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Effect of Stitch Line Sealants on Energy Efficiency Pocket Filters

Roy K. Varghese

Professor, Dept. of Chemistry., Lourdes Matha College of Science & Technology, Thiruvananthapuram

Abstract: In recent decades there has been a growing concern about the quality of the air we breathe indoors. Air cleaners are integral part of commercial HVAC systems and widely used to control both particulate and gaseous pollutants in indoor spaces. Different fields of applications require different degrees of air cleaning effectiveness. Fiberglass pocket filters have been widely used in commercial air filtration. A study of high efficiency pocket type filters made out of ultrafine glass fibers were carried out. The relationship between media area and performance parameters such as media velocity and pressure drop was investigated. The effect of stitch line sealants on the consumption of power has given positive directions in our mission to reduce carbon footprint in future buildings.

Keywords: Air cleaners, Stitch line sealants, Pressure drop, Carbon footprint.

I. INTRODUCTION

Air filters for commercial, industrial and residential applications are manufactured from micro fine glass fibers for consistent and long term efficiency (Though in recent years there has been a considerable shift form glass fiber to synthetic fibrous media). They are commercially available in efficiencies ranging from 40% to 95% on particles as small as 0.3 micron size. MERV values range from 9 to 14 when evaluated under ASHRAE (American Society of Heating Refrigerating and Air conditioning Engineers) standard 52.2.[1]

Pocket filters (in all efficiencies) are available in a variety of configurations to suit the volume of air requirement. Common configurations include from 3 pockets to 12 pockets, depths of 12'' to 36"and up to 129 square feet of net media area. Generally pocket –to- pocket contact, buckling of filters and subsequent premature failure during service life are avoided by controlled media spacing[2,3]. The controlled media spacing (CMS) ensure uniform airflow and allow the full utilization of the media area. The controlled media spacing ensures a lower life cycle product cost and an extended filter life. Most of the filter manufactures across the world uses the skip stitch configuration for optimum controlled media spacing. Also commercially available filters are stitched and sealed to close the needle holes for eliminating the possibility of air leakage through the stitching penetrations. Pocket type filters in all ASHRAE efficiency ranges (MERV values) are seen with a linear sealant line of 8 stitch lines.

II. MATERIALS AND METHODS

The improvement of air quality in modern buildings is a vital constituent of airborne hygiene procedures. It is also of important with regard to occupational health and safety requirements. Improved air quality not only helps to provide a healthier and more pleasant environment for occupants, but also makes economic sense due to its relevance as a preventive and infection control measure. Generally speaking, pocket type filters with higher efficiency are used in hospital and other health care facilities. In the present investigation, fiberglass pocket filters with the different media area were selected, having ASHRAE efficiencies–95% (MERV14) and -85% (MERV 13) effects of media velocity on filter resistance was analysed.

Filters were selected randomly and the configuration loss during fabrication/ manufacturing operation was not taken in to consideration, assuming the configuration loss as uniform in all cases irrespective of the pocket numbers. Energy is needed to overcome the resistance to airflow which is offered by any air filtration system. Since majority of the air filtration units are components of HVAC systems using fans driven by electric motors, the required energy is given in kilowatt hours. Energy has become an important factor in the selection of an HVAC filter system particularly while considering the energy costs and carbon foot print parameters. In order to study the effect of stitch line sealants on pocket filters, fiberglass rolls were sewn in Fales machines. During sewing in the Fales machine, the continuous sealant application of the thermoplastic sealant was avoided. Instead of continuous stitch lines, the needle holes were closed by manual application of molten thermoplastics on needle holes.

Thus the problems of air bypass and fiber erosion through the needle holes were eliminated. All pockets were visually inspected for proper sealing and ensured that the longitudinal stitch lines are free of sealants. Pockets were cut and sewn as per the requisite dimensions and assembled. These filters were then installed in the filter holding frames and measured the media velocity and pressure drop.

TABLE 1.EFFECT OF MEDIA VELOCITY ON PRESSURE DROP NORMAL FILTER

Media Area (Sq. Ft)	Media Velocity(FPM)	Resistance (Inches of W.G)	
		95%	85%
137.5	18.1	0.47	0.35
103.4	21.6	0.52	0.42
80.8	23.2	0.54	0.44
67.0	26.0	0.59	0.47
48.3	36.2	0.63	0.50

The energy used to overcome the resistance of a filter bank is provided by the blower which is part of the HVAC system. The blower in turn gets its energy from the motor. The power requirement can be calculated using the well established equation [(3)]

$kW_h = 1.173\ Q \times SP / 1000$ where

Where, Q is the volume of air in CFM (CFM = quantity of air being filtered expressed in cubic feet per minute)

SP = static pressure of filtration system in inches of w.g

kW_h = kilowatts necessary to overcome resistance of filtration system.

TABLE .II EFFECT OF MEDIA VELOCITY ON PRESSURE DROP ON FILTERS WITHOUT STITCH LINE

Sl. No	Media Area (Sq, Ft)	Air Flow (CFM)	Media Velocity (FPM)	Resistance in W.G	
				95%	85%
1	129	2500	19.4	0.54	0.40
2	97	2400	24.7	0.58	0.46
3	76	2000	26.3	0.60	0.48
4	63	1750	27.8	0.64	0.51
5	45	1750	38.9	0.71	0.54

From conventional principles it is clear that the pressure drop is directly proportional to the media area. And any gain in media area may translate itself to a pressure reduction. The gain in media area was calculated for a particular pocket type of filter without the application of longitudinal stitch line sealants and the corresponding savings in the energy consumption was tabulated.

III. RESULTS & DISCUSSION

Previous investigations reports that the pressure drop of a filter bank system increases with an increase in media velocity[4]. The current investigation also confirms the previous pressure drop relations. The energy is used to overcome the resistance of a filter by blower motor. In the current investigation a correlation between the pressure drop and energy consumption was carried out.

TABLE III MEDIA GAIN ON PRESSURE DROP OF FILTERS

Media Area Gain (Sq. Ft)	Pressure Difference (in W.G)		Energy Saving (KwH)	
	95% Media	85% Media	95% Media	85% Media
8.5	0.07	0.05	0.20	0.14
6.4	0.06	0.04	0.16	0.11
4.8	0.06	0.04	0.14	0.09
4.0	0.05	0.04	0.10	0.08
3.3	0.08	0.04	0.16	0.08

Media velocity effect on stitch line sealants were studied and it has been clearly established that the stitch line sealants play a very significant role in reducing the pressure drop of a particular filter irrespective of the efficiency of the system.

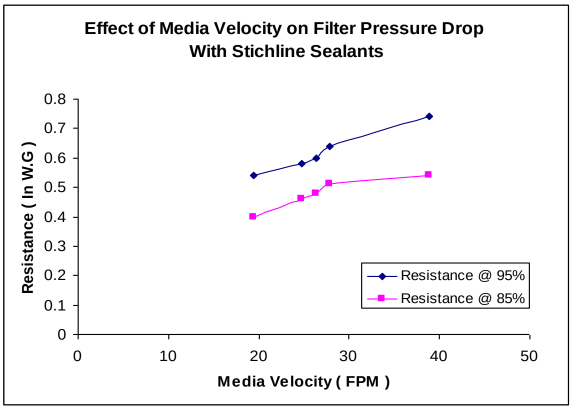

Fig. 1 Effect of Media Velocity on pressure drop with stitch line sealants

The resistance exerted by filter bank in any HVAC system is directly related to the energy consumption. A gain in filter media area by design modification can be a positive step in our effort to reduce carbon foot print. The current studies clearly establishes the relation between media area and energy savings.

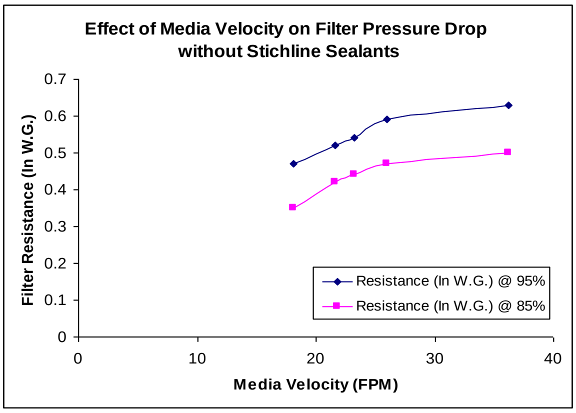

Fig. 2 Effect of Media Velocity on pressure drop without stitch line sealants

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Hence it is suggested to modify the traditional stitch line sealants by point type sealers during Fales machine stitching. This requires further modification of Fales machine and related machineries.

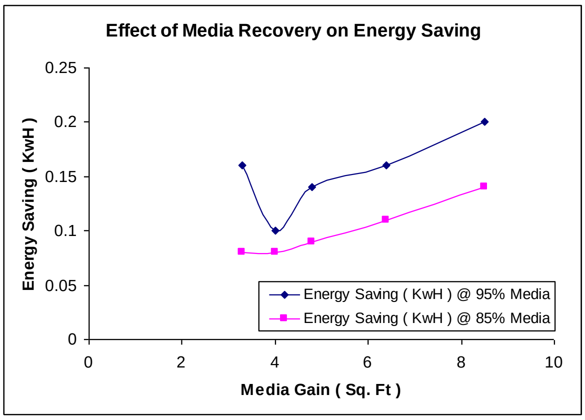

Fig.3 Effect of Media gain on energy savings

IV. CONCLUSION

As we are thinking about reduction in energy consumption and green buildings, HVAC technicians and filtration specialist need to address ways and means for reducing power consumption without sacrificing the performance and efficiency of extended area pocket filters. The age old stitch line sealants to be modified for more media area and further research need to be done in other areas of pocket filters and more detailed investigation to be carried out before establishing a universally acceptable stitch line protocol.

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BIOGRAPHY

Prof. Roy K Varghese is a senior faculty of Lourde's Matha College of Science and Technology, Kuttichal, Thiruvananthapuram. He is a postgraduate in Chemistry (M.Sc) from Kerala University. He was awarded M.Tech in Rubber Technology from I.I.T., Kharagpur. Roy K Varghese did M.B.A from the University of Kerala. He successfully completed a certificate course in Environmental Management from Indian Institute of Science, Bangalore. He is a life member of Indian Society for Technical Education., Indian Rubber Institute., and Society of Polymer Science, India. He is an author of textbooks on "Engineering Chemistry" and "Sustainable Engineering". He is an expert trainer and resource person conducting classes on Environment and Sustainability.