
technical guide

STEAM FILTRATION

technical information • product support • new developments



domnick hunter - Process Filtration

Contents

Page

3	Introduction
3-4	Overview of Steam Quality
4	What are the benefits of steam filtration?
4-5	Filter Media Types
5-6	Filter Micron Ratings
6-8	Product Range
8-9	Which Product for Which Application?
10-11	Installation of Steam Filtration systems
11	Filter sizing
12	Saturated Steam Pipeline Capacities
13-14	Recommended Cleaning Procedures for Stainless Steel Filter Cartridges
15-16	Steam Filtration - The Competition

Introduction

Steam is an often neglected part of a process, regarded as an add-on to a customer's liquid or gas filtration needs. It can however have large specific applications in its own right and should be progressed as an opportunity.

The quality of steam used within the food and dairy industries has been raised higher on the agenda in an ever increasing number of companies. Minimum accepted standards are now being quoted on a more regular basis with particular reference to 'Culinary Grade' steam.

There is also a growing tendency to install central steam filtration systems that are of high capacity. This requires a specific design of filter to optimise the flow characteristics of the filter medium.

The new range of steam filters is geared to provide a solution for all applications.

Overview of Steam Quality

The quality of steam can be divided into three distinct categories:

- Process Steam
- Culinary Steam
- Clean Steam

Process Steam

This is primarily used in instances where there is no direct contact with the product being manufactured such as indirect heating of products via external steam jackets. In the biotechnology industry applications could include WFI stills, bio waste kill systems, process heating, jacketed autoclaves etc. When adequately filtered it can be used for the sterilisation of sterile gas filters.

Culinary Steam (3A Standard 609-01)

This is an American standard laid down for the dairy industry and defined as; "Steam that is free of entrained contaminants, is relatively free of water in liquid form and is suitable for use in direct contact with milk or milk products or product contact surfaces".

The filtration requirements are however applicable to the food and beverage industry as a whole and are being recognised far more outside of the USA. Its growing acceptance is mainly due to a lack of recognised standards for steam outside of the USA. This is the area of steam filtration that will see the greatest growth over the coming years. The new range has been specifically developed to target this area.

General Requirements (3A Standard 609-01)

- The steam filter should be capable of removing 95% of particles 2 microns in size and larger in the liquid phase, and should have an associated condensate trap (thermodynamic type).
- The materials of construction of the filter and pipe work should be manufactured from 300 Series stainless steel or above.
- Any additives to the boiler feed water should conform to CFR Title 21, Chapter 1, Part 173, Subpart D, Section 173.310.

Clean Steam (HTM 2031 :1997)*

There has in the past often been some confusion over differences between 'Clean' steam and 'Pure' Steam. It has been accepted that 'Pure' steam is that which has been produced from pyrogen- free water (Water for Injection: WFI) rather than just Purified Water.

However, clean steam is defined in HTM 2031* as: "*Steam whose condensate meets purity requirements of Water for Injection BP(British Pharmacopoeia) (including a limit on pyrogens) with the additional specifications to protect against corrosion of materials used in the construction of sterilisers and medical devices*".

The requirements are primarily for the grade of water used to generate the steam. It is therefore not possible to produce 'clean steam' through filtration.

*Health Technical Memorandum 2031 "Clean Steam for Sterilization".

What are the benefits of Steam Filtration?

Apart from clean steam, when steam is generated in a boiler there are large amounts of contamination from pipe scale and boiler feed water that need to be fine filtered.

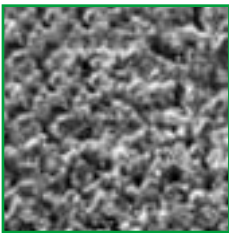
This will ensure that:

- There is no fouling of critical orifices(pressure regulation valves / injectors etc. on filling machines)
- There is no contamination/ discolouration of sterile equipment
- There is no contamination of food and beverage products.
- There is an increase in process efficiencies (e.g. bulk contamination can lead to an increase in pressure drops in distribution pipelines).
- There is adequate protection to downstream filters. For both liquid and gas filters this can ensure that the filter will not block prematurely or be damaged in service because of the presence of large particulate.

Filter Media Types

The type of filters used for steam filtration can be divided into three main groups:

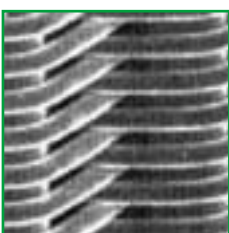
Sintered



- Tight pore structure
- Low surface area
- Low flow rates
- Relatively low cost

This product is produced by forming tubes from metal powder under high temperatures and pressures.

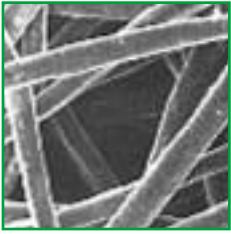
Pleated



- High surface area
- High flow rates
- Relatively expensive
- More open structure

The filtration media in this product is made from weaving metal wires to create a mesh.

Pleated Metal fibre



- Tight pore structure
- High surface area
- High flow rates
- Higher cost than pleated mesh

This filtration media is produced by sintering together (high temperature and pressure) small metal fibres, to produce a material that is essentially a metal version of glass micro-fibre media.

Micron range can be as low as 3 micron absolute but as the micron rating drops the costs rise substantially. The grade used by **domnick hunter** is the 5 micron.

The **domnick hunter** range consists of all three types. The grade used depends on the application.

Filter Micron Ratings

The effect of condensate

The rating of a filter is dependent on whether it is being rated in gas or liquid. For example a filter which has a nominal rating of 5 micron and an absolute rating of 15 micron in liquid will remove particles from a gas stream down to approx 1-2 microns.

If large quantities of condensate are present within the system then the filter efficiency will be reduced from a gas rating to a liquid rating in direct proportion to the amount of liquid present. Therefore to maximise the efficiency and throughput of the filter the design of the steam distribution system and housing is extremely important.

A 5 micron pleated mesh filter in a well designed and drained distribution system could provide better quality steam than a 1 micron culinary filter in a poorly designed system with high condensate loads.

Remember, even though most steam is dry saturated it is not completely free from entrained water. Typically dry saturated steam has a dryness fraction of around 95%

The **domnick hunter** Range

The required micron rating is dependant on the application, but as standard only 3 are included in the **domnick hunter** range. The table below outlines the general specifications of the filtration media:

Micron Rating	Application Type			
	General (Pleated)	General (Sintered)	Culinary (Sintered)	Culinary (Pleated MF)
Absolute (Liquid)	25	40	6	5
Nominal (Liquid)	5	25	1	1
Nominal (Steam)	1	5	0.5	0.5

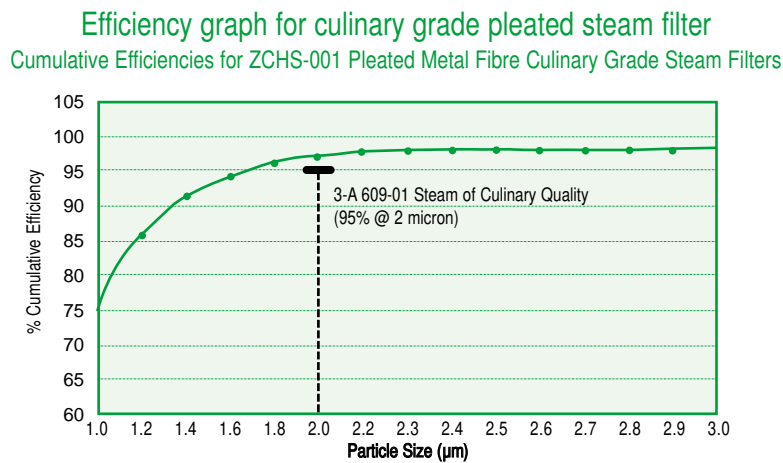
To fall into line with the accepted practices for the designation of steam filter micron ratings the quoted rating in steam will be as follows.

General (Pleated)	General (Sintered)	Culinary (Sintered)	Culinary (Pleated MF)
5	25	1	1

The fact that a nominal rating is given for steam is due to the true rating being dependant on the water content. Rather than trying to complicate the whole subject by quoting the rating as a function of dryness fraction the above general ratings have been adopted.

True efficiencies can be determined for the worst case (liquid phase) as in Culinary Steam standard. Other methods have been adopted such as using titanium oxide powder in an air challenge but this is not representative of the application.

The efficiency in the liquid phase for the pleated metal fibre product is shown below.



Product Range

The new steam filter range can be split into two product types, **sintered** and **pleated**. Both types are available in both a general grade and a culinary grade. The filters are housed in the VBA and new VIS range of housings. All the cartridges use a positive click lock double 'O' ring location.

Filters / Housings

Sintered Tube (refer to Datasheet reference: 17 950 1153)

These are available in two micron ratings; 1(culinary) and 25 (general). The micron rating is designated by:

1 micron : 001

25 micron : 025

Cartridge Code	Sintered Product Range Housing Code	Connection
ZCSSB...T	VBA-7B-	0.5"
ZCSSA...T	VBA-11A	1"
ZCSSK...C	VBA13K	1.5"
ZCSS1...C	VBA-141	2"
ZCSS2...C	VBA-142	2"

All the sintered cartridges are produced from 316L for the sintered tube and 304 for the endcaps.

Pleated Mesh and Metal Fibre

These are also available in two micron ratings; 1micron (culinary : metal fibre) and 5 micron (general : mesh). The micron rating is again designated by:

1 micron : 001 5 micron : 005

Cartridge Code	Pleated Product Range Housing Code	Connection
ZCHSA...T	VBA-11A	1"
ZCHS1...C	VBA-141	2"
ZCHS-J-...3	VIS-01J-D	3"
ZCHS-J-...4	VIS-01J-E	4"
3 x ZCHS-J-...3	VIS-03J-G	6"
3 x ZCHS-J-...4	VIS-03J-H	8"

The new additions to the range are the Jumbo (J) and Multi Jumbo (3J). The Jumbo cartridge is specifically designed to maximise the flow performance of the filter media by maximising the bore of the endcap and hence reducing the differential pressure. The area of pleated media has been optimised to match the capacity of the housing connections with respect to steam flow. For example, a steam system requiring a 5 round 10" housing can now be replaced with the 4" Jumbo product.

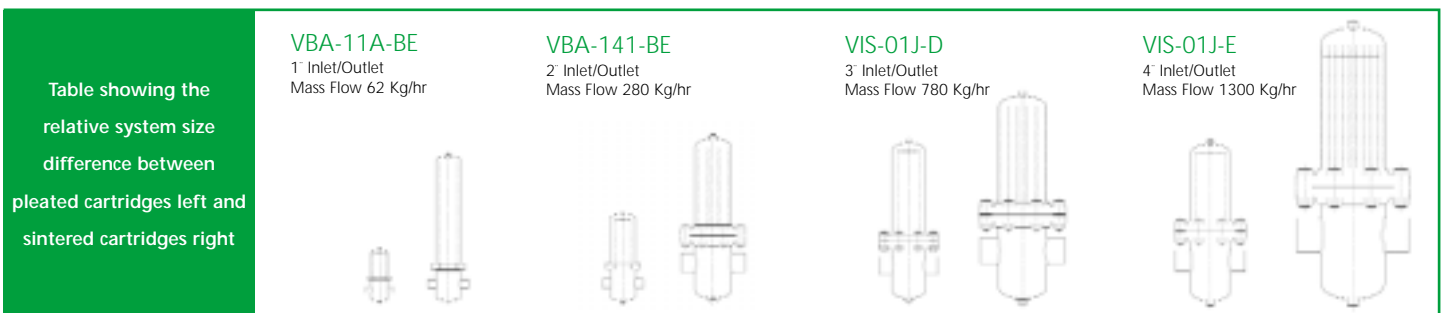
All the pleated products are produced from 316L stainless steel

The introduction of the Jumbo filter has also allowed a more cost effective solution for the pleated range of culinary steam filters for high capacity systems. These systems in the past have all used multiple 10" filters.

Cartridge Code	Equivalent N° of 10"
ZCHS-J-0013	3 x ZCHS1-001C
ZCHS-J-0014	5 x ZCHS1-001C
3 x ZCHS-J-0013	9 x ZCHS1-001C
3 x ZCHS-J-0014	15 x ZCHS1-001C

This places the Jumbo range of cartridges in a very powerful position in comparison to the competition.

The above new range also gives a great advantage in size over a sintered system for culinary steam. A diagram highlighting the relative size of both solutions is shown below.



Ultrafilter Ltd. Retrofits

The full range of Ultrafilter Ltd. sintered steam filters can be retrofitted. The codes for these are: DS-R or PDS-R depending on the endcap variant. The stem of the code indicates the size of the element and is the same pattern as the standard sterile gas product. e.g a PDS-R 10/30 is a push fit which is 10" long and 3" in diameter.

The micron ratings available are 1 and 25 micron. If retrofitting against a 5 micron Ultrafilter product use the 1micron **domnick hunter** variant.

See pages 16 and 17 for more details and a cross-reference list.

Which Product for Which Application

Process Steam

This requires basic prefiltration to render the steam suitable for the sterilisation of membrane and glass microfibre cartridges. The cartridges used are either the 5 micron pleated or the 25 micron sintered. Flow rates through both the sintered and pleated mesh products are high. For accurate details on capacities to allow selection refer to the **domnick hunter** sizing program. (refer to section 10).

Culinary Steam

The choice of a culinary grade steam filter (Pleated or Sintered) is governed primarily by the flow rates required. It is important to note that a sintered culinary grade filter will give the same quality of steam as the pleated metal fibre. The main difference is in the flow capacity. If pipework is old or prone to release of pipescale etc., it is advised that a 5 or a 25 micron filter is used as a prefilter.

The table below gives an approximate guide to selecting when a sintered product should be specified over a pleated variant. For each pipe size a maximum flow rate is given, above which a pleated product should be used.

Connection Size (inches)	Flow Rate (kg/hr @ 1 barg)
0.5"	All
1"	<30
2"	<150

To put the difference in flow rates between sintered and pleated for culinary grade filtration into perspective a 10" pleated filter will flow the same as three 20" sintered filters.

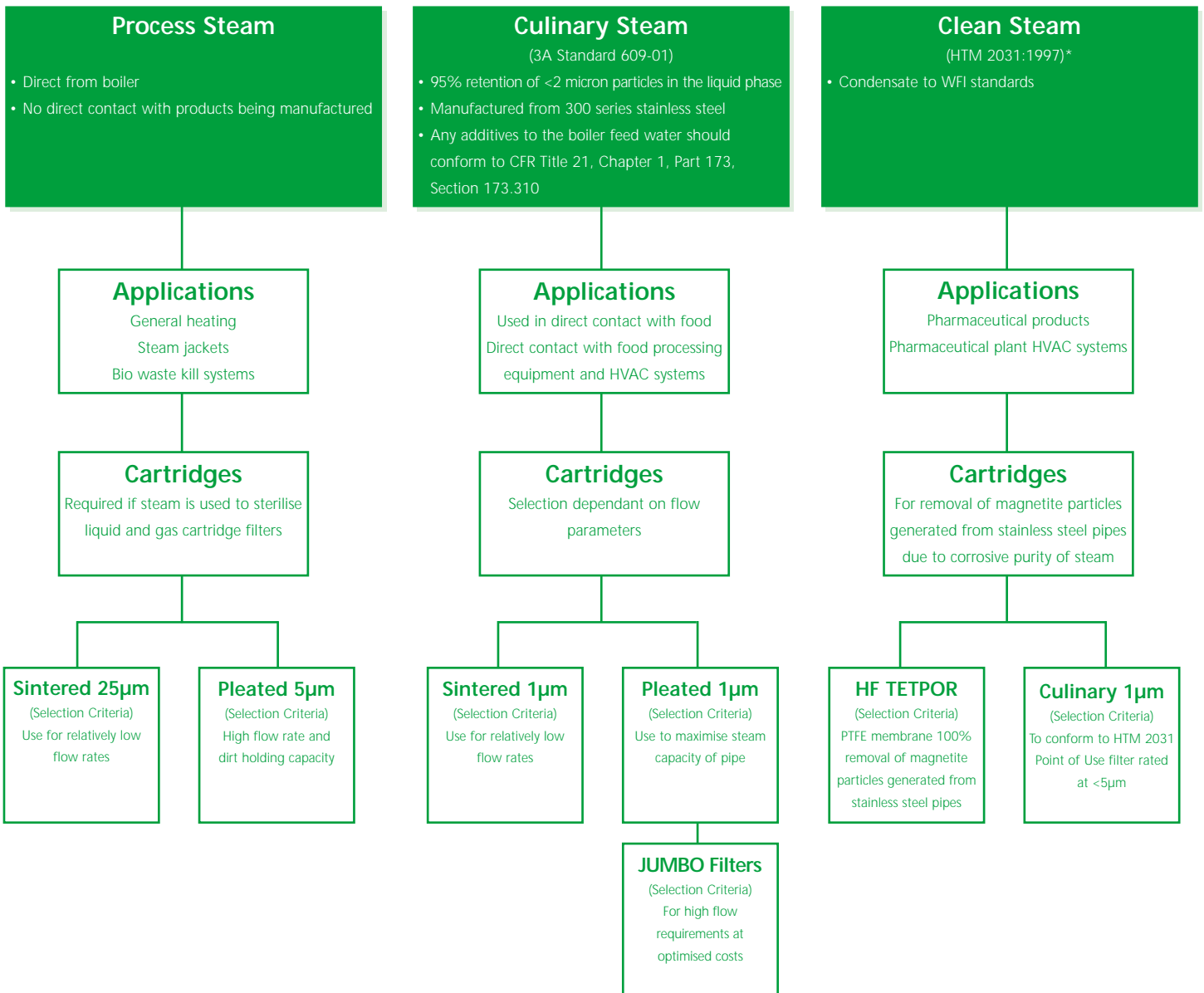
Clean Steam

High Purity water has been demonstrated to be chemically aggressive, the purer the steam, the more aggressive it can be. It is possible to generate clean steam within a standard distribution system rather than using new stainless steel but corrosion issues are more important to consider. Reaction with the pipework and valves can lead to a hard protective oxide layer (magnetite Fe_3O_4) on the inside of pipes. If the steam is acidic (<ph7) the layer can be broken down and particulate shedding results. This contamination is usually identified as black or reddish discolouration of products.

To guarantee this particulate does not contaminate it is recommended(HTM2031) that a 5 micron filter is positioned at the point of use. **domnick hunter** would install the culinary grade filter or a HIGH FLOW TETPOR PTFE product if particulate free steam had to be guaranteed.

A summary is shown on the flow chart below to aid the selection process.

Which Filter for Which Application?



Installation of Steam Filtration Systems

General

It is normal in steam distribution systems to limit the velocity of the steam to a maximum of 40 m/sec and in most cases the velocity will be in the region of 25 m/sec. The higher velocities can be used on short branch lines where higher pressure drops may be acceptable.

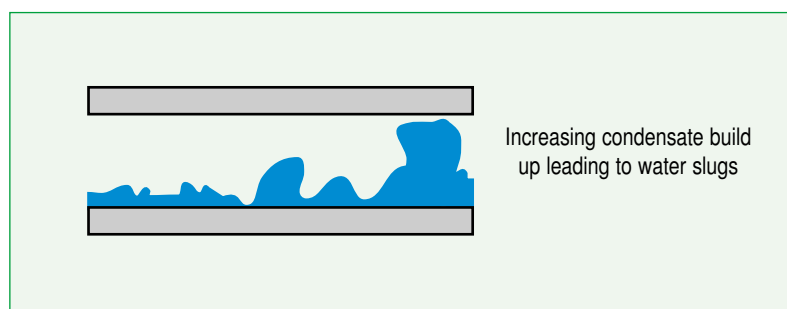
As a guide the pressure drop through pipes at various line pressures is given below. This is given for a worst case of 40 m/sec⁻¹ and purely intended to give an appreciation of the magnitude of pressure drops involved.

Pipe size	Pressure drop(mbars) / 10 meters @ 40m/sec							
	Line Pressure (barg)							
	0	1	2	3	7	10	15	20
0.5"	100	220	260	300	-	-	-	-
1"	60	100	120	170	300	430	550	800
2"	30	40	50	60	130	170	230	280
3"	15	20	30	40	80	110	130	200
4"	10	10	20	20	60	80	100	120
6"	10	10	10	20	30	40	60	80
8"	10	10	10	10	15	20	30	50

Processing steam at higher velocities has a number of disadvantages such as:

- Noise
- Pipework erosion
- Water hammer
- Required operating pressure not achievable at point of use

As soon as steam leaves the boiler it will begin to condense. This condensate first collects on the walls of the pipework in droplet form then accumulates to form a film that gravitates to the bottom of the pipe. When high velocities are involved this film can begin to build up into waves the peaks of which break off, throwing water droplets into the steam flow. This results in very wet steam that has a tendency to condense even more. It can get to the stage where large slugs of condensate are propelled against filters, fittings and valves (water hammer) which can damage the installation.



In general the smaller the pipe size and the higher the system pressure the greater the pressure drop.

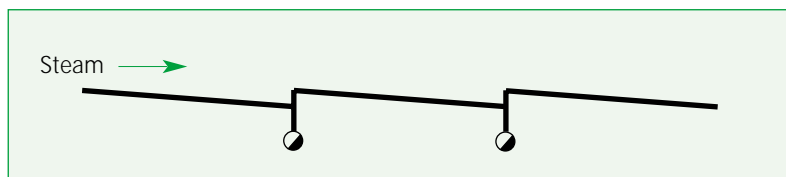
Condensate drainage

The key to an efficient steam distribution system is that of condensate removal. Steam mains can produce a large amount of condensate especially on start up from cold. Even a well lagged line can produce quantities of condensate which if not properly managed will cause problems.

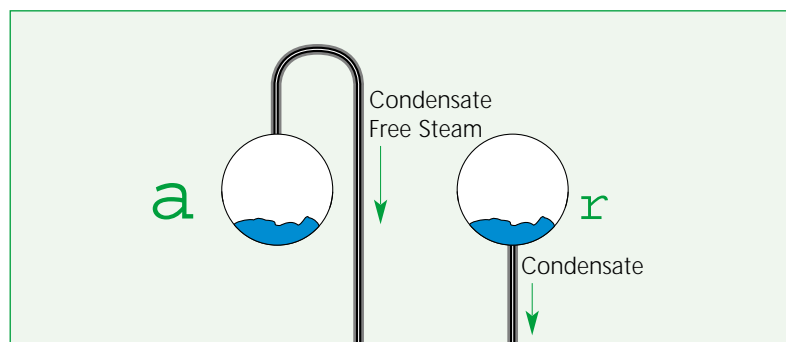
For example, a 100mm diameter pipe 30 meters long carrying steam at 7 barg will produce 16 litres of condensate per hour.

To aid condensate removal pipe lines should have a fall in the direction of flow of around 40mm in every 10 meters of pipe run.

A condensate trap should be placed at each low point as shown in the diagram below.



All take off points from the main steam line should be from the top of the pipe. This ensures that wet steam is not carried over into the branch line.



Inadequate drainage of condensate leads to a number of problems, namely:

- Lowering of filter efficiency (gas to liquid)
- Much higher pressure drops
- Difficulty in obtaining the necessary sterilisation temperatures at the process
- Premature blockage of filters

Premature blockage of filters

If a large amount of condensate is allowed to build up in distribution lines debris from the bottom of the pipe will be picked up and carried onto the filter. This could block a culinary grade steam filter extremely quickly. By eliminating condensate the chance of picking up this contamination from the pipes is significantly reduced .

Filter Sizing

A steam filter sizing program is now available. This requires the input of steam flow and pressure to generate the differential pressures for each filter size. A pre-selection is performed as part of the program as it omits differential pressure values that are either below 15 mbar or above 250mbar.

Saturated Steam Pipeline Capacities at Specific Velocities (schedule 80 pipe)

Pressure bar	Velocity m/s	kg/h										
		15mm	20mm	25mm	32mm	40mm	50mm	65mm	80mm	100mm	125mm	150mm
0.4	15	7	14	24	37	52	99	145	213	394	648	917
	25	10	25	40	62	92	162	265	384	675	972	1457
	40	17	35	64	102	142	265	403	576	1037	1670	2303
0.7	15	7	16	25	40	59	109	166	250	431	680	1006
	25	12	25	45	72	100	182	287	430	716	1145	1575
	40	18	37	68	106	167	298	428	630	1108	1712	2417
1.0	15	8	17	29	43	65	112	182	260	470	694	1020
	25	12	26	48	72	100	193	300	445	730	1160	1660
	40	19	39	71	112	172	311	465	640	1150	1800	2500
2.0	15	12	25	45	70	100	182	280	410	715	1125	1580
	25	19	43	70	112	162	295	428	656	1215	1755	2520
	40	30	64	115	178	275	475	745	1010	1895	2925	4175
3.0	15	16	37	60	93	127	245	385	535	925	1505	2040
	25	26	56	100	152	225	425	632	910	1580	2480	3440
	40	41	87	157	250	375	595	1025	1460	2540	4050	5940
4.0	15	19	42	70	108	156	281	432	635	1166	1685	2460
	25	30	63	115	180	270	450	742	1080	1980	2925	4225
	40	49	116	197	295	456	796	1247	1825	3120	4940	7050
5.0	15	22	49	87	128	187	352	526	770	1295	2105	2835
	25	36	81	135	211	308	548	885	1265	2110	3540	5150
	40	59	131	225	338	495	855	1350	1890	3510	5400	7870
6.0	15	26	59	105	153	225	425	632	925	1555	2525	3400
	25	43	97	162	253	370	658	1065	1520	2530	4250	6175
	40	71	157	270	405	595	1025	1620	2270	4210	6475	9445
7.0	15	29	63	110	165	260	445	705	952	1815	2765	3990
	25	49	114	190	288	450	785	1205	1750	3025	4815	6900
	40	76	177	303	455	690	1210	1865	2520	4585	7560	10880
8.0	15	32	70	126	190	285	475	800	1125	1990	3025	4540
	25	54	122	205	320	465	810	1260	1870	3240	5220	7120
	40	84	192	327	510	730	1370	2065	3120	5135	8395	12470
10.0	15	41	95	155	250	372	626	1012	1465	2495	3995	5860
	25	66	145	257	405	562	990	1530	2205	3825	6295	8995
	40	104	216	408	615	910	1635	2545	3600	6230	9880	14390
14.0	15	50	121	205	310	465	810	1270	1870	3220	5215	7390
	25	85	195	331	520	740	1375	2080	3120	5200	8500	12560
	40	126	305	555	825	1210	2195	3425	4735	8510	13050	18630

Recommended Cleaning Procedures for Stainless Steel Cartridges

WARNING - Please note carefully:

1. These cleaning procedures involve the use of fluids containing acids, alkalis, degreasing agents and detergents. It is the responsibility of the user to obtain the necessary safety information and provide safety clothing, emergency washing equipment and proper ventilation. Always refer to your factory safety code and the appropriate official Factory Regulations. Additionally, when proprietary cleaning solutions are used, refer to the manufacturer's instructions.
2. Always check the materials of construction of filter cartridges. Ensure that the recommended cleaning procedure is used and follow it as written.
3. Unless the precise conditions of the filter use are known to us, we cannot advise whether cleaning will be effective. Partial cleaning will lead to cumulative filter plugging.
4. Cleaning can uncover damaged areas needing repair. These are not always detectable by visual inspection.

We recommend that the user refers to **domnick hunter** for tests to examine the on-going integrity of the filter cartridges.

Procedure 1

TURCO* Alkaline Rust Remover

Caution: TURCO Alkaline Rust Remover contains caustic materials (see Warning Notice Item 1). Avoid contact with the skin. Avoid breathing the dust when making up solutions. Add slowly with agitation when making up new baths. Do not use above 90°C.

- 1.1 Degrease with an appropriate detergent e.g. Aquasol 12VCI.
- 1.2 Dissolve the TURCO ARR in the proportion of 1kg to 4.5 litres of water (2lb per gallon).
- 1.3 Heat the solution to between 88°C and boiling in a milk steel tank with sheathed electrical immersion heaters.
- 1.4 Immerse the cartridge in the hot solution for 60 minutes.
- 1.5 Pre-wash as in Procedure 3.
- 1.6 Heat a 12% to 15% solution of TURCO* 4368 preferably to 66°C and not above 82°C.
- 1.7 Immerse the cartridge in the hot solution for 20 minutes.
- 1.8 Wash and dry as in Procedure 3.

Note 1: TURCO Alkaline Rust Remover may be substituted with 15% reagent grade sodium hydroxide. See Warning Notice Item 1. However, the TURCO is preferred since it contains a wetting agent.

Note 2: For filter cartridges made from 18-8 stainless steel and Nicrobrazed only, procedure 3.6 may be replaced with procedure 2.2.

Procedure 2

DECON* 90 (for the removal of Carbon)

See Warning Notice Item 1

- 2.1 Immerse the cartridge in a solution of DECOM* 90 at 40°C to 50°C for 2 hours. For light contamination, a 2% to 5% solution will be sufficient, but for heavier deposits, use a 10% to 20% solution, In some cases, soaking for up to 24 hours may be necessary. Ultrasonic agitation will greatly increase the cleaning speed but it may be detrimental to the filter cartridges to leave them in the ultrasonic tank for very long periods.
- 2.2 The solution should preferably be circulated through a 3 micrometer nominal filter at a maximum flow at 5 litres per minute per 50 litres capacity of tank. If filtration is not used, the solution should be disposed of after use.
- 2.3 Wash and dry as in Procedure 3.

Note: When rinsing DECON, using a sample bottle, check the water for foaming. The foam should break in less than 10 seconds. If it does not, continue rinsing and re-check.

Procedure 3

Washing Procedure

Note: This procedure should be used on all metallic filter cartridges to remove cleaning solution prior to drying.

- 3.1 A pre-wash tank must be provided with flowing water at a rate of at least 5 litres per minute per 50 litres of tank capacity. A pre-wash period of 10 minutes is required to remove most of the cleaning solution prior to the final wash. Wash water in the pre-wash and final wash stages can be cold, but must be filtered with a 3µm nominal rating filter.
- 3.2 The final wash tank must be provided with flowing water at a rate of at least 5 litres per minute per 50 litres capacity of tank. The tank design must be such that dead spots are eliminated. Compressed air bubbling will help to achieve this.
- 3.3 Wash in cold, filtered water (see 3.1 above) for a minimum of 2 hours or until the pH value is equal to that of the incoming water. Do not flow water through the cleaned filter cartridges to accelerate washing. Finely suspended solids will tend to re-contaminate them.
- 3.4 Dry at 105°C to 110°C. The time required will depend upon the component but will be a minimum of 1 hour.
- 3.5 The wash tank must be emptied at the end of each washing cycle, followed by a check of the pH of the water which should remain at 7 to 8. This check should be carried out at intervals during the washing process.

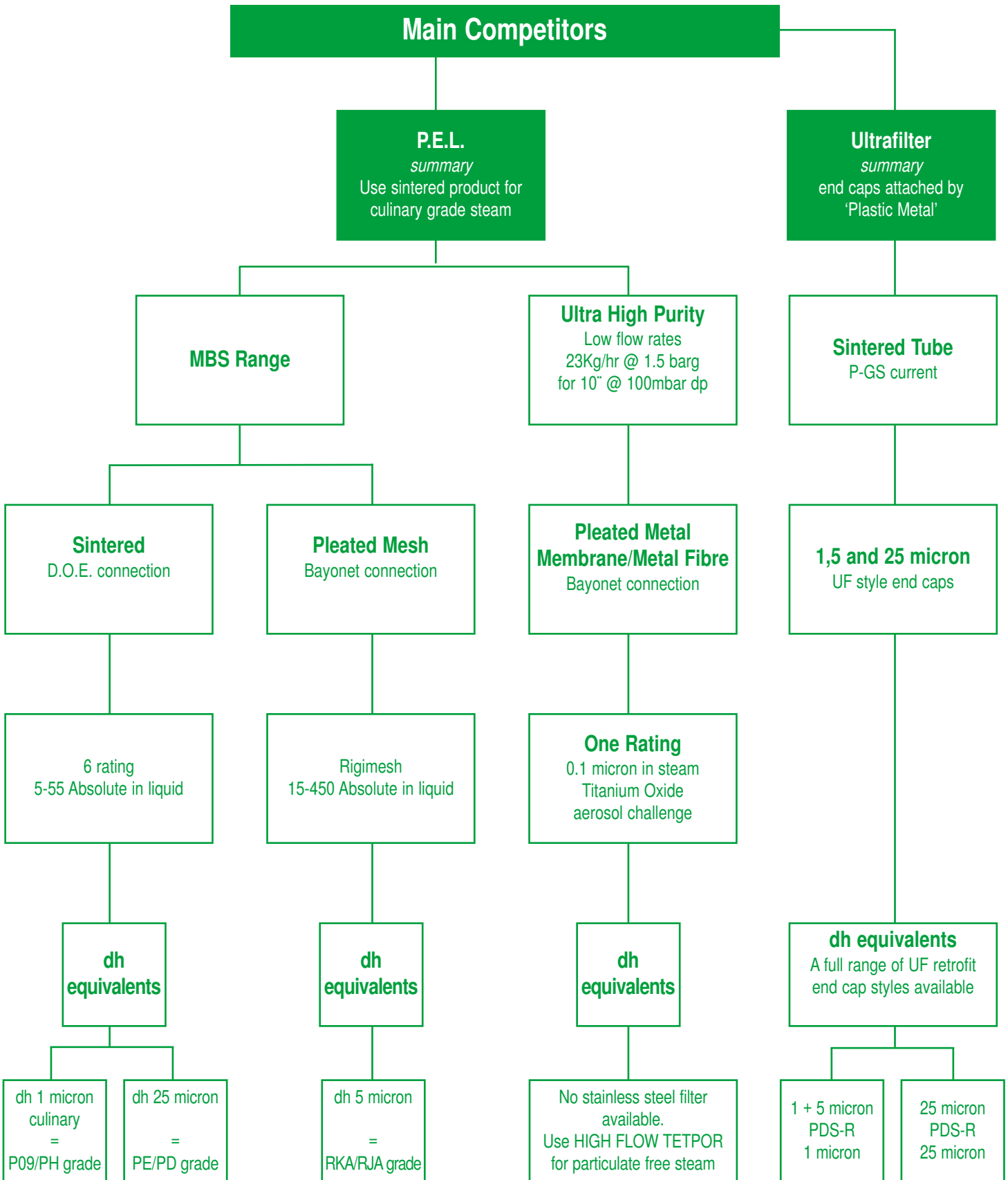
**TURCO , DECON & AQUASOL are Registered Trademarks or Trade Names of the companies listed below and from whom products and information may be obtained.*

*TURCO Turco Products Ltd
Clarke House, Brunel Road, Corby, Northants*

*DECON Decon Laboratories
Conway Street, Hove, East Sussex*

AQUASOL

Steam Filtration - The Competition



Steam Filtration - The Competition continued

Ultrafilter Ltd. Reference		domnick hunter Reference
Ultrax P-GS	Double 'O' Ring Push	PDS-R
03/10		0310
04/10		04/10
04/20		04/20
05/20		05/20
05/25		05/25
07/25		07/25
07/30		07/30
10/30		10/30
15/30		15/30
20/30		20/30
30/30		30/30
30/50		30/50
SS Range	Double 'O' Ring and Thread	DS-R
02/05		02/05
02/10		02/10
03/05		03/05
03/10		03/10
04/10		04/10
04/20		04/20
05/20		05/20
05/25		05/25
07/25		07/25
07/30		07/30
10/30		10/30
15/30		15/30
20/30		20/30
30/30		30/30
30/50		30/50
D Range	Single 'O' Ring and Thread	DS-R
3/1		3/1
3/1.5		3/1.5
4/1.5		4/1.5
4/2.5		4/2.5
5/2.5		5/2.5
5/3		5/3
10/3		10/3
15/3		15/3
20/3		20/3
30/3		30/3
30/5		30/5

**domnick hunter limited****Process Filtration**

Durham Road,
Birtley, England DH3 2SF
Tel: +44 (0)191 410 5121
Telefax: +44 (0)191 410 5312
E.mail: process@domnickhunter.com

**domnick hunter limited
Industrial Operations**

Dukesway, Team Valley Trading Estate,
Gateshead, England NE11 0PZ
Tel: +44 (0)191 402 9000
Telefax: +44 (0)191 482 6296
E.mail: industrial@domnickhunter.com

**domnick hunter limited
Gas Generation**

Dukesway, Team Valley Trading Estate,
Gateshead, England NE11 0PZ
Tel: +44 (0)191 402 9000
Telefax: +44 (0)191 497 1216

**domnick hunter
fabrication limited**

Boldon Business Park,
Boldon, England
Tel: +44 (0)191 519 0066
Telefax: +44 (0)191 519 1400

Tanlea Engineering Limited

Unit 6, Greencroft Ind. Park,
Stanley, Co. Durham, England
Tel: +44 (0)1207 601100
Telefax: +44 (0)1207 529399

**domnick hunter pty ltd**

Boronia, Australia
Tel: +61 (0)3 9762 9922
Telefax: +61 (0)3 9762 9911

**hb-domnick hunter
equipamentos ltda**

Sao Paulo, Brazil
Tel: +55 (0)11 3766 3977
Telefax: +55 (0)11 3768 1421

**domnick hunter Canada inc**

Mississauga, Canada
Tel: +1 905 820 7146
Telefax: +1 905 820 5463
Toll Free: 1-888-342-2623

Xebec Inc

Quebec, Canada
Tel: +1 450 979 8700
Telefax: +1 450 979 7869

**domnick hunter China**

Beijing, China
Tel: +86 10 646 33523
Telefax: +86 10 646 33521

domnick hunter China

Shanghai, China
Tel: +86 21 6283 8435
Telefax: +86 21 6283 8311

**domnick hunter SweTec AB**

Alleröd, Denmark
Tel: +45 481 44513
Telefax: +45 481 44512

**domnick hunter France S.A.**

Villefranche sur Saône, France
Tel: +33 4 74 62 34 51
Telefax: +33 4 74 62 35 44

**domnick hunter gmbh**

Krefeld, Germany
Tel: +49 (0)2151 83660
Telefax: +49 (0)2151 395779

**domnick hunter Group
Benelux BV**

Roosendaal, Holland
Tel: +31 (0) 165 527 127
Telefax: +31 (0) 165 394 461

**domnick hunter India Pvt Ltd**

New Dehli, India
Tel: +91 11 6166304 / 6188940
Telefax: +91 11 6185279

**P.T. domnick hunter Indonesia**

Jakarta, Indonesia
Tel: +62 21 458 40488
Telefax: +62 21 452 4323

**domnick hunter Nihon**

Yokohama, Japan
Tel: +81 (0)45 250 1522
Telefax: +81 (0)45 250 1523

domnick hunter Nihon

Kobe, Japan
Tel: +81 (0)78 391 8055
Telefax: +81 (0)78 391 8056

**domnick hunter - RL
(Malaysia) Sdn Bhd**

Petaling Jaya, Malaysia
Tel: +60 3 733 3415
Telefax: +60 3 735 1699

**domnick hunter SweTec**

Askim, Sweden
Tel: +46 (0)31 748 0610
Telefax: +46 (0)31 748 0621

**domnick hunter
Group Pte Ltd**

Singapore
Tel: +65 744 4088
Telefax: +65 744 9959

**domnick hunter Iberica**

Barcelona, Spain
Tel: +34 93 572 0050
Telefax: +34 93 572 1585

**domnick hunter SweTec AB**

Askim, Sweden
Tel: +46 (0)31 748 0610
Telefax: +46 (0)31 748 0621

**domnick hunter - RL
(Thailand) Co Ltd**

Bangkok, Thailand
Tel: +66 2 255 5305
Telefax: +66 2 255 5340

**domnick hunter inc**

Charlotte, USA
Tel: +1 704 921 9303
Telefax: +1 704 921 1960
Toll Free: 1-800-345-8462

**domnick hunter**

PROCESS FILTRATION

Durham Road, Birtley, Co. Durham,
England DH3 2SF

Tel: +44 (0)191 410 5121

Telefax: +44 (0)191 410 5312

E-mail address: process@domnickhunter.com

Website: http://www.domnickhunter.com

Copyright domnick hunter limited 2001

Publication Reference: FB51/01/01

domnick hunter limited has a continuous policy of product development and although the Company reserves the right to change specification, it attempts to keep customers informed of any alterations. This publication is for general information only and customers are requested to contact our Process Division Sales Department for detailed information and advice on a products suitability for specific applications. All products are sold subject to the company's Standard conditions of sale.

a member of the domnick hunter group plc

UK • AUSTRALIA • BRAZIL • CANADA • CHINA • DENMARK • FRANCE • GERMANY • HOLLAND • INDIA • INDONESIA • JAPAN • MALAYSIA • NORWAY • SINGAPORE • SPAIN • SWEDEN • THAILAND • USA