Report

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RESULTS OF THE DUCT AIR TIGHTNESS TESTS ON DUCT SAMPLE FITTED WITH GRIPPLE DUCT TRAPEZE

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1 INTRODUCTION

This report is presented to provide the results of the air leakage measurements on a section of ductwork supplied by Gripple and how the installation of 2 No. 'DUCT TRAPEZE' effects this.

A standard Class C rated section of duct measuring 300x300x1500mm was tested for air leakage. 2 No. Duct Trapeze duct hangers were then installed onto the duct, representing the number of hangers usually required for supporting ductwork.

Three different methods of installing the Duct Trapeze were tested. These were:
Self drilling screw with rubber pad,
Self drilling screw with no rubber pad,
5mm rivets with rubber pad.

Each installation method was tested by applying positive pressure up to 2000Pa and negative pressure to –750Pa.

The surface area of duct measuring 0.3m square duct of length 1.5m
= 0.3 X 4 X 1.5 m = 1.8m^2.

2 TEST PROCEDURE

Air was supplied / extracted from the duct via a centrifugal fan and laminar flow element flow measuring device. The air flow rate was measured using a 0.1 to 10 $l.min^{-1}$ Furness Controls Laminar Flow Element (LFE). Pressure differentials across the duct were measured using a calibrated PVM100 micromanometer and those across the flow measuring device were measured using a calibrated DG700 micromanometer.

The test method used was to set the air flow to the duct to achieve a pressure around +/- 200Pa, allowing the reading to settle, before noting down the duct pressure and pressure differential across the LFE, then increasing the air flow to take the next reading and continuing with this method until 2000Pa (or –750Pa) was reached.

For the first positive and negative tests (before fitting the Duct Trapeze) when 2000 Pa positive pressure (and -750Pa negative pressure) had been reached it was maintained for a period of 15 minutes before the supply was turned off, allowing the pressure in the duct to return to near zero. The airflow was turned back on again and left until 2000Pa (and -750Pa negative pressure) was reached to ensure similar airflow rates created the same pressure in the duct. This is used to check the end seals of the duct are holding and was only performed for the first positive and negative tests on the duct before any hangers had been fitted.

The tests undertaken were:

Duct only, positive
Duct only, negative
Duct, with product screwed in, with rubber pad, positive
Duct, with product screwed in, with rubber pad, negative
Duct, with product screwed in, WITHOUT rubber pad, positive
Duct, with product screwed in, WITHOUT rubber pad, negative
Duct, with product riveted in, with rubber pad, positive
Duct, with product riveted in, with rubber pad, negative

Equipment Used for all tests	Identification Number
0.1 - 10$l.min^{-1}$ Laminar Flow Element	93-7-509
Duct Pressure Micro manometer PVM100	107453
Flow Meter Micromanometer DMI DG –700	M043

The accuracy of the micromanometer used to measure the duct pressure differential was better than +/- 1%.
The accuracy of the flow meter (including micromanometer) was better than 5%.

Calculation Details

The method below shows how the leakage rate per metre squared of duct is calculated. For this example the data for initial positive pressure test on the duct was used.

Data from test		Calculated flow rate	
LFE (pa)	Duct Pa	l/min	l/sec
12.5	201	1.238	0.021
21.4	406	2.120	0.035
33.8	801	3.349	0.056
45.2	1198	4.478	0.075
52.1	1508	5.162	0.086
58	1705	5.747	0.096
60.1	1797	5.955	0.099
62.7	1920	6.212	0.104
65.3	2000	6.470	0.108
65.8	1986	6.519	0.109
65.7	1990	6.509	0.108

The pressure reading across the LFE flow measuring device is converted into a flow rate using the calibration of the LFE (100.93Pa = 10l/min).

The flow rate is plotted against the duct pressure.

A Power Trendline is added to the graph and the equation of the trendline shown on the graph.

This equation can then used to work out the flow rate in l/s for any given pressure within the range tested.

This flow rate in l/s can then be divided by the surface area of the duct to obtain the leakage per metre squared.

Using the example of the last spot reading from the table above…..

The pressure across the LFE to achieve 1990Pa in the first test of the duct is 65.7Pa.

$$\frac{65.7}{100.93} \times 10 = 6.5 \ \ l / \min$$

The flow rate in l/min is converted into l/sec.

$$\frac{6.5}{60} = 0.1085 \ l / s$$

This value of 0.1085 l/s at 1990Pa is plotted on a graph along with all the other readings taken for this test (this graph is the first one shown in the appendix section).

The equation of the trendline is $Q = 0.00048.\Delta p^{0.71325}$
(Where Q is the flow rate in l/s and Δp is the differential pressure of the duct)

This equation can then be used to determine the duct leakage at the required duct pressure.

Dividing this value by the surface area of the duct gives the leakage in litres per second per square metre of surface area.

For example using the above equation:

Duct Pressure (Pa)	Flow rate (l/s)	Flow rate per square metre l/(s.m^2)
200	0.0210	0.0117
400	0.0344	0.0191
800	0.0565	0.0314
1200	0.0754	0.0419
1500	0.0884	0.0491
2000	0.1086	0.0603

3 RESULTS

The results shown in the tables below show the leakage of the duct in litres per second per square metre of surface area at various duct differential pressures.

Table 1: Negative pressure test results

		2 hangers fitted		
Duct Pressure	**Duct as received**	**Self drilling screws with rubber pad**	**Self drilling screws without rubber pad**	**Riveted with rubber pad**
(Pa)	l/(s.m^2)	l/(s.m^2)	l/(s.m^2)	l/(s.m^2)
200	0.0118	0.0117	0.0169	0.0116
400	0.0213	0.0211	0.0296	0.0209
750	0.0363	0.0364	0.0494	0.0358

Table 2: Positive pressure test results

		2 hangers fitted		
Duct Pressure	**Duct as received**	**Self drilling screws with rubber pad**	**Self drilling screws without rubber pad**	**Riveted with rubber pad**
(Pa)	l/(s.m^2)	l/(s.m^2)	l/(s.m^2)	l/(s.m^2)
200	0.0117	0.0120	0.0174	0.0121
400	0.0191	0.0196	0.0282	0.0198
800	0.0314	0.0319	0.0457	0.0325
1200	0.0419	0.0425	0.0606	0.0433
1500	0.0491	0.0497	0.0708	0.0508
2000	0.0603	0.0609	0.0867	0.0623

4 CONCLUSIONS

These results show that the holes made in the ductwork to fit the duct hangers make no measurable difference to the leakage of the duct provided the rubber seal pad is used.

Differences in leakage rates of less than 5% are considered to be within the accuracy of the test equipment used.

Where the rubber pad is not used the leakage of the duct did increase noticeably but for the sample of duct provided the overall duct leakage was still within the Class C specification.

Figure 1 below shows a plot of the maximum allowable leakage rate of the duct to achieve class C standard using the equation $0.003.\Delta p^{0.65}$ from DW/143.
Also shown on this graph are the leakage rates for 4 of the tests carried out. Positive and negative results are shown for the duct as received and for the duct with hangers installed without the sealing pad.

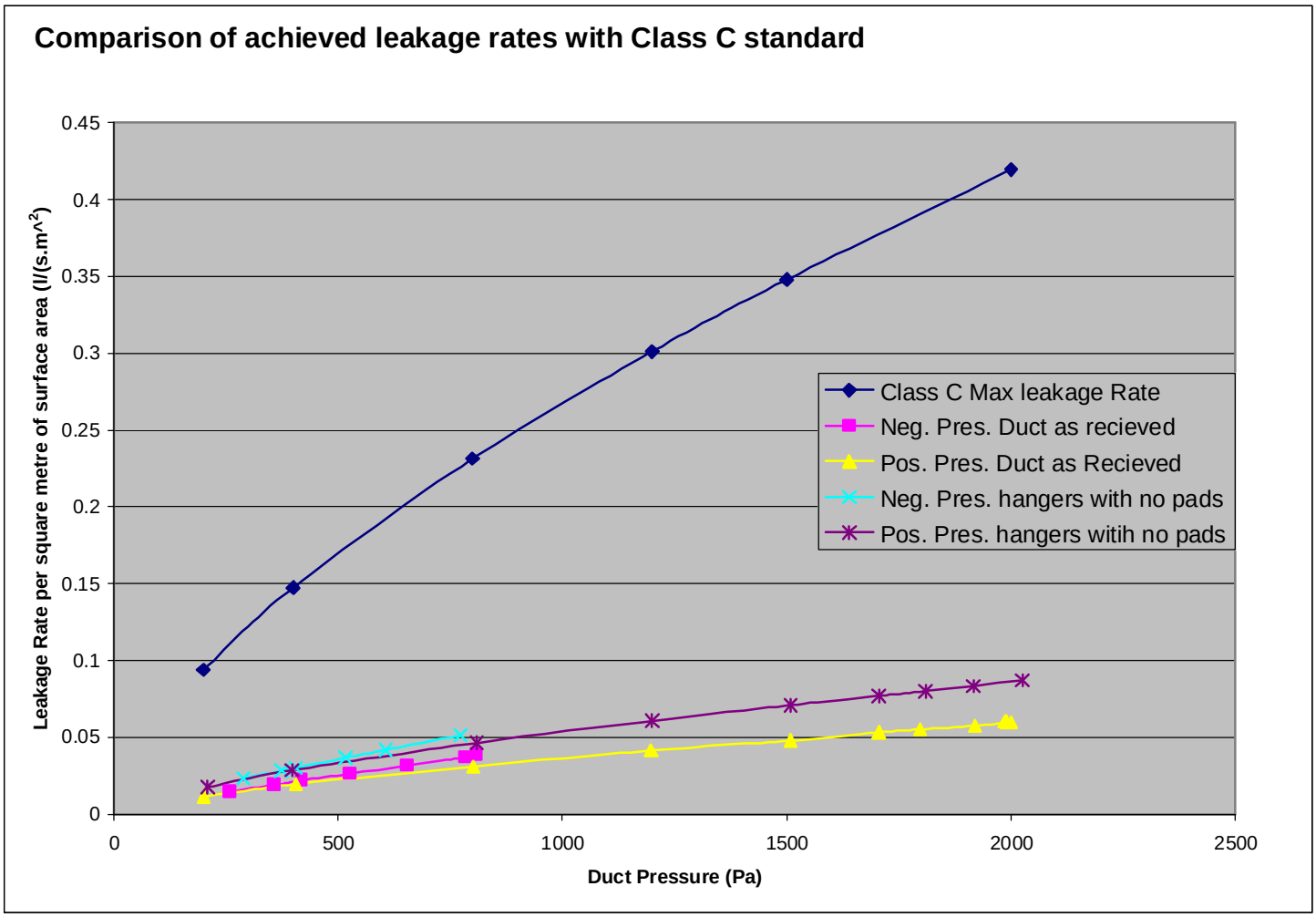
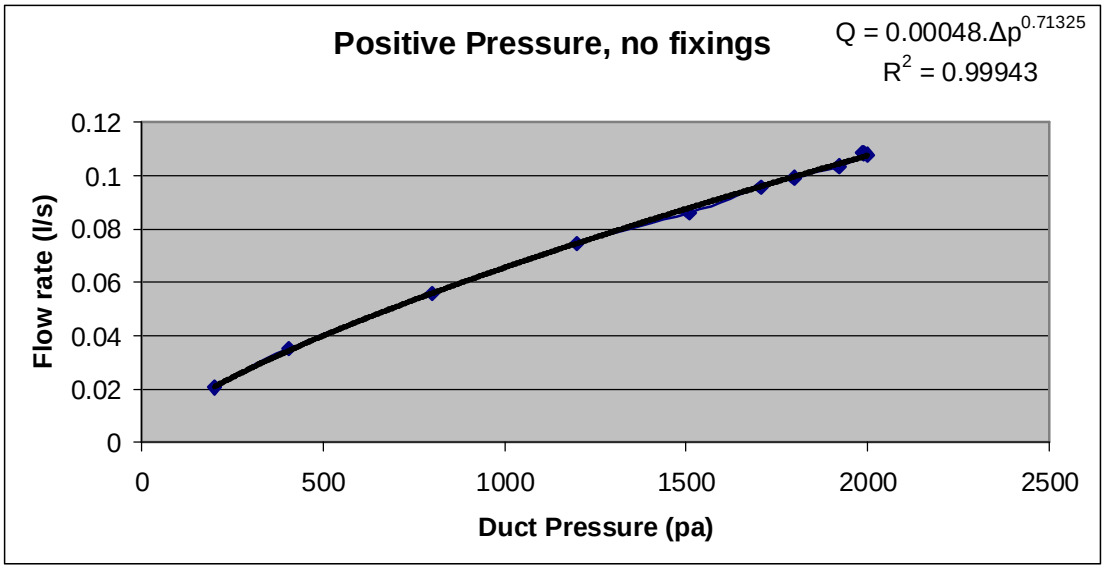


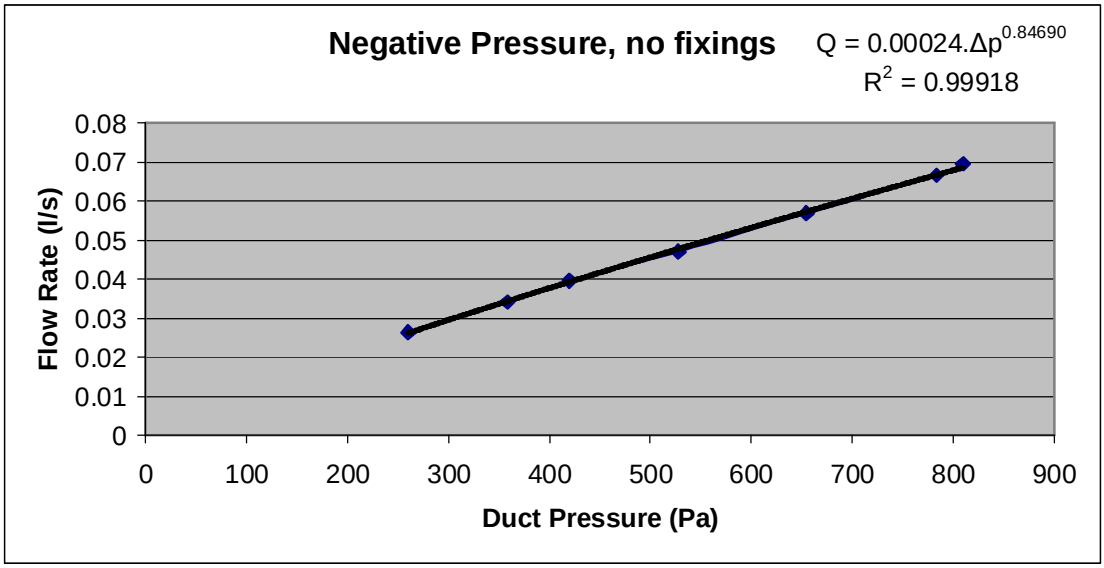
Figure 1: Comparison of achieved leakage rates with Class C standard

5 APPENDIX:

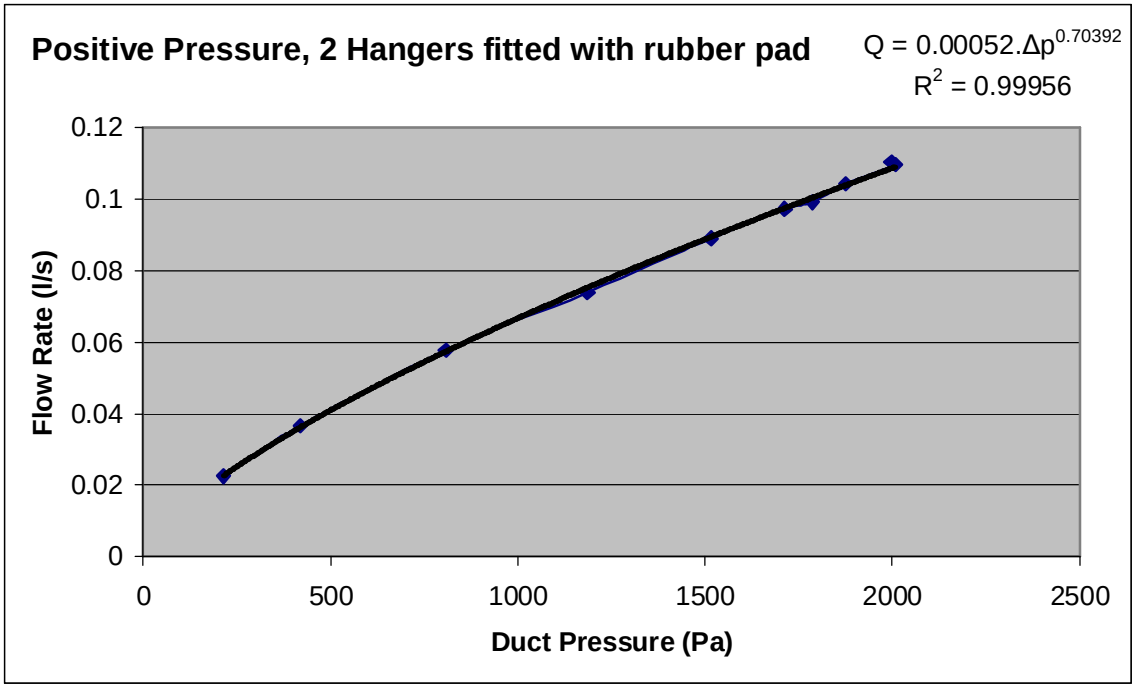
This section shows the graphs plotted for each test.
Graphs show duct pressure against flow rate **(in l/s)** required to achieve that pressure.



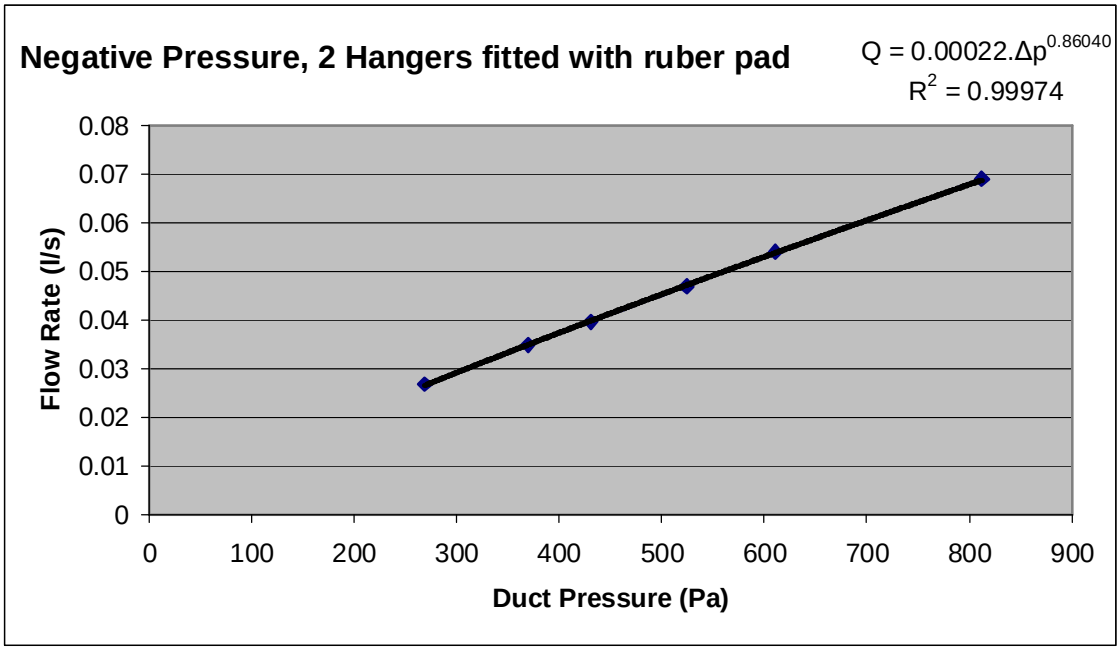
Initial positive pressure test. No fixings installed



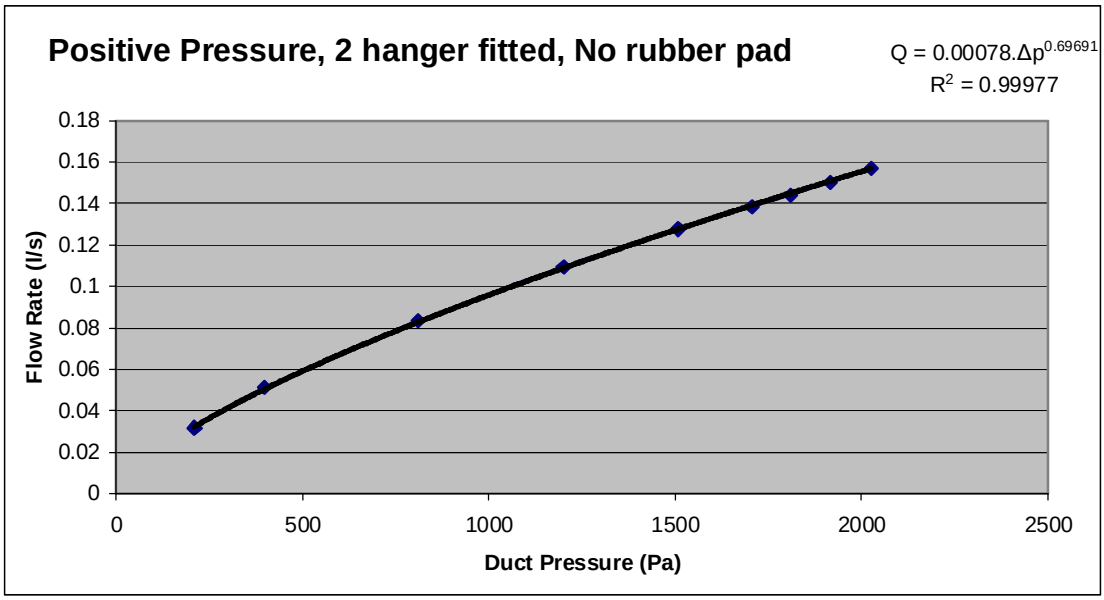
Initial negative pressure test. No fixings installed



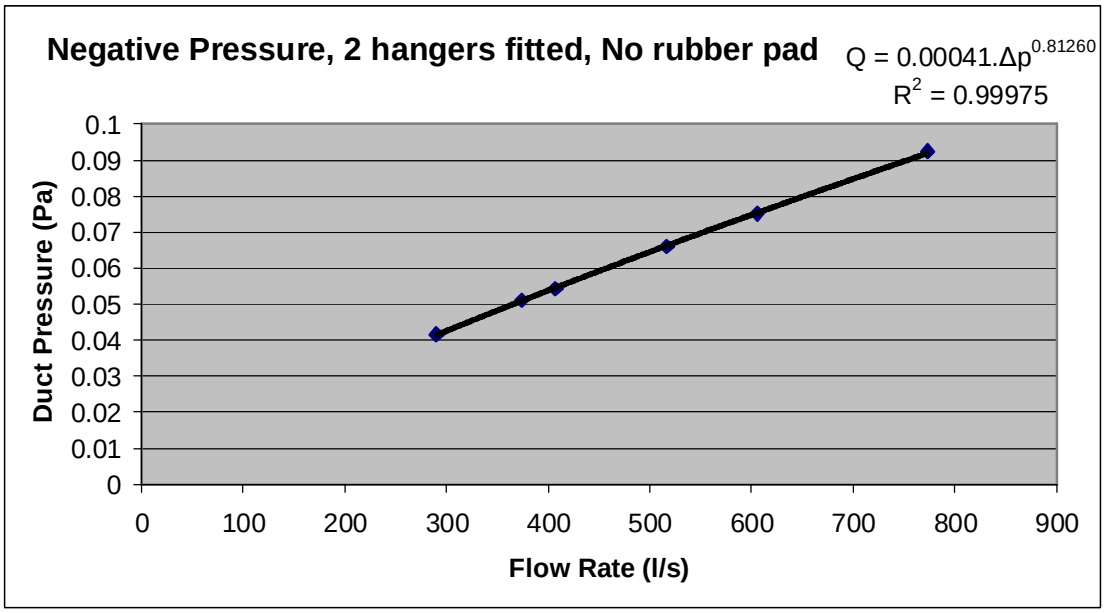
Positive pressure test. 2 hangers fitted using self drilling screws and rubber pad



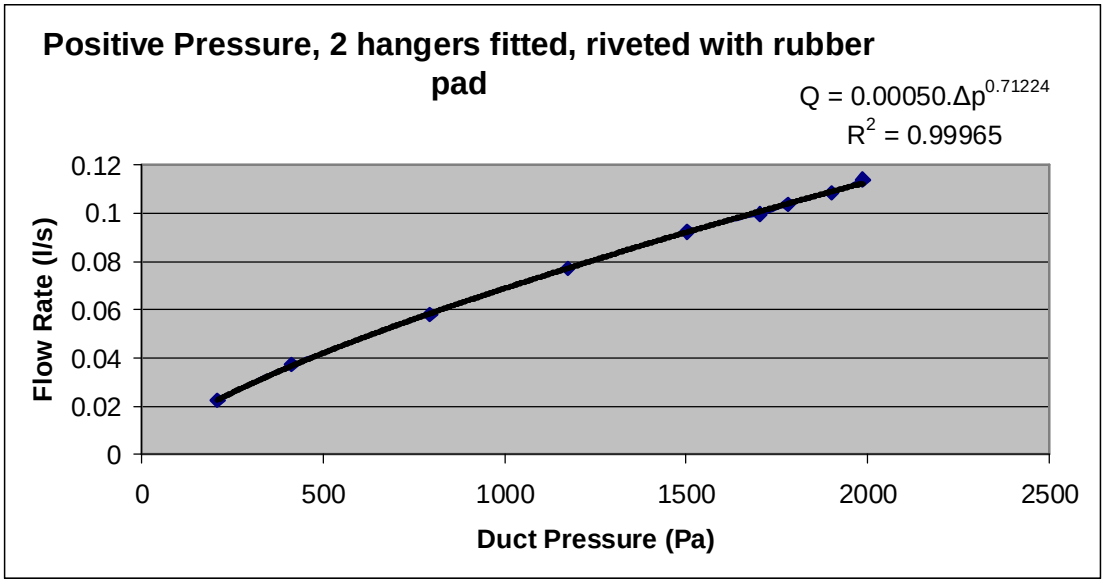
Negative pressure test. 2 hangers fitted using self drilling screws and rubber pad



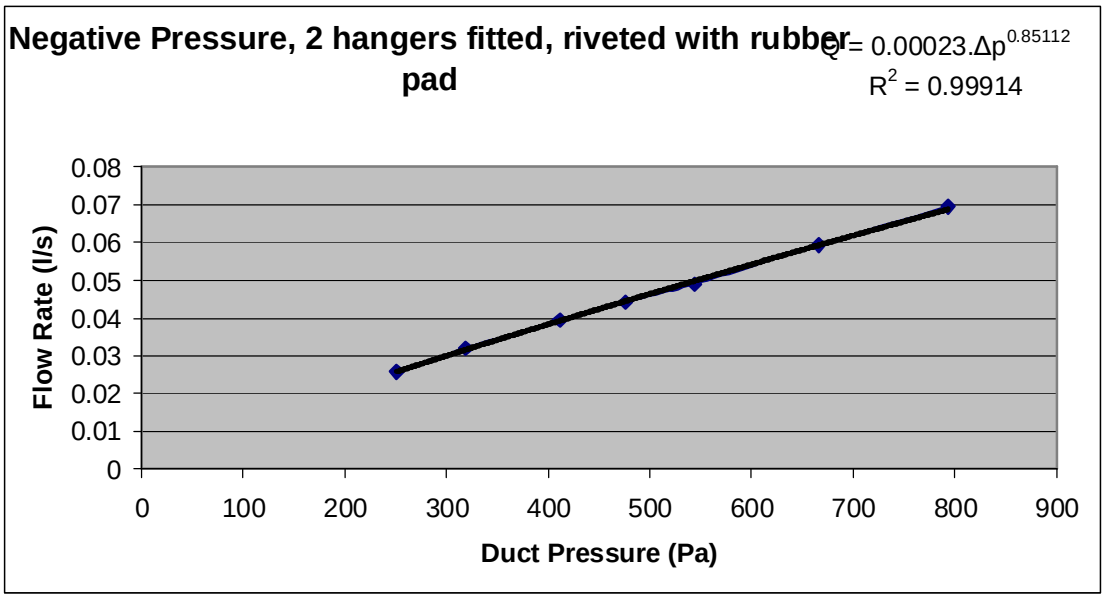
Positive pressure test. 2 hangers fitted with self drilling screws without rubber pad



Negative pressure test. 2 hangers fitted with self drilling screws without rubber pad



Positive pressure test. 2 hangers fitted using rivets and rubber pad



Negative pressure test. 2 hangers fitted using rivets and rubber pad