Investigation on Air Permeability of Needle Punched Non-Woven Fabrics

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Abstract- Air permeability of the non-woven fabrics is important property which indicates the thermal insulation characteristic of the fabrics. Air permeability of the fabric is an important fabric property which measures the rate of air flow through a fabric under differential pressure conditions. It decides the thermal insulation properties of the needle punched non-woven fabric. These properties are tested for the non-woven fabric used in this study and reported. The effect of areal density, porosity and thickness of different blend composition of sisal and polypropylene needle punched non-woven fabrics are thoroughly investigated in this paper.

Indexed Terms- Areal density, porosity, thickness, needle punched, blend composition.

I. INTRODUCTION

This paper deals with the dependence of air permeability on the geometrical properties of needle punched non-woven fabrics, namely areal density, thickness and porosity with different blend proportions. Air permeability is an important property which gives an indication of thermal insulation. This information will be useful for designing non-woven fabrics. Air permeability indicates thermal insulation and a lower value implies better insulation. In the application of non-woven fabrics as Geo-textiles, it is important that they have good thermal insulation.

II. RESULTS AND DISCUSSION

The results of those fabrics having variations in GSM but identical in other variables such as depth of penetration is 8mm and strokes per minute is 200 are discussed.

2.1 The Effect of Areal Density on Air Permeability

Table 1 presents data on air permeability, areal density, thickness and porosity in respect of all the samples considered.

Table 1: Average values of air permeability, thickness and porosity

S. No.	Details of Samples	Areal density	Air permeability ($cm^3/cm^2/sec$)	Thickness (mm)	Porosity (%)
1.	20% Sisal / 80% Polypropylene	250	120	2.75	90.03
		350	106	3.08	87.54
		450	92	3.75	86.84
2.	80% Sisal / 20% Polypropylene	250	275	3.70	94.96
		350	230	4.62	94.35
		450	202	5.86	94.27
3.	50% Sisal / 50% Polypropylene	250	170	3.20	93.35
		350	152	4.11	92.75
		450	116	5.09	92.48

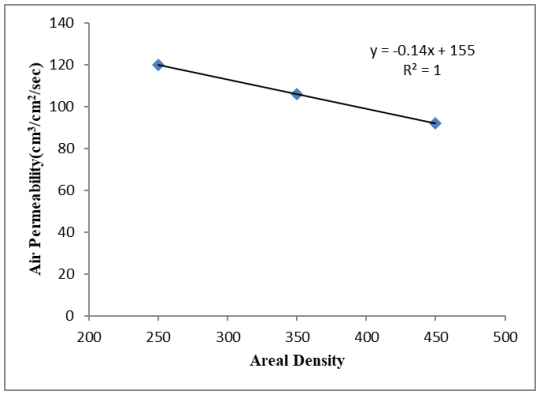

Figure 1: Relationship between areal density and air permeability of 20% sisal/80% polypropylene needle punched non-woven fabric

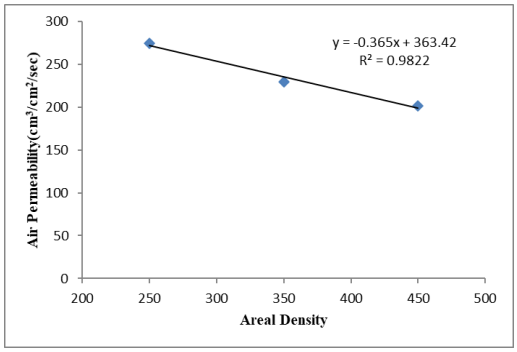

Figure 2: Relationship between areal density and air permeability of 80% sisal/20% polypropylene needle punched non-woven fabric

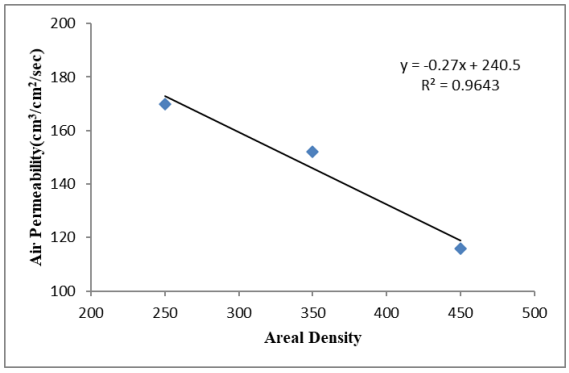

Figure 3: Relationship between areal density and air permeability of 50% sisal/50% polypropylene needle punched non-woven fabric

Figures 1 to 3 display the relationship between areal density and air permeability. It is noticed that with an increase in areal density the air permeability decreases. The reasons are mass, thickness and porosity of fabrics. This is in agreement with the findings of Kothari and Newton (1974), Zhu *et al.* (2015) and Venkatraman *et al.* (2014).

Table 2: Regression Analysis of air permeability and areal density

Blend Compositions	Equation y=a+bx	Value	Adj. R^2	t-test			F-test		
				t-value	p-value	LoS	F-value	p-value	LoS
20%S/80%PP	Intercept	155	1	*	*	S	*	*	S
	Slope	-0.14		*	*	S	*	*	S
80%S/20%PP	Intercept	363	0.98	20.60	0.03	S	55.32	0.03	S
	Slope	-0.37		-7.44	0.09	NS	55.32	0.09	NS
50%S/50%PP	Intercept	241	0.96	12.88	0.05	S	27.00	0.05	S
	Slope	-0.27		-5.20	0.12	NS	27.00	0.12	NS

S-sisal, PP-polypropylene, LoS-Level of Significance, S- Significant, NS-Not Significant

Table 2 gives the F-values and t-values together with their p-values and their significance levels. It is noticed that with the exception of a few cases, most of the values are significant. The correlation coefficients are very high and significant. In 20%sisal and 80%polypropylene, the values are quite significant.

2.2 The Effect of Porosity on Air Permeability

Figure 4 to 6 display the relationship between porosity and air permeability. It is noticed that with an increase in porosity, the air permeability increases. It has a direct relationship with air permeability. This is in agreement with the findings of Prakash *et al.* (2014).

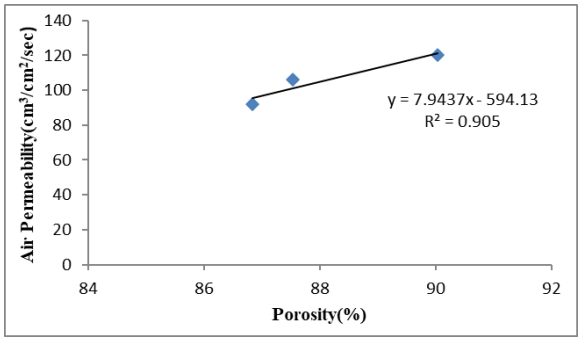

Figure 4: Relationship between porosity and air permeability of 20% sisal/80% polypropylene needle punched non-woven fabric

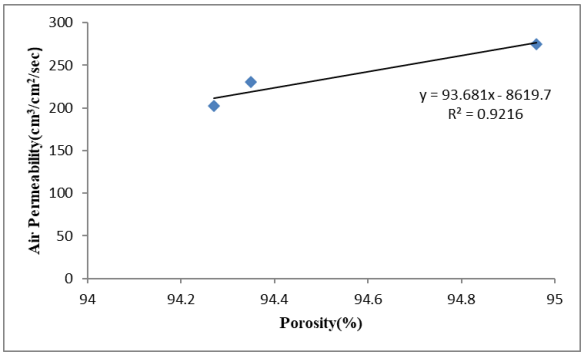

Figure 5: Relationship between porosity and air permeability of 80% sisal/20% polypropylene needle punched non-woven fabric

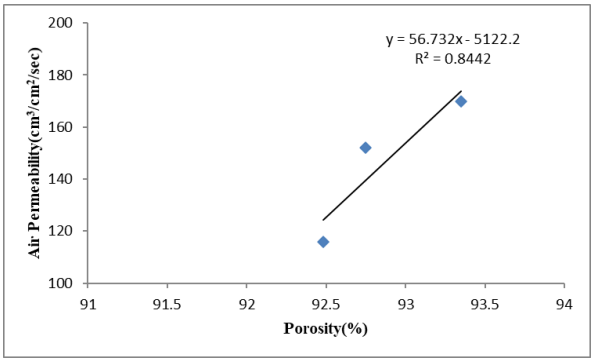

Figure 6: Relationship between porosity and air permeability of 50% sisal/50% polypropylene needle punched non-woven fabric

Table 3: Regression Analysis of air permeability and porosity

Blend Compositions	Equation y=a+bx	Value	Adj. R^2	t-test			F-test		
				t-value	p-value	LoS	F-value	p-value	LoS
20%S/80%PP	Intercept	-594	0.91	-2.62	0.23	NS	9.53	0.23	NS
	Slope	7.94		3.09	0.20	NS	9.53	0.20	NS
80%S/20%PP	Intercept	-8620	0.92	-3.34	0.19	NS	11.76	0.19	NS
	Slope	93.7		3.43	0.18	NS	11.76	0.18	NS
50%S/50%PP	Intercept	-5122	0.84	-2.26	0.27	NS	5.42	0.26	NS
	Slope	56.7		2.33	0.26	NS	5.42	0.26	NS

S-sisal, PP-polypropylene, LoS-Level of Significance, NS- Not Significant

Table 3 gives the F-values and t-values together with their p-values and their significance levels. In respect of the relationship between air permeability and porosity, all the t and F values are not significant. This shows that the relationship is poor.

2.3 The Effect of Thickness on Air Permeability

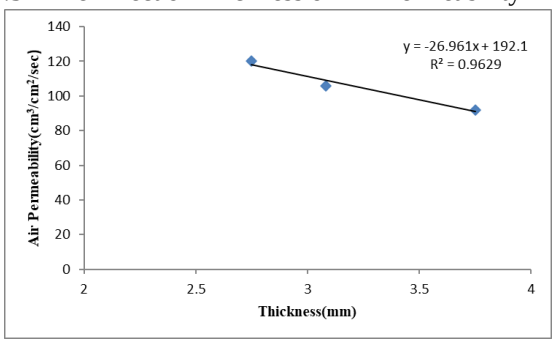

Figure 7 Relationship between thickness and air permeability of 20% sisal/80% polypropylene needle punched non-woven fabric

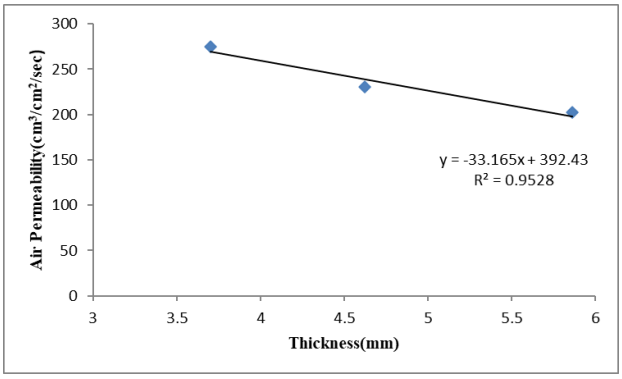

Figure 8 Relationship between thickness and air permeability of 80% sisal/20% polypropylene needle punched non-woven fabric

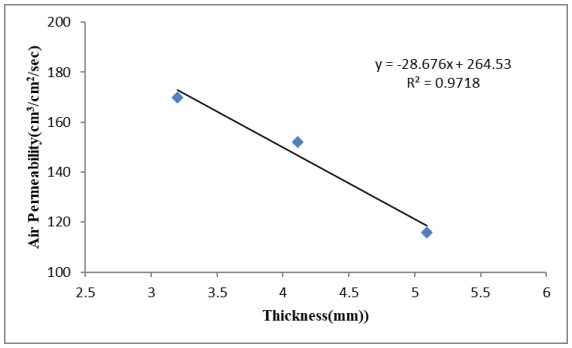

Figure 9 Relationship between thickness and air permeability of 50% sisal/50% polypropylene needle punched non-woven fabric

Figures 7 to 9 display the relationship between thickness and air permeability. It is noticed that with an increase in thickness the air permeability decreases.

Table 4: Regression Analysis of air permeability and thickness

Blend Compositions	Equation y=a+bx	Value	Adj. R^2	t-test			F-test		
				t-value	p-value	LoS	F-value	p-value	LoS
20%S/80%PP	Intercept	192	0.96	11.27	0.06	NS	25.95	0.12	NS
	Slope	-26.96		-5.09	0.12	NS	25.95	0.12	NS
80%S/20%PP	Intercept	392	0.95	11.06	0.06	NS	20.19	0.14	NS
	Slope	-33.17		-4.49	0.14	NS	20.19	0.14	NS
50%S/50%PP	Intercept	265	0.97	12.88	0.05	S	34.45	0.11	NS
	Slope	-28.68		-5.87	0.11	NS	34.45	0.11	NS

S-sisal, PP-polypropylene, LoS-Level of Significance, S- Significant, NS- Not Significant

Table 4 presents data on air permeability and thickness for the non-woven fabrics. That the t and F values are not significant can be inferred.

CONCLUSION

Air permeability of non-woven fabrics containing various blend compositions of sisal and polypropylene was investigated in this study. Among the factors studied, only areal density seems to have an effect on air permeability of 20%sisal and 80%polypropylene. The other parameters do not show any effect. This study will help in designing the needle punched non-woven fabric produced from sisal and polypropylene for specific industrial applications.

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