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# Comparison between Polyester and Fiber Glass as Filter Media to Collect Silica Fumes: Case Study

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**Abstract:** The National Research Center (NRC) in Cairo and Aqua Misr Co. for Investment Equipments were invited by kima Co. for ferrosilicon production to study, investigate and provide a solution to the problem encountered with the main bag house filter used for dust & fume extraction and collection. Silica fume, also referred to as micro- silica or fumed silica, is a by-product from silica metal manufacturing. During the process, a fraction of the feedstock quartz vaporizes from the high temperature furnaces. With high efficient dust capture system, the vaporized quartz (i.e. silica dioxide) is collected in cloth bags (bag house dust collectors). High grade of quartz used in silicon metal production can result in high purity of silica fumes (typically >94 %) and amorphous form [(1), (2), (3)]. One of the most beneficial uses for silica fume is concrete. Due to its chemical and physical properties, it is a very reactive pozzolan. Concrete that contains silica fumes can have very high strength and be very durable.

**Key words:** Polyester, Fiber Glass, Filter Media,Collect Silica Fumes.

## Introduction:

The National Research Center (NRC) in Cairo and Aqua Misr Co. for Investment Equipments were invited by kima Co. for ferrosilicon production to study, investigate and provide a solution to the problem encountered with the main bag house filter used for dust & fume extraction and collection. Silica fume, also referred to as micro- silica or fumed silica, is a by-product from silica metal manufacturing. During the process, a fraction of the feedstock quartz vaporizes from the high temperature furnaces. With high efficient dust capture system, the vaporized quartz (i.e. silica dioxide) is collected in cloth bags (bag house dust collectors). High grade of quartz used in silicon metal production can result in high purity of silica fumes (typically >94 %) and amorphous form [(1), (2), (3)]. One of the most beneficial uses for silica fume is concrete. Due to its chemical and physical properties, it is a very reactive pozzolan. Concrete that contains silica fumes can have very high strength and be very durable. Silica fume consists of amorphous silicon dioxide. Each individual particle of silica fume is very small in the order of 1/ 100th the size of a cement particle [(4)]. The material has wide industrial applications, for example, it is used in:

- Structures exposed to harsh chemicals or environmental conditions.
- Bridge decks, highway overpass structures
- Marine Structures
- Slabs
- Air-port runways
- Pre-cast concrete and many others

**Problem Encountered:**

High emission rate of micro – dust (nearly 496 mg/$m^3$) was reported, that caused:

a) Loss in production and,

b) environnemental pollution.

**Filtration System :**

The existing dust control system used has the following Specifications:

1. Method : reverse air [5]
2. Capacity : 200,000 $m^3$/h
3. Air / cloth ratio : 50
4. Filtration area : 4000 $m^2$
5. Material of filter media : fiber glass with membrane[6]
6. Air permeability : 37 l/$dm^2$ /min
7. Number of bags : 2264
8. Bag size : Φ 150 × L 4500 mm
9. Temperature 200 °C

The system has been used for quite long time (nearly 30 years) and commonly used worldwide in ferrosilicon industry.

**Microscopy:**

Samples of fiber glass bags after 8 months usage and experienced dust emissions were viewed under the electro scanning microscope. Fig (2), shows the membrane and the surface side of the fiberglass of a new bag. Fig (3) shows the same surface side after dusting and fig (4) (5) shows that the membrane suffered a severe rupture after 8 months of usage due to flex fatigue failures at the bottom of the filter, fig (6) shows the mechanical description of flexing the bottom part of the filter bag. Also, fig (7), (8) show the back side of the fiber glass fabric with sever dust bleed from the top surface to the direction of the back side .Fig (9), with magnification X 150 shows the dust distribution on the back side of the fiberglass fabric over a wider area .

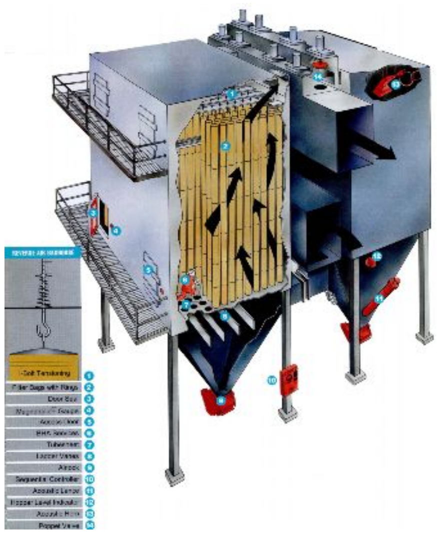

**Fig (1) Reverse air filtration system**

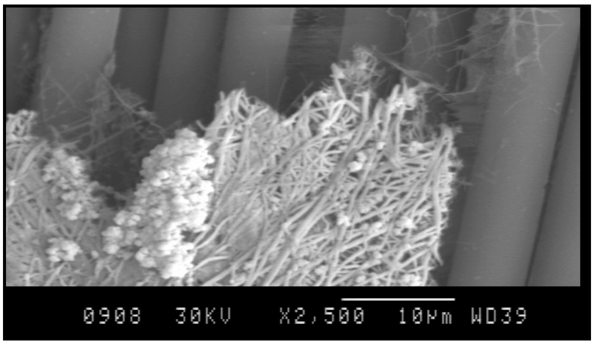


**Fig (2) New fiberglass fabric**

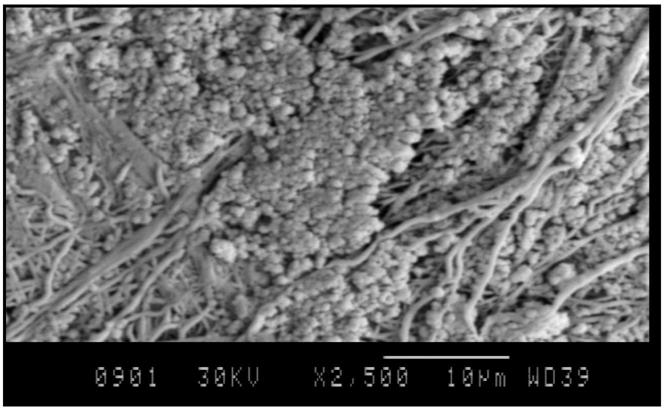


**Fig (3) Dusted surface of fiber glass fabric after 8 months**

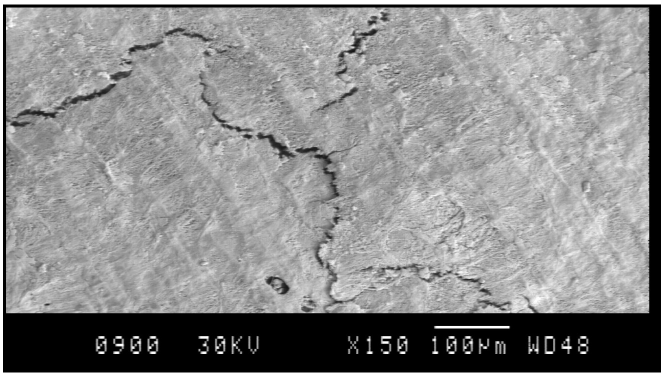


**Fig (4) Rupture of membrane over the surface of fiber glass fabric after 8 months**

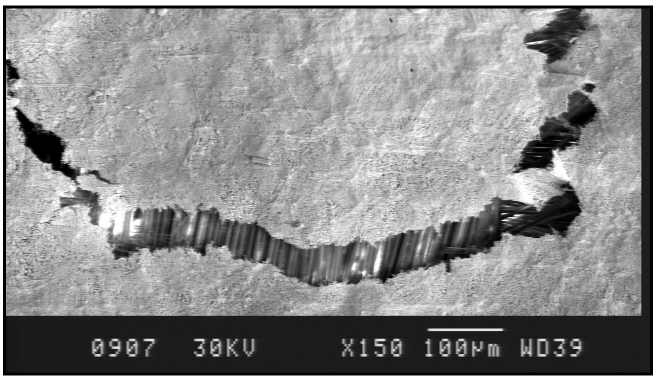


**Fig (5) Close-up photo for the membrane rupture after 8 months due to flex fatigue failure at the bottom of the filter**

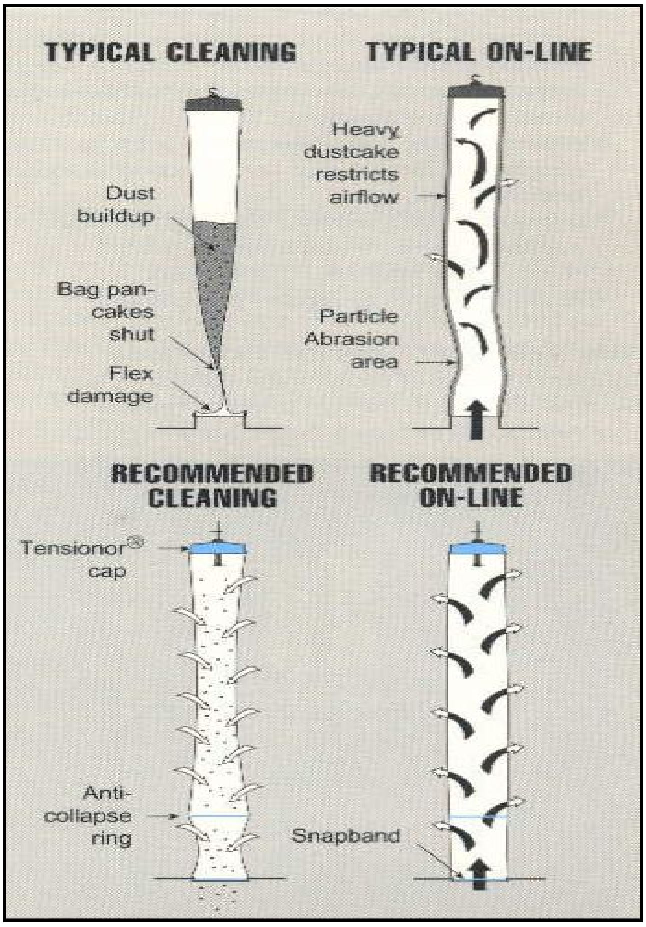


**Fig (6) Description of the mechanical flexing action of the bottom part of the filter bag [7]**

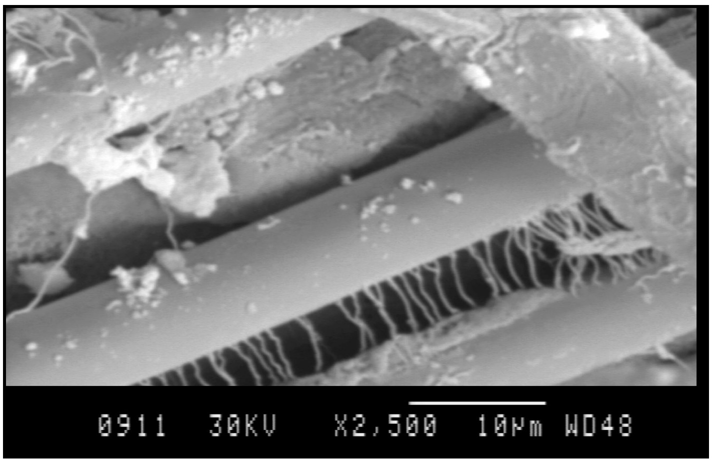


**Fig (7) Back side of the fiber glass bag showing the rupture of the fiber glass fabric**

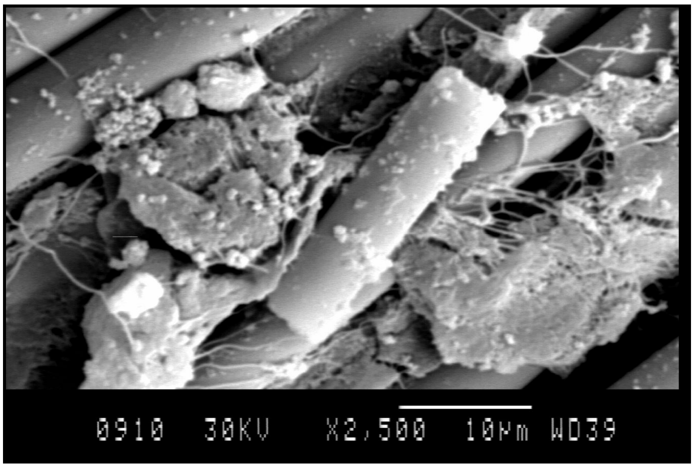


**Fig (8) Back side of the fiber glass fabric showing damage & rupture of some yarns causing dust bleed**

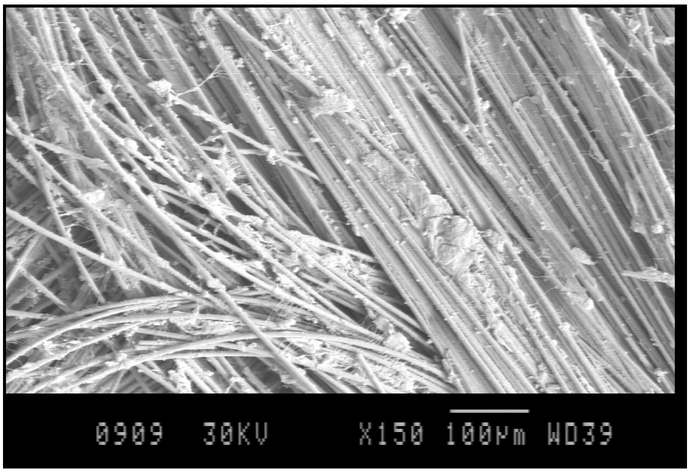


**Fig (9) Back side of the fiber glass fabric with less magnification showing general panorama of the dust bleed**

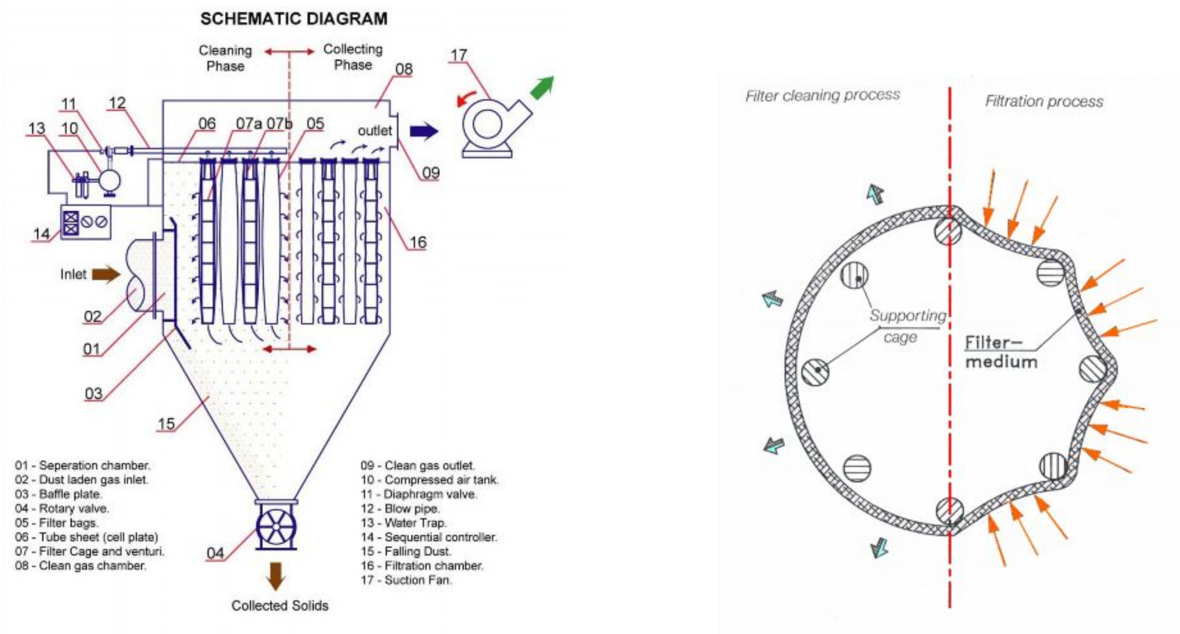


**Fig (10) Schematic diagram of Controlled flexing action Jet-pulse system**

## Solution & Discussion:

The design which we proposed and that kima co. accepted was for changing the filtration system from reverse-air to jet- pulse (see fig 10) and using polyester instead of fiber glass as filter media. False air was fed together with the fed dust laden gas so as to reduce the gas temperature from 200°c down to 120 °c. The system was operated with the same parameters including: fan capacity, air / cloth ratio, filtration area, number and size of bags except filter media and gas temperature. Samples of the used polyester bags for 14 months of operation (still in operation up to now) were viewed and tested by the electro scanning microscope. Fig (11), shows the new sample of polyester fabric, and fig (12) shows the surface side after dusting while fig (13) shows the deposition of particles onto the polyester fiber surface even after washing with water and detergent. The back side of the dusted sample is viewed in fig (14). Compared to the case of fiber glass material, it is noticeable that dust bleed is remarkably less than in the case of polyester material. Also the results of physical & mechanical testing given in table (1) reveal to better performance of polyester with regard to tensile strength, elongation at break and puncture resistance. It is obvious that the % change of the values of elongation at break had a remarkable effect on the flexing of both types of material, the fiber glass fabric suffered more than 130 % in both directions and that might explain the poor performance on cleaning , while for polyester fabric the % change was reasonable. The % change of polyester tensile strength was minor ( total -14.9 for both directions while the % loss in fiber glass tensile strength was much higher ( total - 47.8 % for both directions) although the measurements represent tow different durations of operations. Also, the value of residual puncture strength of polyester (73 kg) is nearly twice the value of fiber glass. This can be referred to the silica particulates deposition in a similar way to coating as can be seen in the SEM photos, such a permanent layer of particulates may acts as a protective sheath to the polyester fibers.

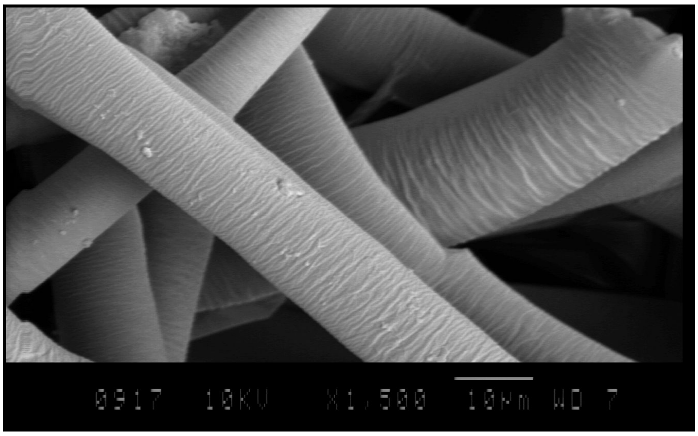


**Fig (11) New polyester fabric**

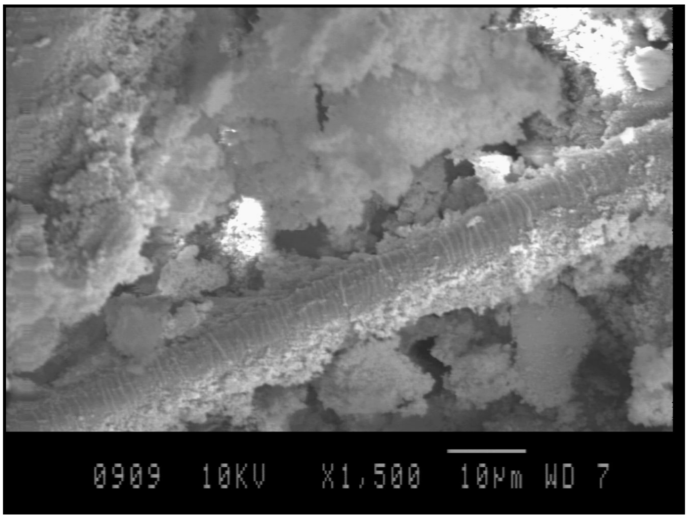


**Fig (12) Top surface dusted polyester fabric**

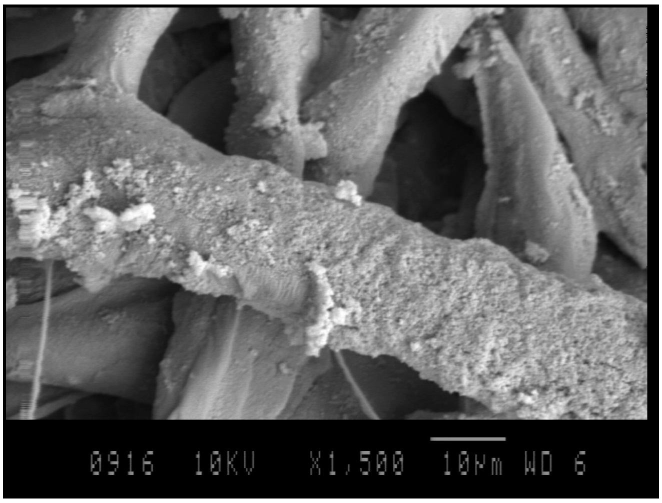


**Fig (13) Deposited particles onto the surface of polyester Fibers after washing acting as a protective sheath**


**Fig (14) Back side of the polyester fabric**

**Table (1): Physical & Mechanical Properties of Used Bags:**

| Property \ Type of bag | Fiber glass woven filter fabric with membrane | | | Polyester non woven filter fabric | | |
|---|---|---|---|---|---|---|
| | New | 8 months | % change | New | 14 months | % change |
| 1- Weight (g/m2) | 583 | 582 | (-0.17) | 525 | 540 | (+2.89) |
| 2- Thickness ( mm) | 0.69 | 0.71 | (+2.9) | 1.58 | 2-54 | (+ 60.8) |
| 3- Air – permeability L/dm2/min @ 20 mm WG | 42 | 32 | (-23.8) | 183 | 105 | ( -42.6) |
| 4- Tensile strength | | | | | | |
| L | 124 | 107 | (-13.7) | 126 | 103 | (-18.3) |
| W | 85 | 56 | (-34.1) | 118 | 122 | (+3.4) |
| 5- Elongation at break (%) | 4.5 | 11.5 | ( +155.6) | 32 | 35 | (+ 9.4) |
| L | 6.7 | 15.6 | (+132.8) | 25 | 38 | (+ 52.0) |
| W | | | | | | |
| 6- Puncture strength (Kg) | 39 | 35 | (-10.3) | 78 | 73 | (-6.4) |

## Conclusion:

According to the investigation and study carried out, the work team could come up with the following points:

1. Although most if not all ferrosilicon production plants are using reverse-air dust control system, the jet-pulse system is strongly recommended. The suitable material for reverse-air system is the fiberglass which needs special care during operation such as temperature (not less than 200 °c), low temperature may cause problems due to dew point.

2. Changing the dust control system to be jet- pulse is highly advantageous due to technical and economic reasons:

- Jet- pulse system needs less maintenance program.
- Less rates of dust emissions are obtainable.
- Using polyester material as filtration media achieves a high economic benefit since it
- is the most frequently replaceable part in the system. It the unit area of polyester is
- X, fiber glass with membrane is 4 X, thus a remarkable save is achieved due to using
- polyester instead of fiber glass fabric as a filter media .
- Deposition of silica particles onto the surface of polyester fabric fibers enhanced its
- performance as filter media in the jet-pulse filtration system .
- polyester scrim supported non woven fabric experienced longer operational life than
- fiber glass woven fabric with membrane for the typical application of silica fume filtration.

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