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The Effect of Conditioning Time on Mean Fibre Diameter Results

By

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SUMMARY

At the 1999 IWTO meeting in Nice a working group was formed to investigate the gravimetric and fibre diameter conditioning profiles of core samples. It was recommended that, for the sake of simplicity, only one fine and one coarse core sample be used at this stage. This report investigated both the gravimetric and fibre diameter conditioning profiles for scoured logs and Shirley Analysed webs, as well as overnight and rapid conditioning of the samples. The two core samples used for this evaluation had nominal fibre diameters of 17.5 μm and 28.0 μm (AF) respectively.

The gravimetric analysis yielded the following results :

1. When samples are conditioned afternoon and overnight (>16 hours), Shirley Analysed samples conditioned faster than scoured logs. The fine wool samples also conditioned marginally faster than the coarse wool samples for both scoured logs and Shirley Analysed webs. All samples reached 99 % of their equilibrium mass after eight hours of normal conditioning.
2. When large volumes of conditioned air is drawn over or through the sample (i.e. rapid conditioning), there is virtually no difference between the conditioning profiles for Shirley Analysed or scoured logs, irrespective of fibre diameter. The sample equilibrium mass is reached after only one hour of rapid conditioning.

The fibre diameter (Airflow only) analysis yielded the following results :

1. The fibre diameter for both the fine and coarse wool samples stabilised after eight hours of normal conditioning. The fine wool fibre diameter was 17.63 μm after eight hours of conditioning compared to 17.59 μm at equilibrium. For coarse wool the corresponding values were 28.10 μm compared to 28.01 μm at equilibrium.
2. Both the fine and coarse wool samples yielded stable fibre diameter results after only one hour of rapid conditioning. The fine wool sample fibre diameter was 17.55 μm after one hour compared to 17.60 μm after eight hours of rapid conditioning. For coarse wool the corresponding values were 27.55 μm compared to 27.50 μm after eight hours. The slightly lower fibre diameter for the coarse wool samples can be ascribed to the additional Shirley Analysing step used prior to the rapid conditioning part of the investigation (see **Flowchart 1.2**).

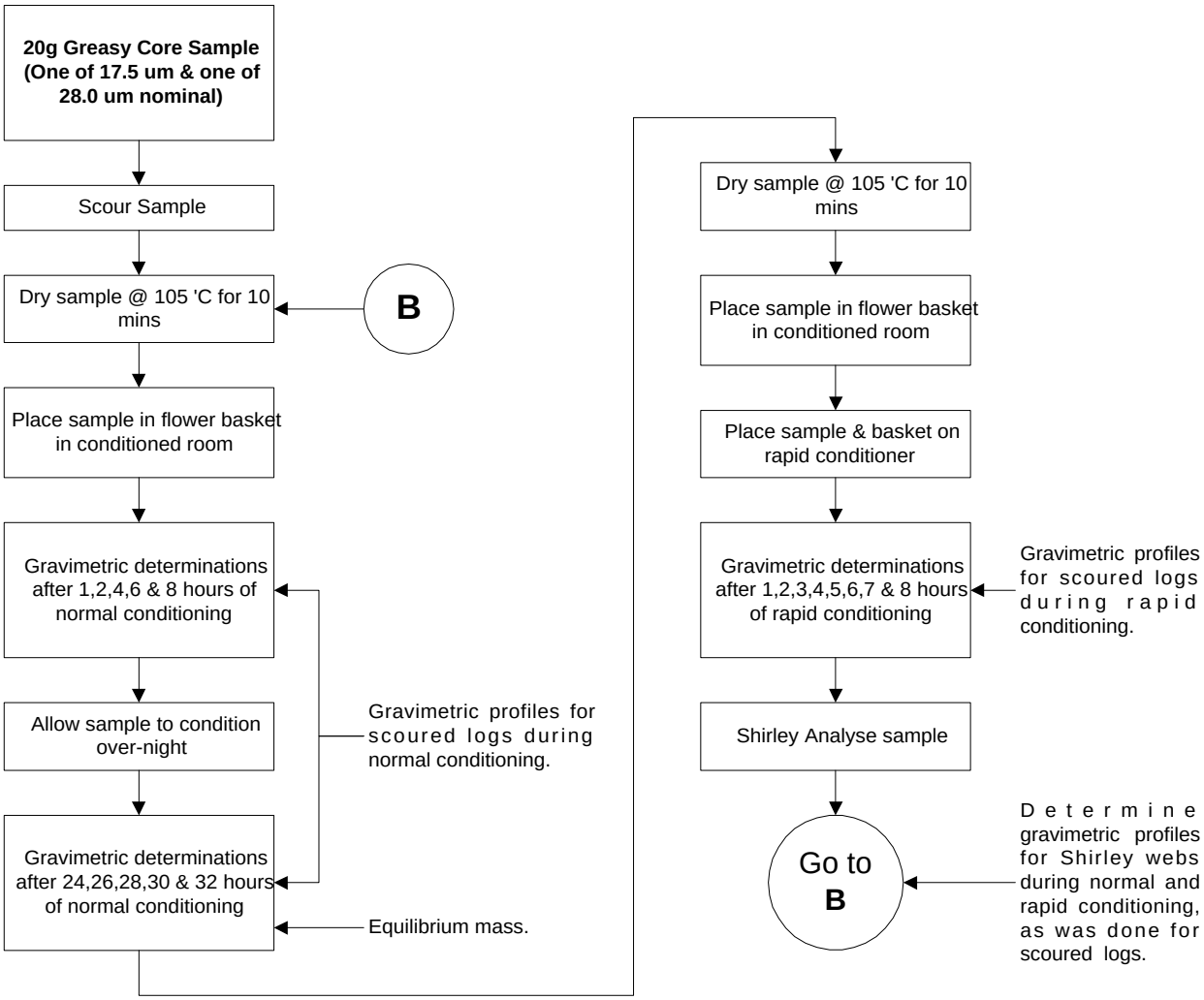
The above results indicate that eight or more hours of normal conditioning, of Shirley Analysed webs, should be sufficient to produce stable fibre diameter results using the Airflow instrument. It is also evident that rapid conditioning Shirley Analysed samples for as little as one hour may be sufficient to produce stable fibre diameter results using the Airflow instrument.

NOTE : All results listed in this report are provisional as only two samples were used !

METHOD

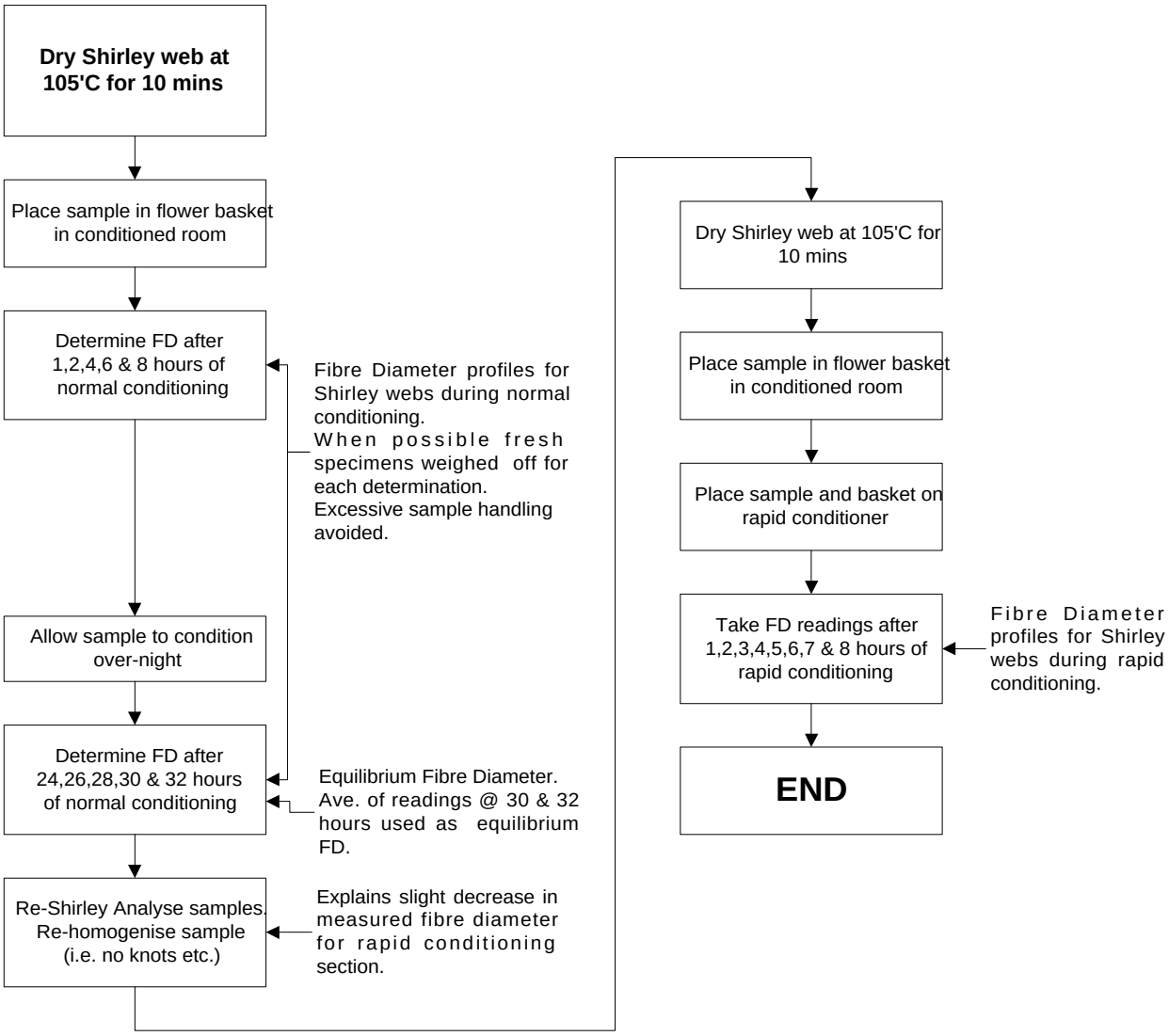
This investigation consisted of two sections. In the first part the gravimetric conditioning profiles for scoured logs and Shirley Analysed webs (normal as well as rapid conditioning) were determined. In the second part the fibre diameter conditioning profiles for Shirley Analysed webs were determined for both normal and rapid conditioning. Only two samples were analysed in this investigation, one with a nominal fibre diameter of 17.5 μm and the other with a nominal fibre diameter of 28.0 μm. This represents both the fine and coarse end of the South African wool clip for normal core samples.

Flowchart 1.1 – Gravimetric Determination Procedure



Once all the gravimetric data had been collected the Shirley Analysed webs were again dried and used for the mean fibre diameter analysis part of the investigation. The methodology used for the fibre diameter analysis is outlined in **Flowchart 1.2**. The fibre diameter conditioning profiles for normal as well as rapid conditioning could be determined from the data obtained. These profiles are for Shirley Analysed webs measured on Airflow instruments only. For every fibre diameter determination, two 2.5 ± 0.004g plugs were used, thus providing four readings per determination.

Flowchart 1.2 – Fibre Diameter Determination Procedure



RESULTS

PART 1 – Gravimetric Conditioning Profiles

After all the gravimetric data was collected it was converted to percentage values. The highest equilibrium mass for each category was set as the 100 % conditioned level and all the other data points were adjusted accordingly. This made direct comparisons of the different data sets possible. **Graph 1.1** clearly illustrates the different gravimetric profiles for the different sample types. The Shirley Analysed webs conditioned faster (absorbed moisture quicker) than the scoured logs. The finer wool samples also conditioned marginally faster than the coarse wool samples for both scoured logs and Shirley Analysed webs.

Table 1.1 – Normal Conditioning Gravimetric Data Expressed as Percentage of Maximum Equilibrium Mass

Condit. Time	Fine Log	Coarse Log	Fine Web	Coarse Web
1	94.06	93.57	95.95	95.96
2	95.71	95.36	97.64	97.58
4	97.75	97.63	99.03	98.99
6	98.69	98.64	99.42	99.42
8	99.16	99.13	99.58	99.58
24	100.00	99.99	100.00	100.00
26	99.98	99.97	99.96	99.97
28	99.97	99.97	99.92	99.94
30	99.98	99.97	99.91	99.93
32	100.00	100.00	99.96	99.96

Graph 1.1 highlights the sample gravimetric stability from 24 hours of normal conditioning onward. **Table 1.2** and **Graph 1.2** shows similar data, the only difference being that the samples were rapid conditioned.

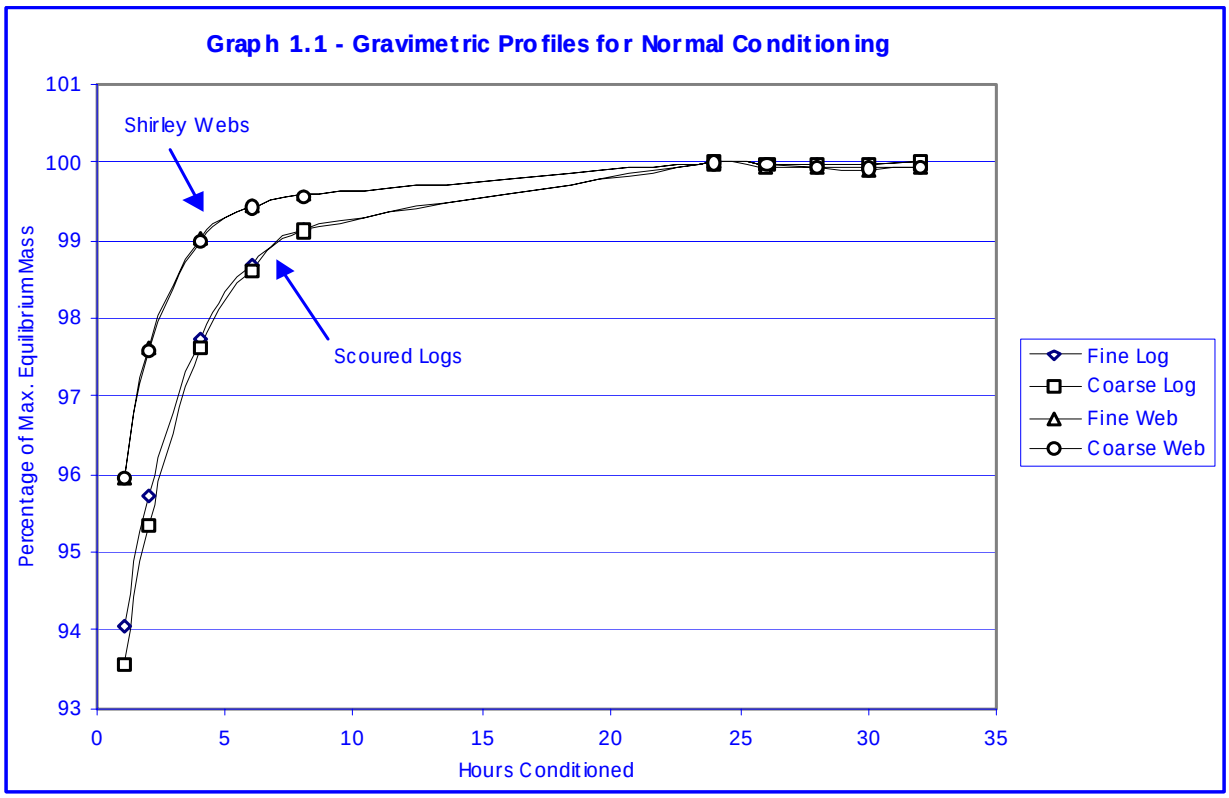
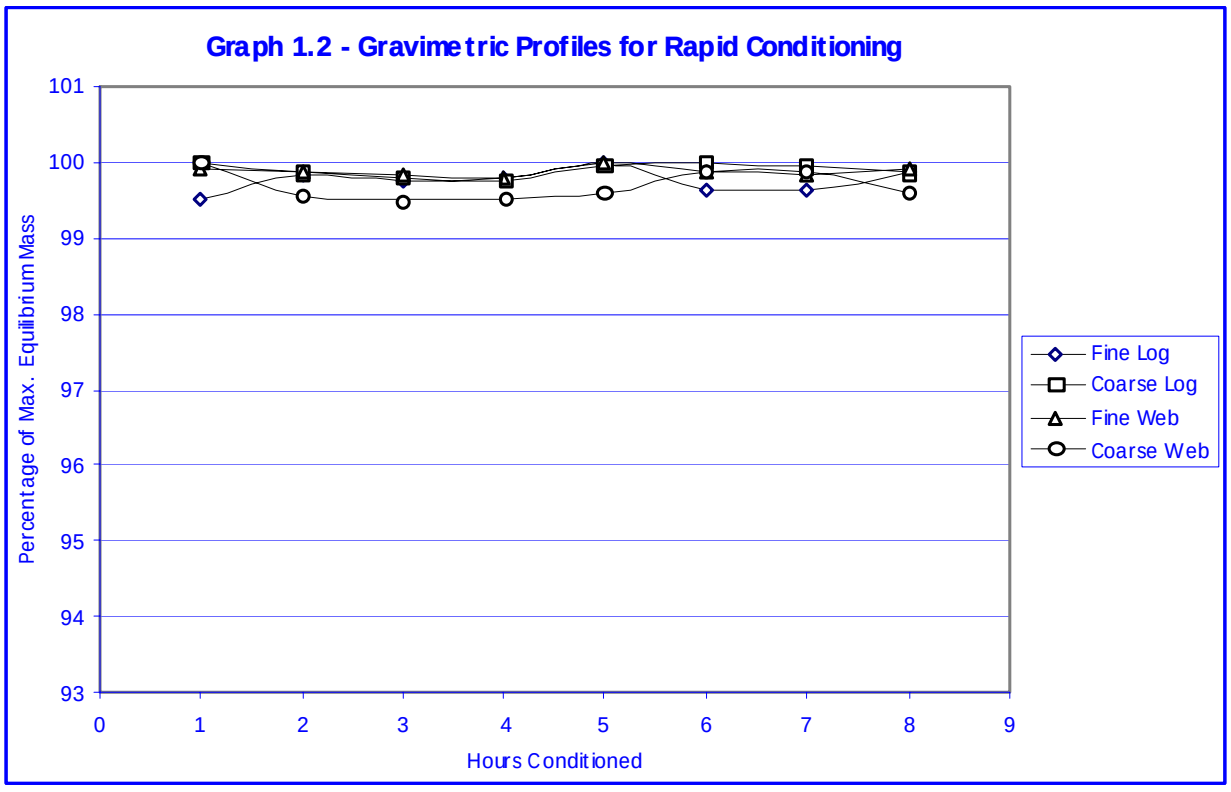


Table 1.2 – Rapid Conditioning Gravimetric Data Expressed as Percentage of Maximum Equilibrium Mass

Condit. Time	Fine Log	Coarse Log	Fine Web	Coarse Web
1	99.53	100.00	99.92	100.00
2	99.83	99.87	99.88	99.54
3	99.77	99.81	99.83	99.51
4	99.78	99.75	99.80	99.52
5	100.00	99.96	100.00	99.60
6	99.66	99.98	99.89	99.90
7	99.67	99.96	99.85	99.89
8	99.85	99.86	99.91	99.59

The plots in **Graph 1.2** confirmed what was intuitively expected. The samples all reached gravimetric equilibrium rapidly and in this case in as little as one hour. This value may vary depending on the type of rapid conditioner used as well as the air displacement capacity of the machine. There was no significant difference in sample mass, irrespective of diameter or sample state, after one hour of rapid conditioning and eight hours of rapid conditioning.

The y-axis scale of **Graph 1.2** is the same as that of **Graph 1.1** to aid in visual comparisons.



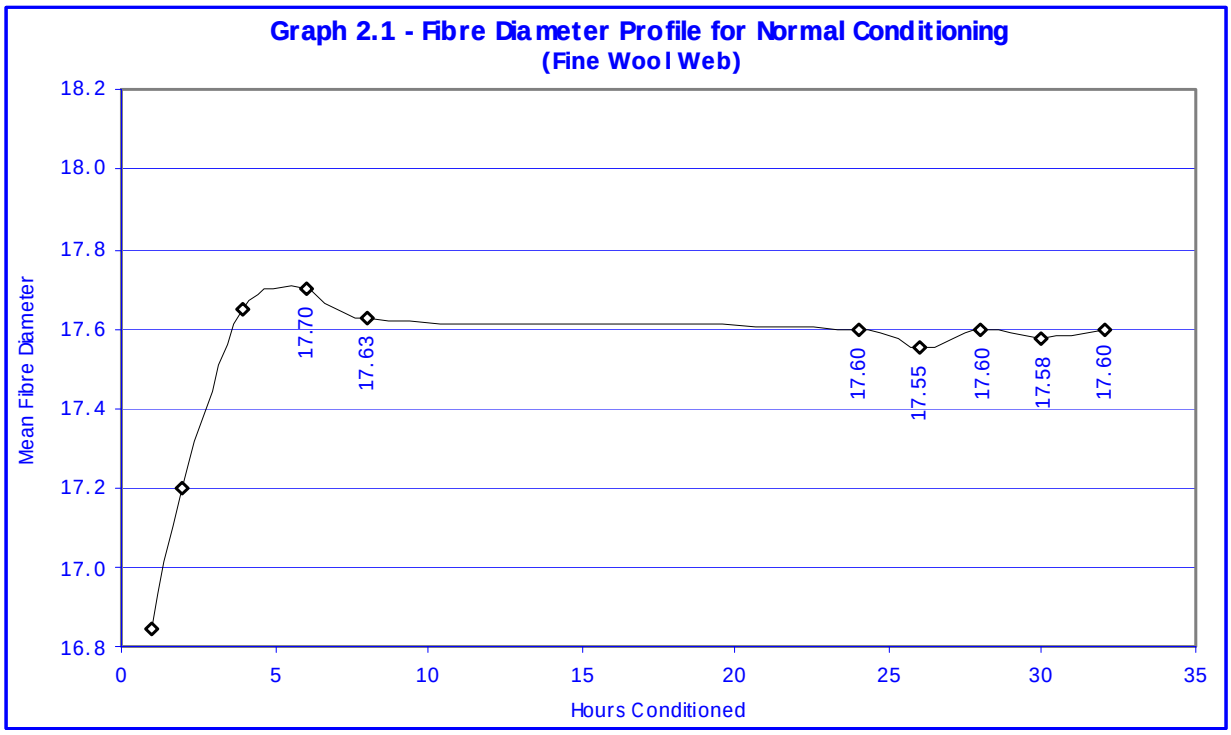
PART 2 – Fibre Diameter Conditioning Profiles

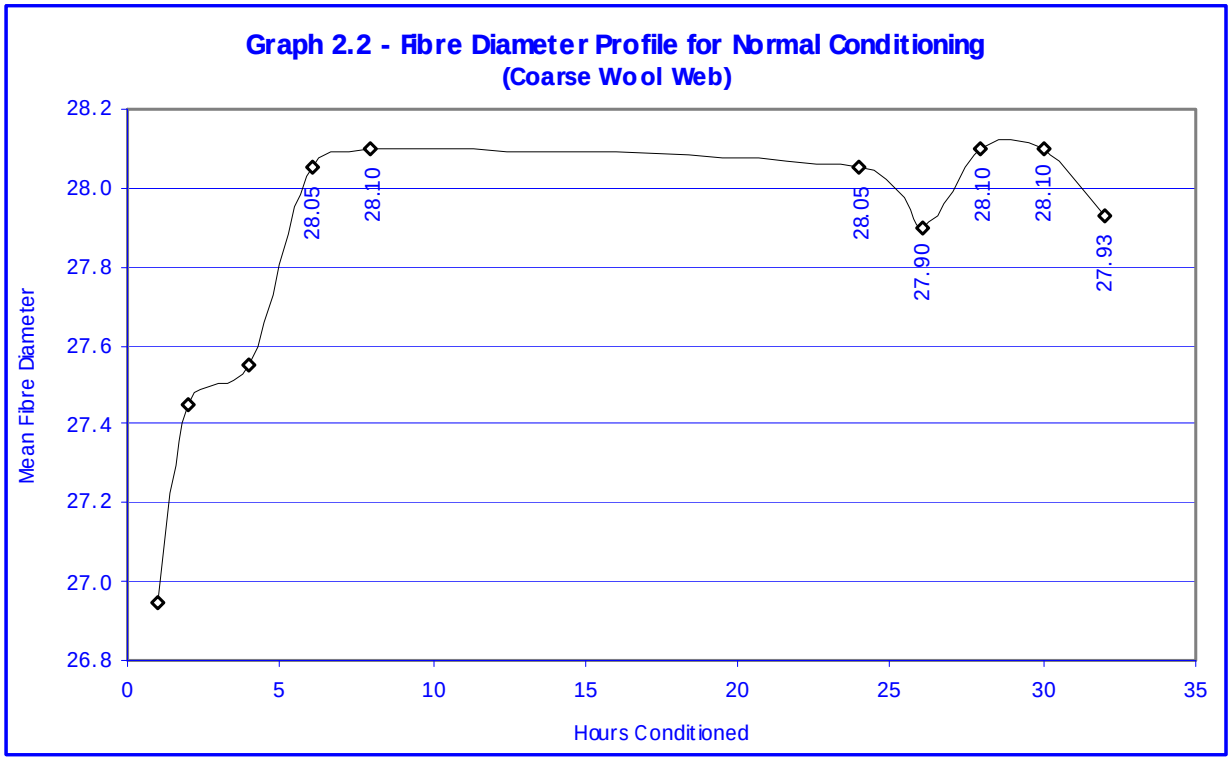
The investigation of the gravimetric conditioning profiles for fibre diameter samples was important, but had no direct commercial implications, even though the rate of change of mass is directly linked to the rate of change in mean fibre diameter as samples condition. Commercially the change in mean fibre diameter as samples condition is of great importance. **Table 2.1** indicates that a sample which has conditioned for one hour (from the dry side) could have a fibre diameter of 16.85 μm compared to 17.60 μm at equilibrium. The difference of 0.75 μm is large and commercially significant. For the coarse wool samples this difference was 0.98 μm. It is for this reason that sample conditioning profiles should be determined and understood.

Table 2.1 – Normal Conditioning Fibre Diameter Data

Condit. Time	Fine Web	Coarse Web
1	16.85	26.95
2	17.20	27.45
4	17.65	27.55
6	17.70	28.05
8	17.63	28.10
24	17.60	28.05
26	17.55	27.90
28	17.60	28.10
30	17.58	28.10
32	17.60	27.93

The mean of the fibre diameter readings after 30 and 32 hours was set as the equilibrium mean fibre diameter for reference purposes. For the fine sample the equilibrium mean fibre diameter was thus 17.59 μm and for the coarse sample 28.01 μm. The data in **Table 2.1** indicates that wool samples which have conditioned for a period eight hours or more, produce sufficiently stable fibre diameter results compared to those produced after 24 hours or more of normal conditioning.





Graphs 2.1 and 2.2 can be compared directly as the y-axis scales on both graphs have a range of 1.4 μm. It is clear that the rate of change in fibre diameter during normal conditioning is fibre diameter dependant. The coarse wool mean fibre diameter changed by 1.15 μm during the first eight hours of conditioning, compared to 0.78 μm for the fine wool sample. From 24 hours onwards the mean fibre diameter data for the fine wool sample remained very stable, whereas the mean fibre diameter of the coarse wool sample exhibited slight variability in this region. This variability is probably linked to the mechanism of moisture regain/loss by the fibre over time. Variations in the ambient relative humidity of the controlled atmosphere room could also be a contributing factor, as it is known that coarse wool samples are more sensitive to changes in relative humidity than fine wool samples.

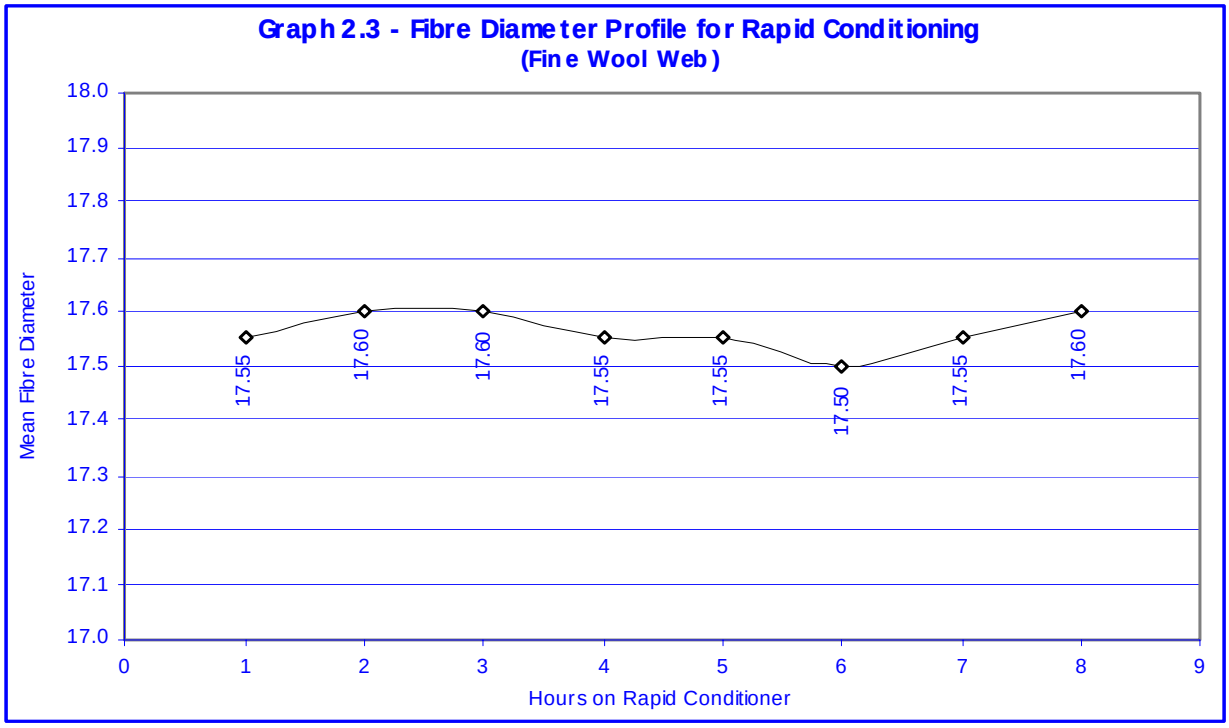
All the above data was related to samples being exposed to a conditioned atmosphere, and allowed to condition normally. The remainder of this report will investigate the fibre diameter profiles for samples which have been rapid conditioned. The samples were exposed to the same conditioned atmosphere, but large volumes of the conditioned air were pulled through the sample using a rapid conditioner. This procedure is performed to ensure that the wool samples reach moisture (and thus fibre diameter) equilibrium much faster than normally is the case. **Table 2.2** shows the mean fibre diameter data for the fine and coarse wool samples which were rapid conditioned.

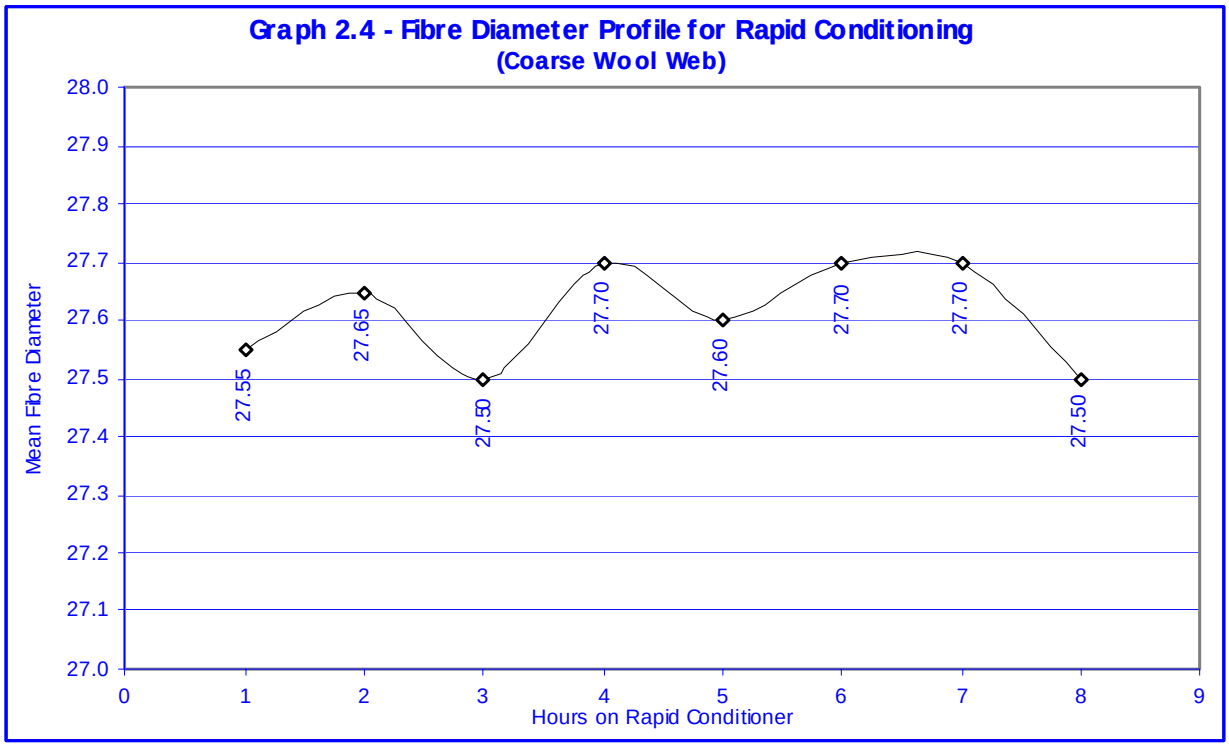
Table 2.2 – Rapid Conditioning Fibre Diameter Data

Condit. Time	Fine Web	Coarse Web
1	17.55	27.55
2	17.60	27.65
3	17.60	27.50
4	17.55	27.70
5	17.55	27.60
6	17.50	27.70
7	17.55	27.70
8	17.60	27.50

The slightly lower mean fibre diameter for the coarse wool sample (27.50 μm compared to 28.01 μm for normal conditioning) can probably be ascribed to the additional Shirley Analysing step, prior to the rapid conditioning investigation, as described in **Flowchart 1.2**.

The data in **Table 2.2** indicates that stable fibre diameter results can be produced after only one hour of rapid conditioning, irrespective of the mean fibre diameter value. This period may vary depending on which type of rapid conditioner is used as well as the air displacement capacity of the machine. **Graphs 2.3 and 2.4** show the fibre diameter profiles for fine and coarse wool samples which have been rapid conditioned.





Comparing **Graphs 2.3 and 2.4** directly, the coarse wool sample again exhibited more variability than the fine wool sample, as was seen with normal conditioning. The same reasons listed earlier would also apply here. For both the fine and the coarse wool samples it is evident that fibre diameter equilibrium was reached in one hour. The fine wool sample fibre diameter only fluctuated about 0.05 μm about it's mean value, whereas the coarse wool sample fibre diameter fluctuated about 0.1 μm about it's mean value.

The fine wool sample fibre diameter was 17.55 μm after one hour compared to 17.60 μm after eight hours of rapid conditioning. For coarse wool the corresponding values were 27.55 μm compared to 27.50 μm after eight hours. This indicates that, irrespective of mean fibre diameter values, stable and accurate results can be obtained after only one hour of rapid conditioning, depending on the type of rapid conditioner used.

CONCLUSION

The gravimetric analysis yielded the following results :

1. When samples are conditioned afternoon and overnight (>16 hours), Shirley Analysed webs conditioned faster than scoured logs. The fine wool samples also conditioned marginally faster than the coarse wool samples for both scoured logs and Shirley Analysed webs. All samples reached 99 % of their equilibrium mass after eight hours of normal conditioning.

2. When large volumes of conditioned air are drawn through the sample (i.e. rapid conditioning), there is virtually no difference between the conditioning profiles for Shirley Analysed webs or scoured logs, irrespective of mean fibre diameter. The sample equilibrium mass is reached after one hour of rapid conditioning.

The fibre diameter (Airflow only) analysis yielded the following results :

1. The mean fibre diameter for both the fine and coarse wool samples stabilised after eight hours of normal conditioning. The fine wool fibre diameter was 17.63 μm after eight hours of conditioning compared to 17.59 μm at equilibrium. For the coarse wool the corresponding mean fibre diameter values were 28.10 μm compared to 28.01 μm at equilibrium.

Both the fine and coarse wool samples produced stable mean fibre diameter results after only one hour of rapid conditioning. The fine wool sample mean fibre diameter was 17.55 μm after one hour compared to 17.60 μm after eight hours of rapid conditioning. For the coarse wool sample the corresponding mean fibre diameter values were 27.55 μm compared to 27.50 μm after eight hours. The slightly lower fibre diameter for the coarse wool samples can be ascribed to the additional Shirley Analysing step used prior to the rapid conditioning part of the investigation (see **Flowchart 1.2**).

The results indicate that eight or more hours of normal conditioning of Shirley Analysed webs should be sufficient to produce stable mean fibre diameter results using the Airflow instrument. It is also evident that rapid conditioned samples can produce stable mean fibre diameter results using the Airflow method, irrespective of mean fibre diameter, after only one hour of rapid conditioning.

NOTE : ***All results listed in this report are provisional as only two samples were used !***

Special Thanks

The author would like to thank those staff members involved with this project for their time, effort and contributions.