The ultimate filtration & drying technology

Alternative Elements Performance Validation

Air Quality - ISO 8573-2:2001 (E)

Independent test report on oil carry-over tests for high efficiency compressed air filters

Northumbrian Environmental
Training and Research Centre
School of Applied Sciences
Northumbria University

Contents

Introduction

Market leadership

Walker Filtration is a leading innovator in the manufacture of filtration products for use across a wide range of markets.

Since formation in 1983, Walker Filtration has led this competitive sector through the ability to provide quality, technical expertise, innovation and an excellent standard of customer service.

A commitment to continuous improvement has seen the Company be first to market with the introduction of many new technologies, including the use of polyester needle felt as a superior drainage sleeve, paving the way for other manufacturers to follow.

Walker Filtration is a pioneer within the industry thanks to a willingness to continue driving research and development forward.

Walker Filtration has stayed true to its goal of delivering a market leading product range that provides the customer with reliable and efficient solutions to their needs.

Choosing the right filter element

Deciding on the correct filter element to use within your operation can have huge implications. Quality must be your number one priority. Substandard elements can cause corrosion, contamination and heap unnecessary operating costs onto your business.

Our ongoing investment in research and development has resulted in elements which are manufactured using the highest quality raw materials. Proven production techniques guarantee superior retention capacity of impurities, sustained performance and a long service life.

Filters from Walker Filtration ensure continuous high efficiency with minimal operating pressure loss during the whole of their life cycle. The materials of construction - stainless steel, glass microfibre, plastics - are selected to ensure they offer no potential for downstream contamination. In particular, our polyester drainage sleeves do not degrade like reticulated plastic foam sleeves and assure high temperature and synthetic oil tolerance.

The alternative filter range

As filtration specialists Walker Filtration manufacture and supply one of the most comprehensive ranges of alternative filter elements, air/oil separators and vacuum pump separators on the market today.

Our elements are subject to rigorous in-house testing. Mono-dispersed aerosol and forward light scattering techniques are used to challenge the filter elements and confirm particle retention efficiency. All alternatives perform ‘equal to or better’ than the original manufacturers filter elements and are manufactured in accordance with ISO8573-1:2001 (E).

Our in-house knowledge means we can readily identify the replacement element you need, with a comprehensive cross reference capability.

Alternative filter elements

Air/Tak	Domnick Hunter	Mils
Airtek	Finite	MTA
Atlas Copco	Gardner Denver	Norgren
Balston	Gemoc	Pioneer
Bea Filtri	Great Lakes	Pneumatech
Champion	Hankison	Pneumatic Products
CompAir	Hiross	Sullair
CompAir LeROI	HPC	Technolab
CTA	Hydrovane	Trocair
Deltech	Ingersoll Rand	Ultrafilter
Dollinger	Kaeser	Zander

Alternative vacuum air / oil separators

Becker	Lacy Hulbert
Edwards	Leybold
Hydrovane	Mattei

Construction

Construction

A dynamic approach to design, material selection and construction means that Walker Filtration is at the forefront of filtration technology. Our internal Research and Development team constantly identify, evaluate and implement enhancements to improve the ease of use and performance of our market leading range. Typically, most alternative filter elements are manufactured to Walker Filtration's standard construction illustrated below.

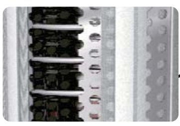
Filter Element Design and Materials

Corrosion Resistant End Caps Injection moulded from glass filled nylon then bonded to the filter core with a quick setting two part polyurethane potting resin for maximum strength.

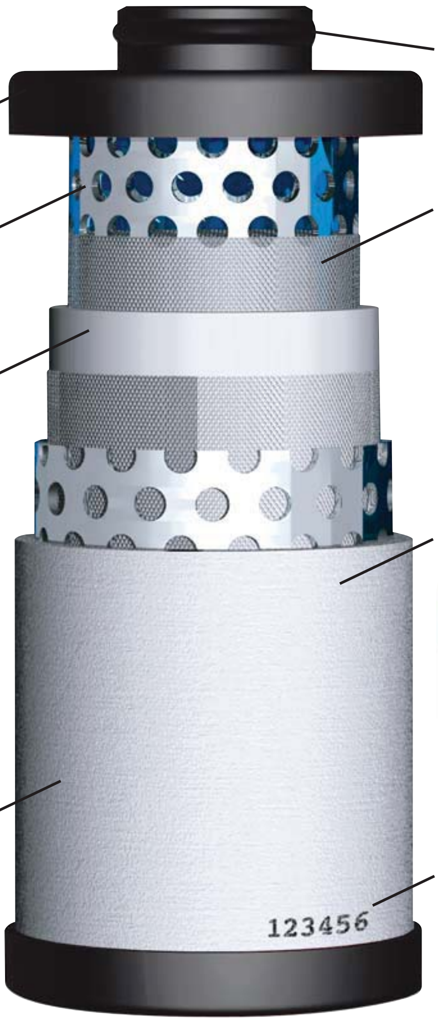
Stainless Steel perforated support cylinders, twice as strong as galvanised steel, can withstand 7 bar (100 psig) in either direction.

Borosilicate Microfibre Glass Material high quality filter material is used to manufacture the media pack. This material, with a bonded structure, withstands high temperatures, is completely inert and is immune to degradation. With sub micron fibre diameters and an extremely high voids volume (as seen in this stereo micro-scan above) it is available in different grades for varying efficiency.

Deep Bed Multi Wrap technology is used to form the media pack. This offers low differential pressure, extremely high oil removal efficiencies and proven continuous performance with long service life.



Extra Stainless Steel inner support on larger reverse flow elements is provided by the addition of a coil spring spot welded to the inner cylinder. This feature ensures these elements meet the demands of "outside to in" flow and do not rupture causing downstream contamination.



High Nitrile 'O' Rings ensure perfect sealing within the filter housing whilst withstanding high temperatures of over 120ºC (250ºF).

Particulate Pre-filtration on both sides of the media pack offers protection with air flow in either direction. This non-woven fabric also enhances the strength of the filter pack and increases filter life.

Polyester Fibre Drainage Sleeve, used by Walker Filtration for over twenty years, has now become industry standard. This polyester material collects coalesced oil from the media pack and allows it to gravitate down to the quiet zone of the filter bowl thus preventing any oil carryover. Unlike reticulated foams which can seriously degrade causing downstream contamination, this material has a high tensile strength and withstands all the demands of compressed air filtration.

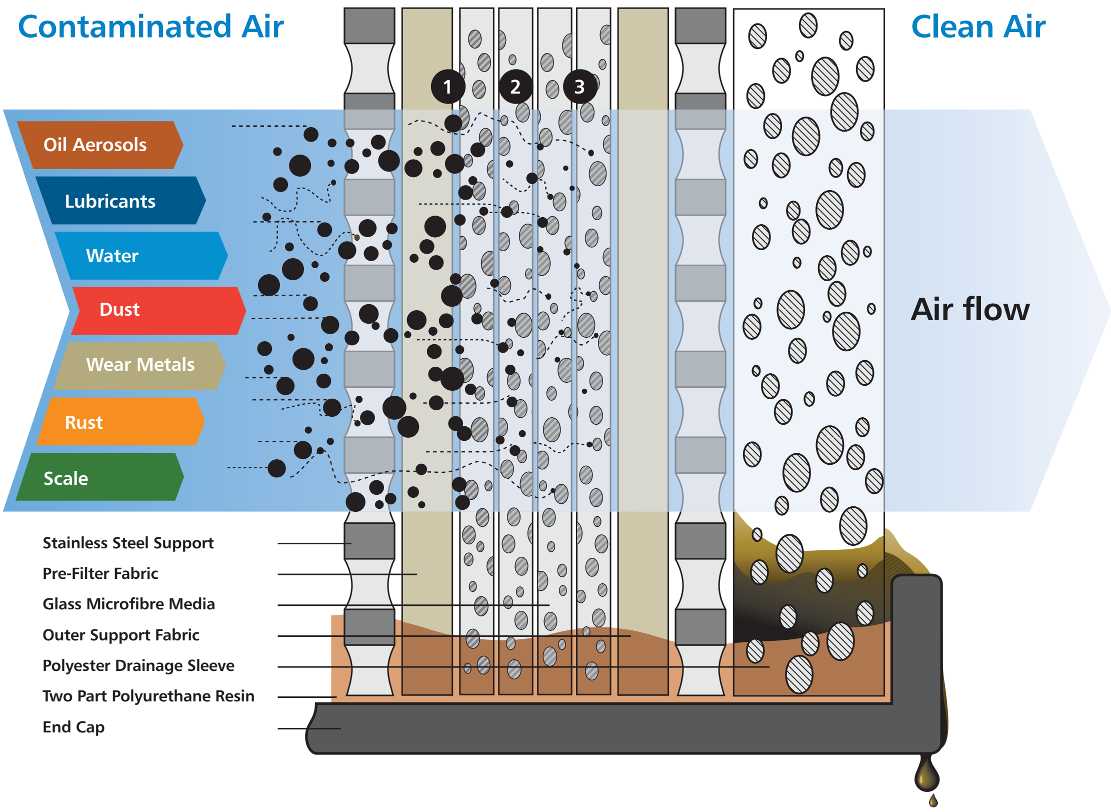
Example of a typical reticulated foam sleeve exhibiting considerable degradation, a much less robust solution than the Walker polyester drainage sleeve.

Quality Control full traceability is provided by ink jet marking specific manufacturing codes on every filter element complying with our ISO 9001 manufacturing procedures.

Performance

Three Physical Methods of Filtration

Effective filtration takes place in three stages facilitated by the single fibre collection mechanisms explained below. Each mechanism is effective in eliminating certain contaminants at varying particle sizes collected on individual fibres in the filter media. These particles are captured and coalesce into larger droplets, migrating through the media to be drained away.



1 Direct Interception

Particles larger than the mean pore size of the filter media will simply impact directly onto the surface of the fibre matrix. Walker Filtration utilises glass micro-fibre filter media with a mean fibre diameter of 0.5 micron.

2 Inertial Impaction

Inertial impaction occurs when small particles (usually less than 2 microns) penetrate beyond the surface of the filter media but cannot negotiate the torturous path within the media and are eventually captured by the fibres.

3 Diffusion (Brownian Motion)

It has been established that very small particles (less than 0.1 to 0.2 microns) move in a very random and erratic manner within the airstream. When particles are so small their motion is often violent and collisions with the fibre matrix are therefore increased.

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Extract from:

Report on oil carry-over tests for high efficiency oil removal filter elements

WALKER FILTRATION LTD | June 2004

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Introduction

This report details the methodology and results for a series of oil carry-over experiments performed on the Walker Filtration XA and X1 series of coalescing filter elements. The XA and X1 series have a target downstream oil aerosol concentration of 0.01 mg/m³ (0.01ppm) and 0.10 mg/m³ (0.1ppm) respectively.

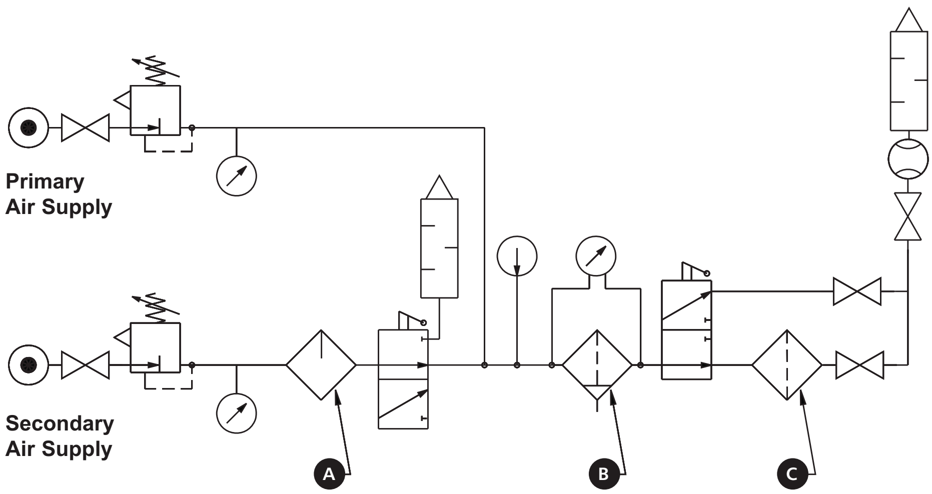
Methods

General

The oil carry-over experiments were performed in accordance with method B1 of BS ISO 8573-2:1996 (Compressed air for general use – Part 2: Test methods for aerosol oil content). This method deals with sampling and analysis of airborne aerosols at a constant flow rate. The general layout of the test rig is shown in Figure 1. The method requires that no wall-flow (liquid contamination that can be formed in the bottom of the pipe work) is present and so the rig was modified by connecting an empty filter housing in series, upstream of the test filter housings. Nevertheless, confirmatory tests with and without the empty housing indicated that wall flow is non-existent in the test rig.

The general principle is to generate a known challenge oil aerosol concentration, in this case using a Laskin nozzle, to pass this challenge concentration through a test filter element and then to determine the downstream oil aerosol concentration by sampling through filter membranes. Oil content is determined by solvent extraction of the membranes followed by analysis of the solvent by infra-red spectroscopy.

Figure 1: Arrangement of the test rig used in the oil carry-over tests.



A Aerosol Generator (Laskin Nozzle) B Test Filter Housing (Element) C Membrane Holder

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Oil aerosol generation

Oil aerosol challenges to the filters were generated using a Laskin nozzle at a typical differential pressure of 0.3 mbar (4.4 psi) to 0.4 mbar (5.9 psi). The actual challenge oil aerosol concentration was determined by weighing the test filter element before and after exposure to the challenge concentration and then dividing the weight difference by the volume of air passing through the filter over the duration of the test.

Pressure and air flow measurements

The following pressure and air flow measurements were made on the test rig:

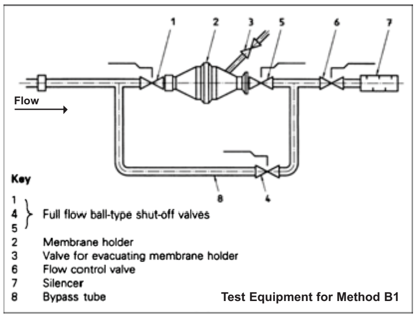
- Differential pressure across housing containing dry filter element
- Differential pressure across empty housing
- Differential pressure across housing containing wet filter element
- Differential pressure across Laskin nozzle
- Flow rate of housing on test

All pressure and flow measuring equipment were within calibration.

Sampling of oil aerosol downstream of the test filters

The sampling apparatus for measuring the downstream oil aerosol concentration is shown in Figure 2. Three Whatman GF/F filters were placed on a membrane support and secured in the membrane holder. Care was taken to ensure that the filter papers were not contaminated during handling, including the use of gloves and solvent washed tweezers. Additionally, because the analysis method depends on the determination of very low levels of oil, particular attention was paid to the cleanliness of the sampling equipment. The sampling equipment, including sample holder was washed with solvent prior to the commencement of sampling.

Figure 2: Sampling equipment



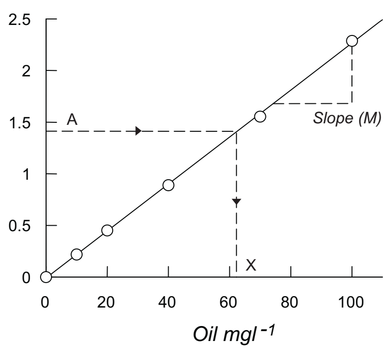
Oil extraction and analysis

Calibration

The principle of the analysis is to extract oil collected on the filter membranes into a solvent and then to determine the oil concentration using Fourier Transformed Infra Red spectroscopy (FTIR). A series of calibration solutions was prepared using the same 'Tellus 32' oil that was used in the oil challenges to the filter elements. All analysis was performed on a Perkin Elmer Paragon 1000 FTIR spectrometer with a 40mm path length quartz cell transparent to IR radiation down to 2500cm^{-1}.

The calibration graph for Tellus oil in 1,1,2,trichlorotrifluoroethane (TCTFE) in the range 0 to 100ppm is shown in Figure 3. The total absorbance is obtained from the sum of the individual absorbances at 2960cm^{-1}, 2925cm^{-1} and 2860cm^{-1} after correction for the solvent blank. The graph shows linearity over the full range and has a correlation coefficient (r) of 0.9998.

Figure 3. Calibration graph for 'Tellus 32' oil used in the filter challenges



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Extraction and analysis

The three filter membranes were removed from the membrane support using solvent washed tweezers and placed in a solvent washed glass container. 50ml of 1,1,2-trichlorotriflouroethane was poured onto the filters and the container was agitated for 5 minutes to extract all of the absorbed oil aerosol.

Approximately 12 ml of solvent was then transferred to a 40mm path-length quartz cell using a Pasteur pipette. As with the calibration solutions, the total absorbance of the sample was determined from the sum of the individual absorbances at $2960cm^{-1}$, $2925cm^{-1}$ and $2860cm^{-1}$ after correction for the solvent blank which was run prior to the sample. The oil concentrations in the samples were determined from the slope of the calibration graph, and were in the range 2.54 to 9.09 mgl^{-1}.

$$\text{Oil carry over } \mathbf{(mg/m^3)} = \frac{\text{oil collected } \mathbf{(mg)}}{\text{volume of air } \mathbf{(m^3)}} = \frac{\mathbf{X}}{\mathbf{Y}}$$

Oil Concentration

Explanation:

$$\mathbf{X} = \frac{\mathbf{(A\text{-}C) \times S \times F \ (mg)}}{\mathbf{M \times 1000}}$$

where

X = Oil collected
A = FTIR absorbance (see graph below)

$$= \log_{10}\left(\frac{I_0^3}{I_1 I_2 I_3}\right)$$

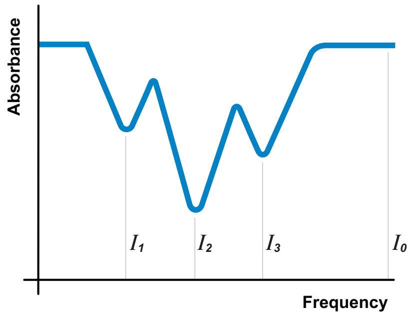
C = intercept from calibration graph
M = slope
S = solvent sample (ml)
F = dilution factor

and

$$\mathbf{Y} = \frac{\mathbf{R \times D}}{60}$$

where

Y = volume of air passed (m^3)
R = test flow rate (m^3/hr)
D = test duration (mins)



Typical FTIR Spectrum

Results

Pressure and flow data for tests

Table 1. Pressure loss data at maximum rated flow (average)

FILTER GRADE	ΔP HOUSING & WET ELEMENT			
	Walker Filtration Specification		Test Results	
	mbar	psi	mbar	psi
Grade X1	150	2.2	150	2.2
Grade XA	300	4.4	223	3.2

Oil concentrations downstream of test filters

Table 2 details the results of the oil carry-over experiments. The specified maximum concentrations downstream of the filters under test are 0.01 mg/m^3 and 0.10 mg/m^3 for the XA and the X1 filter elements respectively. All elements under test exceeded these performance requirements.

Table 2. Results of oil carry-over tests at maximum rated flow (average)

FILTER GRADE	ISO 8573 CLASS	Walker Filtration Specification		Test Results	
		mg/m^3	ppm	mg/m^3	ppm
Grade X1	2	0.1	0.08	0.06	0.048
Grade XA	1	0.01	0.008	0.005	0.004

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Conclusions

In terms of oil removal, the XA and X1 units tested, in both sizes, exceeded their rated performance when tested in accordance with ISO 8573-2.

Signed for and on behalf of NETREC:

Dr Michael Deary BSc, MSc, PhD

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Certification of Compliance to ISO 8573-2

This is to certify that Walker Filtration A20 and A55 Series products were tested in accordance with and complied to ISO 8573-2. Type testing was carried out on X1 and XA grades of each size.

Date of testing : 5th May – 2nd June 2004

Certificate date: 21 June 2004

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Mr Antony J Hackney
Commercial Director

Quality

FILTER GRADE	ISO 8573 CLASS	SOLID PARTICLES maximum number of particles per m^3			HUMIDITY & LIQUID WATER pressure dewpoint 0°C	OIL (including aerosol, liquid & vapour mg/m^3)
		0.1-0.5 micron	0.5 -1.0 micron	1.0-5.0 micron		
Grade XA	1	100	1	0	-70	0.01
Grade X1	2	100,000	1000	10	-40	0.1
Grade X5	3	-	10,000	500	-20	1
Grade X25	4	-	-	1000	+3	5

ISO 8573 the compressed air purity standard

ISO 8573 is the group of international standards specifying the purity of compressed air.

All the Walker elements are designed to perform above the criteria set out by these industry standard classifications and internal quality management measures have been designed to ensure that all products are monitored for continual improvement against these specific industry measures.

The table above illustrates the permitted size of each solid, water and oil particle for each individual class of the quality standard, along with the maximum number of particles per m^3. The table also specifies which filter grade produced by Walker Filtration adheres to each classification.

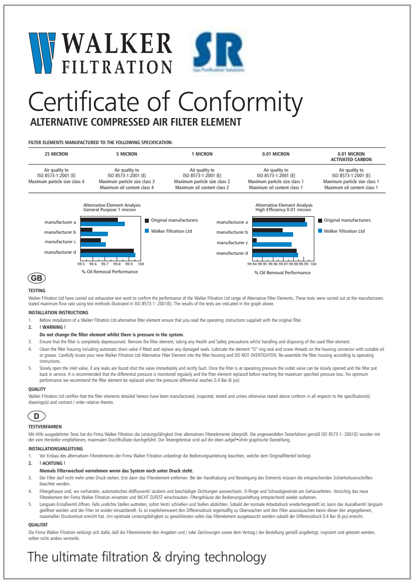
ISO 9001:2000 Quality Management Systems

Walker Filtration is accredited to ISO 9001:2000.

This certification is focused on providing a framework for consistent manufacturing quality with performance objectives set at executive level and arrived at through adherence to pre-defined business procedures.

Walker Filtration measure and review quality on a daily basis from goods inwards, through a vendor rating system evaluating core suppliers, to detailed inspection of all manufactured products produced for despatch to customers.

Accreditation to ISO 9001:2000 is under constant review and certification is granted based on a customer focused policy of continual improvement to deliver the ongoing progression of quality throughout the organisation.


WALKER FILTRATION

Certificate of Conformity

ALTERNATIVE COMPRESSED AIR FILTER ELEMENT

Alternative Element Analysis General Purpose 1 micron

Alternative Element Analysis High Efficiency 0.01 micron

manufacturer a

manufacturer b

manufacturer c

manufacturer d

Original manufacturers

Walker Filtration Ltd

% Oil Removal Performance

The ultimate filtration & drying technology

Accreditations

Accreditations

Walker Filtration's continued commitment to improvement and business excellence has earned re-certification with the international quality management standard, ISO 9001. This standard has been implemented throughout the organisation to assure our customers that there are Quality Management Systems in place.

Our extensive range of elements meets British and international standards. Air filtered by our filter range meets ISO 8573-1: 2001 (E) air quality classification standards.


CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

Walker Filtration Ltd
Washington, Tyne and Wear
United Kingdom

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standards:

ISO 9001:2000

The Quality Management System is applicable to:

Design and manufacture of compressed air and gas filters, dryers and purification equipment, vacuum filters, autoclave filters for steam sterilizers and smoke evacuators for use in medical laser surgery.

Approval Certificate No: LRQ 0930553

Original Approval: 14 June 1994
Current Certificate: 1 June 2003
Certificate Expiry: 31 May 2006

Issued by: LRQA Coventry

This document is subject to the provision on the reverse

International Standards

Particle Removal Efficiency

- ISO 8573-4
- BS-4400
- ASTM D2986-71

Oil Removal

- ISO 8573-5
- BCAS 860990

Vapours

- ISO 8573-5

Air Quality Classifications

- ISO 8573-1:2001(E)

The ultimate filtration & drying technology

Air Quality - ISO 8573-2:2001 (E)

ALTERNATIVE FILTER PERFORMANCE VALIDATION

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