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Instituut vir Termodinamika en Meganika – Institute for Thermodynamics and Mechanics

ITM/VB9606

Roof Ventilator Tests

by

T.W. von Backström

November 1996

Institute for Thermodynamics and Mechanics

Introduction:

Four rotating type wind driven roof ventilators were tested for Windmaster. They had nominal diameters of 250, 350, 500 and 590 mm. The objective was to measure the extraction as dependent on wind velocity for wind velocities up to 25 km per hour. Windmaster also presented us with a brochure giving the air removing capacity, or extraction, for the 350 and 500 mm diameter ventilators. Our understanding was that the data for the 350 mm ventilator was obtained from measurements by CSIR. These data would serve as a valuable check for our own measurements.

Testing Procedure:

The performance tests were done in the large low speed section of the subsonic wind tunnel of the Department of Mechanical Engineering where it was possible to generate wind speeds of up to 35 km/h. At the measuring section the tunnel was 3,7 m wide and 2,86 m high. The wind velocity in the tunnel was measured with a calibrated turbine type anemometer.

The ventilators were successively mounted in a side wall of the wind tunnel. The ventilators protruded into the wind tunnel as deeply as they would normally stand up from a roof. To make the measurements of the air velocity through the ventilator easier and more accurate, the ventilator ducting was extended by 600 mm into the room adjoining the tunnel and fitted with a rounded entry nozzle made up by an inflated inner tube. The rounded nozzle would reduce the inlet pressure loss coefficient substantially from about 0,5 to 0,05 whereas the longer inlet duct would increase the pressure loss in the duct by negligible amount of between 0,01 and 0,02 for each duct diameter of added length.

The nozzle allowed smooth entry into the ducting and ensured a uniform velocity at the measuring station which could be positioned at least one duct diameter downstream of the entrance. Measurement of the velocity profile in the duct by means of a small turbine type anemometer established that the velocity profile in the duct was uniform. Consequently the mean velocity through the ventilator could be measured by means of a single calibrated turbine type anemometer.

The velocity profile in the entrance section of the wind tunnel where the ventilators were installed during the tests was not completely uniform but varied by about 10% across the test section. To ensure that the wind velocity measured was the same as that to which the ventilator was exposed, the wind velocity was measured at a distance from the tunnel side wall equal to the mean distance of the ventilator turbine from the side wall.

The pressure in the room from which the ventilator sucked the air was essentially at the same pressure as the outside air entering the wind tunnel.

Results

The results are summarized in table 1 and presented graphically in figures 1 to 5. Linear curve fits are also given in the figures.

The first test to look at is that of the 350 mm diameter ventilator, for which results were also given in the brochure. In figure 2 our results are again given by the diamonds, while the results from the brochure are represented by the triangles. At 25 km/h there is perfect agreement between the result from the brochure and the curve fit through our results. At 15 km/h there is perfect agreement between the specific measurements, although both deviate from the curve fit. The conclusion from these data is that deviations of up to 10% from the mean occurred during measurement. In our case it could be mainly attributed to unsteadiness of the flow in the entrance to the wind tunnel. Nevertheless, the overall agreement between our measured results and the previously available results is satisfactory.

The graphs of the variation of extraction against wind velocity for the 590 and 250 mm nominal diameter ventilators are given in figures 3 and 4. Both are well fitted by straight lines.

TABLE 1

VENTILATOR 250MM		VENTILATOR 350MM	
Wind velocity (km/h)	Extraction (m³/h)	Wind velocity (km/h)	Extraction (m³/h)
3.7	218.16	5.04	683.3
11.17	436.69	11.5	1226.08
17.78	683.49	16.92	1936.7
25.94	937.87	22.42	2475.14
31.32	1060.06	26.63	2806.92
37.59	1282.76	31.08	3118.73
		33.52	3307.55

VENTILATOR 500MM		VENTILATOR 590MM	
Wind velocity (km/h)	Extraction (m³/h)	Wind velocity (km/h)	Extraction (m³/h)
1.71	1244.92	8.06	2425.37
6.06	1838.72	11.43	3562.28
18.66	4009.56	17.82	4982.81
25.71	5529.04	23.68	6734.76
27.72	6499.98	26.77	7915.98
33.33	7205.65	30.96	8977.67
		35.34	10142.65

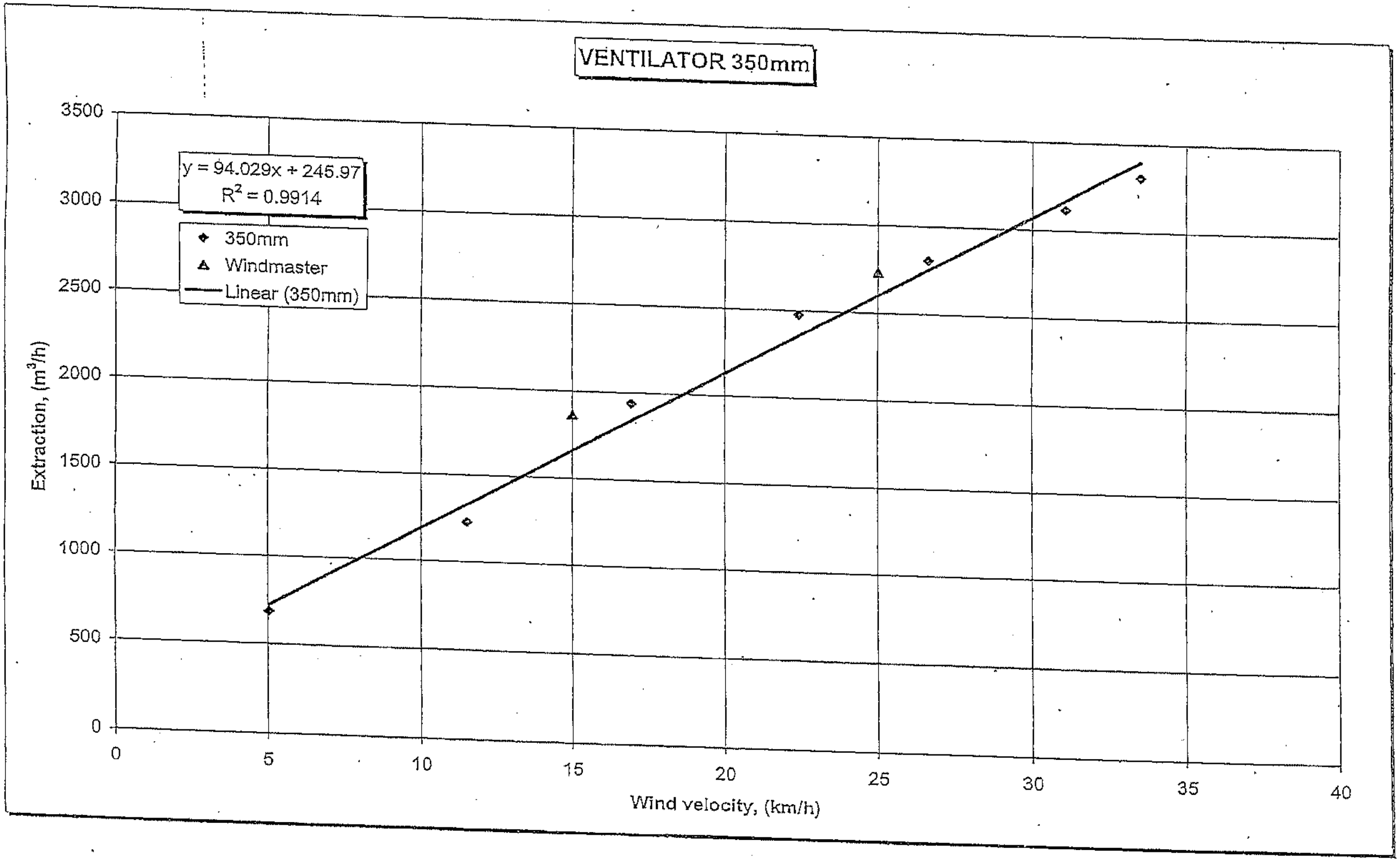

Fig. 1 Performance of Ventilator 350 mm

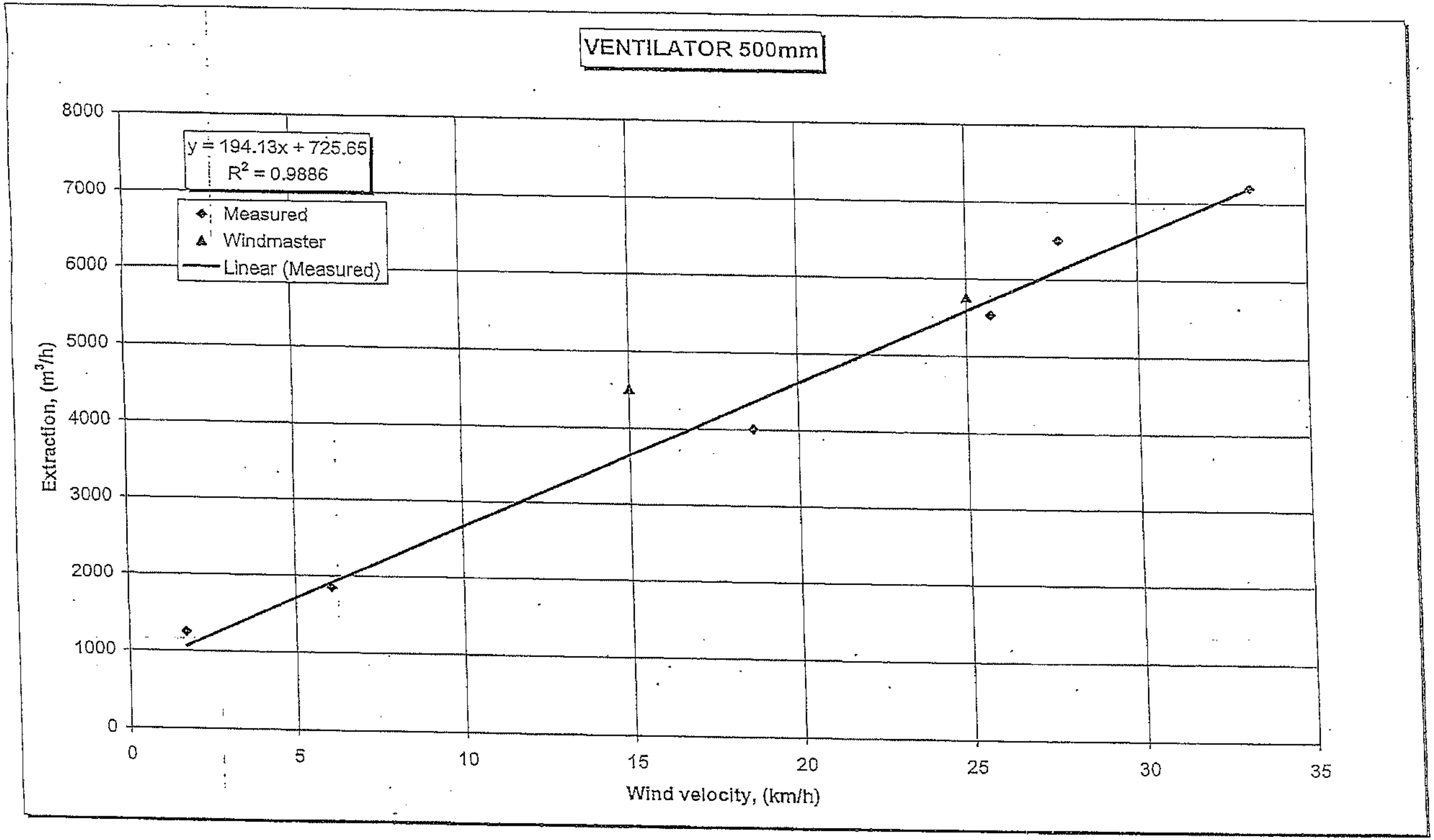

Fig. 2 Performance of Ventilator 500mm

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ITM/VB9802

Wind Tunnel Tests of 600 mm Diameter Ventilator

by

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May 1998

Institute for Thermodynamics and Mechanics

Introduction

This report deals with the test of two models of a 600 mm diameter Windmaster roof ventilator.

Objectives

The main objective of the test was to determine the volume flow removed by the ventilator as a function of the wind velocity to which it is exposed.

A secondary objective was to compare two different designs: one with vertical and the other with horizontal brackets.

Test Facility and Equipment

The tests were done in the 3.7 × 2.9 m low speed test section of the large low speed wind tunnel of the Department of Mechanical Engineering of the University of Stellenbosch. The wind velocity at the test section was measured by means of a calibrated turbine type anemometer placed at the same distance from the wall as the ventilator. Tests on previous ventilators indicated that the distance at which the present ventilator was installed from the wall was large enough to be beyond the boundary layer.

The wind velocity through the ventilator was measured by means of a calibrated turbine anemometer installed in the ventilator duct. To accomplish this, the ventilator duct was increased in length by 1.2 mm and the entrance was rounded by means of an inflated inner tube to prevent flow separation at the inlet. Previous tests showed that this strategy resulted in a uniform velocity profile with thin boundary layers in the duct, thereby confirming the validity of using only one measurement in the duct to calculate the ventilator flow.

Test Procedure

The ventilator was installed in the side wall of the wind tunnel at a section where the width was 3.7 m and the height 2.9 m. The wind velocity at the measurement station was controlled by means of the downstream throttling valve of the wind tunnel between approximately 3 and 33 km/h. Readings were then taken of the wind speed and the ventilator through flow velocity. Inlet atmospheric conditions (temperature and pressure) were also recorded.

Measurements

The measurements are given in tabular form in table 1.

Data Reduction

The wind velocity was calculated from the anemometer reading with the following calibration curve: Velocity = 14.987 (mv) – 0.1319 (m/s).

The ventilator throughflow velocity was calculated from the anemometer reading with the following calibration curve: Velocity = 17.667 (mv) – 0.3562 (m/s).

Presentation and Interpretation of Results

The results are given in table 2 and figure 1 and 2. The differences between the performance of the ventilator with the vertical and the horizontal struts are of the same order as the scatter in the experimental results.

Figure 3 shows that as found in previous test, the flow velocity through the ventilator and the wind velocity over the ventilator are about equal.

Conclusions

The 600 mm diameter ventilator performs as expected when compared to previously tesed roof ventilators. As previously, it should be pointed out that the wind tunnel tests may not completely represent a roof installation. Roof shape and the proximity of adjacent buildings may affect the performance of the ventilator. The difference between the pressure inside the roof cavity and the static pressure outside the roof is also not necessarily equal to the dynamic pressure of the wind, as in our wind tunnel tests. The tests may however be regarded as representative in so far as they agree in procedure to similar tests done previously at Stellenbosch and at the CSIR. Since only two machines were tested, the general applicability of the results to production machines will depend on how accurately the production machines resemble the ones tested.

TABLE 1

WINDMASTER 610mm (Horizontal Bracket)

Wind velocity		Extraction	
(m/s)	(km/h)	(m/s)	(m^3/h)
0	0	0	0
0.93	3.348	0.93	944
1.66	5.976	1.77	1805
2.82	10.152	2.82	2874
3.37	12.132	3.54	3601
3.77	13.572	4.16	4239
5.34	19.224	5.79	5898
7.46	26.856	7.77	7912
7.89	28.404	8.18	8326

WINDMASTER 610mm (Vertical Bracket)

Wind velocity		Extraction	
(m/s)	(km/h)	(m/s)	(m^3/h)
0	0	0	0
1.01	3.636	0.80	815
1.92	6.912	1.83	1861
2.98	10.728	2.94	2989
4.36	15.696	4.55	4629
6.17	22.212	6.49	6610
8.33	29.988	9.25	9412

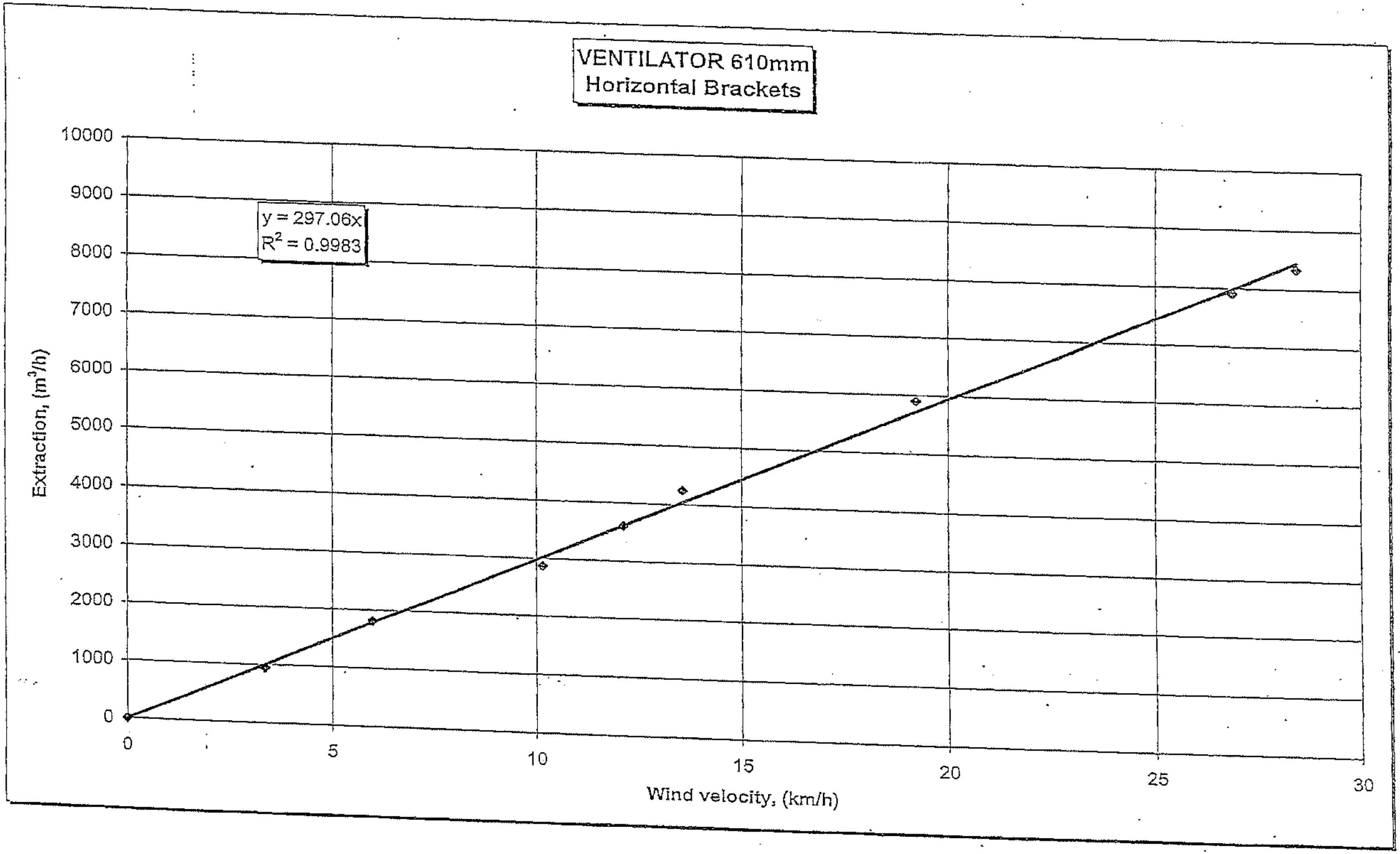
VENTILATOR 610mm
Horizontal Brackets
y = 297.06x
R2 = 0.9983
Extraction, (m3/h)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
5
10
15
20
25
30
Wind velocity, (km/h)

Figure 1

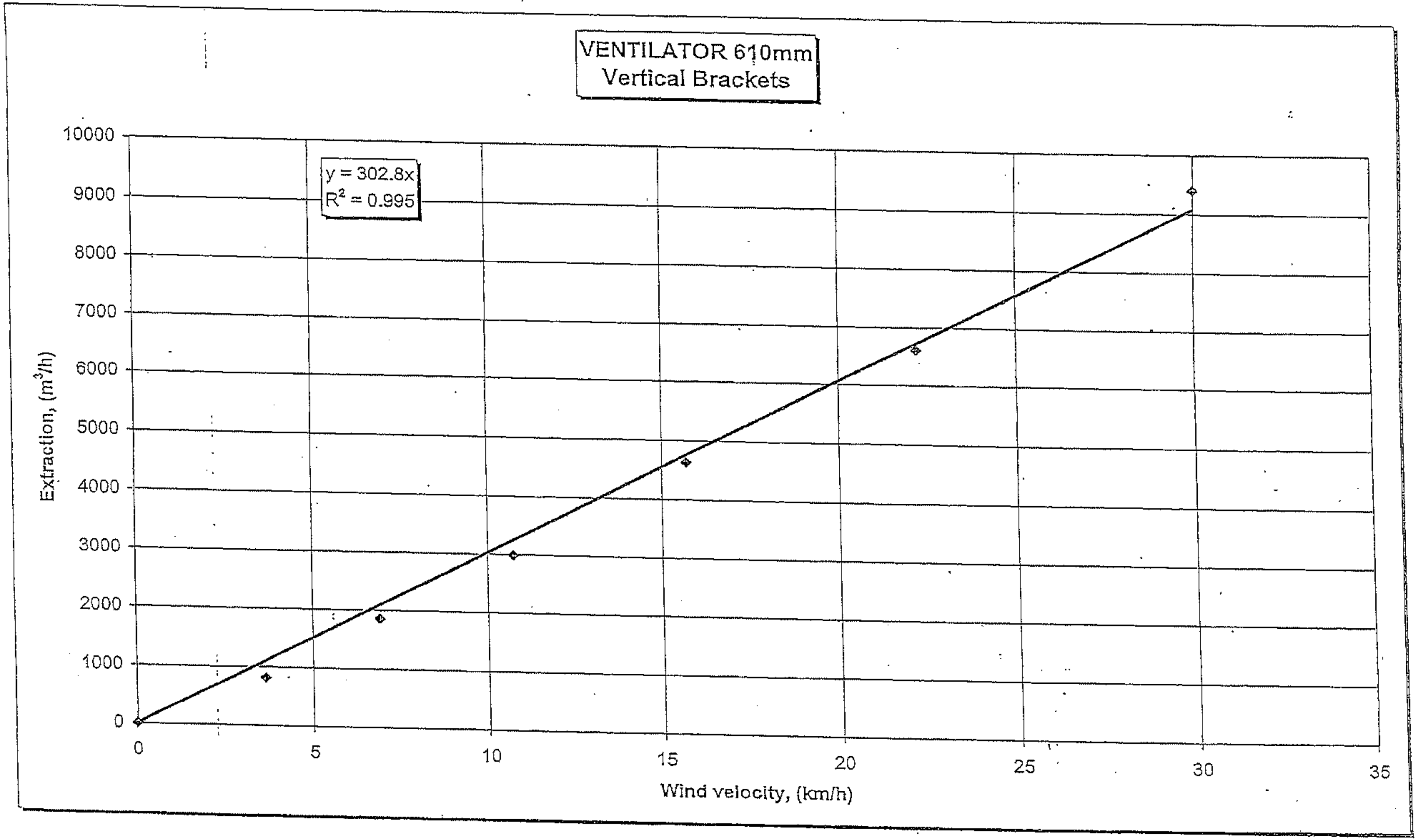
VENTILATOR 610mm
Vertical Brackets
y = 302.8x
R² = 0.995
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Extraction, (m³/h)
0
5
10
15
20
25
30
35
Wind velocity, (km/h)

Figure 2

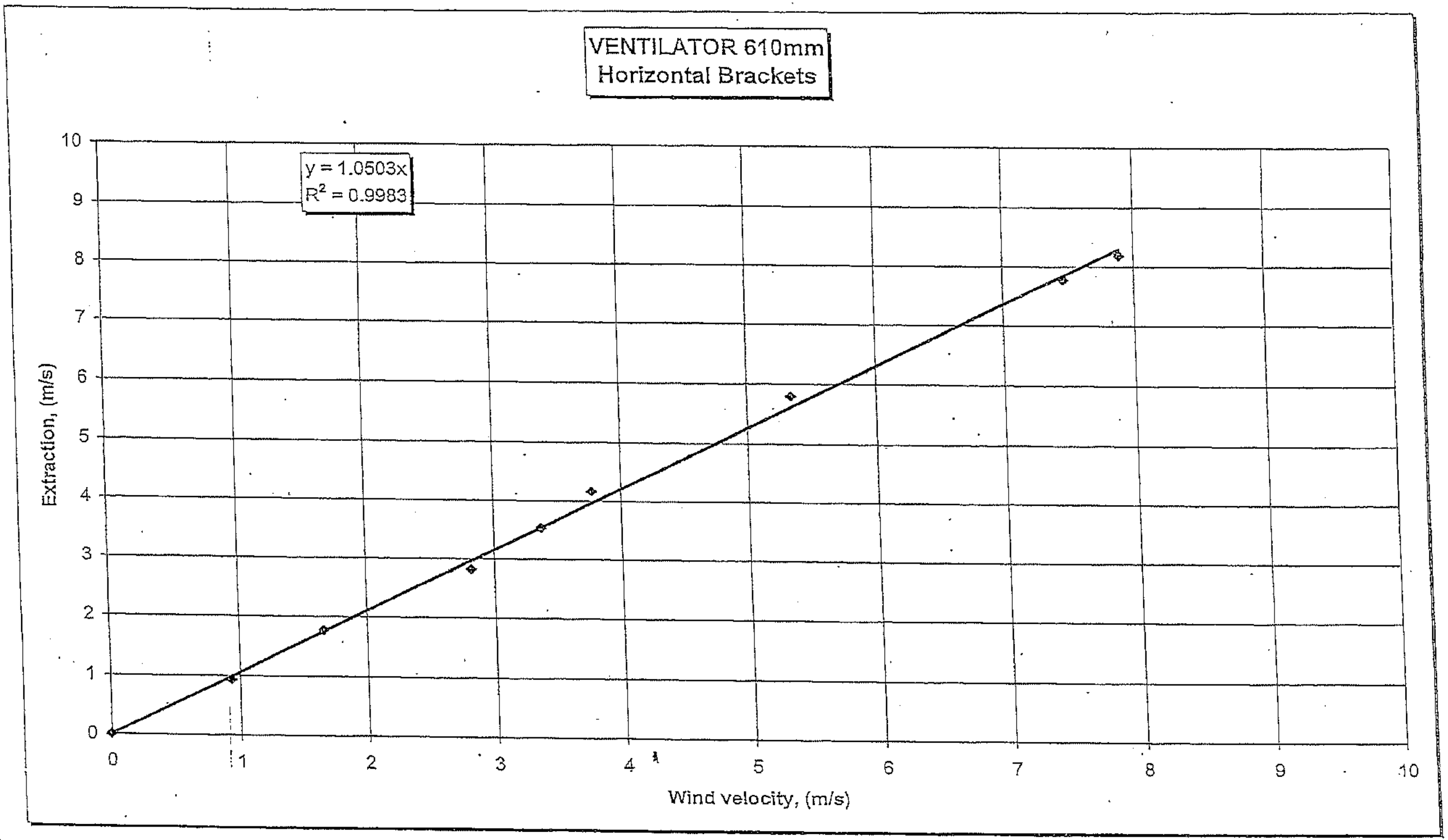
VENTILATOR 610mm
Horizontal Brackets
y = 1.0503x
R2 = 0.9983
Extraction, (m/s)
Wind velocity, (m/s)
0
1
2
3
4
5
6
7
8
9
10

Figure 3

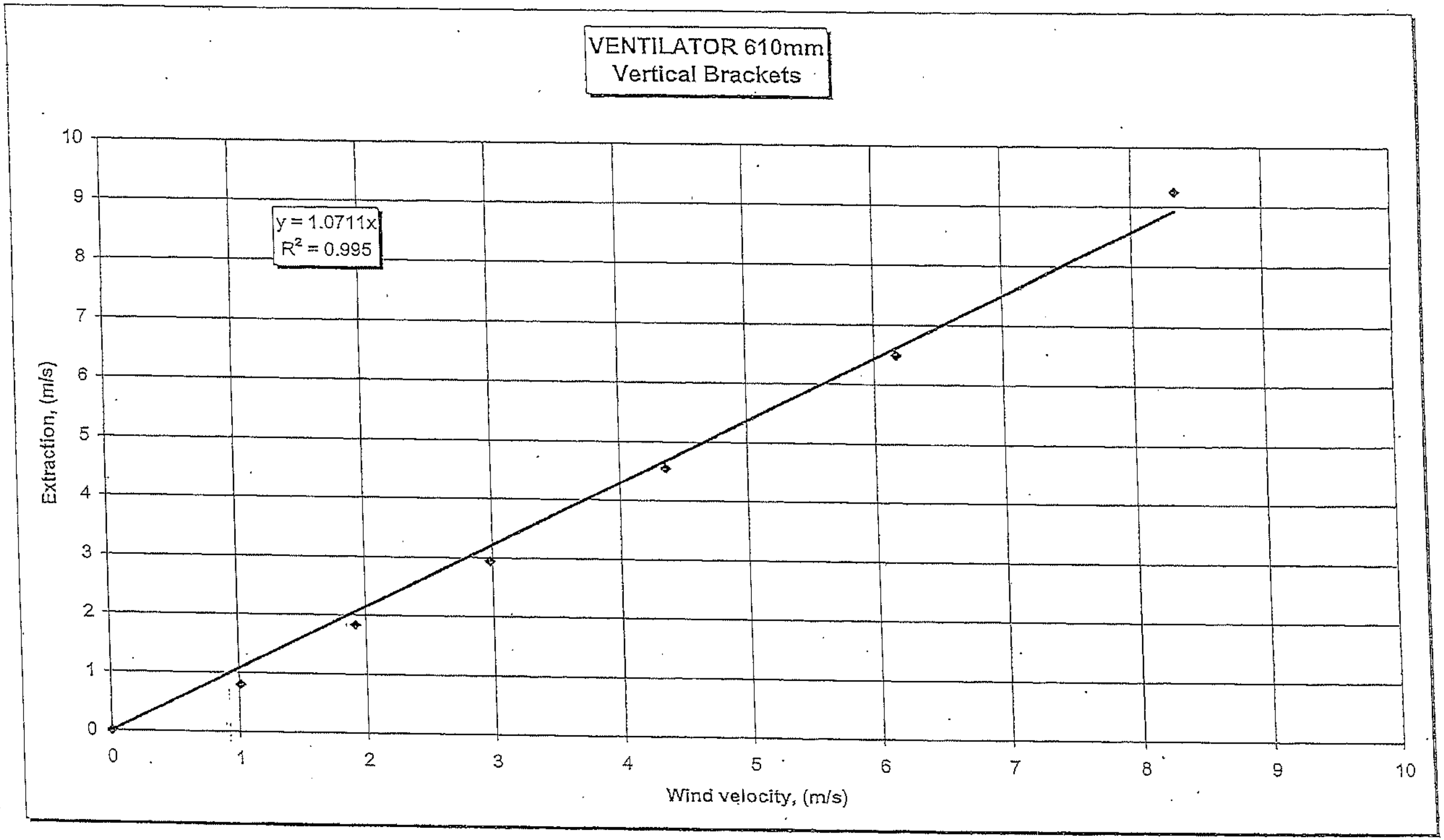
VENTILATOR 610mm
Vertical Brackets
y = 1.0711x
R² = 0.995
Extraction, (m/s)
Wind velocity, (m/s)
0
1
2
3
4
5
6
7
8
9
10

Figure 4

086 689 0983

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Rig asseblief alle korrespondensie aan die President

To (Firm)/ Aan (Firma): WINDMASTER cc

Attention / Aandag: MR J VAN BILJOEN

Dial code / Skakelkode: 012 — Serial No. / Volgno: 08/170

Place / Plek: SILVERTON — Ref. No. / Verwno: 19/4

Country / Land: — Date / Datum: 5 AUG 1996

Fax No. / Faksno: 803 5437 — No. of pages, this one included: / Getal bladsye, hierdie ingesluit: 2

Message / Boodskap:

Windmaster cc
Attention: Mr J van Biljoen
P.O. Box 1908
SILVERTON
0127

Daer Sirs — NATIONAL BUILDING REGULATIONS AND SABS 0400
PART O LIGHTING AND VENTILATION

Reference is made to our telephone conversation and your letter received on 1 August 1996, together with a letter from the City Engineer's Department of Cape Town and your brochure on "Windmaster" ventilators.

In my opinion, the above wind-driven roof ventilators would be acceptable to be used for the natural ventilation system of a building.

The relevant requirements of regulation O1 can be satisfied by an acceptable rational design prepared by or under the supervision of a professional engineer or other approved competent person; or by complying with the provisions of deemed-to-satisfy rule OO4 of SABS 0400. For your infomation a copy of the deemed-to-satisfy rule is enclosed.

Should you wish us to do tests on your product please contact our Mr Herman Strauss of the Air & Gas Flow Technology division on telephone number 428 6601.

Yours faithfully

[signature]