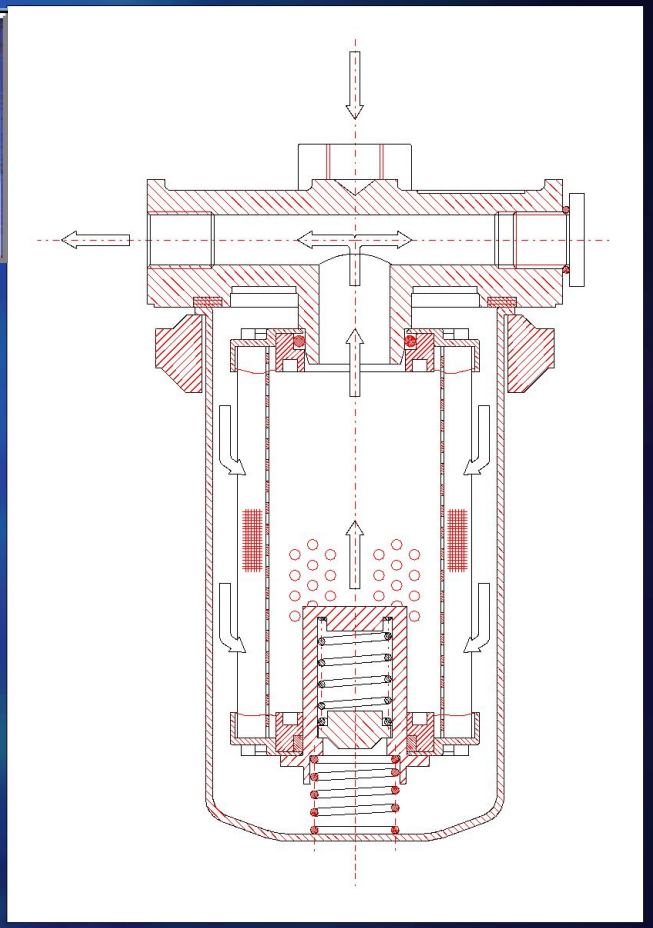
Product Analysis
PRESSURE - AMF Series

- Type: Pressure Filter.
- Mounting: In Line.
- M.A.O.P.: 1200 kPa.
- Nominal Flow Rate: up to 300 Lpm.
- Ports: from 3/4” ÷ 1 1/2” BSPP and SAE Flange.
- Filtration Degree: FT; FC; FD; FV; CD; CV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch); Differential Visual, Visual Electric, Electric+Thermostat.
- Applications: Industrial; Agriculture; Mobile Equipment.



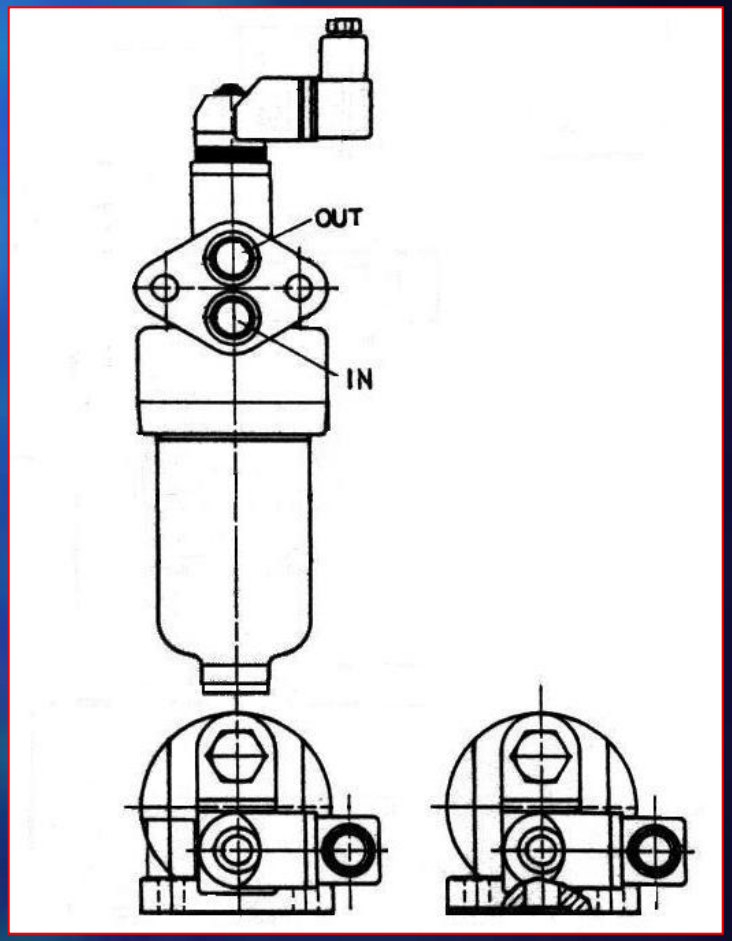
Product Analysis
PRESSURE - LFM Series

- Type: Pressure Filter.
- Mounting: In Line.
- M.A.O.P.: 2 MPa.
- Nominal Flow Rate: up to 350 Lpm.
- Ports: from 3/8” ÷ 1 1/2” BSPP.
- Filtration Degree: FT; FC; FD; FV; CD; CV.
- Indicator: Visual (Manometer); Electrical (Pressure Switch).
- Applications: Industrial; Agriculture; Mobile Equipment.



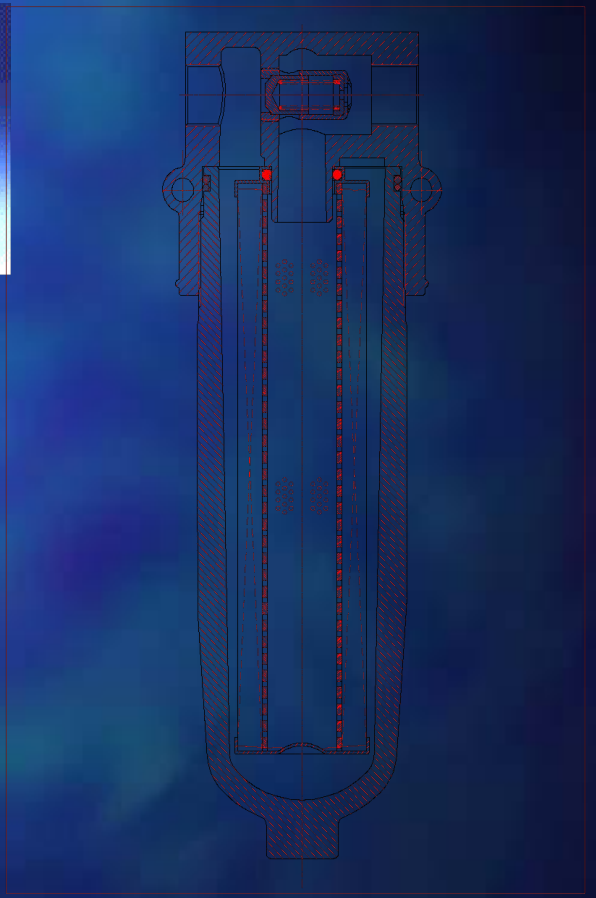
Product Analysis
PRESSURE - SPP Series

- Type: Pressure Filter.
- Mounting: Lateral Manifold.
- M.A.O.P.: 31,5 MPa.
- Nominal Flow Rate: up to 400 Lpm.
- Ports: CETOP 15 – 20 – 32.
- Filtration Degree: FT; FC; FD; FV; CD (collapse 2 Mpa “1”); FT; FC; FD; FV (collapse 21 Mpa “2”).
- Indicator: Differential Visual, Visual Electrical; Electrical+Thermostat.
- Applications: Industrial; Logic Block Manifold.



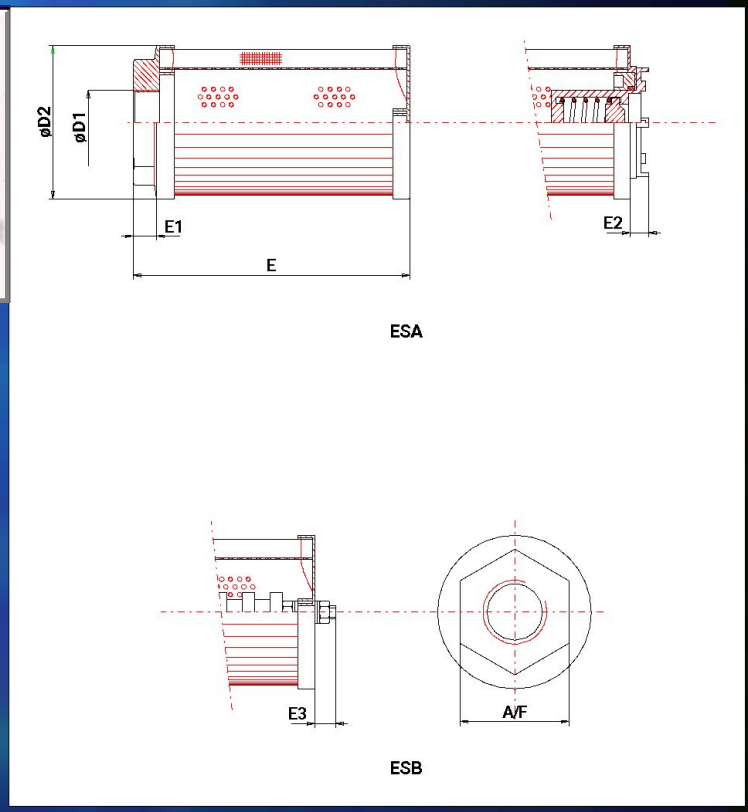
Product Analysis
PRESSURE - SPM Series

- Type: Pressure Filter.
- Mounting: In Line.
- M.A.O.P.: 22 MPa.
- Nominal Flow Rate: up to 130 Lpm.
- Ports: from 1/2” ÷ 1” BSPP.
- Filtration Degree: FT; FC; FD; FV; CD; CV.
- Indicator: Differential Visual, Visual Electric; Electric+Thermostat.
- Applications: Industrial; Agriculture; Mobile Equipment.



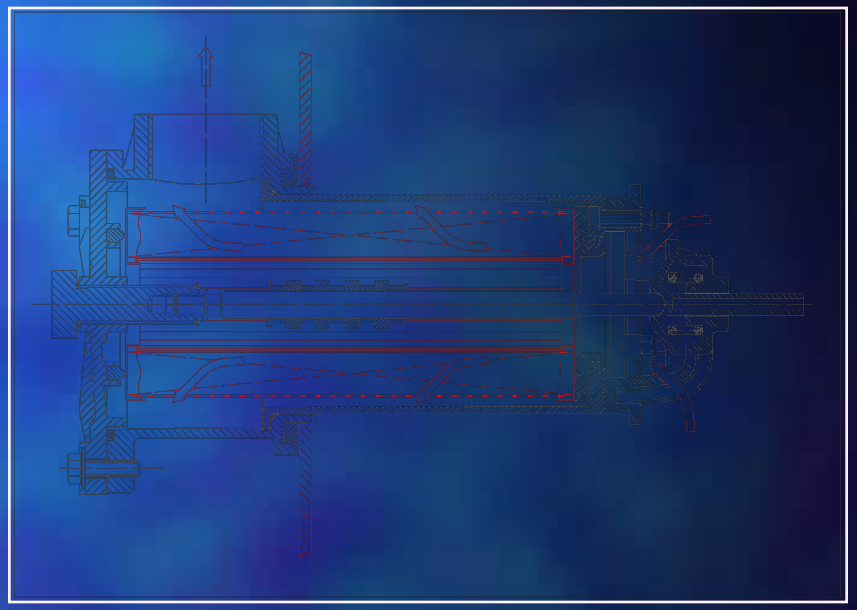
Product Analysis
SUCTION – FAM - MSZ Series

- Type: Suction Filter.
- Mounting: Immersed.
- Nominal Flow Rate: up to 540 Lpm.
- Port: from 3/8” ÷ 4” BSPP.
- Filtration Degree: MS; MCV; MDC.



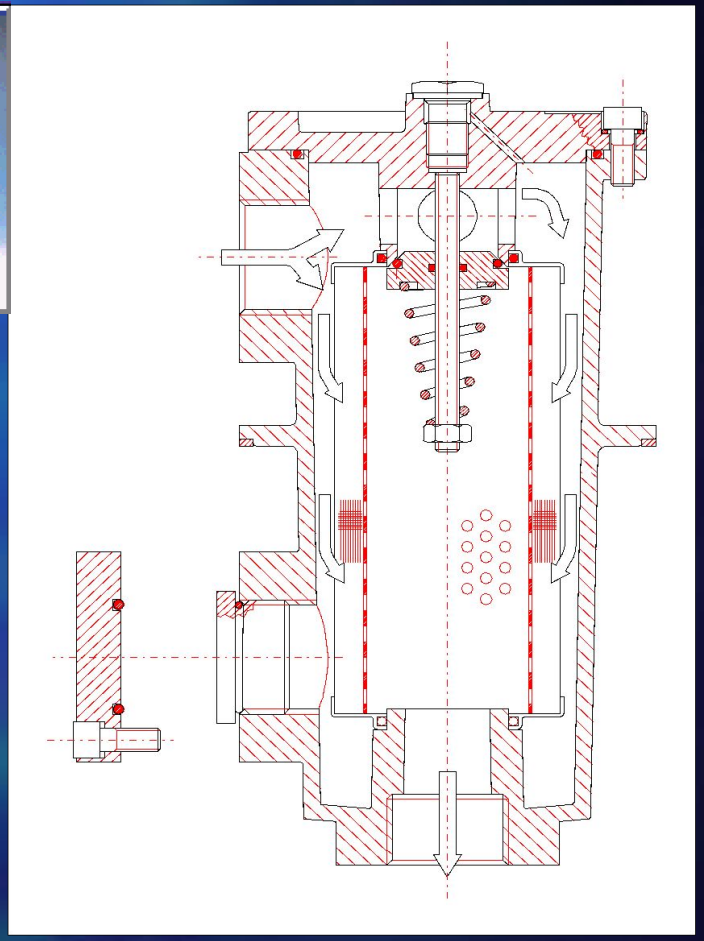
Product Analysis
SUCTION - FSB Series

- Type: Suction Filter.
- Mounting: Sub-Level at Wall.
- Nominal Flow Rate: up to 540 Lpm.
- Ports: from 1” 1/2” ÷ 4”.
- Filtration Degree: MS; MCV; MDC.
- Indicator: Visual (Vacuum gauge); Electric (Vacuum Switch).
- Applications: Industrial, Presses Injection Moulding Machine, Die Casting Machine.



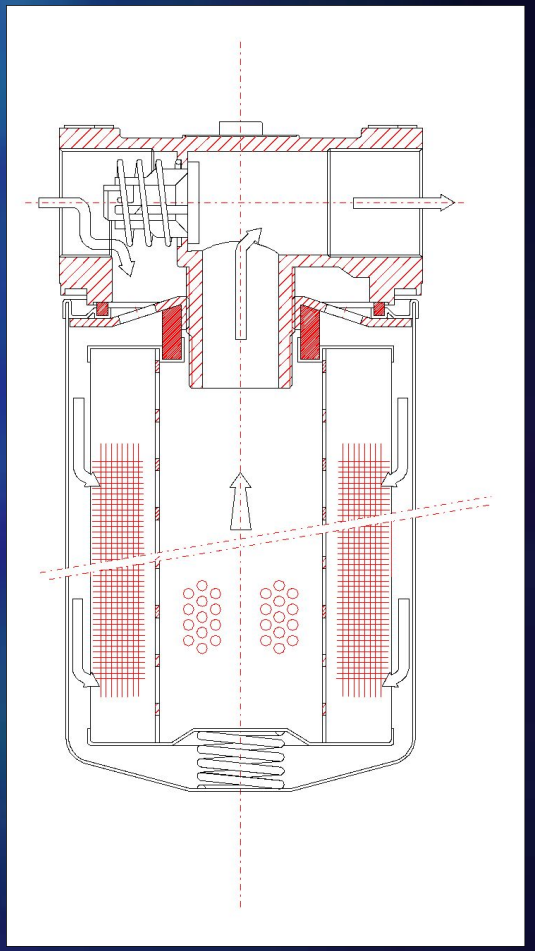
Product Analysis
SUCTION - MSE Series

- Type: Suction Filter.
- Mounting: In Line or Tank Top.
- Nominal Flow Rate: up to 480 Lpm.
- Ports: from 1/2” ÷ 3 1/2”.
- Filtration Degree: MS; MCV; MDC.
- Indicator: Visual (Vacuum Gauge); Electric (Vacuum Switch).
- Applications: Industrial, Lubrication, Steel Ind., Power Packs.



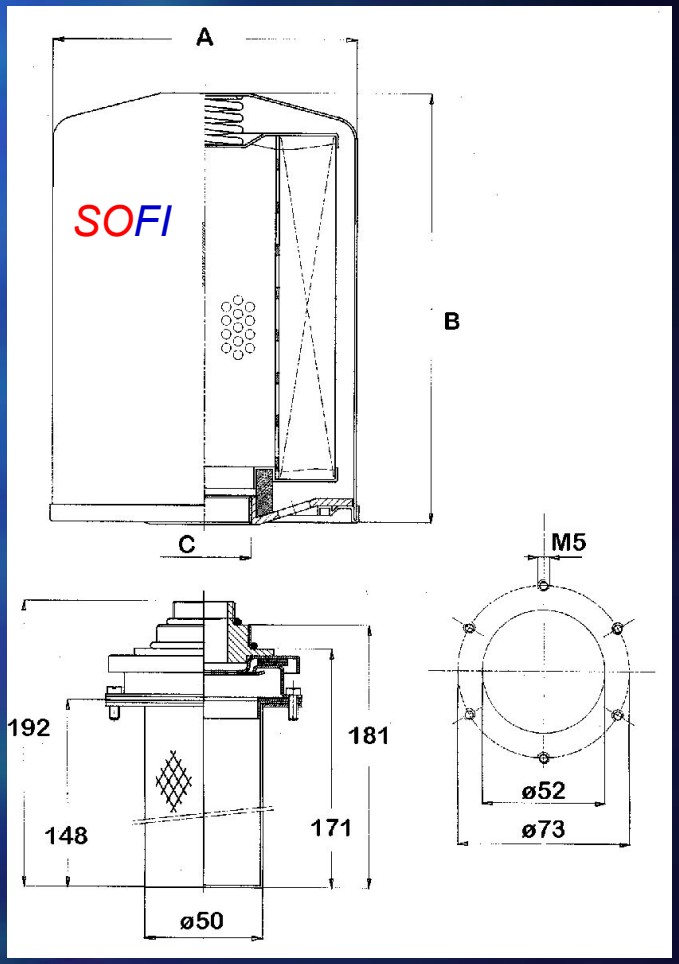
Product Analysis
SUCTION - AMF Series

- Type: Suction Filter.
- Mounting: In Line.
- Nominal Flow Rate: up to 75 Lpm.
- Ports: from 3/4” ÷ 1 1/2”.
- Filtration Degree: CD; CV; MS; MCV.
- Indicator: Visual (Vacuum Gauge); Electric (Vacuum Switch).
- Applications: Industrial, Tooling Machine; Agriculture; Mobile Equipment.



Product Analysis
ACCESSORIES - CSE Series

- Type: Air Filter.
- Mounting: Tank Top.
- Nominal Flow Rate: up to 2.800 Lpm.
- Port: from 3/4” ÷ 1 1/4” BSPP.
- Filtration Degree: up to 3 micron Abs. in AIR.
- Indicator: NO.
- Applications: In All System.



Filtration Training #1

Fluid

Analysis

Fluids Analysis
Analysis Types

Analysis Types

- **Physique:**
  - Patch Test (Sample Membrane); contaminant's type and nature verification with optical microscope "LAB + SITU".
  - Particle Counting; determine particle's dimension and quantity (calibration according to ISO 11171; former ISO 4402), fluid classification according to the actual ISO Standard ISO 4406 - 1999 "LAB + SITU".
  - BENCH Filterability; Fluid's Filterability factor determination (application with fibres media only) "LAB".
  - Gravimetry; (ISO 4405) gives the possibility to know what is the contaminant weight in a specific fluid (mg/litre) "LAB".

Fluids Analysis
Analysis Types

Analysis Types

- **Chemical:**
  - Viscosity; determine the fluid's viscosity grade (according to Engler, Stoke, Saybold, methods); values in cSt.; Engler (°E); cPs; SSU - "LAB".
  - Water Content; determine water's content in the fluid, according to DIN 51777 Standard (Karl Fischer o Infrared Ray) values in ppm; %; - "LAB".
  - Spectrography; determine metals content in the fluid and also additives content, value in ppm - "LAB".
  - PH; determine acidity or basic fluid.

Filters and Filter Elements
Possible TESTS

- ISO 2941: Collapse / Burst Resistance.
- ISO 2942: Fabrication Integrity (Bubble Point Test).
- ISO 2943: Fluid Compatibility.
- ISO 3723: Axial Load Resistance.
- ISO 3724: Fatigue Flow Rate Resistance.
- ISO 3968: "Δp" Verification, (in revision).
- ISO 4572: "OLD" Filtration Efficiency "Multi Pass Test" (A.C.F.T.D. Air Clean Fine Test Dust).
- ISO 16889: "NEW" Filtration Efficiency "Multi Pass Test" (M.T.D. Medium Test Dust).

Filtration Training #1

Thank You for Listening!